# Risks

Frédérick Garcia, Pierre P. Labarthe, Emmanuel Prados, Véronique Bellon Maurel, Grégoire Chambaz

5

# Risks

***Authors –*** *Frédérick Garcia, Pierre Labarthe, Emmanuel Prados, Véronique Bellon-Maurel, Grégoire Chambaz.*

***Acknowledgements (contributions, proofreading, editing) –*** *Ludovic Brossard, Nathalie Gandon, Aurélie Javelle, Nathalie Mitton, Alexandre Termier.*

The ongoing digital revolution has had a significant impact on the world we live in. Chapter 4 explored the opportunities opened up by this new technology, which could help to make agriculture more agroecological, more sustainable and more productive. More broadly, the disruptive potential of digital technology seems boundless, and the digital revolution could be seen as a revolution of empowerment, bringing about a considerable increase in the capacity of stakeholders to efficiently transform all areas of society – not just agriculture, but also health, transport, culture, the environment, etc. Observing, predicting, anticipating and controlling the natural and social processes at play on Earth could soon be possible through digital technology.

The growing development of digital technology in the agricultural sector has raised a number of questions with regard to delivering on promises made and the social acceptability of the accompanying transformations. This awareness of the risks inherent to the digital revolution is not specific to agriculture. Analysis conducted on issues linked to democracy, the economy, the environment, work, education, information, etc. have confirmed the extent of the changes that are taking place, stressing how important it is for society to tackle challenges linked to digital, incorporating the fact that technology is not neutral (*Stiegler,* 2015; *Boullier,* 2019).

Despite the wide range of opportunities it opens up, we feel that the development of digital technology in agriculture brings with it a number of risks: not living up to expectations in terms of agriculture and food systems being made more environmentally-friendly; exacerbating the negative impact of digital technology on society in terms of a loss of autonomy and widening inequality; sliding towards a loss of digital and food sovereignty; and aggravating vulnerability and weakening the governance of an overly complex food system, aggravating vulnerability, weakening the governance and reducing the yields of an overly complex food system.

Exploring these risks will give citizens, farmers and researchers the opportunity to reflect on their practices, their choices and their priorities, guiding them and helping digital technology to become more responsible in order to minimise these risks. This chapter will present an overview of these risks.

## 5.1 Compromising the ecological transition in agriculture

There are a number of factors which could impact the capacity of digital technology to contribute towards the ecological transition. Some see digital technology as an "obstacle" in itself, in that it is deployed in an attempt to treat symptoms as opposed to correcting the causes of problems and hazards facing us, arguing that its widespread deployment is an evasion tactic preventing any possibility of more systemic, radical change. The use of digital technology in agriculture is also seen as stretching thin the ties still linking man and nature. Lastly, although little is known about it and it is rarely taken into consideration, digital has its own environmental footprint, which could call into question any environmental benefits.

### The agroecological transition and technological lock-in

Technological or socio-technical lock-in, a concept taken from theories of innovation (*David,* 1985; *Arthur,* 1994), refers to such situations where an innovation is blocked as a result of the economic and technological strategies implemented by different stakeholders – known as the sociotechnical system – coming together in such a way as to prevent any destabilisation or change, even if the innovation could be widely beneficial.

This concept is often raised in relation to the agroecological transition (*Meynard,* 2018). It aims to guide production systems towards practices which use fewer chemical inputs. This is done with reference to two specific features of agriculture in developed countries: i) crop protection based primarily on the use of pesticides and ii) the increasing specialisation of production alongside the increasing scarcity of holdings which combine crops with livestock breeding. The systemic, integrated way in which the food supply chain is structured around these aspects is an obstacle for the agroecological transition in that all economic, technological and regional stakeholders must act in concert with each other.

