The digital revolution in food and agriculture
Exciting promises, mixed results and risky bet

Just over two years ago, hungerexplained.org questioned whether “Big Data” was reshaping our food systems in ways that would increase corporate influence or whether the growth of digitalisation could lead to more sustainable and just food systems. The tone was rather pessimistic, the only optimism being generated by the hope that citizens could be mobilised to ensure that their interests were fully respected. [read].

Beautiful promises

It is difficult, today, to measure the true extent of a phenomenon which promised wonders. Through huge investments in data storage and processing capacities, “Big Data” was expected to conduct a real-time analysis of a stunning amount of food- and agriculture-relevant information (soil condition, meteorological information, animal and plant health status, existing agricultural technologies, market conditions, consumer needs and preferences, etc.) with the aim of optimising food systems all over the world so as to increase the economic value of food systems while preserving our environment.

Thus, the “Big Data” prophets explained how combinations of different types of artificial intelligence (including its conversational variant), machine learning, augmented analysis, precision agriculture and synthetic data would provide a basis for making optimal management decisions in real time and thereby generate tens of billions of profits. As the years passed, communication intensified on the topic so as to accelerate the

adoption of these new technologies. Digitalization was presented as a game changer that would remould the food sector and alter its rules.

The World Economic Forum, Davos (WEF) – well known to readers of hungerexplained.org [read], close to the business community and invited to co-organise with the United Nations the 2021 Food Systems Summit [read] – and McKinsey (the big international consulting firm that is advising several rich countries during the COVID-19 pandemic, including France [read]), produced a report showcasing all the advantages recent innovations (digital, autonomous vehicles, robots, nanotechnology, biotechnologies and genomics) that make what they call the Fourth Industrial Revolution in food and agriculture. They foresee that this will allow the emergence of inclusive, sustainable, efficient, nutritious and healthy food systems… According to them, this revolution is already taking place, as USD 14 billion had been invested by 2018 in 1000 food systems-focused start-ups.

In their report that dates back to 2018, the World Economic Forum and McKinsey are trumpeting the benefits expected from digitalisation of food systems by 2030. For this, they consider several possible areas of application:

- Mobile services delivery (market information, meteorological data, technical advice, etc.) for between 275 and 350 million farms (out of a total of around 570 million in the world)
- Big data and advanced analytics applied to insurance by financial technology (fintech) companies that declare to be ready to offer adapted solutions to hundreds of millions of producers;
- The use of the Internet of Things, based on the generalised deployment of sensors, such as near-infrared spectrometers, for the management of supply chains;
- Traceability and certification of goods based on blockchain technology; and,
- Precision agriculture [read].

The table below presents the benefits foreseen in terms of increased income and agricultural production, reduction of wastage of outputs, cut in greenhouse gas (GHG) emissions from food and agriculture and better use of water.

Potential benefits generated by the digitalization of food and agriculture by 2030

	Increase of income and of agricultural production	Reduction of losses in agricultural goods	Decrease in GHG emissions	Cut in use of water
Mobile services delivery	3 to 6%	2 to 5%	less than 1% of global emissions	1 to 3%
Insurance systems based on "Big Data"	less than 2%	1 to 2%		
Internet of Things for managing supply chains		1 to 4%		
Blockchain-based traceability and certification		1to 2%		
Precision agriculture		1 to 4%	less than 1 %	2 to 5 %
Total	**3 to 8%**	**6 to 17%**	**less than 2%**	**3 to 8%**

Source: World Economic Forum and McKinsey, 2018 (table compiled by the author).

The above figures – the mode of estimation of which was not specified – remain, finally relatively low when compared to:

- The increase by around 50% of food production needed by 2050 to meet global demand if consumption patters continue to evolve as in recent past [read];
- The water shortage that a large portion of world population will have to suffer from [read];
- The necessity to reduce drastically (approximately 30% over the period 2020-2030) of GHG emissions in order to keep global warming below 2 degrees [read]; and,
- The changes required to make food systems more sustainable.

In Africa, the Malabo Montpellier Panel, a group close to the World Economic Forum and to the International Food Policy Research Institute (IFPRI) is also promoting digitalization of agriculture, using the arguments of the WEF and of McKinsey.

Modest and poorly documented results

There is only a limited amount of research available for judging the actual effectiveness of these new technologies in the field of food and agriculture. Some relatively old studies show rather disparate results:

- For example, in 2012, a researcher found that precision agriculture helped a farm to save 2.4% of seeds, 2.2% of fertiliser and 10.4% of fuel and thus spare USD36 per hectare of wheat in Germany [read];
- Another group of researchers working mainly on cereal crops in the UK found, in 2009, that gains from precision agriculture varied from about USD10 per hectare for a 300-hectare farm to USD27 per hectare for a 750-hectare farm [read];
- In 2013, a group of researchers reviewed the state of Information and Communication Technologies (ICT) and their impact on agriculture in poor countries. Conclusions were that, in general, these technologies improved the performance of agricultural markets, but that they had little effect on prices and incomes, and that the results obtained were quite heterogeneous [read].

