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A Brave New World: Emerging Technology Narratives of Agricultural Robotics in UK Media and Their Implications for Responsible Innovation

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ABSTRACT

While robotics has been identified by some institutions as potentially transformative for agriculture, scholars have argued that the technology could have significant negative impacts. Many agricultural robots are in the early stages of development, commercialisation and adoption – it is therefore important to anticipate the potential impacts of these technologies and substantively engage stakeholders for responsible innovation. However, where substantive inclusion of stakeholders includes lay citizens unfamiliar with the food sector, their understanding of agricultural robotics may be partly informed by narratives encountered elsewhere. In this study, we examine one potential source of these narratives, via a discourse analysis of UK media publications. We identify common 'problem scripts' used to justify agricultural robotics, a tendency towards promissory narratives, and an inevitability framing. We reflect on the implications of such narratives for responsible innovation of agricultural robotics, and their impact on substantive stakeholder inclusion. Finally, we highlight the need to consider media narratives when undertaking responsible innovation, to avoid directing innovation in a linear fashion and instead open up broader agricultural futures.

1 | Introduction

Agricultural robotics has emerged in recent years as a technological response to many of the sustainability challenges facing the agricultural sector. Robotic solutions to agriculture of varying levels of sophistication are currently in development and have begun to be deployed on farms across the world. Institutions such as the United Nations Food and Agriculture Organisation (FAO) have expressed support for innovations in agricultural robotics (FAO 2022). However, many agricultural robotic systems face challenges in technical development, particularly relating to the variable conditions in which they may be required to function (Zhou et al. 2022), and the requirement for standards for safe human–robot interaction (Vasconez et al. 2019). There also remain wide-ranging non-technical challenges, including: impacts on the structure of farm labour (Martin et al. 2022); the costs to farmers of adopting expensive robotic systems (Lowenberg-DeBoer et al. 2022; Shang et al. 2023); and the legal implications of autonomous agricultural robotics (Basu et al. 2020; Rübcke von Veltheim et al. 2022).

In response to social and ethical questions raised by the use of agricultural robotics, scholars have called for a responsible innovation approach to the development of such technologies (Jakku et al. 2022; Rose et al. 2021; Rose and Chilvers 2018; Ryan et al. 2021). A key element of such responsible innovation

is a requirement for inclusion of a broad range of stakeholders in technology development processes (Stilgoe et al. 2013). The responsible innovation framework aims to address such social and ethical concerns and has been integrated as a requirement in several institutions in Europe. Work by Ayris et al. (2024) focussing on the inclusion element of responsible innovation in the UK agricultural robotics sector identified that developers of agricultural robotics regularly undertake forms of consultation with some key stakeholders (e.g., farmers, academics, agricultural companies). However, there remains a lack of engagement with other stakeholders within the food industry, as well as citizens as stakeholders of the wider food system, for example, consumers, environmental groups and countryside users (Ayris et al. 2024).

Inclusion of these wider stakeholder groups is critical to responsible development of agricultural robotics. However, stakeholder groups outside the agricultural sector may have primarily encountered agricultural robotics through media narratives, and this may influence their responses to the technology. While such influence cannot be universally assumed and is not necessarily unilateral (Zhou and Moy 2007), we argue that a holistic approach to responsible innovation would benefit from further attention to both the narrative context and its potential to impact and inform understandings. This is particularly critical when considering agricultural robotics as an emerging technology (Rotolo et al. 2015), with as yet unknown potential impacts. As such, narratives of the technology are heavily influenced by elite vanguard visions (Hilgartner 2015), which may falsely present an impression of a single direction of innovation (Stirling 2024), closing down the possibility for a more inclusive range of stakeholders to express alternative visions for the future .

In order to understand the context in which agricultural robotics development is undertaken, this paper explores popular narratives of the technology through a media analysis of UK national and farming press. We aim to identify key narratives of agricultural robotics in UK media publications and discuss how these presentations may inform and impact implementations of the responsible innovation framework. This paper is structured as follows: We first explore narratives of emerging technologies within the literature and introduce the concepts that are used in our analysis. We then present our methodology for this work, followed by a presentation of the findings and a discussion of how the narratives found could influence ethical discussions of the technology, stakeholder engagement and the direction of agricultural robotics development. Finally, we discuss the wider implications for responsible innovation and reflect on how these can be addressed in future work.

2 | Narratives of Emerging Technologies

Emerging technologies are characterised by their novelty, growth, coherence, impact and ambiguity (Rotolo et al. 2015). These technologies are said to represent a new and disruptive innovation – whether that innovation is incremental or radical (Rotolo et al. 2015). Because these technologies are not yet embedded within society, their potential impacts are unclear and they often become the subject of ethical discussion. Key governmental and practitioner sources have identified robotics – and in particular autonomous robotics – as an emerging technology for the agricultural sector (Defra 2022; FAO 2022). While some automated agricultural systems have already become relatively commonplace, such as automated milking parlours (Bear and Holloway 2019; Burton and Farstad 2020; Vik et al. 2019), many other robotic technologies, such as automation of crop care, remain in early development (Defra 2022). Aerial drones and autonomous tractors are at a more advanced stage of development but face regulation and safety challenges (Agri-EPI Centre and Hands Free Farm 2022; Frankelius et al. 2019).

Our approach to considering narratives of agricultural robotics draws on a body of work examining patterns of narrative within public responses to emerging technologies. Below, we explore previous work that explores such narratives. This emphasises not only the importance of considering how narratives and framings relate to emerging technology but also identifies key concepts that we use in our subsequent analysis of agricultural robotics. This exploration of agricultural robotics through the emerging technology ethics conception of narrative allows us to pay particular attention to the ways in which news media presentations of emerging technologies may shape understandings and imaginations of the technology. We are thus able to reflect on the implications of these narratives for technology development within a responsible innovation framework.