This raises the question: could the development of digital technology in agriculture also carry the risk of further technological lock-in, thereby limiting the chances of success for the agroecological transition, in all its diversity? Digital would appear to be an excellent driver of integration between the different stakeholders within the agricultural supply chain, at all levels. It is also, broadly speaking, compatible with the current agricultural model's sociotechnical system, particularly in terms of its associations with agricultural machinery (tractor-GPS-modulated application software) or satellite technology, highlighting the objective of greater control over the consumption of inputs (*Labarthe,* 2010). In this way digital technology could reinforce the technological lock-in of the current situation, further restricting the possible emergence of alternative innovations promoting agricultural practices which are radically more environmentally-friendly and less production-driven, and which could eventually help the current system to evolve. Digitalisation can thus be characterised by a sort of path dependence[63], excluding alternative forms of agriculture (*Clap and Ruder,* 2020). The concern is not, therefore, linked to digital agriculture "not being environmentally-friendly", but rather to the digitalisation of agriculture reinforcing the dominant, production-driven model, when in fact the goal is to make agriculture more agroecological.

## Taking humans further away from nature

The digital revolution and the new technology it has brought with it have transformed our perception of the world, through interfaces designed to expand and enrich our physical and cognitive capacities.

In agriculture this has resulted in "augmented farming" through the use of smart robots and sensors, forming a new interface between farmers and the living world of their farms, animals or plants. Research has been carried out in the social sciences on the consequences of these new interfaces, particularly in livestock breeding, exploring whether or not *"machines separate humans from matter"* through data or if robots are *"a liberating or restricting force for animals and humans"* (*Lagneaux and Servais,* 2014). Although little consideration has been given to the world of plants, we have started to see some research into the way in which digital technology is transforming our relationship with plants (*Javelle et al.,* 2021).

Over and above the risk of losing our material connection to nature through an increase in digital interfaces, a number of authors have also tackled the issue of the reification of the living world brought about through precision agriculture, and the ethical questions this raises (*Bos et al.,* 2018). This is particularly true in livestock farming, some seeing the growing engineering and artificialisation of agricultural production as evidence of possible transanimalism[64], geared towards developing "augmented" animals in order to not only improve their well-being but also to boost productivity. What impact will this reductionist approach – which reinforces the perception of the animal machine (*Meuret et al.,* 2013) – have

63. Having first emerged in political science in the nineties, path dependence is a term used to describe how influential decisions made in the past and decisions taken by political bodies are on present decision-making.

64. Droit Animal Ethique & Sciences (2017). Trans-animalism, augmented animals and cyborg animals: towards the status of "sub-machine"? 93, https://www.fondation-droit-animal.org/documents/revue93.pdf

on human-animal relations (*Larrère and Larrère,* 1997) or the efficiency of the production system as a whole? How do citizens view this type of agriculture? These are all issues which have been explored in the humanities in conjunction with agronomy.

## Contributing to digital's growing environmental imprint

Digital technology has an environmental impact which has been given little or no consideration in agriculture. As is the case with other areas of society, the development of digital technology in agriculture will involve an increase in the use of equipment for data capture, transfer (deploying wireless sensor networks, or even employing the use of 5G), storage and processing (see platforms offered by tractor manufacturers), requiring increasingly powerful and energy-intensive electronic components and systems, with all of the environmental consequences [65]that this entails (resource depletion, climate change, etc. (*Marquet et al.,* 2019))..

### Find out more

The agricultural supply chain is currently responsible for 13% of overall energy consumption in France (particularly for maintaining the cold chain); across all sectors digital is responsible for 12% of electricity consumption and 3% of total energy consumption, the biggest contribution coming from video streaming. Although there does not seem to be anything particularly alarming about current statistics for agriculture, attention will need to be paid to the rising contribution made by digital agriculture.

The increase in the number of various different types of connected sensors will result in greater reliance on resources such as the precious metals (silver, gold, palladium) and rare-earth elements (neodymium, praseodymium, gallium, germanium, etc.) found within these electronic components, the extraction and separation of which uses up vast quantities of energy and water. The geographical distribution of production sites is also highly uneven, the majority currently found in China (*Pitron,* 2018). This will also pose challenges when it comes to end-of-life management for materials, with the not properly controlled risk of the spreading of technological waste, similar to what we have seen with the reprocessing of mobile phones in France: only 15% of handsets are collected out of more than 25 million phones sold every year, despite the existence of a specialist stream for the recycling of electronic waste (*Blandin,* 2016).