In 2019, a report on digitalization of agriculture in ACP countries prepared by Dalberg Advisors for the Technical Centre for Agricultural and Rural Cooperation ACP-EU (CTA) concluded that "*despite growth, progress towards* [Digitalisation for Agriculture] *has been somewhat slow to serve the smallholders that produce 80% of Africa's agricultural output*". It estimated that over 33 million smallholders (around 13% of the total), mostly young people operating in high value chains, were involved and that their number was increasing rapidly[1]. The report did not, however, offer any credible data on the benefits that these producers had gained from digitalization [read].

It is quite surprising to note the dearth of information on the performance of "digitalized" agriculture and the almost total absence of estimates of gains outside of primary production despite, for example, the multiplication of digital market-place platforms developed mainly by start-ups.

Considering these mixed results – and the relatively modest promises mentioned in the first part of this article – the question arises as to why there is such a great interest in digitalisation of food and agriculture? What is the rationale underpinning it?

[1] It is important to remember, however, that information and communication technologies remain still unaffordable to part of the world population [read].

After some reflection, it is possible to identify two plausible reasons:

- The first could be the wish of certain corporations to enhance their position with the help of Big Data in a strategic sector that has grown in importance since the 2007-2008 food crisis. An OECD report of 2019 supports this view by stressing the fact that those businesses that adhere to digitalisation early, gain an advantage over their competitors and are bound to consolidate their market position [read]. This renewed importance contributed to raising prices of agricultural commodities and of land, and opened the way for a financialisation of the sector that took the form of speculative investments in agri-food companies, start-ups and land itself. This strategic positioning was reinforced as awareness grew of the potential threats to the future of our food [read].
- The second, more prosaic reason stems from the fact that, for the time being, most of the development of Big Data being applied to agriculture appears to be occurring as the result of action taken by upstream companies, in particular agricultural input giants like Bayer/Monsanto, DuPont, Dow, Bayer, BASF, Syngenta and ChemChina, as well as various agricultural equipment manufacturers (John Deere, Yara, Naïo Technologies) and digital machine-sharing platforms that are all investing in digitalisation as if it could help them to retain their customers and, if possible, to broaden their client base by advertising more efficient digital services (agricultural advice, equipment sharing or maintenance). This is similar, in a way, to what automobile companies are doing now when they tout their connected digital tools or customer services, rather than the actual performance of the cars they are selling.

One possible consequence of this is a growing disconnect between the prices received by farmers for their output and the retail prices charged to consumers for the same products. Prices seem be determined less by the relationship between supply and demand than by the pricing strategies of global corporations that have extended their engagement into many of the key links in the food chain – from the production of farm inputs, to international trade in food commodities and to large-scale food processing and distribution.

This being said, it is worth considering the potential risks associated with “Big Data”.

The risks of “Big Data”

When listing the risks associated with “Big Data”, the most frequently mentioned themes are those of the accuracy of data processed by digital innovations, data security, privacy and ownership, reduction of agricultural employment because of an increased use of robots, hyper-concentration of businesses and of economic power, as well as the need to establish a proper governance system [read].

There is also a concern that “Big Data” might suffer from the “garbage in, garbage out” syndrome and, for example, that rapidly changing meteorological forecasts [read] or disrupted recording by sensor because of actions by animals could lead to wrong decisions, impacting negatively on production and incomes [read].

Examples are many, where businesses or governments use data produced by economic agents (farmers, traders, industrialists) for their own benefit, because, in a number of countries, the law is not sufficiently clear on who owns and who is entitled to use

collected data, and for what purpose. This situation may lead to wrong doings, with digital platforms using them to make profits by selling them or by using them without informing or asking for permission from their rightful owners and, of course, without sharing these profits with them.

Finally, the great movement of concentration observed in the agribusiness sector spawns quasi-monopolies that create conditions for some agents to collect a rent at the expense of others, in particular farmers and consumers [read]. On this particular aspect, it is interesting to note that "Big Data" apologists talk a lot about its benefits without ever engaging in discussion on how these possible benefits of the Fourth Industrial Revolution should be shared! It could be expected that with the trend towards concentration, it is more than likely that the digital giants, being in a near to monopoly or cartel situation, they may find a way to grab the major part of these benefits while leaving, at best, a few crumbs for others, thus contributing to exacerbate inequalities.

