sustainability

MDPI

Article

The Digital Transformation of the Agricultural Value Chain: Discourses on Opportunities, Challenges and Controversial Perspectives on Governance Approaches

Katrin Martens [1,†] and Jana Zscheischler [1,2,*,†]

[1] Land Use and Governance, Leibniz Centre for Agricultural Landscape Research, Eberswalder Str. 84, 15374 Müncheberg, Germany; katrin.martens@zalf.de
[2] Geography–Faculty II, University of Vechta, Driverstr. 22, 49377 Vechta, Germany
* Correspondence: jana.zscheischler@zalf.de
† These authors contributed equally to this work.

Abstract: The extent to which the digitalisation of agriculture will make a significant contribution to solving urgent sustainability challenges will depend on the design of political, legal and economic frameworks. In this context, social discourses play a central role as they not only reflect collective interpretations and systems of meaning but also reproduce power relations in "truth regimes" and prepare policy actions. While a critical scientific debate on unintended side effects of the digital transformation on agriculture has recently emerged, there is little knowledge about the discourse relations beyond academia. This article presents the results of a discourse analysis during a two-day online conference on the digital transformation of the agricultural value chain. We systematically visited and analysed sessions and presentations. The aim was to identify the main themes, concepts and ideas and different perspectives among actors from science and practice. The results show a wide range of perceived opportunities and challenges but also controversies, especially regarding governance issues such as regulation versus nonregulation, centralised versus decentralised data sharing, the appropriate design of data sovereignty models and trust and evolving inequalities. In addition, it became apparent that discourses on digitalisation are largely expert affairs. We discuss and conclude that a sustainability-oriented digital transformation requires a critical perspective, reflexivity and an adaptive governance approach where science–society collaborations play a central role.

Keywords: sociotechnological transition; digitalisation risks; responsibilisation; agrifood systems; digital divide; responsible research and innovation; technology assessment

check for updates

Citation: Martens, K.; Zscheischler, J. The Digital Transformation of the Agricultural Value Chain: Discourses on Opportunities, Challenges and Controversial Perspectives on Governance Approaches. *Sustainability* **2022**, *14*, 3905. https://doi.org/10.3390/su14073905

Academic Editor: Donato Morea

Received: 17 February 2022
Accepted: 23 March 2022
Published: 25 March 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

We are currently facing significant sociotechnical transitions along the agricultural production chain, summarised under the term "agriculture 4.0". The digitalisation of agriculture is expected to fundamentally and disruptively transform our agrifood systems with still unknown consequences and socioecological implications [1–4]. The advancement of information technologies such as the Internet of Things, cloud computing, big data analytics, and artificial intelligence (AI) is greatly accelerating the digitalisation process. These new technologies form the basis of a paradigm shift in the evolution of digitalisation that is leading to a new stage of cyberphysical integration [5,6]. Progressively, the physical and virtual worlds are converging towards the digitalisation of all processes of the agricultural value chain, which will allow the development and implementation of dynamic digital representations of real-world systems, including real-time feedback monitoring, direct consumer–producer interaction, planning, prediction and a high degree of automation and optimisation to become achievable [6–9]. Digital infrastructure will become inextricably linked to all processes of agricultural production and the value chain [10].

Food and agricultural production are confronted with great global challenges. In the future, it will be necessary to supply a growing world population with healthy food and clean water to combat advancing climate change and its consequences for agriculture, while at the same time preventing a further loss of biodiversity and protecting natural material cycles [11,12]. In this context, digitalisation is considered to provide promising means to improve current agrifood systems and enhance sustainability. Among others, digital technologies allow for precision farming that may attenuate the environmental externalities of agriculture while enhancing efficiency, productivity and profitability for farmers [13]; furthermore, blockchain management provides more transparency along value chains and may increase trust from consumers [14–16].

However, research has only just begun to empirically study the potential opportunities and challenges posed by digital transformation [1,17,18]. Nevertheless, it remains to be determined whether digitalisation will fulfil all its promises for more sustainable agricultural production. In the past, the major technical upheavals in agriculture, such as mechanization or genetic engineering, were always associated with many undesirable effects, such as environmental degradation [19]. It will, therefore, be essential to shape the digital transformation in a sustainable way.

The extent to which digitalisation will make a significant contribution to solving the urgent sustainability challenges, we argue, depends on the design of political, legal and economic frameworks. In this context, little attention has been given to the design of socially responsible innovations to steer the digital transformation in agriculture [1,20,21]. However, digital transformation is an ongoing process whose future technological development and its effects are highly uncertain and hardly assessable in advance. Developments in very different ways, and thus quite different future outcomes, are conceivable [22]. What form such transformation will take certainly depends on the steering of intervention and governance measures taken in the present. How it is shaped politically and legally will depend on how the developments of the digital transformation are assessed and perceived by the actors with influence, and which collectively shared meaning structures are established with regard to the consequences [23].

In this context, social discourses play a central role as they not only reflect collective interpretations and systems of meaning but also reproduce power relations in truth regimes and prepare policy actions [24–26]. Discourses are the starting point for adaptive action and policy development towards perceived problems [27]. Discourse studies not only reveal how different actors try to influence the definition of a problem. Their analysis also helps to explain the mechanisms by which certain policies are developed and others are not. Critical discourse analysis can, thus, help to identify and draw attention to gaps in political adaptation and governance processes at an early stage [28]. Based on this, Rijswijk et al. [29] highlighted the role of problematisation and responsibilisation within shared discourses to shape a socially responsible digital transformation in agrifood systems.

This article presents the results of a discourse analysis on the digital transformation of the agricultural value chain during a two-day online conference. We systematically visited and analysed sessions and presentations. The aim was to identify the main themes, concepts, ideas and perspectives among actors from science and practice with regard to the perceived opportunities, challenges and controversies posed by the digital transformation in agriculture. In contrast to the emerging scientific discourse on ethical concerns and socioecological implications of digitalisation in agriculture [17,30–33], we argue that the focus of this study may complement existing knowledge by providing insights into the process of problematisation and responsibilisation outside academia.

The following questions guided our exploration: How is the digital transformation in agriculture currently perceived and discussed by different actors? What are the potentials, challenges and controversies documented in the current discourse on the digital transformation in agriculture? Which topics determine the discourse with regard to the development of appropriate governance instruments?

In this article, we use the terms "digital transformation" and "digitalisation". In line with Rijswijk et al. [30], we define digital transformation as a fundamental and ongoing sociotechnological change process in which digitisation and digitalisation increase over time. Digitisation describes the process of converting analogue information into digital form. In contrast, digitalisation refers to "the sociotechnical processes surrounding the use of (a large variety of) digital technologies that have an impact on social and institutional contexts" (ibid.).