2.1 | Responsible Innovation and Technology Narratives

Responsible innovation requires a reflexive and responsive approach to considering ethical challenges in the development of new and emerging technologies (Stilgoe et al. 2013). The goal of responsible innovation is to holistically explore and consider the potential impacts of technologies, such as agricultural robotics, through engagement with an inclusive and expanded range of stakeholders beyond those directly involved in the technology development – such as harder-to-reach and lay stakeholders. It aims to avoid the development of a technology without adequate engagement with those at the centre of, and most acutely impacted by, potential adoption (Von Schomberg 2011; Stilgoe et al. 2013). Responsible innovation approaches have been adopted and integrated across both international and national organisations – such as the European Commission, the Dutch Research Council, and the UKRI (United Kingdom Research and Innovation) funding body.

Investigation into farmer engagement with, and acceptance of, agricultural robotics systems is being undertaken, with work in New Zealand investigating the use of apple harvesting robots (Legun and Burch 2021), and studies in Europe examining farming stakeholder attitudes regarding agricultural robotics (Holm et al. 2024; Papadopoulos et al. 2025; Spykman et al. 2021; Uehleke et al. 2024). However, while these studies provide insights into stakeholder perspectives on the technology, many agricultural robotics development processes focus on stakeholders working professionally within the agricultural sector, and fail to include voices from wider society, including the non-human realm (Ayris et al. 2024). As such, a more substantive approach to inclusion is required, both in broadening participation from underrepresented stakeholders, and considering the wider context within

which such stakeholders form their views of both the agricultural sector and agricultural robotics.

Understanding how technologies are framed in media narratives can inform a wider understanding of the position of the technology within public discourse, in terms of both ethics of the technology, and critical questions surrounding its (potential) adoption more widely. Where an emerging technology is not yet widely adopted, media narratives can be shaped by 'vanguard visions' – presentations of a technology by influential, elite stakeholders, which can be deployed both in support of and in opposition to the technology (Hilgartner 2015). Despite representing the views of specific stakeholders in a sector, and often aligning with influential interests, a vanguard vision does not necessarily always represent the status quo (Polzin 2024). While vanguard visions have the potential to become collectively held visions, evolving into sociotechnical imaginaries (Jasanoff 2015) that are institutionally supported and entrenched within society, they also have the potential to be rejected and discarded (Flegal and Gupta 2018; Polzin 2024). Where responsible innovation is being pursued, these vanguard visions must therefore be encountered and presented critically and reflexively, to avoid assumptions that a vanguard vision represents a more widely held view and mitigate the influence of such an assumption on stakeholder responses to emerging technologies.

2.2 | Problem Scripts for Agriculture

In considering narratives of emerging technologies, we draw upon the concept of 'problem scripts' (Gugganig 2024) in our analysis of media presentations of agricultural robotics. Problem scripts are specific narratives frequently and repeatedly used to define the problems facing a specific sector. Common examples within the wider agricultural sector include challenges of population expansion and food production and environmental problem scripts regarding the state of soils and land use challenges (Lajoie-O'Malley et al. 2020).

Those developing robotic solutions for crops often cite labour shortages and the environmental impact of agriculture as the main problems that their innovations address (Baur and Iles 2023; Duckett et al. 2018; Duncan et al. 2021; Rotz et al. 2019). Academic literature examining the future role of agricultural robots in the food system has highlighted benefits to their widespread adoption, such as robots taking on dangerous farm jobs (Sparrow and Howard 2021), electrified robots reducing the carbon footprint of agriculture (Pearson et al. 2022) and robots facilitating the precision application of pesticides to reduce their use (Lu and Young 2020).

Scholars have also highlighted a range of potential negative consequences of agricultural robots, which are not directly aligned with the problem scripts commonly presented. There remain unresolved ethical questions for the development of agricultural robotics, including: the impact on farmer lifestyles and rural culture; the balance of positive and negative impacts on the environment; and the potential for labour displacement and increased inequality within the agrifood system should barriers to entry (e.g., cost, technical skills) for agricultural automation remain high (Ayris and Rose 2023; Daum 2021; Rose et al. 2021; Ryan et al. 2021; Sparrow and Howard 2021).

Identifying common problem scripts of agricultural robotics in the media is an important part of building a holistic understanding of the narrative context of the technology development. By understanding the problem scripts presented, responsible innovation processes can reflexively engage with how such narratives may impact responses to technology and question the framing of problems to elicit alternative anticipated futures.

2.3 | Promissory and Cautionary Narratives

Researchers exploring responses to emerging technologies have identified common narratives that represent the complexity of the ethical engagements at the heart of responsible technology development. The majority of these narratives can be categorised as either promissory or cautionary. Cautionary narratives often focus on the potential detrimental impacts of a technology and highlight how it may create new problems. Promissory narratives serve as a foil to these cautionary narratives, highlighting the benefits of a technology and how it may solve existing problems.

Narratives of emerging technologies have been explored particularly in the context of public responses to such technologies. Taking a case study of gene editing, Middelveld et al. (2023) explored responses to gene editing technology via focus group discussions in the Netherlands and identified five different primary narratives (a mix of cautionary and more promissory narratives): 'the technological fix'; 'the market rules'; 'in pursuit of perfection'; 'finding the golden mean'; and 'governance through care'. Similarly, the European Commission-funded DEEPEN project explored ways to enhance ethical engagement with nanotechnologies in the 2000s (Davies et al. 2009) and identified five common emerging technology narratives. These narratives were specifically associated with responses by lay stakeholders reflecting on ethical questions: 'be careful what you wish for'; 'Pandora's box'; 'messing with nature'; 'kept in the dark'; and 'the rich get richer' (Dupuy 2010; Macnaghten et al. 2019). As suggested by their titles, these narratives tend towards technological pessimism, striking a cautionary note regarding the impact of an emerging technology on society.

While these studies explored responses to specific emerging technologies, Swierstra and Rip (2007) identified patterns of argumentation and narratives common across technologies within a specific branch of ethics for new and emerging science and technology (NEST). Patterns of argumentation within NEST-ethics include discussion of boundaries (from cautionary narratives of 'playing God' to promissory narratives of scientific breakthroughs), as well as arguments of technology habituation wherein historical examples suggest that a technology will be ultimately acceptable to society (Swierstra 2015).