65. https://www.lemonde.fr/blog/binaire/2019/01/29/impacts-environnementaux-du-numerique-de-quoi-parle-t-on/

# 5.2 Widening inequality and power imbalance

One of the risks associated with the digitalisation of agriculture, first flagged up in the nineties (*Wolf and Buttel,* 1996), relates to the increasing industrialisation of agriculture, the social and environmental consequences of which are a source of controversy. It is argued that there will be a sort of co-evolution between the roll-out of digital technology and production becoming concentrated in ever greater production units, driven by a desire for greater efficiency and productivity at the expense of other types of agriculture or groups of agricultural workers. These risks have been discussed using strategies from different disciplines in the humanities, primarily sociology, political science and institutional economics (*Klerkx et al.,* 2019).

## Risks of exclusion

There are a number of risks of exclusion associated with digital agriculture, linked to various different debates on the subject of the diversity and coexistence of agricultural production models.

The first risk relates to agricultural holdings with a small economic impact. The issue of small farms being excluded is not specific to digital technology: it has been shown how the modernisation of agriculture in France has excluded small agricultural holdings, chiefly through the economies of scale which are typical of technological development (*Deléage,* 2013). Digitalisation is part of this technological trajectory for agriculture, which is centred around increasing the size of agricultural holdings. It could even accelerate it given that, by its very nature, some digital technology (such as that based on satellite imaging) requires holdings of a minimum size in order for it to be profitable. This risk of exclusion can be compared to the incompatibility outlined in 5.1 between digital technology and certain ways of making agriculture more ecological, which require a more extensive overhaul of production systems.

The second risk is linked to aggravating the precarious nature of agricultural work, at a time when there is a growth in the percentage of salaried workers in agriculture and a desire to reduce labour costs in the interests of increased productivity. The development of robotics – which could either replace human labour or limit the human workforce to certain, more qualified positions – could further exacerbate precarity among certain groups, particularly the poor in society or immigrant workers.

The third risk is linked to the difficulty of accessing digital technology and/ or the skills needed to use it, which could also drive exclusion in the agricultural sector. This debate is partly linked to the digital divide and the risk of excluding certain rural areas lacking in digital equipment at an infrastructure level.

## A loss of autonomy for farmers

Research has been carried out in the field of rural sociology to assess the potential implications of digitalisation on the decision-making autonomy of farmers and the meaning they place in their work. This could have significant repercussions for the cultural fabric of rural areas and farmers in that it will alter what it means to be a farmer (*Burton and Riley,* 2018). Digitalisation may bring about a shift in agriculture from "practical", experience-based management towards a data-driven approach. It could "discipline" working routines for farmers, conditioning them through a new form of "algorithmic rationality" (*Miles,* 2019). As a result, digitalisation which is not controlled by farmers is a topic for debate.[66] Questions have also been raised regarding the effect of digitalisation on the autonomy of farmers, including a fear that farmers could become "data workers" (*Rotz et al.,* 2019).

## Upstream and downstream control

Another issue relates to the imbalance between agriculture and its upstream and downstream sectors, which digitalisation could exacerbate. Agriculture has often been described as a sector that is dominated by upstream and downstream, and particularly by its upstream (mechanisation, the chemical industry, seeds/ grains, etc.) when it comes to innovation dynamics. A number of authors have questioned the role played by digitalisation in transforming (or exacerbating) the balance of power between agriculture and other sectors.

Upstream, digital technology could increase farmers' dependency on certain inputs (pesticides, mineral fertiliser, etc.) while optimising and limiting their use. This paradox can chiefly be explained by the fact that digital technology takes the form of specialist equipment which embeds models, standardises decision-making and leads to asymmetry of knowledge. This is changing the way in which knowledge is controlled (*Bronson and Knezevic,* 2016).

66. https://www.amisdelaterre.org/communique-presse/nouveau-rapport-agriculture-et-numerique-vers-une-fuite-en-avant/

Downstream, new tools for sharing and controlling information (particularly blockchain and big data technology) have the capacity to change or strengthen the positions of different stakeholders in innovation ecosystems and value chains. Questions relate to the consequences on value sharing, how sectors are governed, the risk of forms of subsidiarisation within agriculture and control by agribusiness companies situated downstream from agriculture.

