D6.3: Ethics in DIH services

WP6 – Building a sustainable network of agri-food robotic DIHs

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Table of Contents

Executive summary 5
1 Introduction 6
2 Literature review 6
2.1 Autonomy 7
2.2 Social acceptance of robots 8
2.3 Labour 9
2.4 Data access, sharing and processing 10
3 Methodology 10
4 Results 12
4.1 Autonomy 12
4.1.1 Degree of autonomy 13
4.1.2 Liability and responsibility for accidents 13
4.2 Social acceptance of robots 14
4.2.1 High-tech food production and societal acceptance 15
4.2.2 Robots and the environment 16
4.2.3 Robots contributing to animal welfare 17
4.3 Labour market 18
4.3.1 Robots filling labour gaps vs robots substituting human labour 19
4.3.2 Labour migration and the imminent digital divide 20
4.4 Data access, sharing and processing 22
4.4.1 Fair competition and generating power inequalities 23
4.4.2 Loss of control over one's data 24
4.4.3 Surveillance and punishment 25
5 Discussion and conclusion 25
6 References 28
7 Appendix: four themes of the workshops 30

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Executive summary

Ethics and agricultural AI robots

reflections of robot developers throughout Europe

As agricultural robots are a new area that has not been explored in ethics, our work for agROBOfood was primarily focused on an exploration of the ethical questions to which development of these robots give rise. We have done this work in several steps, which we have carried out in the context of two related projects: agROBOfood and the Autonomous robots project which is part of the national KB programme 'Big Data and High Tech' in the Netherlands.

First, we have done a literature review, investigating ethical questions raised about AI robotic systems in general and exploring their relevance for agricultural robots. This paper was published (Ryan, van der Burg and Bogaardt 2021).

Second, we have done four case studies in the Netherlands exploring the ethical issues raised about different examples of agricultural robots under development, such as the weeding robot, the manure scraping robot, the food processing robot and the vegetable picking robot. This paper is accepted with minor revisions in AI & Society, but it is not yet published (Van der Burg et al. forthcoming).

To get to the report presented here as the third step in the row, we used the input of the two earlier papers as a background to question agricultural robotics professionals across Europe about the ethical issues they encounter in their roles and which ones they consider most relevant in relation to their specific regional context. We did this in order to find out whether the same questions come up across European regions, or whether awareness of ethical questions and reflection about them differ from region to region. Furthermore, we wanted to know whether regions need to be supported in similar or in different ways to deal with these questions. As there may be a variety of moral outlooks available in different European countries, it is important to find out whether a response that is tailored to a region is needed, or whether a general approach is best.

To realize this deliverable, we have firstly provided an overview over the ethical issues that were already identified in the literature. After that, we explored the viewpoints of professionals working in research institutes and companies developing agricultural robots across Europe (27 participants in total) during five workshops, which we carried out online due to Covid-related travel restrictions, which prevented us from doing the workshops during an annual meeting of agROBOfood partners.

Our results suggest that all ethical questions related to AI robotic systems that are described in the literature, are also brought forward by researchers and commercial robot developers who participated in our focus groups across Europe. Questions related to (1) autonomy, responsibility and liability, (b) social acceptance of robots, (c) labour and (d) data sharing and protection, are all mentioned and discussed in across Europe. Based on the way in which (the relevance of) these issues are articulated and discussed, however, we conclude that questions related to social acceptance and labour need a regional approach, in order to be able to understand the meaning of these questions and their relevance for concrete cultural and socio-economic contexts and to be able to develop a tailored response. Questions related to autonomy, responsibility and liability and data sharing, however, do not seem to need a regional, contextual approach, as the discussion of these themes in the workshops does not mention relevant contextual differences, that ought to be taken into account. These issues could be approached in a more generalized fashion, developing a single approach that prescribes how to deal with them across the various European contexts.

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1 Introduction

This paper will examine how agricultural robotics professionals across Europe view ethics in their roles; especially what ethical questions they see in relation to their work and which ones they think deserve priority in relation to their specific regional context. We will do this by firstly providing an overview over the ethical issues that have already been described in the literature on ethics of agricultural robot development and use, and secondly, through a qualitative analysis of data collected during five workshops with professionals working in research institutes and companies developing agricultural robots across Europe (27 participants in total).

The structure of the paper will be as follows: section 2 will offer an overview of the main areas being discussed within the literature around ethics and agricultural robots. The methodology used for our empirical analysis will be described in section 3 and section 4 will provide the empirical analysis of five workshops carried out with agricultural robot professionals around Europe, during June – October 2021. Concluding with section 5, which will provide a discussion of our main findings from the workshops, indicating what ethical questions need a more general response across Europe and which ones deserve a regional approach which pays more attention to contextual specificities.

2 Literature review

The evaluation of moral and societal impacts from agricultural robots[1] is a relatively new area of ethics research, with much of the literature appearing within the past few years. There has been articles that have touched upon these implications, but often they are minor subsections within larger bodies of research on AI or robotics. It is only in the past year that we have seen a number of research papers focusing on ethics of agricultural robots. Three noteworthy publications have driven the discussions forward in the area (Rose et al. 2021; Sparrow and Howard 2020; Ryan, van der Burg, and Bogaardt 2021). The three papers focus on the moral and societal impacts of agricultural robots, and the ethical questions that this raises, but their approaches are quite different and they start from different bodies of literature.

Firstly, Rose et al. 2021 start from a responsible research and innovation approach and body of literature. They employ the four-point 'responsible innovation' methodology developed by Stilgoe et al. (Stilgoe, Owen, and Macnaghten 2013). This focuses on the AIRR principles (Anticipation, Inclusion, Reflexivity and Responsiveness), which is explained as 'anticipating the impacts of innovation; reflecting on one's work and adapting accordingly (reflexivity); including a wide range of stakeholders in the design process; and responding to stakeholders' concerns, ideas and knowledge by constructing appropriate institutional structures' (Rose et al. 2021). The authors state that there is an increased awareness among policymakers about the importance of taking a responsible innovation approach (Engineering and Physical Sciences Research Council 2020; InnovateUK 2020), and this should also be encouraged in the development of agricultural robots.

Secondly, the research conducted by Ryan, van der Burg, and Bogaardt 2021 analyses agricultural robots through the lens of AI ethics literature.[2] They evaluate themes found within the literature that have never

[1] For the purpose of this paper, when we refer to 'agricultural robots', we are talking about robots with some form of artificial intelligence built into them, and not simply robots, generally. We will use agricultural robots as shorthand for agricultural *AI* robots, which means robots employing some form of machine-learning, deep learning, natural language processing, or other form of AI.

[2] The paper categorises five main themes within the debate of AI ethics: autonomy and morality, moral status, responsibility, relationships between robots and other sentient beings, and employment.

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been applied to an agricultural robot context, such as Moral Turing tests, teaching robots morality, and the possibility of robot rights (Allen, Varner, and Zinser 2000; Allen, Smit, and Wallach 2005; Wallach and Allen 2008; Wallach, Franklin, and Allen 2010; Gunkel 2018a; 2018b). The paper highlights that greater attention should be spent looking at environmental, employment, and animal welfare issues, as these are often under-researched areas, but have a particular importance for agricultural robots.

Thirdly, the Sparrow and Howard 2020 article has a policy focus and examines the impacts of using agricultural robots by classifying impacts as 'environmental; economic; political; cultural; social; and security' (Sparrow and Howard 2020, p. 820). While the placement of impacts into these categories is somewhat arbitrary, most of the impacts are underpinned by ethical choices that policymakers have to make (Sparrow and Howard 2020, p. 819). While Rose et al. (2021) is more directed towards *organisations developing agricultural robots*, the article by Ryan, van der Burg and Bogaardt focuses on the role of ethicists in assessing them and the Sparrow and Howard (2020) article is aimed at the ethical challenges faced by *policymakers*.

All three papers offer their own unique contribution to the debate, as they employ different methodologies, have different target audiences, and offer different findings. While this is true, there is also much overlap between them. The aim of this section is to provide an overview of the main topics being discussed in these documents, using four thematic sections (autonomy, societal acceptance, labour, and data concerns), which originated from our earlier findings of empirical research conducted in the field (we interviewed numerous individuals working on agricultural robot projects in the Netherlands). These themes materialised as being key topics to frame our literature review, and later, our empirical analysis of the five workshops we conducted, in order to find out which of these themes were recognized and prioritized by those working on the development of robots. We did not restrict participants from discussing other issues, but these four themes were simply used as a springboard to enhance the reflection and discussion of participants on the ethics of agricultural robotics.