Similarly, based on a meta-analysis of previous public dialogues, Macnaghten et al. (2019) argue that three 'master narratives' exist: (1) a dominant narrative of scientific breakthrough, (2) an ancient counter-narrative of the transgression of natural boundaries and (3) a modern counter-narrative of public exploitation and

alienation. In this case, the dominant narrative is promissory, while the others represent more cautionary positions.

The categorisation of narratives as promissory and cautionary – in contrast to positive/negative or good/bad – leaves room for nuance in the narrative presentation. For example, cautionary narratives such as 'be careful what you wish for' acknowledge the potential of a technology to satisfy a desire or solve a problem, while cautioning against the potential for unforeseen, undesirable consequences (Macnaghten et al. 2019, 9). Equivalently, a narrative of technology habituation can acknowledge fears that may underpin adoption of a new technology, while simultaneously offering historical precedents to assuage those fears and highlight instead the potential benefits (Swierstra 2015, 12).

2.4 | An Inevitability Framing

Within NEST-ethics, Swierstra (2015) also highlights that ethical discussion often takes place following the technology's introduction into society – a retrospective ethical approach. While this approach allows for less speculation regarding the impacts of a technology, it may also lead to a notion that it is too late to turn back, as the technology has become both inevitable and crucial. Where such inevitability is introduced, there is a risk that the ethical debate is no longer a 'live' issue and the technology becomes morally acceptable – adoption becomes an assumption.

Identifying an inevitability narrative is therefore a critical part of understanding the narrative context of technology development. In examining the wider presentation of digital agriculture for sustainability in policy documents, Lajoie-O'Malley et al. (2020) found that these technologies were often framed as inevitable. Work by Sparrow (2007) also explored narratives of nanotechnology development, identifying narratives that present the technology as inevitable while simultaneously implying a precarity to its development that therefore requires public and institutional support to fully realise potential benefits. This parallels the findings highlighted by Lajoie-O'Malley et al. (2020) regarding the imperative nature of the environmental problem script, in which they discuss implicit and explicit suggestions that a failure to adopt digital agriculture technologies will put societies at risk.

More specific to agricultural robotics, the FAO have identified agricultural automation as an inevitable and ultimately beneficial technology, while acknowledging that the impact on labour displacement and inequality requires attention (FAO 2022). The imperative environmental problem script is also underlined, with the report highlighting the potential contribution of agricultural automation and robotics to several Sustainable Development Goals (FAO 2022, v) and citing an urgent need for its adoption. This underscores an acceptance of agricultural robotics as a technology offering resilience and adaptability in times of (climate) crisis. This perpetuates a narrative of inevitability, despite many robotic systems highlighted in the report remaining in the early stages of development and/or adoption (Defra 2022; Pearson et al. 2022). Where adoption is assumed and inevitability narratives are perpetuated, responsible innovation is less able to represent a reflective and responsive process. As such, the presentation of agricultural robotics within the media is an important contextual point when applying responsible innovation principles to this technology.

3 | Methodology

In this study, we explore narratives of agricultural robotics in UK media publications. We examine how the problem scripts of agricultural robotics are defined, how narratives are presented in the media and the temporal framing of the technology within the context of inevitability narratives. In making explicit these aspects of the media presentation of agricultural robotics, we aim to build upon established work considering narratives and vanguard visions of emerging technology to reflect on how an awareness of these aspects could be integrated into more substantive responsible innovation.

3.1 | Discourse Analysis

A key tool for making explicit the patterns of narratives, problem scripts and vanguard visions surrounding a technology is discourse analysis. These analyses permit an exploration of how a technology is being presented in textual representation (i.e., as an article with limited capacity for public response). Several studies have explored discourses of wider digital agriculture, considering texts such as policy documents (Lajoie-O'Malley et al. 2020; Marquis 2024), online media (Duncan et al. 2021) and industry and academic discussion (Baur and Iles 2023) and presentations in the print media (Barrett and Rose 2022; Marquis 2024; Rust et al. 2021; Simmonds et al. 2025). Narratives in these analyses were commonly found to positively frame agricultural technologies for sustainability, presenting them as solutions to problems of food security and environmental challenges (Barrett and Rose 2022; Lajoie-O'Malley et al. 2020; Marquis 2024; Rust et al. 2021). Discourse analysis of published texts can offer insights into constructed problem scripts and technology narratives and invite reflection on how those narratives may influence public discourse and visions of the future. In this study, we focus on understanding how constructed narratives of agricultural robotics are presented in UK media publications, and what the influence of that may be on inclusion and reflexivity within responsible innovation.

We undertake a discourse analysis of six UK publications, exploring the narratives and themes presented within articles discussing agricultural robotics in each publication. We follow examples of similar analyses of agricultural sustainability issues in the UK agricultural sector (e.g., Barrett and Rose 2022; Morris 2018; Morris et al. 2016; Rust et al. 2021) and apply the methodology to the context of agricultural robotics. We attend to the narratives presented in articles relating to the contribution of agricultural robotics and consider these as isolated texts. This choice was made to focus explicitly on the narratives of agricultural robotics as they relate to our key areas of interest regarding problem scripts, promissory and cautionary narratives and inevitability. Traditional media publications were selected to focus particularly on how narratives are presented to those outside the food industry, and who may be less familiar with both agriculture and robotics (in contrast to examining, e.g., policy documents or white

papers that might more commonly be accessed by professionals within the industry). The choice of these publications also allows an examination of vanguard visions as presented with limited capacity for public response, but future work could explore social media narratives to understand how these vanguard visions adapt in contexts that have more capacity for response and dialogue.

Existing discourse analyses of digital agriculture and agricultural technologies have focussed on exploring the breadth of agricultural technology within specific contexts (e.g., Barrett and Rose 2022, on the Fourth Agricultural Revolution; Marquis 2024, on sustainability of Canadian agriculture). While Baur and Iles (2023) have explored narratives of agricultural robotics within industry and academic discourse, there has otherwise been limited exploration of the media narratives of agricultural robotics specifically. Although analyses of discourse around digital agriculture in general may share some reflections with agricultural robotics, there are also social and ethical issues specific to agricultural robotics that may not be present in wider discussions (Ayris and Rose 2023; Ryan et al. 2021; Sparrow and Howard 2021). This discourse analysis seeks to address this gap while exploring the implications of narratives present in media publications for achieving substantive inclusion and reflexivity in agricultural robotics.