2. Methodological Approach

As described above, in this study we have adopted a discourse analytic approach to better understand current societal meaning- and decision-making processes related to the digitalisation of agriculture. In this way, we highlight and acknowledge the central role of societal discourses in shaping policies.

2.1. Discourse Analysis

The term "discourse analysis" is related to a wide variety of methodological approaches from different disciplines and there is no coherent theory. There are linguistic approaches that especially concentrate on language and linguistic structures and there are sociological perspectives focussing on processes of social meaning making. In this context, discourse theory and analysis proceed from the assumption that human beings collectively produce symbolic systems of meaning and orders of knowledge about the world (e.g., [34]). Most influential to a whole range of discourse theory approaches has been the work of Michel Foucault. According to Foucault [35], discourses constitute truth regimes, reflect power relations and serve to regulate the system of power in a society. This means that discourses can be seen as arenas in which truths and realities are defined by those in power. Foucault's work inspired a whole range of discourse analytical approaches such as critical discourse analysis [36], argumentative discourse analysis [37] or the sociology of knowledge approach [38].

In this study, we follow a Foucault-inspired discourse analytical approach recognising that there is no ultimate truth but rather social processes of discoursive constructions of truth and reality. Discourses can be defined as a collection of performative statement practices, objects, ideas and concepts that mutually constitute stable meaning systems [24]. In this backdrop, we understand discourse analysis less as a fixed methodological procedure than as a theoretical framework that guides our analysis. Discourse analysis can therefore make use of various qualitative methods in the analysis and include a variety of qualitative materials such as documents, qualitative interviews, group discussions, videos, etc.

We decided to observe the discourse on digitalisation of agriculture during a two-day online conference where experts from science, practice, politics and civil society met for exchange. The digitalisation of agricultural production is a complex topic whose competent discourse largely requires specialised knowledge. At the moment, the discourse on the digitalisation of agriculture mainly takes place in professional expert circles and receives little attention from the public. Scientific conferences thus serve as platforms for knowledge exchange between scientists, policy makers and practitioners and as places where results are presented, ideas are discussed and networks are built. Conferences are important arenas for discourse on the latest developments in innovation and research.

2.2. Event Overview

The European digital conference titled "Digital Transformation of the Agricultural Value Chain—Opportunities, Challenges and the Role of Science" invited actors from politics, academia and practice. A special focus was placed on science–practice discussions rather than being a scientific conference dominated by academic perspectives and presentations. The conference was organised by the German Federal Minister of Agriculture due to the German EU Presidency in 2020. In addition to the German government, the European Commission and EURAGRI, a nonprofit organisation dealing with research and

innovation in the agrifood sector, co-organised the conference [39]. The event took place over two days, from 2 to 3 December 2020. In addition to an opening session led by political representatives and three keynotes introducing the conference theme from legal, policy and governance perspectives, two parallel tracks involved a series of sessions. Track 1 focused on "The sustainable digital transformation of the agricultural value chain" and mainly included presentations from researchers working within all parts of the food value chain, except for one slot for which representatives from different umbrella organisations (COPA-COGECA, EEB, CEMA and Bitkom) were invited to discuss the question "What is needed from policy makers (EU/national level) to make the digital transformation of agriculture a success for all stakeholders?". Track 2 was titled "A governance framework for agricultural data." Here, scientists, policy makers and practitioners provided information on the current state and development of a European Open Data Space and its challenges.

According to the organisers, up to 1000 participants took part. A survey of 208 respondents conducted during the conference showed that most of the participants were from academia (49%), followed by politics and administration (24%), associations and interest groups (9%) and industry (10%); a small proportion of participants were agricultural extension service professionals (6%) and practitioners (1%).

Speakers from different fields and disciplines presented their work. A total of 14 EU countries were represented, with Germany, as conference host, sending 11 speakers, Belgium sending 7 speakers, many of whom were from the European Commission, Ireland and the Netherlands sending 3 speakers each, Denmark sending 2 speakers and the remaining countries sending 1 speaker each. One contribution came from an Australian scientist. The speakers' areas of expertise were wide ranging, covering the fields of ethics, political science, agriculture, law and technology. In addition, there were contributions from politicians, farmers and other practitioners working on the implementation of new digital solutions (see Supplementary Materials for more details on the speakers' background).

2.3. Data Collection and Analysis

All sessions were recorded by the organisers and could later be accessed by streaming on the conference website for up to three months. To explore the discourses during the two-day event, we used ethnography and participated in all sessions, recorded presentations and discussions by systematically taking notes and documenting contents. We focused our notes on stated opportunities and challenges associated with the digital transformation but also on controversies. Notes that seemed relevant to these foci were cross-checked with the recorded sessions. Data were collected through nonparticipant observation [40,41] as we did not interact with the presenters or with other attendees due to the online format.

Data processing was performed manually and the material was openly coded. To structure our analysis, we focused on main themes, argumentations, concepts, ideas and perspectives among different actors about the digitalisation of agriculture. Over a multistage process, the information was condensed and assigned to the categories "opportunities", "challenges" and "controversies".

3. Results: Main Themes of the Discourse on the Digitalisation of the Agricultural Value Chain

Table 1 provides an overview of the main topics of discourse clustered as "opportunities", "challenges" and "controversial issues" addressed during the two-day event. The table shows that the participants perceived numerous opportunities but many challenges as well.

Table 1. Overview of opportunities, challenges and controversial issues discussed during the event.

3.1 Opportunities	3.2 Challenges	3.3 Controversial Issues
Enhances the sector's sustainability performance; makes the sector more resilient; more precise, productive and efficient farm work; enables the use of better prediction models; reduces administrative burdens on farmers; reduces costs, working hours and administrative efforts; increases transparency for consumers; proves law compliance; enables fairer subsidy system; makes the farming profession more attractive to younger generations; strengthens competitiveness; increases societal appreciation for farmers and food production.	Unequal access to broadband connection; digital divide due to high costs and unequal financial power; adaptation requirements: new skills and qualifications; loss of "traditional" farmers' knowledge; perceived risks of user disempowerment; tailored advisory services; data sovereignty requirements; high number of stakeholders and their interests; new global players with high financial power and know-how; legal and technical challenges; constant sociotechnological evolution; data diversity.	Governance of digital transformation: arguments in favour of more regulation; arguments against stronger regulation; data ownership and data sovereignty models; centralised versus decentralised data platforms; understanding the value and new role of data; addressing the digital divide; the role of the EU; trust as the basis for success.