2.1 Autonomy

One of the main attractions about agricultural robots is that they function in an increasingly independent way. While robots used to be one-function automatons, they have nowadays evolved into intelligent systems which are sometimes referred to as Artificial Intelligence (AI). AI is developed as part of computer programs and software which can be added to automatons, thus enabling performance that is sometimes described in metaphors that refer to human qualities, such as 'intelligence', 'rationality' and 'autonomy'. In comparison to non-AI robots that have been around for some time, AI robots are anticipated to carry out tasks that require context awareness, learning, problem solving and logical reasoning, which are also characteristics of human intelligence. While such intelligence makes these robots attractive, as it means that humans can delegate tasks to robots that are usually carried out by humans.

This increasing independence or 'autonomy' of robots, however, is also an important reason for concerns about these robots. There is for example concern about damage or accidents caused by independently functioning robots. It is for this reason that humans are sometimes employed as supervisors or caretakers of these robots, in order to prevent accidents. This is sometimes considered detrimental for the freedom of movement of the robot supervisors: 'Increases in the autonomy of machines are often at the expense of the autonomy of those who must supervise them' (Sparrow and Howard 2020, p. 824). Another concern is that robots may reduce the freedom of farmers to make decisions on their farm and this decision-making process will be transferred to tech companies who own, maintain, and control these robots (Ryan, van der Burg, and Bogaardt 2021).

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Rose et al. (2021) state that anticipating potential short- and long-term consequences of autonomous robots which move and perform actions by themselves, is key to preventing harms caused by them. While robots may be able to do many of the dangerous jobs on the farm, they also hold the potential to be hacked, becoming a privacy and security threat, or cause physical harm to people (or animals) on the farm (Rose et al. 2021). These autonomous machines may also be a danger to workers or the public as a result of malfunctioning or glitches with their software or hardware (Ryan, van der Burg, and Bogaardt 2021; Sparrow and Howard 2020).

Given these dangers, the three articles in addition bring forward that AI agricultural robots may raise the question who is responsible and liable for accidents cause by robots. Because of the increased number of stakeholders, teams, and organisations involved in the design, development, production, deployment, and use, of agricultural robots, it is challenging to pinpoint the cause of an accident and the actor responsible for it (Ryan, van der Burg, and Bogaardt 2021). Is it the company who designed the computer vision, the machinery manufacturer, the company who developed the AI software, the agent who leased the robot, or the farmer themselves? The use of agricultural robots brings new challenges on how to identify responsibility and accountability.

Rose et al. (2021) claim that despite calls for companies to implement better practices and take responsibility for their technologies, there is still 'a lack of commitment to, or reporting of, the steps taken in technology development in the agriculture industry' (Rose et al. 2021, p. 306). Companies need to be aware of their responsibility by 'exploring the challenges that could arise from innovation and acting on their findings in a transparent, inclusive and timely manner' (Rose et al. 2021).

2.2 Social acceptance of robots

It is vital that agricultural robots bring about benefits for individuals, communities, and society as a whole. Thus, there needs to be careful analysis of what 'good farming' means, how robots can contribute to it, and what effects robots will have on achieving this in practice (Ryan, van der Burg, and Bogaardt 2021, p. 11). This should encompass such things as a 'respect to the level and quality of production, (flexibility of) choice of crops, physical burden of work, leisure, social relationships of the farmer on and around the farm' (Ryan, van der Burg, and Bogaardt 2021, p. 11). It also means that it should be established that robots actually demonstrate their added benefit in relation societal challenges (Daum 2021). To do this, agricultural robots should bring about changes in the world that are important for society; they should be designed with users in mind, and acknowledge their impact on habitats and animals (Ryan, van der Burg, and Bogaardt 2021). To develop a robot that is appreciated by society, it is important to identify how to establish a 'good society, which produces food in a sustainable manner, and whether and how robots can contribute to it' (Ryan, van der Burg, and Bogaardt 2021, p. 13).

While robots are often praised for their potential to reduce the burden of farming on the environment, e.g. by mechanical weeding robots eliminating the need for farmers to use pesticides, Sparrow and Howard (2020) state that the use of robots may also increase the use of harmful pesticides, because farmers will not be directly harmed by them. Robots may also cause increased harm through soil compaction if design decisions lead to a robot that weighs heavily on the farmland (Sparrow and Howard 2020, p. 821) or emits 'toxic material, fumes and waste into their surrounding environment' (Ryan 2019, p. 12). If robots perform poorly in unstructured environments, there is also the potential that farmland will be manipulated to better accommodate robots, leading to increased bioengineering and genetic modification of plants, farms, and livestock (Sparrow and Howard 2020, p. 822).

An additional societal concern surrounds the interaction of robots with livestock (Ryan, van der Burg, and Bogaardt 2021). There are fears that robots will cause undue stress and annoyance to farm animals, but also,

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an increased physical harm to the animals themselves, as well as a further dominance of humans over animals (Sparrow and Howard 2020, p. 827). Animal welfare could aggravate due to robots as 'there will sometimes be few human witnesses to the activities of robots may facilitate a higher organisational tolerance for harms to animals and thus actually exacerbate the threats to animal welfare in practice' (Sparrow and Howard 2020, p. 823).

Ryan, van der Burg, and Bogaardt 2021 state that the ethical debate around robots in the ethical literature is often shaped from an anthropocentric viewpoint. As a result, the effects of robots on other organisms, species, and ecosystems, often get overlooked or are an afterthought (Ryan, van der Burg, and Bogaardt 2021). Looking at the ethical literature on robotics will therefore often fail to serve as a guide to recognize the relevant ethical aspects of agricultural robots. These aspects are however often important for the societal acceptance of agricultural robots.

One of the ways to ensure societal acceptance of agricultural robots, according to Rose et al., is to ensure inclusive stakeholder participation around the development of agricultural robots, by acknowledging their requirements and preferences through surveys, workshops, and field experiments; along with the examination of best practice guidelines, codes of conduct, and international standards (Rose et al. 2021, p. 308). This inclusion should be realized in a meaningful manner, avoiding 'tokenistic gestures' of inclusion, that do not materialise in any substantive change (Rose et al. 2021, p. 308). This is to avoid what some have termed 'participation washing' (Ayling and Chapman 2021; Sloane et al. 2020), which refers to the inclusion of stakeholders in order to fulfil societal requirements, without actually giving participants any way to actually influence what is happening.

2.3 Labour

Employment is an important concern in the broader literature on agricultural digitalisation (Carolan 2020; Rose et al. 2021; Klerkx, Jakku, and Labarthe 2019; Rodzalan, Yin, and Noor 2020; Stock and Gardezi 2021; Ryan, van der Burg, and Bogaardt 2021; Sparrow and Howard 2020; van der Burg, Bogaardt, and Wolfert 2019). Some of the benefits of agricultural robots are that they may attract younger workers, plug a labour gap, increase skilled jobs, and reduce dull, dangerous, and dirty farm jobs (Rose et al. 2021, p. 307). However, there are also concerns in the industry that they will compete with humans for desirable jobs (Ryan, van der Burg, and Bogaardt 2021), that workers will be unable to retrain when robots are deployed in order to move to better jobs and that dangerous jobs will be displaced elsewhere instead (Rose et al. 2021, p. 307).

Agricultural robots offer the potential to improve the wellbeing of the farmer, but there is also the possibility that some farmers will get 'left behind', because they are unable to afford, or use, them (Rose et al. 2021). Sparrow and Howard (2020) also claim that agricultural robots may cause nations in the Global South to be outcompeted by richer nations that can afford to implement them (Fleming et al. 2018; Ryan 2019; van der Burg, Bogaardt, and Wolfert 2019). In addition, the introduction of robots on the farm may lead to greater gender divides because STEM (Science, Technology, Engineering and Mathematics) has had a historically-low rate of women working in these disciplines (Carolan 2020; Sparrow and Howard 2020).

Sparrow and Howard (2020) argue that agricultural robots will replace many jobs within the sector, such as fruit picking, food handling, and food packing (see also Werkheiser 2018). This will have a significant impact on employment opportunities in rural locations, particularly if the robots are controlled and/or maintained by those working in cities (Sparrow and Howard 2020, p. 825). There is the potential that this restructuring will also diminish investments in rural areas, leading to harmful impacts on the quality-of-life of people living there and fracturing the rural community (Sparrow and Howard 2020). This may result in a loss of experiential knowledge, culture, and generally, disrupt rural communities (Rose et al. 2021; Ryan, van der Burg, and Bogaardt 2021).

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The dignity of those working in rural settings may be impacted by the prevalence of agricultural robots due to a reduction of the role of humans within the sector (Sparrow and Howard 2020). If farming is closely associated with the manufactured, automated, and synthetic, this may further push the human element out of the industry. Farmers may be reduced to caretakers of these machines (Ryan, van der Burg, and Bogaardt 2021; Ryan 2020). This may harm the dignity and sense-of-identity of people within rural communities (Sparrow and Howard 2020, p. 826).