Among the rarely mentioned risks, there is the risk of exclusion of some farmers from dominant supply chains. It arises from the collection by firms of information regarding the harvest date for a specific product, the location and owner of the plot. The combination of this data with product quality information makes it possible to target individual farmers, if their goods are considered substandard, and exclude them from the market. Cargill, one of the four major food trading multinationals, uses this kind of information. The same type of information helps companies to communicate, for example, that their products are top quality and have not been produced on recently deforested land. Risks of exclusion and of disciplinary tendencies are also associated with digital insurance services [read].

A real revolution … and its dangers

All the risks so far mentioned are quite real. There are yet a few more aspects that are hardly referred to but that may be about to transform food and agriculture fundamentally and change its operating rules. With the digital revolution, the market is now capturing something that, until recently, had generally been considered as a public good and, because of that, had largely eluded it, namely, knowledge. This revolution has little to do with the sustainability of food systems. Its purpose is to completely overhaul the mode of operation of the sector and redefine the rules that govern relationships among its agents.

Indeed, it is essential to understand that the relationship established between the client and the "Big Data" company is a commercial exchange between, on the one hand, data and the subscription fee paid by the producer to the company, and on the other hand, information and advice provided by the company to the producer. It is quite clear that the company is selling knowledge to the producer, in exchange to information and money. This is why some have been declaring that data has become one of the most valuable goods produced by agriculture, perhaps, together with food [read].

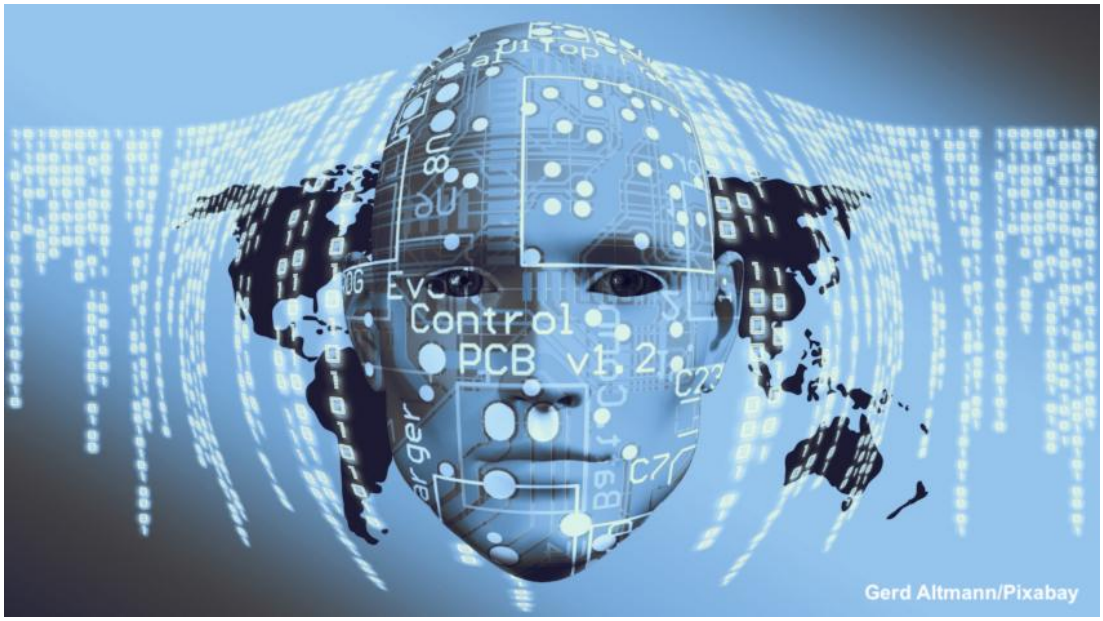
What does the nature of this relationship imply?

Throughout history, humans have continuously sought to extend their brain, first by engraving cuneiform scripts on tablets, then by covering parchments with signs with the view to prolonging the life of their ideas. Nowadays, teachers use a board and a screen, while pupils – but also workers – may still use notebooks to record what is important for

them, read books where knowledge accumulated by others are kept and, increasingly, refer to the Internet.

A fundamental aspect linked to current change is that while a book was bought once for all, today, access to knowledge – and to the services of digital companies – is by lease, and this creates a dependency relationship between the client and the company that provides this service. Those who might think this qualification too strong, should remember their reaction when, suddenly one day, their telephone or their Internet access did not function any more. Have we not become addicted to the web or to social networks?

Farmers have always been considered – and have seen themselves with pride – as independent workers. With time, however, they have found themselves entangled in several dependency relationships. Sometimes, it is an economic dependency on subsidies paid by governments in order to keep the price of food low [read], or it might be a financial and technical dependency experienced in the case of certain types of integrated or contract farming where farmers are no more master of the technology they use and find themselves in a situation very similar to that of wage labourers, despite having to fund the capital required for their activity (for example in industrial poultry or pig production) [read particularly p. 138, in French].