3.1. Opportunities and Benefits of the Digital Transformation of the Agricultural Value Chain

Digitalisation and digital technologies were associated with many opportunities and great advantages. Political and economic actors repeatedly emphasised the potential of digitalisation, particularly with regard to more sustainable practices. Many stakeholders expressed their conviction that digital transformation will improve the sustainable performance of the agricultural sector while making it more resilient, for example, by enabling better predictive models.

However, digitalisation is also seen as an opportunity to significantly improve production and working conditions for farmers. It was frequently mentioned that farmers would be able to work more precisely and increase their efficiency with new digital solutions. The creation of digital platforms is expected to reduce administrative work, costs and time. The application of blockchain technologies and the measurement of agricultural activities are expected to increase transparency for consumers, prove compliance with laws and show possible successful outcomes of measures. It was argued that digitalisation could also help create a fairer subsidy system that is no longer primarily based on agricultural land but instead is focused on ecosystem services.

Politicians speaking at the conference stated that linking agriculture to new digital solutions would encourage younger generations to work on farms and make the farming profession more attractive. It was argued that new digital solutions would reduce working hours for farmers, which will lead to less work and more flexibility for farm households. In turn, this will also increase farmers' appreciation for and willingness to invest in new digital solutions. In general, digital transformation is considered to strengthen competitiveness.

In principle, it was largely assumed that digitalisation would increase societal appreciation for farmers and food production.

3.2. Challenges and Perceived Unintended Side Effects

One of the most frequently mentioned challenges facing the digital transformation of the agricultural sector concerned unequal access to fast, stable broadband connections, which had created a digital divide between areas with and without broadband access. However, the problem of a digital divide was also seen due to unequal financial opportunities of

large and smaller farms and the high initial costs of new digital technologies. Remarkably, the latter argument was not very well received overall; it was only raised by individuals and dismissed as meaningless by EU representatives, who argued that not every digital technology would be cost intense. The dominant narrative was that digitalisation benefits everyone equally.

Another challenge mentioned concerned the new profiles and adaptation requirements of future farmers. Participants noted that farmers could be at risk of becoming mainly data analysts dependent on technology and with little knowledge of traditional farming. The loss of "traditional" knowledge could also lead to a loss of power for farmers and greater dependence on large companies providing these technologies and associated support services.

In this context, the need for extension services was emphasised to develop tailored means for farmers to present these new solutions in a common language. This would require training for all actors along the agricultural value chain and was identified as an urgent challenge.

In this regard, there were also concerns about the lack of a common understanding of data sovereignty and about the varying perspectives and interests of different stakeholders. The great diversity of the sector was mentioned as a challenge for governance and the implementation of policies.

Furthermore, the constant sociotechnical evolution, the increasing interest in the agriculture of large global players with high financial power and digital know-how (such as Amazon and Google), the speed of innovation they offer and their difficult-to-predict and complex effects pose intricate and difficult governance challenges. In this context, it was also stressed that new agricultural practices would need time to show effects, such as in terms of soil quality, making it difficult to propose new technologies or evaluate them in terms of their sustainability potential.

Last but not least, the diversity of data is also a challenge, which was discussed at the conference. The way raw data are collected, processed and stored varies widely, and there is currently no common standard. As a consequence, agricultural data and public data are difficult to integrate into a single system. This leads to challenges for the development of a functional knowledge service platform.

3.3. Controversies: How Should the Digital Transformation of Agricultural Value Chains Be Governed?

The central controversies during the two-day event lay in the question of a suitable governance approach to shaping the digital transformation in a socially responsible way. The constant sociotechnological evolution of digitalisation poses a significant challenge to a suitable governance framework. National policy makers noted the difficulties of developing effective policies regarding digital transformation, as the process of digital transformation does not follow the usual policy processes. Governments have constantly lagged behind sociotechnological developments, making it difficult to implement smart measures. In addition, it was mentioned that the food sector is particularly difficult to regulate due to the great diversity and power imbalances of the stakeholders. Governments would have to proceed carefully to avoid harming any actors. Despite efforts made by the EU, it was apparent that a coherent governance approach is currently missing. Participants indicated that the proposed common EU data space was too abstract and would need to be clarified, for example, in terms of responsibilities.

In the following, we describe controversial topics related to the governance issue that emerged in the course of the event.

3.3.1. Arguments in Favour of and against More Regulation by the Public Sector

The topic of how much digital transformation should be regulated by the public sector was a main controversial theme. Proponents of regulation sought a framework that sets important limits on users and buyers of technologies and data to prevent abuse, ensure that

sustainable goals are considered and achieve a fair distribution of profits among stakeholders. These individuals also argued that the existing market rules surrounding digitalisation were established not by the agricultural sector but by other industries that might have different interests and needs that are not aligned with those of the agricultural sector.

A need for regulation is seen in particular in the handling of data. Although the Code of Conduct of 2018 [42] established by agricultural sector umbrella organisations was seen as promising, it was referred to as outdated. Scientists highlighted the importance of distinguishing between a binding contract and a loose code of conduct that leaves much room for interpretation. A specific recommendation in this context was to establish legal provisions so that companies wishing to buy data are responsible for ensuring that the contracting parties understand the contracts. Contractual partners without legal training often avoid contracts or do not understand agreements sufficiently. Official rules for contracts at the EU level, for example, on the purchase of data, were considered useful not only to secure all contracting parties but also for the evaluation of the actions of private companies. This approach was seen as necessary to assess the actions and impacts of major players because there is currently a perceived power asymmetry due to the different digital capacities and skills of the public and private sectors.

In addition, it was mentioned that the arrival of new global players (such as Google and Amazon) in the agricultural and food sector should be critically observed and regulated if needed. For instance, questions were raised about programming algorithms and who should determine what such algorithms should focus on if there are no binding regulations on everyone. This argument was repeatedly used in the conference and articulated through the use of metaphors describing digitalisation as a "tool" or "child" that politicians and scientists must ensure is used correctly such that it does no harm.

Other needs for regulation were noted in reference to ensuring sustainability. It was argued that regulations are important to improve sustainability measurements. One suggestion was to integrate environmental costs by major players to balance unequal power systems. Some participants discussed regulation in regard to public good provision and, thus, sustainability. Digitalisation was described as a tool that could help achieve the EU's sustainability goals. In addition, it was mentioned in general terms that the agricultural sector faces great pressure due to digitalisation and that the Green New Deal had intensified this pressure.