2.4 Data access, sharing and processing

There is a growing concern about the transparency of robot deployment. Farmers may be unaware of the types of data being retrieved by robots and how they will be used and stored (Ryan, van der Burg, and Bogaardt 2021). Most farmers are not roboticists or computer technicians, so the deployment of robots brings a degree of opacity. There have examples in the US where farmers are prohibited from repairing their own machinery, because the tech provider has sole authority in the maintenance and repairing of them (Ryan 2020). There is an intentional, or unintentional, opacity about how robots function on the farm and who has control over them.

Greater levels of automation, tracking, and processing data, raises the issue that agricultural robots may be used to spy on farm workers or the general public (Sparrow and Howard 2020). One concern is that workers will be monitored and tracked, leading to infringements on their privacy (Ryan 2019). Additional repercussions from this are that employers may exert greater (and undue) control, power, and pressure on their employees (Sparrow and Howard 2020).

3 Methodology

While our literature analysis provided insights about what is commonly being discussed in the literature, there has been very little empirical research conducted on the ethical impacts of agricultural robots. Therefore, it is important to complement our literature analysis with the perceptions and beliefs of those actually researching, designing, and developing these robots in practice, and find out which of these themes and questions are recognized and prioritized in the various regions in Europe and whether regions differ with respect to the ways they tend to approach them. In order to achieve this, we carried out five workshops with participants from around Europe to gather insights about what they see as the most pressing ethical challenges in relation to agricultural robots.

The workshops themselves were conducted online, through Microsoft Teams, because of Covid-19 restrictions, travel distances, and time constraints of everyone involved. The events took place between June – October 2021 and were recorded and transcribed by the authors of this paper. Before the workshops, we established a workshop protocol, which contained some basic requirements for the workshop, such as ensuring a minimum number of participants per workshop (four), each would be 1.5-hours long, and we would follow the same steps for all workshops.

The five workshops had between 4 – 6 participants each and were loosely formed by country or territorial region. This was implemented in an attempt to incorporate a diversity of European nationalities and organisations within the project. We invited over 200 people to the workshops from our project's stakeholder network list, people within our community, and researchers that we found online. However, there was a low response rate and a number of planned workshops had to be cancelled, because it was not possible to meet the required minimum number of participants. Initially, we had planned to conduct the workshops based on

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country, with the ambition of ten workshops in total, each focusing on a different country around Europe. However, this was only possible for Greece and Spain, and we ended up having to merge workshops, based on approximate geographical location from those who wanted to attend (e.g., Baltic states [C], South-East Europe [D], and North-West European countries [E]) (see Table 1).

Group	No. of participants	Countries
A	6	Greece
B	5	Spain
C	5	Lithuania (2), Estonia (1), Latvia (2)
D	5	Romania (2), Bulgaria (2), Serbia (1)
E	6	Germany (2), Denmark (1), Irish (1), UK (2)

Table 1 The Five Workshop Groups Analysed in this Paper

While the participants came from a range of countries, they all worked on agricultural robot projects or organisations that designed, developed, or used, them. The workshops were conducted in English, the audio was recorded, transcribed and analysed using a grounded theory approach (Charmaz 2006). Thereby, we were not aiming to find the 'truth' or to validate a hypothesis, but rather, we aimed to conceptualise the viewpoints of the participants and their lived experiences in relation to the ethical themes raised for agricultural robots. The research questions that we were hoping to answer were: what ethical issues are relevant for those working on agricultural robots in various regions across the EU? How have they encountered them in practice, and how do they respond to such challenges? We were especially interested to find out whether there are regional differences in the issues that people encounter or the way in which they tend to respond to them.

We asked the participants to engage with a PowerPoint slide that mapped four ethical themes and a list of questions that often arise from each of these themes (see Appendix 1). To initiate early dialogue, we asked participants which issue they consider most important, which issues they have encountered, and if they had specific examples of these in practice. This slide was used as a springboard for discussion and gave focus to the workshops. However, we did not limit discussion to these areas, and used a 'snowballing' effect for our follow-up questions, through an open round-table open discussion.

The four topics that we illustrated on the PowerPoint originated from our literature study and earlier empirical research conducted on four case studies focusing on agricultural robots, where we interviewed numerous stakeholders from the Netherlands (Van der Burg et al, forthcoming). These themes materialised as being the most significant topics and we wanted to identify if they correlated with the reflections of the people from different areas in the EU who participated in the five workshops. We did not restrict participants from discussing other issues, which did not fall under the parameters of these four areas. These four themes were simply used as a starting point for reflection and conversation.

We integrated Braun and Clarke's (2006) thematic methodology for the analysis of the workshops. This is 'a method for identifying, analysing, and reporting patterns (themes) within data. It minimally organizes and describes [the] data set in (rich) detail' (Braun and Clarke 2006, p. 79). The data in our case refers to the content from the workshops, namely, the individual respondents' viewpoints and the overall groups' dynamics and outlook. The workshops were first transcribed, and then we used the themes that we originally identified in the literature to code relevant content of the workshops that fitted with these themes. Within our analysis, these there were four overarching themes (autonomy, social acceptance, labour, and data). Within these four topics, we established numerous sub-topics, where the participants touched upon interesting themes under the broad rubric of these four topics. We worked together to analyse these themes, which comprise the following four subsections in our findings.

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4 Results

For ease of reference, we will label the participants from each workshop by number and by the workshop that they participated in, using Table 1 provided earlier. No personal information will be given about the participants, in order to ensure anonymisation. The participants in the five workshops varied in relation to confidence levels in discussing ethical themes, knowledge of ethical issues, and modes of expression, as well as ability to speak English. We also aim to give the overall feelings and ideas that emerged from the five workshops, with a particular focus on whether the issues discussed are general or regional. This was not an explicit objective when we were conducting the workshops, but general and regional distinctions became obvious during the analysis process. Thus, these issues materialised organically, without the authors forcing regional or general themes upon the respondents.

Many of the topics outlined in the literature were also understood and being discussed among professionals working on agricultural robots. However, this level of expertise, as indicated earlier, varied a great deal among the different groups. We have structured this section in the same way as we guided the discussion throughout the workshops; through four main thematic sections: autonomy of robots; social acceptance of robots; the labour market; and data access, processing, and data sharing. The aim of this section is to provide a clear overview of the ethical challenges felt 'on-the-ground' among professionals working in the field of agricultural robot development and use. Throughout the following four sections, we will also indicate whether the topics being discussed are more general concerns or have specific regional nuances that require attention.

4.1 Autonomy

The question of autonomy was posed in each of the workshops, centring around what levels or degrees of autonomy should an agricultural robot have and how would this impact levels of human autonomy. Of course there is a lot of discussion about whether the autonomy of robots can be compared to human autonomy at all, and there are large differences between the ways in which human and robotic autonomy are described. In the following, however, we will take the reflections of our respondents about what autonomy means as a starting point. In their reflections, there is a basic difference between the autonomy ascribed to robots and to human beings. In the case of robots, 'autonomy' is usually defined in terms of its capacity to move around independently, to respond to changes in its environment, to alternate between different options of action or be flexible and combine and alternate between different tasks. In the case of human beings, autonomy is usually considered in terms of human being's capacity to make choices after reflection about the consequences of action and without interference of other people or technology.

Related to autonomy, respondents in the five workshops also considered related topics of responsibility and liability, as the human capacity to make choices after reflection on the consequences of the options of action, is also the reason why they are responsible for those choices. When robots take over jobs and cause accidents, it is questioned who should be held responsible and liable for the consequences. In the following sections we will describe the questions related to these topics, that the respondents considered (see also Table 2 for a summary of the questions raised).

Group	Questions	General or regional
Baltic States	Who is responsible and liable for accidents?	General
South-East EU	Who answers for the deeds of the robot? The robot, the person who made it, the person who uses it?	General

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Greece	What happens if something goes wrong? I think, responsibility is, at least in my mind, the number one thing in our region.	General
North-West EU	What happens on the field when the robotics machine is moving and acting? Who's controlling that? And who pays in case of an accident?	General
Spain	Should it be regulated, or should it be an insurance company that is going to give insurance for agricultural robots in the field?	General

Table 2 Autonomy questions raised by participants

4.1.1 Degree of autonomy

Firstly, there were many different perspectives on the topic of autonomy, with most groups giving some importance to establishing what levels of independence their robots should have. Some people anticipated that it would not be a good idea if robots become too independent, and that it would be better if robots and human beings collaborate. For example, one of the respondents from the South-East Europe group, said that robots cannot be left alone completely to do jobs. Instead, collaboration between human beings and robots was important: in this line of thinking, one respondent said that the notion 'cobots' (robots collaborating with other robots; collaborative robots) is misleading and that they are more like collaborative systems 'that somehow work with humans'. This group stated that human-robot collaboration is more realistic than completely independent robots. It is more likely for the short to medium-term. While increasing the independence of robots would bring more benefits, it would also be more expensive and there would be more barriers to their use as people would not trust leaving robots alone to do jobs, because of the accidents they might cause.