3.2 | Scope – The UK Perspective

We have elected to focus this analysis on UK media presentations of agricultural robotics. This allows an exploration of a national context in which agricultural robotics remains an emerging technology but is institutionally supported by government funding programmes. In exploring narratives of media within this context, we aim to provide insights that can be applied in similar national contexts where agricultural robotics remains in early stages of development. Further, UK media has a wide international readership (Thurman et al. 2021), suggesting the narratives identified in this analysis may apply beyond the United Kingdom.

In the United Kingdom, agricultural robotics remains predominantly in the early stages of development (Defra 2022), often with support from government funding programmes targeting agricultural innovation (Defra 2023). Presently, many platforms developed by developers in the United Kingdom have not reached the mass market. Where platforms are in use on-farm, this is often as a field trial with farming stakeholders who are involved directly in the development process (Antobot 2023; Fieldwork Robotics 2023; Muddy Machines 2021). Many robotics development processes in the United Kingdom have been funded by Innovate UK (which is part of UKRI) – these projects are therefore expected to demonstrate alignment with responsible innovation practices.

This technology development environment is similarly reflected in other national and international agricultural robotics sectors – particularly in mainland Europe, where there is a significant body of work exploring both the technical development of agricultural robotics and the societal acceptance of the technology (Papadopoulos et al. 2025; Spykman et al. 2022; Tamirat et al. 2023). As such, insights from the UK sector for inclusion and responsible innovation of agricultural robotics may be valuable to this wider international audience.

3.3 | Article Selection

The national publications selected were *The Guardian*, *The Times*, *The Daily Mirror* and *MailOnline*, and the farming publications selected were *Farmers Weekly* and *Farmers Guardian*. This selection followed a review of other discourse analyses of media presentation of issues in the UK farming and food sectors (Batel 2020; Cook et al. 2006; Harcourt et al. 2020; Holstead et al. 2017; Morris 2018; Morris et al. 2016; Rust et al. 2021). The publications represent the most frequently analysed papers across the political spectrum (based on a review of 10 similar studies of UK media). We also selected two publications representing the farming press, which are widely read by farming audiences predominantly in the United Kingdom, with a circulation in 2023 of 32,135 for *Farmers Weekly* (ABC 2023b) and 22,769 for *Farmers Guardian* (ABC 2023a).

We used LexisNexis to search the archives of these publications, using the following search terms: *agricultural robotics*, *agricultural robot*, *farming robotics* and *farming robot*. These terms were used to gain a broad view of agricultural robotics, without prejudicing the search criteria towards a particular type of robotic system (e.g., automated milking systems, drones). The search function also returned results based on variations for the search terms (i.e., 'farming' returned articles including the words 'farm' or 'farmer'). The search was limited to the period between January 2014 (based on the publication of the United Kingdom's Agri-Tech Strategy in 2013 bringing agricultural technologies to the forefront of UK agricultural policy, HM Government 2013, to June 2023 (present day at the time of document retrieval).

The search produced 3785 initial results, reduced to 2327 results after duplicates were removed. Subsequently, headlines were checked to confirm relevance, and articles that were unrelated to agricultural robotics were removed, leaving 250 results. This significant drop was a result of the search results returning articles with individual instances of the search terms – for example, mentioning robotics in one paragraph and agriculture in a later unrelated paragraph (e.g., in articles discussing political manifestos). These 250 articles were checked for relevance based on article content, and irrelevant articles were removed, to leave the final total of documents for analysis at 177 – a full list of articles is provided in the Supporting Information.

3.4 | Analytical Approach

The articles selected in this study are examples of media discourse, wherein the article itself is a purposefully constructed text (i.e., not spontaneously constructed as in a conversational dialogue), and the audience does not have the platform with which to respond directly to the content of the article (O'Keeffe 2012). We use a pragmatic approach to understand the contextual meaning of language and narrative within these articles. We did not perform a close textual analysis of specific patterns within language (Gee and Handford 2012), as the wider narratives of each article are the focus of this study.

The analysis considers three key concepts: problem scripts, promissory and cautionary narratives and the inevitability framing. These are explored in the previous section of this paper in detail. We draw upon the definition of 'problem scripts' as presented by Gugganig (2024), as common narratives that define the problems facing a specific sector. We take 'narratives' to be the way in which stories of agricultural robotics are told and draw upon established work on emerging technology narratives as discussed in the literature review. We take 'framing' to be the ways in which particular themes within a narrative are presented. Our application of these terms follows a similar exploration of narratives within emerging technology ethics, particularly NEST-ethics.

A thematic coding approach is used to conduct an analysis of the data (Braun and Clarke 2006). The approach combines both deductive and inductive approaches to analysis. One aim of this discourse analysis is to identify commonalities between the presentation of agricultural robotics in UK media publications and the narratives identified within the emerging technology ethics literature. As such, the initial deductive set of codes is based on the narratives of emerging technologies explored in the previous section. Articles are analysed to identify these codes and subsequently inductively coded to explore the further themes present in the articles (Braun and Clarke 2006). We take whole articles to be the unit of analysis, and the following results will be discussed in this context.

4 | Results and Discussion

In this section, we present three primary findings from our discourse analysis: (1) the problem scripts of agricultural robotics, (2) promissory and cautionary narratives of agricultural robotics and (3) the inevitability framing.

4.1 | The Problem Scripts of Agricultural Robotics

Many of the articles analysed presented robotics as a solution to problems facing the agricultural sector, both at a national scale within the United Kingdom and on a global scale. Three primary problem scripts were identified: a labour problem script, a population expansion problem script and an environmental problem script. These scripts align with the problem scripts found in other analyses of innovations in agriculture, such as those found in wider discussions of the Fourth Agricultural Revolution (Barrett and Rose 2022) and in vertical farming (Gugganig 2024).