The opposite viewpoint was expressed by opponents of regulation who fear that regulation will harm the European market and prevent important innovations in the field from developing. It was argued that the market is responsible for steering digital transformation. The Code of Conduct established in 2018 by market participants outlines the ability of private stakeholders to self-regulate. Those against regulation argued that it is the task of the EU to promote innovation, invention and diffusion at any scale, not to prevent it. It was argued that regulations and laws have to be made by those who are responsible for and participate in the market. Furthermore, it was argued that digitalisation creates uncertainty and that rules implemented now may not be relevant for future agricultural development, as it is not possible to regulate something that is unknown. While stakeholders in favour of governmental regulation viewed technical innovation as a tool that requires rules to be used socially and responsibly, stakeholders against governmental regulation argued that innovation can provide solutions for trustworthy data sharing and other challenges we are facing today.

3.3.2. Data Ownership and Data Sovereignty Models

Data sovereignty and data ownership were major themes at the conference and were most often mentioned in regard to securing farmers' rights and opportunities. Scientists repeatedly highlighted data sovereignty as a precondition for farmers' acceptance of data-sharing activities. However, how data sovereignty is interpreted differs by perspective. It was mentioned that thus far there is no common definition of the term and that it is

not possible to ensure data sovereignty due to a lack of interoperability and trustworthy data exchange.

Cognitive barriers due to different knowledge backgrounds and professions became apparent, which was argued as hampering building trust and creating an equitable innovation ecosystem. To move towards a more equitable system, it was said that capacity building and extension worker training are crucial, especially at the farm level. In this discussion, there was debate on whether data are a private or common-pool resource. It was argued that viewing data as a common-pool resource will slightly change its definition as a collective means for governing common-pool resources, while considering data as a private good will emphasise topics of data ownership and protection. Elaborating on this, it was mentioned that, depending on how such value is defined, different data sovereignty models would be needed to ensure a fair distribution of value. It was stated that not all businesses create value for everyone, as most investor-owned companies primarily serve their shareholders' interests. One scientist argued that such a new data sovereignty model could be adopted by data cooperatives primarily committed to their members and representing farmers' interests. Depending on what value is received from data, new data sovereignty models could be needed to use this value sustainably. The idea of the traditional agricultural value chain, starting with input and ending with an output whose value is measured by the market and the idea of "creating more and more value", was seen as outdated.

It was also claimed that farmers would share their data once they see a benefit from this approach, mainly in the form of financial resources. Some scientists mentioned that this is not how the system works anymore, as farmers are concerned with what happens to the raw data they provide, and the willingness to share data and information will depend on the trust of stakeholders and the right to withdraw from the system. Others stated that farmers are not aware that they are already being exploited, as spatial data and data from machines are already collected without farmers profiting from them.

3.3.3. Centralised versus Decentralised Data-Sharing Platforms

In terms of how data sovereignty should be governed, data platforms and a common data space were discussed. Some scientists argued that data platforms must first be regionally focused through a bottom-up process and then, with acceptance from farmers, rolled out nationally or across Europe. In contrast, the EU is promoting a top-down approach, namely, a common EU data space that should be implemented from the top and that might represent several platforms. Two types of platforms were proposed: a technology platform that might be of interest to large companies fostering new business opportunities, while a data-sharing platform would aim at data management topics to reduce bureaucratic transaction costs for farmers and the public sector. This second platform may also serve to pay subsidies and provide important information that farmers need. While there were also voices from practitioners in favour of a decentralised data platform, the adoption of a few centralised platforms was preferred by politicians and academics.

3.3.4. Understanding the Value and New Role of Data

Conference discussions expressed that digital transformation was perceived as a disruptive process that would change the entire agricultural sector and create value. With this comes a restructuring of the agricultural sector and a reorganisation process from which all stakeholders can benefit from the value of new technological solutions. It was mentioned several times that there is no common understanding of who can attach value to data or how to measure it. It was also highlighted that the point is not to collect data but to determine its financial value. Nevertheless, it is unknown how much value creation will result from data usage. Estimations presented by an EU representative forecast that by 2025, EUR 829 billion of value will be created from data and that data value will increase by 530% globally. The same applies to statements describing Big Data as the new resource of the

21st century. Digital transformation in this sense was mentioned several times, especially by politicians, as an enabler from which all stakeholders will benefit.

3.3.5. Addressing the Threat of the Digital Divide

Fears that digital transformation could deepen already existing inequalities, for example, between large and small farmers, were expressed on several occasions. There seemed to be an expectation that action by European governments is required to protect small farmers and suppliers from "new big players" on the market, as this was mentioned directly by speakers but was also underscored by questions asked by the audience. However, while the audience asked how small farmers could afford new technologies to cope with new developments, EU representatives countered that not every technology would be cost intensive. Overall, concerns about a potential digital divide between large and small farming enterprises were not extensively addressed during the conference.

One concern related to the new role of the value of data was how to ensure that every farmer would benefit from data sharing. The Code of Conduct established in 2018 by a broad range of different practitioner umbrella organisations was designed to establish a list of values that align with farmers' values [42]. While conference participants generally welcomed this code of conduct as a good approach, they also questioned whether it truly supports farmers in practice. A study presented at the conference explored which kinds of data management approach farmers would agree on [43]. Farmers were given four approaches to choose from: 1. farmers govern data management, 2. data libraries (data altruism) store data and policies are developed on data governance, 3. the market governs farm data sharing through a laissez-faire approach and 4. data are shared among partners who do business together in the value chain. The results show that options 1 and 2 were preferred over the others, which indicates that the value of data according to farmers should not be organised by the market but rather by farmers or governments. Another argument regarding ensuring that all farmers will profit from data sharing refers to contracts. According to some presenters, the freedom of a contract is of high value. One participant argued that a competition law perspective and the restriction of stakeholders in charge should only be adopted if market distortion is at play.

3.3.6. Trust as the Basis for the Success of Digital Transformation Governance

Trust was a central theme of the conference discourse and appeared as a core value and barrier to any digitalisation process dependent on farm data. With digital transformation, there has been a radical shift in management practices and relationships. Speakers pointed out that digital transformation will change the ways in which trust is built, used and awarded, especially for farmers. Trust will no longer be based on personal relationships but will be created through technical solutions. Various arguments for the value of trust were raised. Digital technologies such as blockchain will create increasing transparency in the value chain and, thus, lead to trust among consumers about the safety of their food. This was seen as important with respect to various food scandals occurring in the European Union, such as the BSE scandal of 2000 and the horsemeat scandal of 2013. However, farmers in particular have to familiarise themselves with new rules and norms with which they do not currently identify. Several researchers have emphasised that building trust among farmers is still mainly conducted through personal contact rather than through the development of technical solutions.