Another barrier of increasing the levels of independence in robots is that they may limit or interfere with the autonomy of the farmer. For example, one participant in the North-West of Europe group pointed out that some farmers want complete control over their farms and machines, but some robot companies are trying to package robots as a complete service and anticipate that there may be tensions between the two. This point was also reiterated by one of the participants in the Baltic group, when referring to the farmer hiring robots, giving away their data, and the potential loss of control of the farmer over his farm when he implements robots: 'you're just becoming a client, but are you still in charge?'

These issues surrounding loss of control over accident prevention and loss of control of a farmer over his own farm were raised across diverse regions, as well as in the literature (Ryan, van der Burg, and Bogaardt 2021; Rose et al. 2021; Sparrow and Howard 2020). We therefore called them 'general' types of questions.

4.1.2 Liability and responsibility for accidents

Responsibility, liability, and insurance, were discussed in all of the groups as most were quite familiar with these topics. One participant in the South-East Europe group, who is a trained lawyer, stating that 'the person responsible for the robot, in my opinion, is the owner of the robot'. One of the participants in the North-West Europe group felt that the onus of responsibility was on the manufacturer of the technology to ensure it was safe. One of the robot developers also stated that responsibility was framed differently, depending on their customer. For larger organisations, it was always more formal and contractual, whereas, with smaller organisations, there was often less of a need for these kinds of formalities:

> *sometimes it's just informal, it's not written. It depends on whether it's a multinational who has lots of rules or just a farmer, or a small hospital. But usually it's someone who is responsible for using that particular robot, and those in charge with what's happening. For example, in our contract, we stipulate*

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> *very clearly if anything happens they should push the red button, because every larger robot in the European Union needs to have one emergency button (participant, South-East Europe).*

However, this idea of 'just push the big red button' is often not enough to convince farmers of robot safety. For example, one of the Greek participants said that it has been very difficult to convince farmers to use their robotic sprayers because 'they don't trust the amount of liquid is going to be sprayed. So it's quite hard for us to convince them to modernize themselves' (Greek roboticist). Farmers are worried that the robots will cause harm and that they will be held responsible. Many of the Greek respondents supported this, stating that safety is very important during the design process to ensure that no harms arise from their robots: 'the most important issues for us is the safety, as it is a big vehicle and it could harm people. It could harm the cultivation' (Greek roboticist).

In addition to this, there was an emphasis on ensuring that agricultural robots are fit-for-purpose. This is one way to reduce mistrust and uncertainty of farmers. To reduce concerns about responsibility and blame, it is best to ensure that minimal problems occur in the first place:

> *the way we are dealing with this is that first and foremost we do a lot of testing, so we're trying to figure out the any, even miniscule possibility for something to go wrong. And then we would take the necessary steps to make sure that it will not go wrong (Greek roboticist).*

This was also discussed in the North-West Europe group, with some emphasising the importance of effective design philosophies to prevent harms from occurring in the first place. The overall feeling from all of the groups was that responsibility allocation was a concern for all regions. The groups gave many very general recommendations to solve this, such as robots must be safe to deploy and use on the farm, and this should function as a prerequisite for robot developers during the design, testing, and integration phase. If robots are safe, then there will be less concerns about harm, responsibility allocation, and liability. The solution to the responsibility question is to ensure no harms occur in the first place, which is a very general requirement not only for agricultural robots, but most digital technologies, generally. There were some variations among the groups about who should be held responsible when robots cause harm, but this appeared to be more of a difference between two individuals, rather than necessarily something which demonstrates specific regional challenges.

4.2 Social acceptance of robots

The social acceptance of agricultural robots was another important topic that was discussed throughout all five workshops, which contained much more regional diversities than the previous topic of autonomy. There were many different views on how different cultural practices, viewpoints, and associations with food production, will affect the acceptance of agricultural robots. Throughout our discussions with the participants, they also highlighted many key questions within the debate, which created more discussion and interactions within the workshops. As can be seen from the questions raised in the table below, the focus is on much more regionally-specific themes (see Table 3).

Group	Questions	General or regional
Baltic States	How to make these robots appealing for a broader group of people whose business survival may depend on it?	Regional
South-East EU	How to educate farmers so that they can work with robots and see what they have to offer?	Regional
Greece	Should we convince people that we should stop using non biological farming which is really bad for the planet and start using robots?	Regional
North-West EU	Should policy make clear what robots can and can't do for animal welfare?	Regional

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Spain	How can we make agriculture less physically demanding and still produce tasty, good quality food that people will want to buy and eat?	Regional

Table 3 Social Acceptance Questions Raised by Participants

4.2.1 High-tech food production and societal acceptance

A topic which arose during our discussions was how different societies around Europe viewed food produced by robots. Whether or not this was favourable, neutral, or negative, and how this may have an impact in the successful deployment and use of agricultural robots. In addition, were there regional differences with the social acceptance of using agricultural robots in high-tech food production or could a more general approach be taken.

To begin with, the South-East Europe group felt that the use of robots to 'grow vegetables or cereals, or wine or grape' is not a problem. These robots are used to reduce pesticides and to make farming more environmentally-friendly. If these reasons are explained to customers, then they will be widely used. In the Baltic group, respondents claimed that if the positive aspects of robots can be shown (ability for farmers to upskill, monetary value), there will be less concern about their use in food production.

The Greek group felt that there was an ideological view of nature and a nostalgic idea that fruits should be picked by hand. Despite this, many Greeks are aware of the physical hardship of doing this type of labour and the need to innovate and modernise to stay competitive. One respondent said that '70% of the population was raised in an agricultural place. That means they have seen it is a very difficult situation, growing by hand [...] so they would like to see it more modernized (..) so people are actually quite pro innovation'. The high percentage of the population working in agriculture, or has worked in agriculture, has a strong regional context to the implementation of agricultural robots. Parallel, in the Baltic group, participants said if you can show people that the introduction of robots will make life of farmers easier and will not threaten jobs or livelihoods, then they will be more socially accepted.

While there may be a need to convince or show many in Greece that agricultural robots are safe, and the food that they produce will not be compromised, there is great potential for agricultural robots to have public acceptability. One said that Greek people often tend to be 'sentimental with the traditional methods or traditions', but 'if you can convince them, or if they can take something that tastes actually equally good with what they are used to, up to their standards, then I think they will be more eager to increase yield of this good product'.

Despite this, there will always be a customer-base that wants traditionally-produced products, hand-picked by humans. This was a point expressed in both the South-East Europe and Spanish groups:

> *I think that there is this wave of customers interested towards traditionally produced products [...] But, of course, I think the these are completely different target groups. [...] but our market is mostly looking at customers, still the biggest number of people I think, purchase their food at the regular supermarkets (South-East Europe respondent).*

They suggest that customers will not care if the product is produced by a robot or not, if it is cheaper. Those who truly care about this, and can afford it, will opt for the more expensive options of human-hand-picked fruit and vegetables. Thus, there will be different target groups for traditionally produced products and those found in the regular supermarket. They indicate that agricultural robots will thrive in the mass produced goods found in supermarkets, but there will still be a market for small, niche, specialised goods, that would not use or need agricultural robots (presumably because they are too expensive, but also, because the customer demands hand-produced, or traditionally-produced, products).

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The Spanish group said that the quality and healthiness of the food is very important for Spaniards and will take priority over whether it was collected by human or robot. Another Spanish respondent stated that the taste of the food is very important, when deciding between humans and robots. People will opt for what gives them tastier food. Thus, the health, quality, and taste of the end-product is important, rather than who or what produces the food.

The cultural and regional differences in attitudes towards food and food production became clear throughout the workshops. Some put a strong emphasis on the economic viability of introducing such robots, while others said that their success depended on alleviating burdensome jobs (which most of the population were aware of), and others emphasised the importance of taste and the healthiness of the food itself, for societal acceptance. The societal acceptability of agricultural robots clearly requires differences approaches and sensitivities implementing them in different contexts and regions around Europe.