One new issue relates to the role which new stakeholders – firms in the digital technology sector, from startups to multinationals – could play; digital giants have, for example, made significant investments in agriculture, sometimes in conjunction with equipment manufacturers. Alongside this investment, a number of questions have been raised regarding data governance in agriculture, and the capacity of stakeholders in the agricultural sector to control knowledge integrated into digital technology and to grasp the value which it produces (*Carbonell,* 2016).

Digital technology is therefore associated with cross-sectoral dynamics, calling for multidisciplinary research to be carried out on the resulting institutional changes and the risk of potential lock-in (*Carolan,* 2020; *Labarthe,* 2010).

## Accessing information and training - what role can advice play?

A fundamental feature of digital technology is that it is not neutral for innovation systems and agricultural knowledge: it has the capacity to completely overhaul the way in which knowledge and information within the sector is constructed and disseminated (*Busse et al.,* 2015).

Research carried out recently has revealed both the potential of digital technology and the threat it poses to certain stakeholders or roles within innovation systems. This is particularly true for farming advice – its participants, methods, content and even legitimacy are all called into question by digital technology (*Fielke et al.,* 2020).

However, there are a number of issues linked to the role advisors or other-intermediaries in innovation systems can play with the advent of digital technology: how can more and more information be integrated without generating excess stress or mental strain for farmers? Who will be in a position to evaluate the efficiency, durability and suitability of digital tools? Who will have the capacity to monitor the content of knowledge (agronomic models, validity testing, etc.) contained within these tools and applications?

The question of digital's impact on the dissemination of information and knowledge within the agricultural sector also takes us back to the issue of inequality, as discussed in the previous subsection. This inequality is linked to issues surrounding accessibility (financial, cognitive, connectivity) to digital technology. The issue of unequal access to advice and information is not a new one (*Mundler et al.,* 2006); the goal will be to determine whether digital helps to reduce or exacerbates this inequality. This refers us back to issues such as cost and the digital infrastructure of rural regions, but goes further than that; it will be necessary to train rural and agricultural communities, in all of their social diversity, giving them the opportunity to acquire the skills needed to use this technology in an effective and appropriate manner.

## 5.3 Loss of sovereignty

The final report from the 2019 French Senate inquiry "Digital Sovereignty" (*Longuet,* 2019) proved that the issue of digital sovereignty has never been more topical. The report was keen to stress that this is a threefold problem for France, relating to *"ethics, security and economic liberty"*, at a time when our societies are finding their values are being questioned and humans are *"increasingly collections of data to be exploited".* Although agriculture is an area in which the question of national sovereignty – at both an individual and a collective level – may be thought of as a given (production is by nature rooted in regions, there are strong cultural ties to the land, public authorities have a track record of supporting and guiding agricultural production, the importance of public research into agronomy is recognised in France, the CAP is a cornerstone of the European project), the development of digital technology is bringing forth new challenges linked to digital sovereignty (*Klerkx et al.,* 2019).

### A loss of autonomy over food supplies

The increasing digitalisation of the supply chain – from producers to processors to distributors to consumers –, the primary aim of which is to bring production into line with needs, to minimise logistics and processing costs and maximise customer satisfaction, could potentially lead towards ever greater integration of agriculture. Sovereignty becomes an issue when monopolies develop, as can be seen with the current offensive being led by digital giant Amazon in the food distribution industry[67] Also worthy of note is the rapid development and use of connected tools on smartphones for evaluating food and other consumer products (in terms of environmental impact, nutritional value, etc.), which could have a significant

67. https://siecledigital.fr/2020/08/31/amazon-ouverture-de-son-premier-supermarche-connecte-amazon-fresh/

long-term impact on modes of consumption[68] There is no guarantee of democratic control over these new tools, resulting in the risk of a monopoly developing. Lastly, the economic model for the digital transition is partly based on start-ups, some of which have designs on being bought over by major groups. This inevitably raises questions linked to national sovereignty with regard to the digital technology and services developed for agriculture and the data it produces (*Schneider,* 2020).