3.3.7. The Role of the European Union

A major point of controversy concerned the role the EU should play in digital transformation. A soft approach discussed at the conference would involve seeing the EU as a facilitator that brings important partners together and sets boundaries by implementing a data strategy but maintains its subsidiary role. Another point raised was that national governments view the EU as in charge of governing the digital transformation of the agricultural value chain, as national impacts on digitalisation have been limited and the

agricultural sector is especially steered at the EU level. During the conference, the EU was asked to take on this responsibility. Concerning the agricultural sector, it was mentioned that other sectors are leading and that stakeholders responsible for establishing a governance framework should be aware of and learn from other sectors, especially the industry and banking sectors. Some stakeholders pointed out that governments should be in charge of collecting data, while others called for a certified third party to act as an intermediary between the private and public sectors.

4. Discussion and Conclusions

How digitalisation is shaped politically depends on which collective attributions of meaning prevail and manifest themselves in social discourse. The problematisation of ethical concerns in shared discourses linked to the digitalisation of agrifood systems enables a process of responsibilisation and the development of appropriate governance approaches [30,44]. This study analysed this process of problematisation. It aimed to analyse how the opportunities and challenges of digitalisation, as well as concepts and ideas about the appropriate governance of digital transformations, were socially constructed through communication across science, practice and politics during a two-day conference.

We identified a number of perceived benefits as well as challenges of digital transformation in the agrifood sector (for an overview, see Table 1). The results show many overlaps with recent anticipatory studies on ethical issues and social implications from digitalisation along the agrifood chain [1,17,31–33,45]. This implies that a process of problematisation outside of academia is evolving. However, this discourse remains restricted to a limited group of experts. A broad social discourse on the social impacts of digitalisation in the agrifood chain is still pending. During the two-day event, techno-optimistic narratives dominated.

In addition to several perceived benefits and challenges of digital transformation, we especially identified controversies regarding governance issues (see Table 1). While opportunities and challenges of digitalisation in agrifood systems are increasingly addressed, governance approaches have been rather neglected in the scientific literature thus far. In the following, we discuss the results with regard to implications for policy, practice and science.

4.1. The Sustainability-Oriented Shaping of Digital Transformation Requires a Critical Perspective, Reflexivity and an Adaptive Governance Approach

Policy actors highlighted the importance of digitalisation for addressing future challenges in the agrifood sector. However, how digitalisation should be used and governed remained unclear throughout the conference. At the moment, national governments and various interest groups have different views on suitable governance strategies, ranging from a "laissez-faire, industry-driven approach" to a "precautionary and preemptive strategy on the part of government" [46]. The conference showed that the EU government is still in the negotiation phase and is not prepared to make concrete proposals or statements that could limit the actions of certain groups of actors. One difficulty in developing regulatory measures is that they can quickly become a barrier to innovation processes and often have undesirable effects [47]. In contrast, the EU representatives at the conference elaborated on the importance of digitalisation for entering new markets gaining and maintaining market advantages in a global context. Concerns about not being able to keep up with technological developments in an international comparison seem to avoid critical views. Throughout the conference discourse, political representatives primarily contributed technology-optimistic narratives and tended to adopt the positive visions of technology developers and business actors. Their positions appeared noticeably uncritical. This phenomenon has been described earlier, e.g., by Geels [48], who showed how policy and incumbent business actors tended to form alliances due to mutual dependencies, hindering sustainable transitions. In this regard, it can be questioned what benefits this strategy offers for sustainable digital transformation and the general aim of the EU to work "on a digital transformation that will benefit everyone" [49].

In contrast, an increasing number of scholars point to the necessity of proactively shaping and governing digital transformation [50,51]. Nally [4] argues: "arguments that suggest that technology will "solve" hunger and agricultural poverty, for example, fail to appreciate that technologies are only ever as strong as the political, social and economic forces that promote them". In addition, Rose et al. [51] emphasise that the main challenge will be to address the social implications of digital technologies.

A suitable governance approach is, therefore, urgently needed if digitalisation is to be shaped in a socially responsible way. For this, it is necessary, despite all the rightly expected positive effects of digitalisation on the part of the political actors, to also take a more critical standpoint. One of the main difficulties in developing policy measures is the great uncertainty about the effects and future developments of digitalisation. To deal with these unknowns and uncertainties, we argue, requires an adaptive and dynamic governance approach facilitating "continuous and gradual learning and adjustment that permits a prudent handling of complexity, scientific uncertainty and/or sociopolitical ambiguity" [52].

4.2. Science Plays a Central Role in Shaping a Socially Responsible and Sustainable Digital Transformation

While digital transformation can still be considered a new phenomenon, a review of the existing scientific literature reveals many critical voices and improved analytical frameworks [6,50,53–55]. However, the conference shows that policy makers have thus far tended to ignore these perspectives, and there are still few ideas to respond to undesirable developments caused by digitalisation. For example, some studies have already shown that farm size correlates with adaptability to technological innovations [56–58], which raises the question of how governments across Europe plan to protect smallholders from this digital divide.

The controversial topics explored throughout the conference indicate that further research is needed to inform political action. More knowledge is especially required on the impact of regulatory measures on the development of innovations and on how the digital transition will impact small farmers [53].

Some scholars point out that a just and sustainability-oriented design of digital transformation will require the involvement of all relevant and affected societal interest groups [59]. Different perspectives and ways of knowing and expertise from a broad range of disciplines have to be integrated to achieve a comprehensive understanding of the opportunities and challenges of digitalisation in agriculture. Various ethical and value conflicts, as well as risks and vulnerabilities (which have always been part of technological progress in the past and thus can also be expected with digital transformation), must be negotiated and harmonised to legitimise political action [2,54]. In this context, numerous authors highlight the importance of promoting collaborative research projects that link knowledge, interests, values and perspectives from different stakeholder groups [56,59,60]. As stated above, governance and political action regarding the shaping of digital transformation are faced with a high degree of complexity, uncertainty and ambiguity. To grasp these complexities, uncertainties and normative dimensions, transdisciplinary learning, anticipation and assessment processes between scientists from different disciplinary backgrounds and multiple stakeholders in agrifood systems are needed. This will enable a more integrative understanding of the largely obscure interactions of different mechanisms in the digitalisation of agriculture and the development of preventive measures oriented towards common goods, food security and sustainability. Transdisciplinarity is a frequently mentioned core criterion of the responsible research and innovation (RRI) framework [61]. In the context of digitalisation, it should become mandatory for all research organisations to develop and provide digital technological solutions to embed their research activities in the RRI framework. Nevertheless, science on agricultural production and land use is largely dominated by natural science. We observed that many scientists do not reflect on the normativity of their work or on digital technologies. In addition, there are strong

technology-optimistic perspectives in science, which may be related to a lack of critical and interdisciplinary exchange between social and natural scientists on an equal eye level. This inner-scientific discourse must be strengthened in the future.