4.2.2 Robots and the environment

All groups gave attention to the use of robots to reduce chemical and pesticide use, to produce more food with less energy, and to reduce the carbon footprint of food production. There is a pressure on the agricultural sector to produce more food with the same (or less) resources. The reason for caring about robots' environmental impact varied from group-to-group. For example, some felt that there was a responsibility on developers and robot producers to create more environmentally-sound robots, but also to convince the wider community that these practices and technologies are a better solution:

> *our main value proposition of the product is that the we will mitigate the environmental impact of the agricultural sector and this is why our robot does the automated mechanical with management, and we are focused on biological cultivations, where people are not able to use pesticides or harmful herbicides, and the actual goal is to just say to the people that "here is an efficient solution to handle the weeds in a biological farming" [...] we will be able to convince people that biological farming is a good investment both for our health and for the environment. [...] And we should stop using non biological farming, which is really bad for the planet and for the food quality and generally in the long term it makes much more harm than we think. [...] This is why our robot is fully electrical and we want it to be powered from solar energy like have solar panels and battery based instead of the tractors which consume fuels (Greek respondent).*

The Greek respondent felt that having more sustainable technologies will be a selling-point to farmers, and the market will ensure more sustainable practices, because that is what is demanded by farmers. This was also felt by one of the respondents in the Baltic group, stating that there should be a focus on more environmentally-friendly technologies that use less pesticides. If farmers can produce more with less fertilisers, water, and pesticides, it will be more advantageous to use robots that can achieve these goals:

> *considering the European Green Deal and all this effort to reduce the emissions globally, I think there will be a huge boost to the clean energy and efficient machines and practices. So, despite the reduction in costs, I think a green energy machine will be promoted even from the European or globally, so it will also give a boost to the adoption of such techniques (Greek respondent).*

The respondent went on to say that there should be a combined effort between market forces and political action to make cleaner energy a more desirable and cost-effective option. This is also demonstrated in many new environmental policies, such as the European Green Deal: 'if we consider also the Green Deal working in parallel, boosting in providing funding for research and developments that that isn't necessarily tied from the first moment with the market. It's going to work itself out, let's say' (Greek respondent).

Another Greek respondent also stated that they should aim towards achieving the European Green Deal (Greek respondent). A South-East Europe respondent was a little more critical: 'if you look at the new Green

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Deal proposed by the European Commission, you will see that it's basically about precision agriculture', but that 'money and the workforce are the main objectives of the owners of robots and for the choice to use robots'. Better environmental impacts are a 'nice to have, but not a must have and I think it will be like this until there comes some sort of a very strong directive that says these environmental goals need to be achieved' (South-East Europe respondent).

According to this position, environmental goals must be tied to economic sustainability, particularly, for less well-off countries within the EU. This was strongly felt in the South-East Europe group, with respondents stating that if it is not economically beneficial, then it will be difficult to sell agricultural robots based on their environmental benefits alone:

> *Yes, it sounds nice. So to do all the green stuff and protect the planet. Reduce waste and everything, but I think in Romania we mostly use robots because we don't have the workforce and our approach is going [...] to present numbers and we say, OK, you're going to be able to compete with another company if you use robots (South-East Europe respondent).*

This same point was also reiterated by another South-East Europe respondent, claiming that emerging technologies are seen as beneficial and people want to innovate, but the high investment costs may prohibit them from entering the market: 'looking from the point of view of Serbia specifically. [...] they are interested in all the new technologies, but this is still quite expensive and the return on investment for them is still not very clear' (South-East Europe respondent).

Within the South-East Europe group, there was an emphasis on return-on-investment. Environmental benefits from agricultural robots will only materialise if they make economic sense:

> *I can tell you that people don't have a problem with technology. Their concern is the cost. [...] I can tell you that in Romania it's a little bit trickier than in Western part [of Europe] because the wages are rather low, so the return of investment it's longer than in western economies. For example, if an autonomous steering wheel, you have a return of investment in two or three months in Western countries; in Romania, it takes about eight months to one year (South-East Europe respondent).*

Altogether, the groups felt that agricultural robots would bring about more environmentally-safe behaviour on the farm: 'I think robots can help to reduce carbon footprint of food or the chemical foot-printing in the fields' (Spanish respondent). The Spanish group felt that there was a greater interest within society to use less pesticides, have fresher produce, and cause less pollution; which have been promised with the widespread use of agricultural robots.

Overall, there was a feeling that the environmental impact of agricultural robots was a general issue, something which is important for all regions and should be taken into account no matter where it is deployed. However, there were striking regional differences between the countries in why they would care about the environmental impact of their robots (economic reasons, political requirements, or out of a sense of moral obligation). This was partially due to the specific divergences between countries, the wealth of each, and the dependence on the economic success of those robots (and thus, prioritising economic benefits from environmental requirements). Environmental concerns varied among regions, so perhaps, a more regional-focused approach to a general issue is required to ensure sound ecologically-sustainable practices is required.

4.2.3 Robots contributing to animal welfare

Animal welfare was only mentioned once throughout the workshops, by a participant in the North-West Europe group. Therefore, it is quite difficult to infer any kind of specific regional differences or general attitudes towards animal welfare, except the fact that this was a component that was missing among the workshops. One of the participants referenced the lack of regulation to control and protect the welfare of

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animals on farms with the introduction of agricultural robots, which may also contribute to this overall lack of concern about animal welfare felt among the groups:

> *if you have a robot going around in in trained the cows in cleaning, cleaning the floor, it's not regulated. Is it legal for it to go 24 hours a day and of course is stressing the animals in the herd. [...] we are not able to have light all day, and they [the chickens] are laying more eggs if they have more lights, but we don't have a regulation from robots, so I have farmers talking about should there be regulation. Some suggested the animals will eventually get used to it. [...] Uhm subwoofers suggested make sure your robots are cow-proof, because it might try to attack it. It's clearly a risk (North-West Europe respondent).*

They went on to say that policy should be clearer about what agricultural robots can and cannot do in relation to animal welfare, and that this is not always clear in practice. They mentioned that there has been little discussion given to the welfare of livestock, but also, wildlife surrounding the farm, during agricultural robot implementation. This respondent felt that they should be given greater attention in the debate. Biodiversity, along with climate change, is considered the most important environmental challenge that we face (World Economic Forum 2021), and the impact from agriculture is considerable (World Wide Fund For Nature 2021). Thus, its importance and need incorporating into the deployment of agricultural robots is clear, but this was not reflected in the workshops.

4.3 Labour market

Labour came forward most prominently in the discussions of the participants in the workshops. It was the number one theme that they chose as priority-topic for agriculture. But it was approached from slightly different angles by people coming from different contexts, depending on whether it is a region with low wages for low-skilled farming jobs and where people tend to leave to find well-paid jobs elsewhere (mostly the north-east and south-east of the Europe and Greece) or regions where migrants tend to go to find better paying jobs (Spain, North-West Europe). While some of the topics were general (such as the problem of robots replacing human workers), much of the discussions has distinctive regional issues and contexts. The participants also raised many important questions on the topic of labour throughout the workshops (see Table 4).

Group	Questions	General or regional
Baltic States	People move to the west or to the larger cities and there is no one left on the countryside to do the work. How do we make sure that food production will continue if not enough people are available to do the work?	Regional
South-East EU	Are robots going to be affordable to small farms? And will small farms be able to survive the competition with farms in the West if they cannot invest in robots?	Regional
Greece	How do we make sure that farming continues to be an attractive profession where people will continue to want to work?	Regional
North-West EU	Should new low-skilled jobs be created, such as a person who keeps an eye on the bloody robots?	Regional
Spain	How do we prevent social inequality to aggravate when migrant workers no longer have a job in agriculture and will have no money to buy food or pay rent, etc?	Regional

Table 4 – Labour questions raised by participants

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4.3.1 Robots filling labour gaps vs robots substituting human labour

Throughout Europe, it is perceived that robotic labour is very welcome, because there is a chronic lack of labourers, which leads to dramatic results such as fruits and vegetables that decay in the fields as there are not enough people to harvest them. Moreover, it is expected that the need for labourers will increase when the population increases and more food needs to be produced to feed more mouths. Different causes for the lack of labourers are brought forward, such as the difficulty to find labourers that are sufficiently qualified, or who are motivated to do the heavy and often monotonous work even on hot days or in the rain, receiving low wages. Further reasons for the lack of sufficient labourers are mentioned, such as the migration of people from the countryside to the city and the availability of better paying jobs in construction due to urbanization. And it is mentioned by respondents all over Europe (east-west-south-north) that the population grows which increases the need to improve the performance of farms to realize the food needed to feed the growing number of mouths, thus needing more labour-availability in the future.