The first problem script identified in the articles analysed was the labour shortage problem script. Sixty-eight articles (38%) referenced labour shortages, with an additional 13 articles (7%) addressing generational challenges around the ageing farmer population and a further 16 articles (9%) suggesting agricultural robots would take on dangerous and dull jobs to alleviate the burden on human workers. Labour issues have been frequently highlighted as a challenge for the agricultural sector. Following the United Kingdom's vote to leave the EU and the impact of the COVID-19 pandemic, the shortage of immigrant labour for harvesting has been a commonly cited motivation for the introduction of agricultural robotics (Defra 2022, 2024). The UK government commissioned an independent review of labour shortages in the food supply chain, addressing a shortage of entrants to a sector dominated by low-paid work with limited opportunities for promotion (Shropshire 2023). In that review, three of the 10 recommendations to address such challenges focussed on accelerating development of automation technologies for the sector.

A second common problem script was the need to 'feed the world' in the face of population expansion – a problem script also identified by Gugganig (2024) in her exploration of vertical farming technologies. Of the articles coded, 16 articles (9%) contained a narrative that referenced agricultural robotics as a technology to feed a growing population. A further 35 articles (20%) were coded as containing a techno-optimistic narrative of agricultural robotics (i.e., that technology will be key to creating a better world; Danaher 2022), a narrative that Lajoie-O'Malley et al. (2020) suggest is the natural response to the problem of population expansion.

The final problem script identified focusses on the environmental impacts of agriculture and the potential for robotics to be deployed to address these issues. Key points in this script include soil degradation and the potential benefits of lighter robots (30 articles, 17%), cutting chemical inputs (36 articles, 20%) and pollution (25 articles, 14%) on-farm through, for example, laser weeding. One promissory article states 'with the full force of climate change beating down, anything that allows farmers to produce more food in a more environmentally friendly way has to be seen as a good thing' (N12) – this imperative statement suggests that the urgent environmental problem script is to be prioritised over any other ethical concerns, including any concerns regarding the potential environmental damages from the use of agricultural robotics.

Many articles provided explicit motivations for adoption of agricultural robotics, and these motivations can be mapped to the problem scripts presented throughout the data as means to rationalise adoption of the technology (see Table 1). There were two motivations that did not map to the problem scripts identified: a profit motive that was often associated with the cost of living (although this motive often integrated discussions of labour shortages) and an animal welfare motivation, which was specific to a subset of robotics focussed on animal agriculture. The remaining articles mapped to the dominant problem scripts. The population expansion problem script was frequently supported by motivations regarding food security (21 articles, 12%) and yield/productivity (55 articles, 31%). The labour problem script was frequently supported by motivations regarding efficiency (55 articles, 31%) and economic factors (13 articles, 7%), while the environmental crises problem script was reflected in both the environmental benefit motivation (17 articles, 10%) and a broader focus on addressing climate change (27 articles, 15%) – see Figure 1.

These problem scripts play a crucial role in establishing the framing of agricultural robotics as a technological solution for the agriculture sector. Problem scripts are commonly used to support and legitimise technology development (Fairbairn et al. 2022; Gugganig 2024) and in some cases have been deployed by companies pursuing disaster capitalist approaches to secure their positions in the agri-food system (Reisman 2021).

TABLE 1 | Illustrative quotations reflecting the key problem scripts and associated motivations for the use of agricultural robotics.

Problem script	Motivation	Example
Labour challenges	Efficiency	'He said a fleet of six Earth Rovers armed with artificial intelligence technology enabling them to communicate with one another would do more work than 200 farmhands' (*Mail Online*: ref N111)
	Economic	'Some growers have already expressed interest, under pressure from rising minimum wage, with labour accounting for half of their costs' (*The Guardian*: ref N56)
Population expansion	Food security	'Food production around the world must rise by half in the next 30 years to sustain a global population expected to top 10 billion by 2050' (*The Guardian*: ref N23)
	Yield/productivity	'As the human population continues to expand and a changing climate threatens food production, the efficiency and production of farms will likely only become more critical' (*MailOnline*: ref N22)
Environmental impacts	Soil health	'It is also lightweight, helping reduce compaction of soils – a consequence of using traditional tractors – which will help improve soil health' (*The Times*: ref N48)
	Reducing chemical inputs/pollution	'Dick, the zapping robot, will remove the need to use chemical weed killers, which can harm other plants and animals' (*MailOnline*: ref N39)

While responsible innovation often focusses directly on the technology under development, an exclusive focus on narratives of the technology itself risks closing down alternatives. Reflexive responsible innovation should therefore also attend to the framing of a technology through problem scripts and question whether normative assumptions have been made both in the framing of the problem and the subsequent framing of the solution.

Our study identifies labour shortages, population expansion and environmental crises as the main problem scripts framing the introduction of agricultural robotics to the sector. In so doing, sustainable agriculture often becomes a question of sustainable intensification – increasing yields with electrified technologies that mitigate a lack of human labour. However, other potential problem scripts that may alter the framing or the nature of the proposed solution (such as those explored by Ayris and Rose 2023; Rose et al. 2021; Ryan et al. 2021; e.g., farming mental health, animal welfare and right to repair) were not present in the articles. Responses to agricultural robotics may change if the key problem script presented were improving sustainable land use or addressing the impact of resource extraction on workers and the environment.

As such, careful consideration of problem scripts is crucial to build a holistic approach to responsible innovation. Attention must be paid to opening up not just pathways for development of the technology but also discussion of the problem scripts facing the wider sector. The inclusion of stakeholders must not be solely in pursuit of developing a technology – it should look to create an inclusive understanding of the problem(s) to be solved, to then consider a wider range of potential solutions. Problem scripts left unexamined and unchallenged within agriculture can close down pathways and create demand for a technological fix, risking a cycle of ag-tech solutionism (Baur and Iles 2023; Guthman and Butler 2023). Attending to the narrative context of problem scripts presents an opportunity within the reflexivity pillar of responsible innovation to challenge common problem scripts and examine alternative perspectives of the agricultural sector and its potential future.