4.3. The Socially Responsible Digitalisation Will Require the Empowerment of Nonexperts to Participate Competently in Negotiation Discourses

Beyond a stronger interdisciplinary exchange, however, there is also a need for intensified discussion between science, policy and practice. The transfer of knowledge about the undesirable consequences of digitalisation and their problematisation in social discourse will be an important precondition for a societally desirable and sustainability-oriented digital transformation. This will also require the empowerment of nonexperts to participate competently in the discussion. Currently, the discourse remains largely an expert affair. In public perception, the topic barely takes place. However, we argue that an intense engagement between experts, societal actors and final users will enhance trust in new digital technologies that are, thus far, often perceived as a "black box" (e.g., [20]).

While the conference organisers seemed to ensure that different stakeholders were represented, the survey presented in Section 2.1 shows that the smallest cohort of participants and speakers included practitioners such as farmers. Even if farmers were represented by their lobby organisations, it should be noted that there was an uneven distribution. Farmers either did not have direct access to the event or could not participate for other reasons, e.g., lack of interest, knowledge or time resources. This raises questions about power imbalances between different groups of actors and interests in such negotiation processes.

Insights presented at the conference by scientists, extension service representatives and practitioners show that farmers would like to make decisions about their data. Farmers are concerned with not only the type of platform used but also with how their data is used. Based on the contributions of the practitioners at the conference, it was clear that discussions at the scientific and political levels are often too abstract and do not reflect reality or practitioners' expectations. For instance, a major barrier to digital transformation at the practitioner level is stable internet access to enable access to data and the standardisation of data. This is true not only for farms but also for many administrations. From the discussion on common data-sharing platforms held at the conference, it appears as if the fundamental challenges of digitalisation have been mastered and a foundation for further discussions on EU-wide data trade has been established. However, according to practitioners, this does not seem to be the case at all. In discussing the stages of a transformation process, practitioners and actors applying new technologies are still working to create the necessary conditions [55], while governments refer to a stage where all farmers have access to a functioning infrastructure, are digitally literate and are waiting for new opportunities with which to share and use their data. We argue that this observation may sometimes lead to a lack of acceptance from farmers of their government, as, according to this perception, the government does not care about the challenges farmers face, such as the creation of a functioning infrastructure and education. At the same time, these practitioners, who are currently dealing with other challenges, might feel disconnected from discussions at the EU level. The major tech companies, on the other hand, are again at a different stage of digital transformation and can use this position and their capacity to participate in and dominate the discussions on a common data distribution platform. This shows that governance discourses are taking place at different stages of transformation, which makes it difficult to include all stakeholders equally in the development of such a platform and leads to risks of the platform becoming a solution dominated by political and industrial interests. Eastwood et al. [50] support this assumption by noting that some stakeholder groups within the field of smart dairy innovation development are excluded through ignorance of socioethical differences. Furthermore, Kernecker et al. [56] demonstrate the importance of involving farmers in the development of new smart farm technologies. In the future, it will be necessary to strengthen the exchange with practitioners to create a

neutral level of communication to involve all actors, regardless of their power, in all levels of transformation and to increasingly communicate critical positions to society.

4.4. Methodological Reflections and Research Outlook

The results of this study are based on the analysis of a two-day online conference. As discussed above, they largely reflect the current discourse in the academic literature and complement previous knowledge through the integrative consideration of different positions from science, politics and practice. It has been shown that a conference can provide comprehensive access to social discourse. With the outbreak of the COVID-19 pandemic, many digital conferences were held and documented by recording, which facilitates scientific analysis and thus represents an interesting new approach for discourse analysis.

However, the focus of this study remains limited to a single discourse event. Additional studies with in-depth analyses of discourses in different social subgroups, but also including further qualitative material and artefacts as well as their triangulation, would be desirable. In addition, discourses are not static but an ongoing process and continuously evolving. The investigation of these dynamics particularly reveals different interests but also power constellations. We argue that how the topics, arguments and narratives attributed to digitalisation change over time and how problematisations and responsibilisations are assigned and accepted, will be of great interest for the socially responsible design of a sustainability-oriented digitalisation of agriculture. This would require a continuous analysis of the processes of social meaning making and thus of discourses over a longer period of time.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su14073905/s1, Supplementary S1: Conference Participants. Supplementary S2: Speakers' areas of expertise and conference structure.

Author Contributions: Both authors contributed equally. All authors have read and agreed to the published version of the manuscript.

Funding: This work was funded by the Federal Ministry of Education and Research (BMBF) within the junior research group "BioKum" (grant number: 031B0751).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Acknowledgments: The APC was funded by the ZALF publication fond. We also thank three unknown reviewers for their supportive and enriching comments.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Klerkx, L.; Rose, D. Dealing with the game-changing technologies of Agriculture 4.0: How do we manage diversity and responsibility in food system transition pathways? *Glob. Food Secur.* **2020**, *24*, 100347. [CrossRef]
2. Scholz, R.; Bartelsman, E.; Diefenbach, S.; Franke, L.; Grunwald, A.; Helbing, D.; Hill, R.; Hilty, L.; Höjer, M.; Klauser, S.; et al. Unintended Side Effects of the Digital Transition: European Scientists' Messages from a Proposition-Based Expert Round Table. *Sustainability* **2018**, *10*, 2001. [CrossRef]
3. McLean, J. Delivering Green Digital Geographies? More-Than-Real Corporate Sustainability and Digital Technologies. In *Changing Digital Geographies*; McLean, J., Ed.; Springer: Cham, Switzerland, 2020; pp. 139–158. ISBN 978-3-030-28306-3.
4. Nally, D. Against Food Security: On Forms of Care and Fields of Violence. *Glob. Soc.* **2016**, *30*, 558–582. [CrossRef]
5. Qi, Q.; Tao, F.; Hu, T.; Anwer, N.; Liu, A.; Wei, Y.; Wang, L.; Nee, A. Enabling technologies and tools for digital twin. *J. Manuf. Syst.* **2021**, *58*, 3–21. [CrossRef]
6. Wolfert, S.; Ge, L.; Verdouw, C.; Bogaardt, M.-J. Big Data in Smart Farming—A review. *Agric. Syst.* **2017**, *153*, 69–80. [CrossRef]
7. Carbonell, I.M. The ethics of big data in big agriculture. *Internet Policy Rev.* **2016**, *5*, 1–13. [CrossRef]
8. Bronson, K.; Knezevic, I. Big Data in food and agriculture. *Big Data Soc.* **2016**, *3*, 205395171664817. [CrossRef]
9. Carolan, M. Agro-Digital Governance and Life Itself: Food Politics at the Intersection of Code and Affect. *Sociol. Rural.* **2017**, *57*, 816–835. [CrossRef]