Participants from different areas in Europe, however, look at the labour shortage from slightly different angles, as participants in the workshops in north-east Europe, south-east Europe and Greece also mention that people move to the West to find better paying jobs,

> *'Well, I think, uh, I'm located in Lithuania, so that's a bit of a different perspective and what I already see in my country, and perhaps in other countries, it's a similar trend. A lot of people moving from the more rural areas into these big cities. (..) And that's causing overpopulation in the big city centers and under population in the rural areas. And [there's also] emigration and people living in other countries (..). I think that's changing a lot, especially for Agri sector in the in the end, the labor market, because there are now not enough people in these, you know villages and different places where you can (..) work on demand and produce food. There's no labor there because everyone wants to move to a bigger city to do other things.' (Baltic respondent)*

> *In Greece before the crisis 10% of the population of workers were immigrants as well form Albania, Bulgaria, Romania, mostly, uh, but then half of them left and went to northern Europe. So we have big problems. I mean we don't have people to harvest now. The olive trees for example. So there is actually an issue. And now when you know now we have the economic recovery. Now you know things are going very high in in the economy. So there's going to be a lot of construction. And many people will move to construction, because it pays more. So the labor, work, is going to be an even bigger issue in the coming years. (Greek respondent)*

Different respondents reflect that human workers will never be superfluous and that the arrival of robots will also lead to the creation of new 'more highly educated jobs'(Greece) focussing on the development, design, operation, supervision and repair of robots. Some compare the arrival of robotics as the 'next industrial revolution' (North-West EU, Spain, Greece), indicating that there's a parallel with the previous revolution 'where creating automation didn't remove jobs, but massively multiplied the available jobs' (North-West Europe). These jobs would also be more 'mundane'(North-West Europe), leaving the 'difficult work of labouring and the farming to the robot' (Greece).

However, in our workshops in North-West Europe and in Spain, participants also reflected on the presence of immigrant labourers coming from East Europe to the North-West or from Morocco to work in Spain. These immigrant workers filled the labour gaps in the agricultural sector in the past decades, which the local population left behind who moved to the cities and to jobs in different sectors. As wages are higher in North-West Europe and in Spain compared to the home-countries of these immigrants, this allowed these workers to work for a season and then return home with enough money to live for the rest of the year. Participants in our workshops anticipate that it is primarily the jobs of these immigrant workers that will be filled by robots

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in the future. While some reflect that these immigrant workers will have the chance to be educated and move to different more educated jobs next to the robots, others foresee that the socio-economic difference between countries and between different parts of the population will aggravate,

> *Basically what I think it would happen [when robots take over jobs] is that Moroccan people will keep working in Morocco, where there are no robots, at a lower price. This will help, as you say, to improve the profitability of companies, but also will increase the differences between countries and that will become a problem. So I don't know that say, that's a difficult question, because, uh, of course we cannot, as Europe or Spain, influence Moroccan competition, education, politics and Moroccan immigration is not controlled, it is in most cases illegal and irregular, so we cannot influence that. I think as we get more technified, and that's something that we cannot stop. It is, say, unstoppable. Differences grow between countries, and especially between those who have the opportunities to create their robots and those who are not. That's my pessimistic review of the world (..)' (Spanish respondent)*

Similarly, in the workshop in the North-West of Europe it is anticipated that there will be a growing difference between large farms who are able to invest in robots, and small farms that do not have enough labourers and who cannot invest. It is anticipated that these smaller farms will eventually not survive the competition in the market. This is expected to also effect the labour market across the EU, as it will mean that the more remote rural areas with small farms will likely not survive and therefore the little jobs that are available there now, will likely disappear as well.

> *'So on the labor market developments I would argue there's a really interesting ethical secondary social impact that if a farm collapses 'cause it can't get labor, didn't use robots, and this is what's happening in the United Kingdom at the moment, but I'm sure, and the rest of the EU. Uh, uh, then that has acquired a negative effect on the permanent staff employed in those companies. And then there's a sort of societal thing around farmers being anchor institutions in the rural economy, so I think. There are primary impacts on the workers on farms, but the secondary impacts probably even bigger and I think I think that's just something needs to be thought through.' (North-West European respondent)*

Aggravating socio-economic inequality between regions and between groups of people who are able to get relevant education and find new jobs is anticipated by various respondents in Spain as well as the North-West, which is thought to impact on social stability, continued urbanization, loss of small-scale farms and characteristic rural landscapes. The need for specific contextual and regional implementation of agricultural robots is important when tackling issues around labour and employment. This section demonstrated that while some issues can be tackled generally, there are many differences between the regions that require tailored responses, integrate different approaches, and adopt alternatives, for the ethical implementation of agricultural robots.

4.3.2 Labour migration and the imminent digital divide

Probably the most important general difference in perspective to robots that we encountered fell together with an East-West divide of Europe: answers from participants from the Baltic countries and South-East Europe suggested that in these contexts there is a lot of interest in robots, but their concern focuses on the high costs of robotics and the consequences this might have for the accessibility of AI robotics for farmers located in their regions, as well as the future competitiveness and survival of farms without robots compared to high-tech farms in the West.

> *'I can tell you that people don't have a problem with technology. Their concern is the cost. (..) If, uh, if they have a return on investment. Uh, and uh, for example, I can tell you that in Romania it's a little bit trickier*

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> *than in Western part because the wages are rather low, so the return of investment it's longer than in western economies. (..) The problem is that whether they want to or not they will have to embrace technology because otherwise their production costs will be higher than than the ones in the West. So basically, if you want to still be competitive on the market, you will have to adopt technology (..).' (South-East European respondent)*

Lack of sufficient money to invest in robots, coupled to lacking technical knowledge and skills of farmers is considered an important obstacle to the adoption and acceptance of robots. Sometimes it is anticipated that farmers could collaborate to invest in robots and share the costs, or to provide robotic services that individual farmers can buy without having to invest in the machinery themselves (Greece). In general, however, our respondents did not consider it an option to refuse robotics, as the technology will proceed and farms will have to start using them to remain competitive. Especially in our workshops in the Baltic countries and in South-East Europe we therefore encountered an especially positive attitude towards robotics, as people considered it of pivotal importance for the survival of farming businesses, and the preservation of a lively job market in their regions. But they also see that the technology is especially difficult to access for farmers in their region, as it takes longer to earn the invested money back.

Lacking digital skills and having to educate people to work with robots, also come forward in all workshops. In North-West Europe and Spain this is primarily addressed as a question that concerns the education of low-skilled labourers to deal with the robots, in our focus groups in Greece and South-East Europe countries and the Baltic countries, is also discussed as being relevant for the farm owners. Being aware that robots exist and what they can do for farmers, and being able to understand and work with the robot is considered importance for the accessibility of the robots,

> *'I think for this, uh, agrifood kind of aspect that is just depending on on location. We we did discuss this digital gap and the fact that education and the.(..) Uh, awareness raising. I don't know if that's that can be, uh, identified under the social acceptance of robots category. I think it's still needed to kind of spread the knowledge.' (Baltic respondent)*

> *'Uhm, it is the question of (..) how tech savvy are we? Supposed to be? As farmers do actually have to be able to implement ... work with this, knowing that the robots are not dead autonomous, that we cannot just leave them there and they will do the work. So [they ask] what type of support is there available for us? Is it only in English or will we have someone who can explain it in Serbian as well and how much do we need to learn? Because yeah there is this, uh, a big demand for seasonal workers and workers in general in agriculture. And yes, robots can be solving these these issues, but on the other hand we don't have enough.... Let's say we can't just move the people we have from their ordinary area agricultural work towards operating robots. So this yeah, this is a quite a big question and it is a concern. (South-East European respondent)*

The distinction between people who are skilled and wealthy enough to buy and use technologies, and those who are not able to do that, is in fact discussed in abundance in our workshops without actually mentioning the term 'digital divide'. All concerns about loss of competitiveness when farms do not work with robots and consequently a loss of small farms and the labour they provided in rural environments are closely related to concerns about ending-up at the low-tech side of the digital divide. Different participants locate the divide however in different places. In our workshop with participants from North-West EU, for example, the low-tech part of the divide is anticipated to be in developing countries, which will need '(..) very specific development of low cost robotic systems, which aren't dependent upon local infrastructure'. While

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participants in this workshop anticipate that there's a risk that 'developers don't actually develop specifically for it', they also are confident that 'if they develop for it, it can be managed.'(North-West Europe)

Other focus groups, however, place the digital divide elsewhere, such as Spanish participants who anticipate that the divide will lie at the border of Europe, between Spain and Morocco as the robots will benefit the Spanish farmers, but will take away the jobs from Moroccan immigrants who will remain at the low-skill and low-tech end of the divide. According to participants from East Europe, however, the digital divide seems to go right through the EU, dividing the East and the West. While the term 'digital gap' or 'divide' is mentioned rarely in our workshops with participants from the Baltic countries, from South-East Europe and from Greece, concerns related to the high costs of robots, which make them hard to access for farmers, and lack of digital skills, are brought forward by them in abundance. In these workshops, it is also anticipated that countries located in the West of the Europe will win the competition, as they will have money to invest in tech and they will have the necessary tech skills. Their reflections are therefore focused a lot on educating farmers in their own rural areas, supporting farmers to invest and connecting to the 'more advanced' West to harvest needed knowledge (South-East Europe). In this line of thinking, the hope is sometimes expressed that young and adventurous people who go work abroad, will come back afterwards with money and skills that will help their country forward,

> *'Some of the migrants who you whom you called immigrants, are lucky and returned to Latvia. And they are, uh, they are skilled. (..) They can establish here a new business because they worked there (..). It is also big value, because they have got these digital skills. (..) They established here business, uh they have dream, but the rest as they just come for holidays to Latvia even come from Spain here to meet the family but then they return back (..) I would say that we are also facing [a population decline]; less people and less children in their families. And that means that robotics will also be needed from that point of view. Of course there is overpopulation in other countries in the world. But not in Latvia.' (Baltic respondent)*
>
> '*But honestly I don't think people from Eastern Europe will come back to Eastern Europe or to work because they can get higher salaries in the West so. It's a matter of how much they earn. I think they will not change their mentalities because even... even if the the workplace will provide an easier, uh, an easier environment, let's say, uh, by bringing robots to help them, uh, the mentality will always be that: we we're not going to earn enough money, so....' (South-East European respondent)*

Clearly, there is a very different emphasis on labour issues and the relevance of the digital divide, with some regions being very concerned about it (as they will be on the receiving end of it), while more prosperous regions note the concern, but it is much less of an immediate problem for them. The digital divide was also shown to be very real and the respondents provided additional clarity and contextualism to a concept that is often discussed in more general and vague terms. Altogether, the impact of agricultural robots will have varying impacts and (potentially) create different digital divides, depending on where they are implemented.