## Seizure of agricultural data

Digital sovereignty entails control over data. Whether it is down to major manufacturers of agricultural equipment or digital giants, there is a risk of agricultural data being seized, either by access to data simply being restricted or by data being opened in formats which are not practical to use. Agricultural machinery could act as a Trojan horse for the collection of data in agriculture. This includes milking robots in livestock breeding, but also tractors and harvesting machines for field crops. These agricultural machines feature an increasing number of sensors, gathering data on tasks performed which is then shared with manufacturers. Purchase agreements govern their use in a way which benefits manufacturers (it is often stipulated that farmers must share all agricultural data). This helps to maintain a lack of transparency along the data chain (what does the data contain, where is it going, and for what purpose?), resulting in a near lock-in situation (it is sometimes very difficult for farmers to gain access to their data, and even harder to put it to any purpose) (*Carbonnel,* 2016). There is an awareness within the profession of this risk, farmers in France having come together *via* the Data Agri[69] charter put forward by two trades unions, the FNSEA and the JA. This is aimed at improving the handling, transparency and security of agricultural data in contracts. France would appear to be somewhat ahead of the game at a European level when it comes to reflecting on the use of agricultural data, building independently on the GDPR regulation on personal data.

The sharing of agricultural data is a priority both for the agricultural profession and for research in agronomy, the goal being to support the development of agronomic knowledge and digital technology and services in agriculture. This is a key issue in relation to digital sovereignty. Agdatahub[70], a data exchange platform for the agricultural sector developed by a number of agricultural organisations (chambers of agriculture, technical institutes, etc.) and businesses, is a good illustration of how a trusted system can be built around data (French companies *DAWEX* and *3DS OUTSCALE* were selected for the *Agdatahub* platform).

68. https://www.capital.fr/conso/peut-on-faire-confiance-a-yuka-pour-ses-courses-1319721
69. https://www.data-agri.fr/
70. https://agdatahub.eu/

## A loss of control over production equipment

Sovereignty is also an issue when it comes to control over production equipment in agriculture. Digitalisation is resulting in this equipment becoming increasingly complex (*Bournigal,* 2014) and maintenance becoming more and more difficult, for both farmers and distributors, who are experiencing a loss of technical autonomy. The same is true when it comes to training: teachers at agricultural high schools have encountered difficulties training future professional users of agricultural equipment in what is a high-tech and constantly changing field (*Isaac and Pouyat,* 2015).

Another issue linked to sovereignty is the lack of French companies among the world leaders in agricultural machinery (*AGCO, John Deere, New Holland, Lely, De Laval*), although France does boast a number of pioneering companies when it comes to mobile agricultural robots (e.g. *Naïo Technologies*).

## A challenge for cybersecurity

In the field of cybersecurity, the first challenge concerns the risk of attacks *via* connected objects and sensors (*Dhar*, 2021). This either involves the connected object itself becoming a source of a denial-of-service type attack, or it is hacked for malicious purposes. The latter example is the most troubling, particularly in the case of highly-integrated agricultural systems where farmers have granted significant autonomy to automatic control systems (automated greenhouses, milking robots, etc.). The fact that these devices are often manufactured outside of Europe and that we have no say over design (to ensure security by design), means we must be even more vigilant as to the risk of backdoors.

A second challenge relates more broadly to protection against the recovery and hacking (theft, modification, destruction) of agricultural data. The choices made in designing the platforms used to share this data clearly have a significant impact on the possible level of protection. Although the most notable examples of cyberattacks have targeted institutions of key strategic importance to society (hospitals, airports, banks, etc.), the crucial importance of our food production and consumption systems could see them becoming potential targets in the future (*Gupta et al.,* 2020).

# 5.4 Accentuating vulnerabilities and negative yields

## The vulnerabilities of the agrifood system

As described in 2.3, modern agriculture interacts with a range of sectors and stakeholders of various types and sizes. This results in very "long" supply chains and decision-making systems. Agricultural activity has also expanded into increasingly specialist areas (*Bowler,* 1986). This system is centred around a large number of asymmetrical relationships of dependency between these stakeholders. It also centres around the intensive use of technology, which users are gradually becoming dependent on. The digitalization of this system could increase dependencies[71] between several of its elements and create new ones. These developments increase the risk that the partial or interrupted functioning of one element could paralyze the entire system. These changes are increasing the risk of an error affecting one element paralysing the entire system. These issues (blockages, interdependency) were highlighted during the Covid-19 crisis, with the emergence of a number of areas of tension in different parts of the agrifood system[72]. By disrupting supply chains, the Covid-19 crisis also resulted in a shortage of goods – including copper and microchips – in a number of sectors, highlighting the risks linked to dependency on such goods (*Bouissou and Albert,* 2021). This warning is all the more striking given that a number of crises expected over the next two decades (regional and systemic),[73] most notably peak oil (*Delannoy et al.,* 2021), are likely to have a far greater impact on society and the agrifood system in particular (*Servigne,* 2014). At a time when increasing the resilience of the agrifood system has become critical, its digitalisation runs the risk of making it more vulnerable.