10. Scholz, R.W.; Beckedahl, M.; Noller, S.; Renn, O. Einführung zum DiDaT Weißbuch: Sozial Robuste Orientierungen für einen verantwortungsvollen Umgang mit digitalen Daten: Zielsetzung, Vorgehen, Ergebnisse und Perspektiven. In *DiDaT Weißbuch*; Scholz, R.W., Beckedahl, M., Noller, S., Renn, O., Eds.; Nomos Verlagsgesellschaft mbH & Co. KG: Baden, Germany, 2021; pp. 1–68. ISBN 9783748924111.
11. Renard, D.; Tilman, D. National food production stabilized by crop diversity. *Nature* **2019**, *571*, 257–260. [CrossRef]
12. Aguilar, J.; Gramig, G.G.; Hendrickson, J.R.; Archer, D.W.; Forcella, F.; Liebig, M.A. Crop Species Diversity Changes in the United States: 1978–2012. *PLoS ONE* **2015**, *10*, e0136580. [CrossRef]
13. Trendov, N.; Varas, S.; Zeng, M. *Digital Technologies in Agriculture and Rural Areas*; Status Report; FAO: Rome, Italy, 2019.
14. Pfeiffer, J.; Gabriel, A.; Gandorfer, M. Understanding the public attitudinal acceptance of digital farming technologies: A nationwide survey in Germany. *Agric. Hum. Values* **2021**, *38*, 107–128. [CrossRef]
15. Walter, A.; Finger, R.; Huber, R.; Buchmann, N. Opinion: Smart farming is key to developing sustainable agriculture. *Proc. Natl. Acad. Sci. USA* **2017**, *114*, 6148–6150. [CrossRef] [PubMed]
16. Carolan, M. Publicising Food: Big Data, Precision Agriculture, and Co-Experimental Techniques of Addition. *Sociol. Rural.* **2017**, *57*, 135–154. [CrossRef]
17. Eastwood, C.; Klerkx, L.; Ayre, M.; Rue, D.B. Managing Socio-Ethical Challenges in the Development of Smart Farming: From a Fragmented to a Comprehensive Approach for Responsible Research and Innovation. *J. Agric. Environ. Ethics* **2019**, *32*, 741–768. [CrossRef]
18. Jakku, E.; Taylor, B.; Fleming, A.; Mason, C.; Fielke, S.; Sounness, C.; Thorburn, P. "If they don't tell us what they do with it, why would we trust them?" Trust, transparency and benefit-sharing in Smart Farming. *NJAS—Wagening. J. Life Sci.* **2019**, *90*, 100285. [CrossRef]
19. Chiles, R.M.; Broad, G.; Gagnon, M.; Negowetti, N.; Glenna, L.; Griffin, M.A.M.; Tami-Barrera, L.; Baker, S.; Beck, K. Democratizing ownership and participation in the 4th Industrial Revolution: Challenges and opportunities in cellular agriculture. *Agric. Hum. Values* **2021**, *38*, 943–961. [CrossRef]
20. Lajoie-O'Malley, A.; Bronson, K.; van der Burg, S.; Klerkx, L. The future(s) of digital agriculture and sustainable food systems: An analysis of high-level policy documents. *Ecosyst. Serv.* **2020**, *45*, 101183. [CrossRef]
21. Bronson, K.; Knezevic, I. The Digital Divide and How It Matters for Canadian Food System Equity. *CJC* **2019**, *44*, 1–6. [CrossRef]
22. Daum, T. Farm robots: Ecological utopia or dystopia? *Trends Ecol. Evol.* **2021**, *36*, 774–777. [CrossRef]
23. Beck, U. *Risk Society: Towards a New Modernity*; Sage: London, UK, 1992; ISBN 0803983468.
24. Leipold, S.; Feindt, P.H.; Winkel, G.; Keller, R. Discourse analysis of environmental policy revisited: Traditions, trends, perspectives. *J. Environ. Policy Plan.* **2019**, *21*, 445–463. [CrossRef]
25. Ash, J.; Kitchin, R.; Leszczynski, A. Digital turn, digital geographies? *Prog. Hum. Geogr.* **2018**, *42*, 25–43. [CrossRef]
26. Sovacool, B.K.; Martiskainen, M.; Furszyfer Del Rio, D.D. Knowledge, energy sustainability, and vulnerability in the demographics of smart home technology diffusion. *Energy Policy* **2021**, *153*, 112196. [CrossRef]
27. Hajer, M.; Versteeg, W. A decade of discourse analysis of environmental politics: Achievements, challenges, perspectives. *J. Environ. Policy Plan.* **2005**, *7*, 175–184. [CrossRef]
28. Frick-Trzebitzky, F.; Bruns, A. Disparities in the implementation gap: Adaptation to flood risk in the Densu Delta, Accra, Ghana. *J. Environ. Policy Plan.* **2019**, *21*, 577–592. [CrossRef]
29. Rijswijk, K.; Klerkx, L.; Bacco, M.; Bartolini, F.; Bulten, E.; Debruyne, L.; Dessein, J.; Scotti, I.; Brunori, G. Digital transformation of agriculture and rural areas: A socio-cyber-physical system framework to support responsibilisation. *J. Rural. Stud.* **2021**, *85*, 79–90. [CrossRef]
30. Bronson, K. Smart Farming: Including Rights Holders for Responsible Agricultural Innovation. *TIM Review.* **2018**, *8*, 7–14. [CrossRef]
31. Fleming, A.; Jakku, E.; Fielke, S.; Taylor, B.M.; Lacey, J.; Terhorst, A.; Stitzlein, C. Foresighting Australian digital agricultural futures: Applying responsible innovation thinking to anticipate research and development impact under different scenarios. *Agric. Syst.* **2021**, *190*, 103120. [CrossRef]
32. Ingram, J.; Maye, D. What Are the Implications of Digitalisation for Agricultural Knowledge? *Front. Sustain. Food Syst.* **2020**, *4*, 66. [CrossRef]
33. Regan, Á. 'Smart farming' in Ireland: A risk perception study with key governance actors. *NJAS—Wagening. J. Life Sci.* **2019**, *90*, 100292. [CrossRef]
34. Keller, R. *Doing Discourse Research: An Introduction for Social Scientists*; SAGE Publications, Ltd.: London, UK, 2013; ISBN 9781446249710.
35. Foucault, M. *Die Ordnung des Diskurses*, 14th ed.; Fischer-Taschenbuch-Verl.: Frankfurt am Main, Germany, 2017.
36. Fairclough, N. Critical discourse analysis and critical policy studies. *Crit. Policy Stud.* **2013**, *7*, 177–197. [CrossRef]
37. Hajer, M.A. *The Politics of Environmental Discourse*; Oxford University Press: Oxford, UK, 1997; ISBN 9780198293330.
38. Keller, R. The Sociology of Knowledge Approach to Discourse (SKAD). *Hum. Stud.* **2011**, *34*, 43–65. [CrossRef]
39. EURAGRI. EURopean AGricultural Research Initiative. Available online: https://www.euragri.aau.dk/ (accessed on 16 February 2022).
40. Flick, U. *An Introduction to Qualitative Research*, 6th ed.; Sage: Los Angeles, CA, USA, 2019; ISBN 9781526445643.