4.4 Data access, sharing and processing

Participants brought forward different ideas about the value of data sharing. Some considered the value of data from a commercial perspective, anticipating the possibility to earn money with data by selling data sets or to develop new products based on acquired data collections (North-West Europe; Greece, Spain). There was also a lot of reflection about the value of data for (scientific) research and to foster innovation (Greece; Spain; North-West Europe). Especially in Greece it was mentioned that developers of robotic systems form

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an 'open community', and that in that community 'sharing is something you should do in order to be able to use other people's information as well and move forward.' Having a data sharing community with other robot developers was considered to be a prerequisite to obtaining more knowledge and innovation.

In addition, the value of data for the realization of public goals was mentioned, such as the monitoring of animal health and administered medication, keeping check of food safety (Baltic Countries), controlling compliance with laws such as environmental law (Greece, North-West Europe, Spain), keeping the market and the economy vital (Greece, Baltic countries, South-East Europe) and keeping jobs in the region (South-East Europe).

Given the value of data sharing, participants in the various focus groups also considered possible reasons to distrust data sharing and they reflected on various risks and dangers when others have access to data – or when they are shared too easily. Their main topics of consideration regarding distrust focused on fair competition, generating power inequalities, a loss of the farmer's control over his or her farm, and surveillance (see Table 5 for some of their own questions on the topic).

Group	Questions	General or regional
Baltic States	Large companies who have your data who have your data may now better what happens on your farm than you do. How do you make sure this power is not misused?	General
South-East EU	A lot of companies are unaware of their duties regarding data sharing. How do we make sure they act responsibly?	General
Greece	Farmers do not want to share their data, for they are afraid it will be used against them. How do we get them to trust?	General
North-West EU	Is it OK to use data for surveillance of people? To check whether they fulfil their duties and comply with the law?	General
Spain	To whom do data belong? Who has the right to use them?	General

Table 4 – Labour questions raised by participants

4.4.1 Fair competition and generating power inequalities

One of the primary risks that focus group participants bring forward is the weakening of one's competitive position when competitors have access to the data of a farm. This topic was mentioned in virtually all focus groups, except the one including participants from South-East Europe. The topic was discussed at more length in the focus groups with participants from the Baltic countries, Greece and Spain, where beside personal data, different types of non-personal farm data were considered 'sensitive' for sharing with competitors; such as, data about yield, about animal health, about the quality of the crops, about the quality of the soil and the choice of inputs such as seeds. These data could be interesting for 'competitors of farmers', who could use it to anticipate the price a farmer will ask and make sure they ask a lower price, but it can also be interesting for the 'buyers from the farmer' as they can 'use it to manipulate the price' (Greece).

Others take a slightly broader perspective and bring forward that data sharing will eventually impact on competition more broadly, as it will change the power relationships in the international market. This is especially brought forward in our focus groups in North-West EU, the Baltic countries, Greece and Spain. In all of these groups, participants mention that in their regions, large businesses are expected to be able to

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profit from data, such as large developers of robotic farm machinery. These companies are expected to be able to collect data from a large number and variety of farms, which will give them a lot of knowledge that they can use to their advantage. This will give these companies unprecedented power, for example because they can use data to anticipate and manipulate demands/needs of their customers and tailor their own supply to that need,

> *'This information is a very powerful tool for commercial purposes. Right now (..) or in the future they will try to use data that robots collect in the field. (..) we have the right now this this problem right now here in Spain as nobody asks ask about to whom belongs this data or has the right to use them. That is usually big companies that have very strong powerful commercial activities who can use it to orient their campaigns and products (..). They have very large catalog of products, so they can discard some of them. (..) So when they see in a certain region that they're growing this type of corn and it's doing very well, then they're going to propose the same corn. They're going to develop seeds, and they (..) have information previous to develop and grow the seeds. (..) So this is a very important information to make a efforts in one line or in another line...so they do commercial offers. Then based on that they tailor their seed production to what is needed now' (Spanish respondent).*

4.4.2 Loss of control over one's data

Loss of control of one's data is an important topic that is mentioned either directly or latently in each of the focus groups. Sometimes it is mentioned just as a matter of fact, as in 'farmers don't seem to want to lose control over data' (North-West Europe). Sometimes this is discussed as a reason to simply ask the farmer what one is allowed to do with the data, and ask for their approval,

> *'That's why you have to deal with the customer when you start working on it. What do they allow us to do with the data? Because if they say it's strictly confidential, I don't want anyone to see my data. Then we don't give access (..).' (South-East European respondent)*

Participants in our workshop in South-East Europe observe that there was not a lot of awareness of data sharing issues in their countries. As one Romanian participant says: 'in Eastern Europe, we're not that concerned about access to data (..) I guess it's a lack of education in this area.' This changed somewhat when the GDPR was administered which focused on protection of personal data and which helped to become more aware that data sharing issues may arise also about other types of data, such as non-personal agricultural data. Yet they observe that people in their countries take a rather formal perspective to data sharing issues.

> *'(..) A lot of companies are unaware of their duties. Let's say towards even they ramped employees. So yes, it's a (..) problem that needs to be dealt with on a daily basis. (..)*
>
> *Yeah, it's pretty much the same [in Serbia]. We don't have this tradition, I guess. (..) Unfortunately, and with the GDPR, this has been, I guess, elevated a bit, and there's been more talk about this. (..) But to be honest, in Serbia, not even the state, the government is very clear. (..) This is still all very new to them and, uhm, unfortunately there's not enough thought put into this and. Yeah, the companies as well. I think we're just going with the flow and doing only the bare minimum' (South-East European respondents).*

In the other workshops, however, the discussion about data sharing, especially about the farmers' concern of losing control over their data, received more profound discussion. This concern and the value of the suggested way to solve it by informing farmers and asking them to agree to the use of their data, was problematized in relation to the changing power relationships between actors in the international market. Especially participants in the workshops of the Baltic states, Greece and Spain talked at length about the

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impossibility for many farmers to understand the implications of data sharing for their own position in the market, especially when large companies collect these data.

> *'And if I may add what I also feel the power balance. (..) robotics suppliers are not just generating and providing you with the machines but also with the sensors and [they are] collecting the data remotely. So it may be that suppliers might know more about your farm than you do. (...)Uh, you're just becoming a client, but are you still in charge? Can you make a decision about who can see it? When you did not go to Harvard? If you feel that actually, your supplier, uh, is making decisions, not you, you'll become more marginalized and that has impact on the competitiveness and your ability to make revenue.' (Baltic respondent)*

The control, access, and use of one's data appeared to be a general issue discussed throughout all of the workshops. While the GDPR was important for giving individuals within the EU and EEA more control over what is done with their data, it was somewhat inhibitory towards businesses within these states. In particular, it may be problematic for data-focused industries, such as the development of agricultural robots, which are typically dependent upon very large datasets. Even though much of the data retrieved and used for agricultural robot development and use is non-personal (thus, not dependent GDPR requirements), they still have to go through extra hurdles to ensure that non-personal data *is* non-personal.

4.4.3 Surveillance and punishment

Besides considerations about competitiveness, participants in the focus groups also mention the problem of surveillance in relation to data sharing. This (potential) problem is discussed in relation to robots, which collect data about the labourers with whom they collaborate, thus making it possible to monitor their performance during the entire working day (North-West Europe). It is also considered in relation to large companies, who are able to collect data remotely and 'see' what farmers do on their farm, thus leading to a situation in which the provider of the robotic system 'might know more about your farm than you do' (Baltic states).