4.2 | Promissory and Cautionary Narratives

Articles in all publications were more likely to present agricultural robotics as a promising technology for the farming sector, with 60.5% (107) of articles describing agricultural robots in this way (see Figure 2). Few articles (11) offered a contrasting cautionary view (6.2%), with 9% of articles (16) presenting both promissory and cautionary arguments. The remaining 24% (43) of articles presented agricultural robotics in a neutral way – that is, the article offered a predominantly factual presentation of a technology. For example, many articles presenting agricultural robotics in comparatively neutral terms constituted 'user guides' in which the article presented a technical description of how a robotic system worked, without additional commentary on the implications of its implementation on-farm. Figure 2 shows the breakdown of narrative type by publication, with most cautionary articles presented by *The Guardian*, and *Farmers Weekly* publishing the most promissory articles .

Of those articles that had cautionary narratives of agricultural robotics, the majority focussed on the impact on labour and the potential for job losses associated with the technology – 16 articles with a cautionary narrative made explicit reference to robots replacing labour, with references to 'stealing our jobs' (*The Guardian*, N93), 'cost farm workers their jobs' (*The Times*, N81) and having 'consequences for rural livelihoods' (*The Guardian*, N16). Other cautionary narratives included alienation from food culture and underappreciation of tacit human farming knowledge, and one article highlighted fears around championing technosolutionism as a philosophy with which to address the climate crisis.

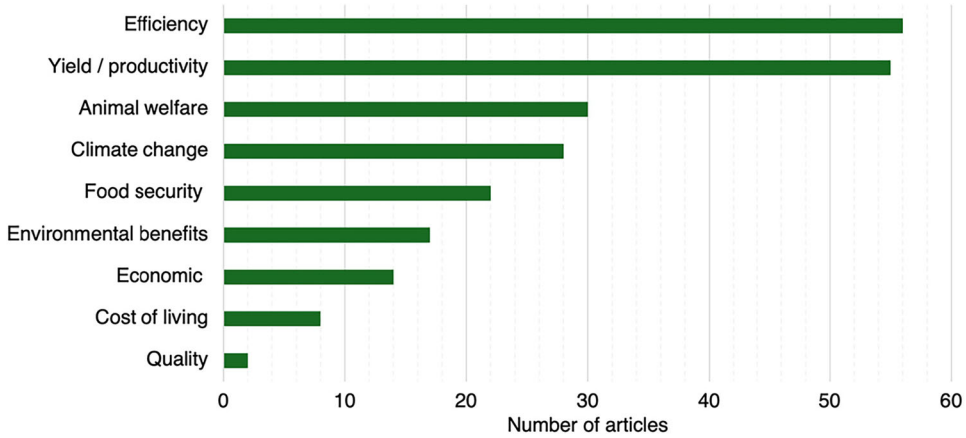

FIGURE 1 | Distribution of narrative type (cautionary, promissory or neutral) found within articles, by publication.

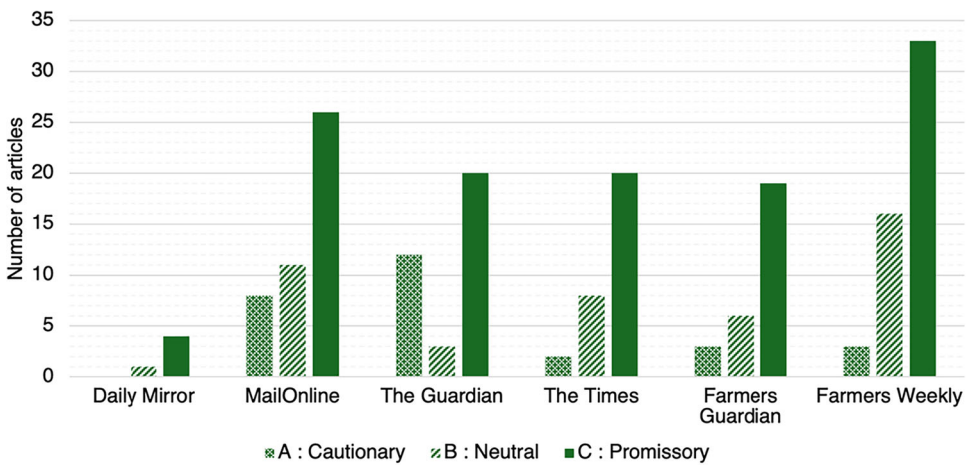

FIGURE 2 | Frequency of motivations suggested for adoption or potential adoption of agricultural robotics technologies on-farms.

Of those articles that had promissory narratives of agricultural robotics, many discussed agricultural robotics as a technological fix to common problem scripts, proposing the technology as a solution to address labour shortages, reduce costs for farmers and provide environmental benefits by reducing pollution and improving soil health. Despite the significantly larger number of promissory articles regarding agricultural robotics relative to cautionary articles in the farming press (see Figure 2), the impact of these narratives on the audience may be lesser, compared to that of the more widely read national media. Rust et al. (2021) highlight that while many farmers cite the farming press as the first place they are likely to learn about a new agricultural technology, they were also conscious of a tendency in the farming press for technologies to be framed positively.

Some themes that aligned with the narratives of emerging technologies were identified in the articles analysed, and these were particularly common in articles with an overall promissory narrative. The most common of these was presenting agricultural robotics as a 'scientific breakthrough' (34 articles, 19%). A related theme of 'science fiction turned reality' was present in 16 articles (9%), presenting agricultural robots explicitly as no longer the preserve of science fiction, using science fiction pop culture references or using science fiction imagery to describe agricultural robotics in use (see Table 2 for examples).

Both the presentation of agricultural robotics as a scientific breakthrough and the theme of science fiction turned reality emphasise the technology as being revolutionary for the sector, highlighting novelty and creating the initial hype that Borup et al. (2006) identify as an attention-building tactic within a hype–disappointment cycle for science and technology innovations. However, another common narrative within the articles was 'novelty to business as usual' – in which the novelty of agricultural robotics is argued to be limited, incremental or historically precedented. This reflects the notion of historical precedence and habituation within NEST-ethics, deemphasising the novel, radical nature of an innovation and its impacts (Swierstra 2015).