With digitalisation of food and agriculture, farmers are not just becoming dependent on the data and decision support provision for which they pay a subscription (like consumers pay for access to the Internet or to an on-line music or film platform and provide them with information on their choices that providers may use), but they also surrender part of their decision-making power to the “Big Data” company that tells them when and how to carry out this or another farming operation (sowing, weeding, spraying, harvesting, etc.), and when and to whom to sell their product to obtain the best possible price.

So, little by little, the farmers pay to lose their decision-making autonomy and, with time, for the resulting deskilling, a loss of know-how that, as years pass, will make them more dependent on the company that will be in a position, when time comes, to fix a higher

price of the subscription, thus increasing their share of the value added generated by the farm.

Neuroscience has proven that coexistence of computers and humans has somewhat changed the mode of operation of the latter's brains [read] that don't find it necessary, any more, to retain in their memory some of their inherent skills (Who is still able, nowadays, to do long divisions on paper? Who still remembers how to do it?) Similarly, it is probable that with time, farmers of the future, dependent as they will be on the digital companies to which they have subscribed, will not remember, any longer, how to choose the best sowing date for a crop or the right moment to carry out a particular operation. What is true individually will also be true collectively, local knowledge resulting from centuries of experience being progressively lost in the mists of the past and the digital cloud of the future. Only those skills required to make an optimal use of the tools offered by the "Big Data" company will be retained.

There is probably no need to dwell on the dangers of such an evolution and on the vulnerability it will generate.

The loss of control over their choices by farmers that will see their actions dictated by their smartphones or computers, will end up by making them feel the same sense of alienation as the Amazon employee or Charlie Chaplin in "Modern Times". Worse still, fully dependent on the "Big Data" company, they will be obliged to accept to pay ever more for services that will have become indispensable, until the day comes when, the situation having turned unbearable, they will be compelled to abandon their land to the first buyer and move to go and try their luck elsewhere.

And – because the consequences are not just individual, but also collective – the moment could come, when for one reason or another, the service is interrupted (power failure, ransomware, massive cyberattack or major cyber-conflict), totally disrupting production of a country or a region. This vision may appear excessively dramatic to some. However, most of the countries of importance are preparing for such events [read], the vulnerability of digital technology being no secret.

These are the dangers that are not discussed often enough.

Conclusion (provisional)

If you take a weighing scale and place the potential gains of "Big Data" that are supported by little unquestionable evidence in the one side, and, all the risks and dangers that have been enumerated on the other side, what can be said?

At hungerexplained.org, we believe that it would be irresponsible to say: "Go ahead, engage in "Big Data" without any kind of precautions!" The risks are so high, compared to expected gains, that vigilance dictates the need to establish all the required measures to be protected from danger, at the cost of abstaining from adopting a solution that carries risks against which it is impossible to be shielded, in case it were not feasible to design or implement appropriate measures because of the existing unfavourable balance of power.

These measures should eliminate, to the extent possible, all the above-mentioned risks and dangers and ensure a fair sharing of benefits arising from digitalisation of food and

agriculture. Great objective, beautiful statement! This implies a capacity to define clearly what these measures are, how and by whom they will be applied and who will monitor and evaluate their implementation.

Evidently, given the global and extraterritorial nature of digital technology, the national level is not sufficient, particularly as the countries that would enforce policies that are judged to be unfavourable by the giants of the digital sector in isolation, could be ignored by them and suffer likely negative economic consequences that would go far beyond the food and agriculture sector.

With this in mind, considering the current weakness of global governance (due in part to a revival of nationalism of all types, but also because of the competition and disagreements existing between the most powerful countries), pessimism is justified regarding the possibility of preserving the general public interest against the growing power of private interests.

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To know more:

- L. Prause et al., Digitalization and the third food regime, Agriculture and Human Values, Springer, 2020.
- Dalberg Advisors and Technical Centre for Agricultural and Rural Cooperation ACP-EU, The Digitalisation of African Agriculture Report 2018-2019, 2019.
- J. Cheminat, FIC 2019 : Se préparer aux futurs cyber-conflits, Le Monde Informatique, 2019 (in French).
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- B. Schneier, Cyberconflicts and National Security, UN Chronicle, United-Nations (undated).
- A. Supiot, Les nouveaux visages de la subordination, Droit Social, Dalloz, 2000 (in French).

Selection of past articles on hungerexplained.org related to the topic:

- Sustainable food systems: 2021 may be a turning point for food, … or it may not, 2020.
- Digitalisation of agriculture in Africa is bound to increase exclusion and inequality, 2019.
- In the global food system, the “farm-tech revolution” could shift the balance of power to the detriment of the weakest, 2019.
- Is “Big Data” remodeling our food system? 2018.
- The World Economic Forum’s “New Vision for Agriculture” is moving ahead on the ground…, 2017.
- A review of two recent publications and of forthcoming studies illustrates EU’s thinking on food and agriculture, 2017.