41. Ciesielska, M.; Jemielniak, D. *Qualitative Methodologies in Organization Studies*; Springer: Cham, Switzerland, 2018; ISBN 978-3-319-65441-6.
42. EU. EU Code of Conduct on Agricultural Data Sharing by Contractual Agreement. 2018. Available online: https://www.cema-agri.org/images/publications/brochures/EU_Code_of_conduct_leaflet.pdf (accessed on 16 February 2022).
43. van der Burg, S.; Wiseman, L.; Krkeljas, J. Trust in farm data sharing: Reflections on the EU code of conduct for agricultural data sharing. *Ethics Inf. Technol.* **2020**, *6*, 275. [CrossRef]
44. Maye, D.; Kirwan, J.; Brunori, G. Ethics and responsibilisation in agri-food governance: The single-use plastics debate and strategies to introduce reusable coffee cups in UK retail chains. *Agric. Hum. Values* **2019**, *36*, 301–312. [CrossRef]
45. Rotz, S.; Gravely, E.; Mosby, I.; Duncan, E.; Finnis, E.; Horgan, M.; LeBlanc, J.; Martin, R.; Neufeld, H.T.; Nixon, A.; et al. Automated pastures and the digital divide: How agricultural technologies are shaping labour and rural communities. *J. Rural. Stud.* **2019**, *68*, 112–122. [CrossRef]
46. Linkov, I.; Trump, B.; Poinsatte-Jones, K.; Florin, M.-V. Governance Strategies for a Sustainable Digital World. *Sustainability* **2018**, *10*, 440. [CrossRef]
47. Rose, D.C.; Wheeler, R.; Winter, M.; Lobley, M.; Chivers, C.-A. Agriculture 4.0: Making it work for people, production, and the planet. *Land Use Policy* **2021**, *100*, 104933. [CrossRef]
48. Geels, F.W. Regime Resistance against Low-Carbon Transitions: Introducing Politics and Power into the Multi-Level Perspective. *Theory Cult. Soc.* **2014**, *31*, 21–40. [CrossRef]
49. EU. Shaping Europe's Digital Future. Available online: https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/shaping-europe-digital-future_en (accessed on 16 February 2022).
50. Eastwood, C.; Klerkx, L.; Nettle, R. Dynamics and distribution of public and private research and extension roles for technological innovation and diffusion: Case studies of the implementation and adaptation of precision farming technologies. *J. Rural. Stud.* **2017**, *49*, 1–12. [CrossRef]
51. Rose, D.C.; Lyon, J.; de Boon, A.; Hanheide, M.; Pearson, S. Responsible development of autonomous robotics in agriculture. *Nat. Food* **2021**, *2*, 306–309. [CrossRef]
52. Renn, O.; Klinke, A.; van Asselt, M. Coping with Complexity, Uncertainty and Ambiguity in Risk Governance: A Synthesis. *AMBIO* **2011**, *40*, 231–246. [CrossRef]
53. Fleming, A.; Jakku, E.; Lim-Camacho, L.; Taylor, B.; Thorburn, P. Is big data for big farming or for everyone? Perceptions in the Australian grains industry. *Agron. Sustain. Dev.* **2018**, *38*, 956. [CrossRef]
54. Renn, O.; Beier, G.; Schweizer, P.-J. The opportunities and risks of digitalisation for sustainable development: A systemic perspective. *GAIA-Ecol. Perspect. Sci. Soc.* **2021**, *30*, 23–28. [CrossRef]
55. Higgins, V.; Bryant, M. Framing Agri-Digital Governance: Industry Stakeholders, Technological Frames and Smart Farming Implementation. *Sociol. Rural.* **2020**, *60*, 438–457. [CrossRef]
56. Kernecker, M.; Knierim, A.; Wurbs, A.; Kraus, T.; Borges, F. Experience versus expectation: Farmers' perceptions of smart farming technologies for cropping systems across Europe. *Precis. Agric.* **2020**, *21*, 34–50. [CrossRef]
57. Daberkow, S.; McBride, W. Farm and Operator Characteristics Affecting the Awareness and Adoption of Precision Agriculture Technologies in the US. *Precis. Agric.* **2003**, *4*, 163–177. [CrossRef]
58. Kutter, T.; Tiemann, S.; Siebert, R.; Fountas, S. The role of communication and co-operation in the adoption of precision farming. *Precis. Agric.* **2011**, *12*, 2–17. [CrossRef]
59. Zscheischler, J.; Brunsch, R.; Griepentrog, H.W.; Tölle-Nolting, C.; Rogga, S.; Berger, G.; Lehmann, B.; Strobel-Unbehaun, T.; Reichel, C.; Ober, S.; et al. Kapitel 4 Landwirtschaft, Digitalisierung und digitale Daten. In *DiDaT Weißbuch*; Scholz, R.W., Beckedahl, M., Noller, S., Renn, O., Eds.; Nomos Verlagsgesellschaft mbH & Co. KG: Baden, Germany, 2021; pp. 145–168. ISBN 9783748924111.
60. Zscheischler, J.; Brunsch, R.; Rogga, S.; Scholz, R. Perceived Risks and Vulnerabilities of Employing Digitalization and Dig-ital Data in Agriculture—Socially Robust Orientations from a Transdisciplinary Process. *J. Clean. Prod.. forthcoming*.
61. Daedlow, K.; Podhora, A.; Winkelmann, M.; Kopfmüller, J.; Walz, R.; Helming, K. Socially responsible research processes for sustainability transformation: An integrated assessment framework. *Curr. Opin. Environ. Sustain.* **2016**, *23*, 1–11. [CrossRef]