Although the narratives identified in this analysis can be broadly categorised as promissory, cautionary and neutral, they were less explicitly aligned with the narratives of emerging technologies elicited from examinations of public discourses in discussions of gene editing and nanotechnologies (Dupuy 2010; Macnaghten et al. 2019; Middelveld and Macnaghten 2021). Many of the

TABLE 2 | Illustrative quotations reflecting some of the key themes in discussions of agricultural robotics.

Theme	Example
Science fiction turned reality	'So a generation of young farmer entrepreneurs controlling an army of agbots via an app on their phone is not science fiction' (*The Guardian*: ref N12) 'the brave new world of mass production agriculture' (*The Times*: ref N78) 'A new Terminator-style robot could be set to kill weeds choking the countryside' (*MailOnline*: ref N104) '[the robot] identifies weeds and zaps them with jets of blue liquid from its mechanical tentacles' (*MailOnline*: ref N64)
Scientific breakthrough	'In a world first, the team behind the ambitious Hands Free Hectare project has broken new ground by growing and harvesting a spring barley crop solely using automated machines'. (*Farmers Weekly*: ref N174) 'Creating a robot with the deftness of touch to pick strawberries represents a breakthrough' (*The Times*: ref N58)
Novelty to business as usual	'In one sense this is merely the culmination of a trend that began with oxen pulling ploughs instead of people wielding hoes, then continued through the invention of threshing machines, tractors and combine harvesters' (*The Times*: ref N143) 'If you think about it that way, precision farming isn't new, as the principles have long been there. What has changed is the technology'. (*Farmers Weekly*: N90)

cautionary narratives explored in these public responses were underrepresented in this analysis.

Our analysis has identified a strong tendency towards promissory narratives of agricultural robotics within the UK media publications examined. As with the problem scripts of agricultural robotics, these narratives of the technology represent a closing-down point. Promissory narratives that lead on from a narrow set of problem scripts can create a sense of inevitability of a technology and support the institutionalisation of certain vanguard visions. In the articles analysed, agricultural robotics was frequently presented as a technological fix for the common problem scripts, as well as being presented as a scientific breakthrough – 'science fiction turned reality'. Similar narratives are reflected in institutional visions of agricultural robotics that depict an imagined future for the technology. The FAO of the United Nations describes agricultural robotics as 'unimaginable just a few years ago' (FAO 2022, iv) and states that 'saying no to automation is not the way forward' (FAO 2022, v). This highlights the way in which some vanguard visions of agricultural robotics – particularly from elite stakeholders within institutions like the FAO—can lead to a closing down of alternatives and an inevitability framing that can undermine the principles of democratic decision making.

Responsible innovation can lend a point of intervention to these technology development processes by considering the context within which stakeholders are presenting their views of the technology. To facilitate inclusion of stakeholders beyond the food system, it is especially important to consider the narratives that form their understanding of a technology. If those narratives close down pathways by presenting only one view (i.e., strongly promissory or strongly cautionary), responsible innovation processes can present an intervention opportunity to introduce, elicit and explore a more diverse range of narratives. By integrating work exploring public engagement responses to emerging technologies, facilitators of inclusive engagement in responsible innovation could introduce alternatives to the prevalent narratives for discussion and reflection. This process could mitigate the risk for stakeholder engagement in technology development to become captured by vanguard visions, which may otherwise lead to a technology becoming entrenched within the sociotechnical imaginaries of a sector without robust societal scrutiny.

4.3 | The Inevitability Framing

Of the articles coded, most described agricultural robotics as an imminent prospect – either a technology already in use or very soon to be deployed on farms. Seventy-four articles (42%) framed robotics in this way, with 19 articles (11%) considering the technology to be a more long-term prospect. Some articles were also more explicit in framing agricultural robotics as inevitable, with 35 articles (20%) presenting the technology as the future of the sector, or a necessity for modern agriculture.

As highlighted by Swierstra (2015), many ethical discussions regarding emerging technologies take place retrospectively, following the introduction of the technology to society. The pattern of this retrospective ethics can be seen particularly in articles that present the inevitability of agricultural robots as a replacement for human workers. One cautionary article poses the question: *'In the brave new world of satellite driven tractors and robotic*

milking parlours, where will rural communities and cultures fit?' (N16). Another article begins '*Technological unemployment is old news for farming […] the agricultural sector could offer some insight into what happens when machines take jobs'* (N12). Another article quotes a contributor saying *'[…] we think the priority should be creating more and good quality meaningful jobs'* (N107), in response to the prospect of robots replacing farm workers. These examples demonstrate a common retrospective approach to ethical issues raised in articles with an inevitability framing – that the inevitability of the technology will necessitate adaptation on the part of the communities affected (e.g., rural communities, farm workers), rather than adaptation of the technology itself, or a rejection of the technology in the first place.

Our analysis also found the implicit suggestion of agricultural robotics as both fundamental and inevitable for a sustainable agricultural future. The robotic systems presented in the articles are often introduced as solutions – 20 articles (11%) present the systems as a technological fix, connecting to framings of ag-tech solutionism (Guthman and Butler 2023) and a cycle of technologies developed to solve problems born of previous technological developments (Baur and Iles 2023). This may reflect the elite sources of vanguard visions of the technology, with articles informed by press releases from technology developers or visions expressed by institutions such as the FAO.

The inevitability framing found in many of these articles demonstrates the potential for technology development to proceed without due ethical consideration. While frameworks of responsible innovation are intended to avoid irresponsible approaches to technology development, they may fail to do so if they do not account for the impact of perceptions of inevitability on public views of a technology. They may risk becoming compromised by an anticipation of the future based on the assumption of inevitability, which thus excludes the reflexive anticipation of alternative futures with different development pathways.

To facilitate inclusive responsible innovation that is at less risk of failing to consider diverse futures, facilitators may bring an awareness of the narrative context of an emerging technology to enhance the responsible innovation process. This could facilitate deeper reflection and responsiveness from participants, by making explicit the normative assumptions inherent in popular narratives relating to the technology under discussion.