Moreover, participants from the focus groups of the Baltic countries and Greece also bring forward that farmers are afraid to share data with governmental officials. Even though sharing data digitally is perceived to be more practical than having to insert the data manually and deliver it in the form of a pdf to government officials (Baltic states), it is also recognized that farmers are often unwilling to do it (Baltic states, Greece) as they are afraid their data may not completely fit the requirements and that they will be punished (Greece).

> '*We've seen a lot of mistrust around data sharing, where the farmers really do want to keep the data close to themselves. They're afraid if they shared the data or they use new technologies to capture data that could be used against them with payment claims, for example. So there is quite a lot of mistrust there. (Greek respondent)*

5 Discussion and conclusion

Our results suggest that all ethical topics related to AI robotic systems that are described in the literature, are also brought forward by researchers and commercial robot developers who participated in our focus groups across Europe. Issues related to (a) autonomy, responsibility and liability, (b) social acceptance of robots, (c) labour and (d) data sharing and protection, are all mentioned and discussed in abundance. Based on the way in which (the relevance of) these issues are articulated and discussed, however, we conclude that

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they do not all need to be approached in a contextual manner. Issues related to social acceptance and labour seem to need a contextual approach to understand their meaning and relevance for concrete cultural and socio-economic contexts and develop a tailored response. Issues related to autonomy, responsibility and liability and data sharing, however, do not seem to need a contextual approach, as their discussion in the focus groups do not mention relevant contextual differences, that ought to be taken into account. These issues could be approached in a more generalized fashion, developing a single approach that prescribes how to deal with them across the various European contexts.

The issues that do demand a contextual interpretation and response are more firmly rooted in culturally rooted traditions of food production and consumption, or in socio-economic differences between contexts. Such as in the case of the Greeks who mentioned that 70% of their population is raised on the country-side and has first-hand knowledge of the hardships of agricultural labour and will therefore understand the need for robots to keep the profession attractive; as opposed to people in the North-West of Europe who predominantly lack that knowledge and who have been used to having their food produced in more industrialized sites for some decades already. Or Spaniards who mentioned that the eventually resulting health and taste of the food are most important explainers of the acceptance of robot-labourers for their fellow countrymen. By contrast, people from the north have less diverse and sophisticated eating habits to start with, thus making it more acceptable for them to compromise for taste.

The more industrialized food production history in the north-west of Europe makes citizens more interested in robots that serve to reduce the burden of farming on the environment or enhance animal welfare. While this is also mentioned as an important contributor to social acceptance in other contexts (Greece, Spain, Baltic states), it plays a less prominent role. These differences suggest that different arguments will be convincing motivators for people located in different contexts to start using the robots. But more importantly, it also means that issues about the environment are not raised in every context, which may be problematic considering that reduction of environmental pollution is considered one of the most important drivers behind digitalisation (including robotization) of farming by influential institutes such as the World Bank, FAO and OECD (Lajoie-O'Malley et al. 2020). Given that few respondents raised issues about the environment and some even mentioned that environmental issues are not prioritized in their country, this may be considered an ethical problem in itself. Lowering the burden of farming on the environment may demand a more generalized approach, which transcends the contexts in which people are now interpreting it.

While some environmental regulation should be implemented on a more general scale for agricultural robots to abide by, there are also many instances where a more regional perspective is important, depending on the type of environmental issue at stake. For instance, the amount of CO2 that a robot emits, the levels of pollution it may produce, soil compaction, and so forth are examples that may warrant a more overarching approach.

On the other hand, there are many environmental issues that will require special attention, depending on the place, type of farm, soil, weather, and wildlife around the farm. It is difficult to incorporate a more general approach to places with so many different variabilities that need to be accounted for. There is so much variability within countries, let alone when it comes to geographic locations as different as Denmark and Spain, or Romania and Ireland, for example. This, of course, brings added layers and complexities to

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agricultural robot development, and explains some of the reasons behind their slow development and commercial use. In order to overcome these issues, there needs to be a close collaboration between ecologists and robot developers to identify these challenges and create solutions that can account for these variables.

Furthermore, there is an important difference between socio-economically competitive and high-tech countries and low-tech areas where the level of digital expertise is generally lower under farmers, and where farmers have less money to spare to invest in tech. In the paper we have explained this as a threatening digital divide, which may result in some regions that have high level technical expertise and which become even stronger and more competitive in the market, while farms in other regions that cannot invest in innovation will go bankrupt. This is expected to go together with an unequal distribution of wealth, education and (tech) expertise, jobs and food supplies across different regions, which may raise questions regarding fairness and just distribution/access to resources. While different respondents anticipated the digital divide to lie in different places (between Spain and Morocco; between the Europe and developing countries; between West and East Europe), the expected inequalities show that there is, for our respondents, reason to anticipate that market-oriented robotic innovation will not self-evidently be accessible and usable for all. And also, that there is reason to suspect that a free market which is not restricted or steered toward desired goals, will by itself lead to robotic innovation that serves the sustainable development goals.

In the context of data protection and uses of data, it was evident throughout the workshops, that the GDPR was a good first step to protecting individuals and their personal data from being shared. However, it was interesting to note that the one respondent (Serbia) who was not within the EU, or European Economic Area (EEA), who the GDPR applies, felt that there was much less of an emphasis on data protection. They stated that the government did not really have effective measures in place, and as such, companies within the country are a bit unsure about how to implement it in practice. This indicates that the effectiveness of general overarching policies, such as the GDPR are effective means for ensuring personal data protection.

However, during the workshops, participants also noted that there is still a lack of coherence among countries about non-personal data-sharing, and the lack of coverage of this under the GDPR. Many said that there was an opaqueness about how this should be implemented in practice, with the standard protocol being within the EU that one must abide by the ‘Free Flow Regulation’ for all non-personal data (European Commission 2021). Typically, most agricultural data, like the ones retrieved and used by agricultural robots, fits within these parameters because of its non-personal nature (data about the weather, crop yield, animal numbers, etc.). The only problem with this regulation is that in Article 6 it states that stakeholders must self-regulate, which makes it confusing, complex, and arbitrary about what can, and should, be shared. This is neither general or regional, but is based on a case-by-case basis. Some efforts have been made towards creating greater unity among the content of agricultural data-sharing contracts, such as the Code of Conduct for Agricultural Data-Sharing (ECPA 2018), but these guidelines are somewhat vague, non-binding, and ultimately, difficult to understand for the farmer. Greater efforts could be made to establish more general, binding, and comprehensive agricultural data-sharing regulation, which those developing and using agricultural robots will have to abide by.

Our research has of course limitations. After having asked over 200 people to participate, we were able to organise only five workshops with 27 participants in total, who already had an interest in ethics. Results could

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have been different if we would have been able to talk to more people, including the ones who are not particularly interested in ethics. In order to check whether our findings are shared more broadly it will be necessary to broaden this research and do additional interviews or focus groups.

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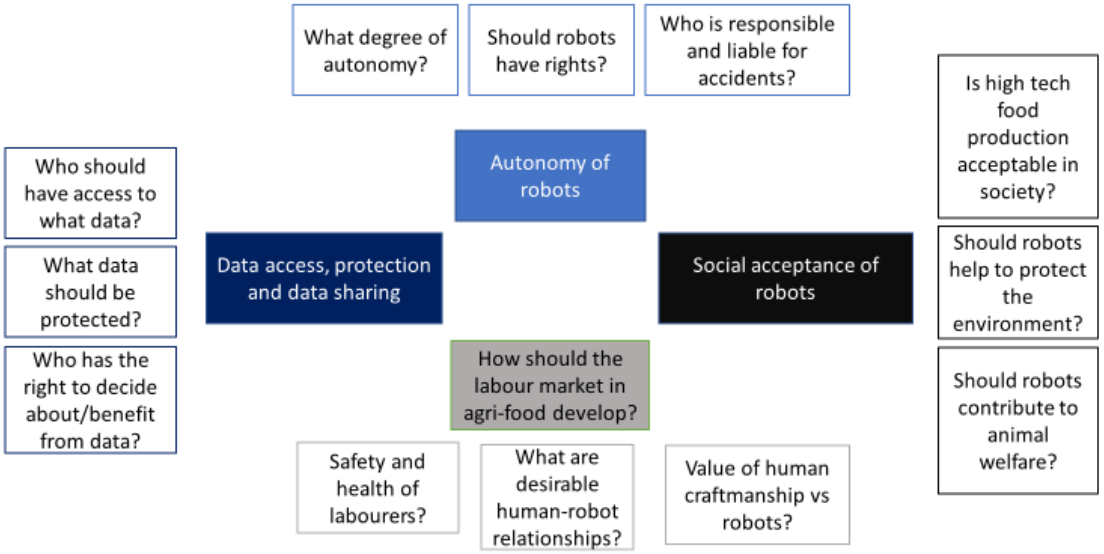
7 Appendix: four themes of the workshops



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