## Increasing complexity, diminishing returns and associated risks

As discussed earlier, the agrifood system is centred around a number of increasingly specialist regions, sectors and stakeholders, of various types and sizes. It is also centred around a number of regulatory mechanisms and various relationships of dependency. Agriculture and its upstream and downstream sectors can now be said to form a complex sociotechnical system in the sense understood by Tainter (*Allen et al.,* 1999).

71. See section 5.1 ("Technological lock-in and the agroecological transition") and section 5.2.

72. This includes risks linked to logistics and halting migratory flows, in addition to the instability generated by the introduction of non-collaborative, "every man for himself" national policies.

73. The probability and intensity of which are set to increase in the decades to come. See Chapter 2.

Tainter demonstrated that human societies have a tendency to become more complex as they solve the problems facing them – this is because the solutions deployed require the addition of new elements to the system and the introduction of new regulations (*Tainter,* 1990; *Chambaz,* 2019). Ultimately, this complexity is "paid for" through energy costs: the more complex a society becomes, the more energy is required for its basic functions (*Tainter,* 2016). This problem is exacerbated by the fact that this increasing complexity follows the law of diminishing returns: above a certain threshold, the benefits of a society increasing in complexity grow more slowly than the costs, until a critical situation is reached at which point costs may be higher than the benefits[74] (known as negative returns), as was the case prior to the collapse of a number of civilisations (*Tainter,* 2009). The challenge of complexity is keeping overall energy costs lower than the profits it brings in; otherwise there is a risk that the evolutionary trajectory of the system will get out of control and that any attempt to correct the system will only result in rendering it more volatile, vulnerable and uncontrollable.

The food and agricultural system is already a particularly complex sociotechnical system, the overall costs of which include indirect costs (sometimes very far removed) linked to negative externalities such as environmental, health and sociopolitical issues, which are either invisible or ignored by the vast majority of stakeholders (see 2.1). Our inability to evaluate these consolidated overall costs (energy, materials, pollution) and to fully grasp the aforementioned dynamic makes us liable to take major risks each time the system develops further complexity.

For this reason, it will be necessary to explore the impact of the development of digital technology in relation to this risk, particularly in agriculture. Indeed, as was discussed previously, the increasing digitalisation of the agrifood supply chain risks making this system more complex and strengthening or expanding ties and dependency. Uncontrolled use of AI and big data[75] could trap us further in a spiral of increasing complexity.

74. The phenomenon of diminishing returns followed by negative returns has been widely studied and documented, including in agriculture (*Brue,* 1993), in security (*Elhefnawy,* 2004), hydrocarbon extraction (*Tainter and Patzke,* 2012) and, more generally, in global macroeconomics (*Elhefnawy,* 2008).

75. With this technology the quantity and the complexity of the services and materials required will significantly increase (data generation, circulation, storage and processing – sensors, platforms, networks, etc.).

# Conclusion

This chapter has covered a number of risks which the development of digital technology in agriculture has brought with it. These risks vary in nature and relate to economic, political, societal, psychological and environmental dimensions, among others. These risks could potentially be inherent to the deployment of this technology, and could be unavoidable or event uncontrollable. How this technology is deployed and used will obviously depend on upstream research, but also – and most importantly – on how stakeholders (citizens, farmers, stakeholders in agribusiness and the food industry, politicians) engage with it, as well as the general functioning of society (economic models, political regimes, standards frameworks, ideologies, etc.). It has long been understood how difficult it is for societies to control the development of technology (*Ellul,* 1977). It will be essential to take all of these factors into consideration when guiding future research in the field, as we have sought to do by identifying the challenges outlined in chapter 6 for making digital responsible, relevant and shared.