5 | Conclusion – Responsible Innovation and Media Narratives Moving Forward

The aim of this study was to identify common media narratives of agricultural robotics in the United Kingdom, to provide insights for facilitating more substantive reflexivity within institutionally required responsible innovation processes. In examining these narratives, we have identified a need for greater emphasis on consideration of the narrative context of a technology when undertaking responsible innovation with broader pools of stakeholders.

Through our analysis, we identified three common problem scripts – the labour shortages script, the population expansion script and the environmental crises script. We analysed the narratives presented within the articles in our study and categorised them as cautionary, neutral and promissory. In so doing, we found that the majority of articles presented promissory narratives about agricultural robotics, regardless of the publication type. Common cautionary narratives that have been previously identified in public responses to other emerging technologies, such as caution regarding interfering with nature, the potential for technologies to only benefit the wealthy or narratives of public exploitation and alienation, were not present in most of the articles analysed. Finally, we found that agricultural robotics was often framed as an inevitable technology that could solve many societal challenges, despite many robotic technologies for agriculture remaining at an early stage of development.

5.1 | Limitations

Our analysis is based on articles that constitute purposefully manufactured texts rather than spontaneous narrative discussions, so they are not necessarily representative of a public dialogue. Many of the voices within these articles are informed by the agricultural robotics industry, which may skew the articles towards promissory narratives. Although this study has focussed explicitly on the text of the articles, future work could also explore the wider context of how the articles are constructed, which voices are influencing the authors and editors of the publications, how visual narratives are presented alongside the text (e.g., accompanying photographs/illustrations) and how audiences respond (e.g., online interactions and comments).

There is further work to be done to understand the broader narratives in agricultural robotics in relation to their impact on substantive inclusion in technology development. This study has focussed on the presentation of visions within the press, but this represents only one facet of the ongoing debate around this technology. It would therefore be interesting to explore the vanguard visions presented to stakeholders working directly with the food system and to what extent the presentation of such visions varies based on the position of the audience in relation to the food system. A further exploration of how visions defined within the professional space of the food system may influence those presented within the media would also be valuable, to further contextualise engagement activities and construct spaces in which participants can explore a wider range of alternative pathways in their engagement with technology.

5.2 | Implications for Responsible Innovation

That the articles in the UK media are skewed towards promissory narratives underlines the importance of substantively engaging a wider range of stakeholders, to elicit alternative views in response to the ethical concerns raised around the technology. The findings of our study also highlight the need for the reflexive design of responsible innovation engagement activities to avoid default promissory narratives going unexamined and instead facilitate a substantively inclusive lay ethics quest, in which participants actively shape their responses to technology beyond the constraints of imposed narrative structures (van der Burg 2016).

With responsible innovation integrated into innovation requirements by multiple institutions, particularly in Europe, stakeholder inclusion becomes a fundamental expectation in many technology development processes. However, the practical implementation of responsible innovation in technology development does not always reflect the aims of the approach. Our findings demonstrate the potential for responsible innovation to be captured by vanguard visions of a technology that lead to an assumption of inevitability. With vanguard visions defined by elite stakeholders, where they are uncritically presented in news media to lay stakeholders, they can become entrenched as inevitable imaginaries. This can lead to linear development of solutions without due ethical consideration or democratic consultation and the disempowerment of citizen and non-human stakeholders. For responsible innovation to be a substantive exercise that is opened up to the directionality of innovation (Stirling 2024), activities that aim to include stakeholders in a process of responsible innovation must be designed in conscious awareness of the narratives present in media.

Attending to the narrative context within which responsible innovation is expected to be undertaken is critical in facilitating substantive responsible innovation. Facilitators of responsible innovation can build more substantive inclusion by first developing a deeper understanding of the narrative context surrounding particular emerging technologies, through methods such as the discourse analysis presented in this paper. Subsequently, the use of approaches such as card-based scenario workshops, which are designed to avoid introducing bias by avoiding the use of direct expert testimony (Felt et al. 2009), can open up spaces in which stakeholders have more opportunity to explore possible futures beyond pre-defined narratives expressed through vanguard visions of technologies. The use of science fiction language in the articles analysed also hints towards the potential for more creative approaches – the use of fiction to allow participants to build and discuss their own visions of the future could be a powerful tool for reflexive participatory engagement (Miller and Bennett 2008; Braun et al. 2024). Future work could explore the application of these methods in this context, to identify how attending to narrative framing may support more substantively inclusive anticipation of technology futures.

This study shows that one of the ways in which plural possible futures in the development of emerging technologies can be closed down is through the narratives of media discourse, particularly where narratives are shaped by elite stakeholders with the power to define vanguard visions of technologies. This case study of UK agricultural robotics development shows an emphasis on particular problem scripts, promissory narratives and the inevitability framing, assuming a single certain future for the technology. To challenge the potential for responsible innovation to direct innovation towards 'inevitable' technological fixes, it is crucial to attend to the context of media narratives in responsible innovation exercises and design substantive responsible innovation engagements that mitigate potential biases introduced by vanguard visions and narrowly defined problem scripts. This understanding can prompt reflections on how inclusion and engagement are undertaken, how questions are asked and problems are represented, and how the 'directing' of innovation can be challenged. Responsible innovation has the potential to represent a critical intervention point in technology development processes and apply reflexivity not only to the technology itself but also the wider context within which stakeholders are responding to that technology. This could represent an important step in building an approach to technology development that opens up alternatives to realise truly responsible innovation.

Author Contributions

All authors contributed to the study conception and design. Study preparation, data collection and data analysis were performed by Kirsten Ayris. The first draft of the manuscript was written by Kirsten Ayris, and all authors commented on previous versions of the manuscript. Additional writing was done by Anna Jackman, David Christian Rose and Alice Mauchline. All authors read and approved the final manuscript.

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Ethics Statement

Ethical approval was not required for this study, as the dataset exclusively comprises publicly available published newspaper articles and did not involve any human or animal participants.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study is included in this article as supplementary material.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.

Supporting Information: Appendix 1 – Summary of documents used in analysis (via LexisNexis search).