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FOOD SYSTEMS AT RISK

NEW TRENDS AND CHALLENGES

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Sandrine Dury,
Pauline Bendjebbar,
Étienne Hainzelin,
Thierry Giordano
and Nicolas Bricas (Eds)

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CHAPTER 4.5

UNCERTAIN IMPACTS OF NEW TECHNOLOGIES: THE CASE OF DIGITAL AGRICULTURE AND BLOCKCHAINS

Sylvaine Lemeilleur[1], Élodie Maître-d'Hôtel[1], Olivier Lepiller[1] and Alexandre Hobeika[1]

SUMMARY

Digital innovations are central to the transformation of food systems, from production and processing through to distribution. While they have the potential to enhance environmental and social sustainability across the value chain, they could also have disruptive effects on organisations and come with huge uncertainties in terms of access to these technologies, working conditions ('Uberisation') and governance. This chapter aims to briefly address the challenges associated with the diffusion of these technologies in developing countries. We focus on the examples of digital agriculture and blockchains.

1. CIRAD, UMR MOISA, F-34398 Montpellier, France; University of Montpellier, F-34090 Montpellier, France.

Digital agriculture: promising but hardly accessible in Low-Income (LI) and Lower Middle-Income (LMI) countries

Digital agriculture makes use of information and communication technologies (ICTs) to enable farmers to improve their agricultural production and marketing. Currently, most farmers make decisions on subjects such as fertiliser use and marketing based on a combination of practical experience and general advice from public or private organisations (companies, public authorities, NGOs). Digital innovations can provide farmers with more accurate information based on the use of specific information and tools such as sensors, positioning systems and databases, modelling software, communication networks and robotics. ICTs may enhance their ability to make decisions and have the potential to foster agricultural production and reduce production costs, while reducing environmental impacts through the promotion of cost-effective input approaches.

Although widely employed in Northern America and expanding in Europe, digital agriculture is currently much less used in Low-Income (LI) and Lower Middle-Income (LMI) countries. However, some promising experiments are being conducted in sub-Saharan Africa. The most advanced of these (Ethiopia, Tanzania and Nigeria) are the ones conducted with the aim of providing farmers with site-specific information on fertiliser use decisions. In Ethiopia, major work has been underway since 2012 by the Ministry of Agriculture to map soil fertility through the interpretation of satellite images and the analysis of soil samples, and to deliver site-specific information to farmers through a toll-free mobile phone service. More than seven million text messages and calls were received in the first year of operation and local wheat production has increased from one tonne per hectare to three tonnes per hectare (ATA, 2019). In Nigeria, the information received resulted in higher fertiliser use and higher yields. However, the positive impacts were significant only for farmers who received a full range of specific information, rather than general guidelines (Oyinbo, 2018; *cf.* Box 13). There is a risk of a two-tier agriculture developing, with territories not covered on the losing end. The diffusion of ICTs should be supported by public service providers or development organisations in the field to avoid creating greater inequalities, which comes at a cost.

In the private sector, a variety of startups are emerging (Ekewe, 2017). For instance, several initiatives are seeking to connect farmers to credit (for example, for inputs), with service providers (to obtain accurate information about agricultural practices and marketing opportunities) and with food processors and/or distributors. Examples include the JAMI application in Senegal, FARMCROWDY in Nigeria and the ESOKO platform services in

Ghana. In Kenya, the SunCulture company is selling solar irrigation kits in semi-arid areas that pump water, store it during the day and distribute it at night in order to optimise water use (AuSénégal.com, 2018).

Digital agriculture has the potential to help poor farmers in developing countries increase their agricultural production while optimising water and input use. It could also contribute to reducing women's workloads by enabling them to access key services (Treinen and van der Elstraeten, 2018). However, technology by itself does not ensure a move to greater equality and, depending on its implementation, also risks widening existing gaps. Costs for accessing technology are high and information on the long-term benefits is not always available. To secure its benefits and broad adoption by farmers, digital agriculture will require stronger collaboration among key stakeholders and need to be governed by inclusive policies, which address specific ICT needs and challenges. Further research is needed to assess the long-term impact of such innovations and the conditions required for scaling up and out.

Blockchains and food systems: risks of market exclusion and uncertainties about governance

Blockchain is being touted as one of the greatest technological revolutions available. It is catching the interest of a wide variety of industries and will soon penetrate the global market. Developing countries are not excluded from this technological development, especially as it provides great potential for food systems (Ge, 2017).

A blockchain is a decentralised digital accounting ledger that records all transactions made by its participants. Each user enters the data on the transactions he or she is involved in, for instance information about the goods they interact with. The data is shared and verified by all members using cryptography and collaborative verification algorithms. In comparison to traditional, centralised ledgers, the benefits are very high data security and disintermediation of transaction processing, in addition to speedier and automatically verified transactions. This technology therefore has the potential to facilitate trade and increase transparency, accountability and traceability.

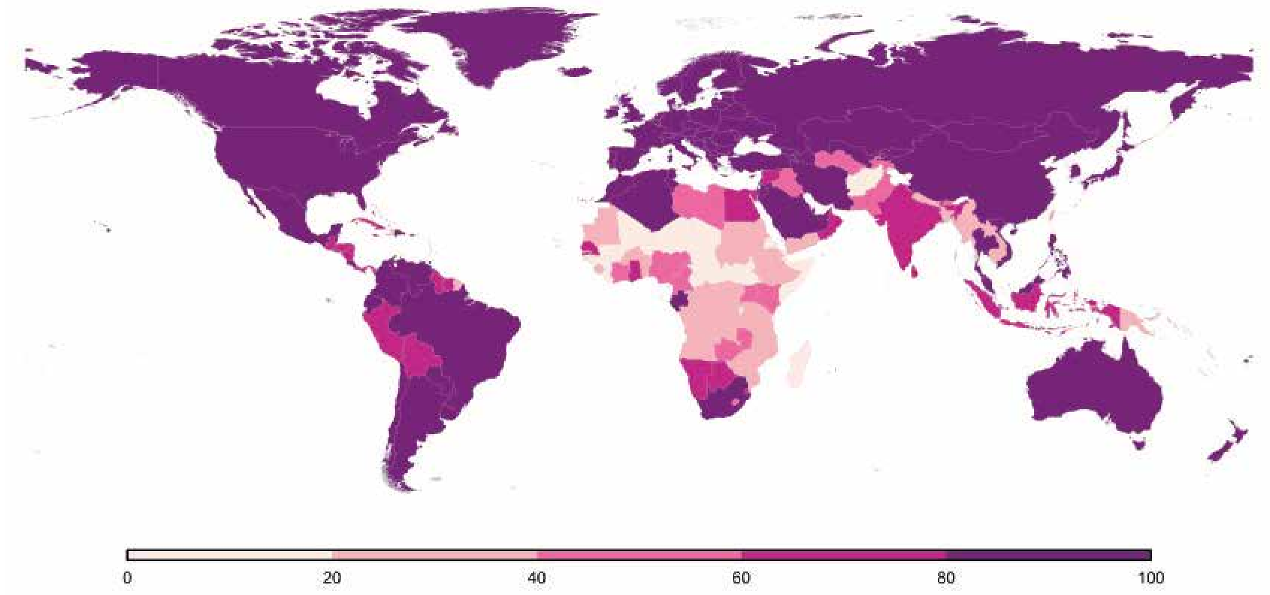
It can be applied to long supply chains, land titles or creditworthiness. Blockchain is claimed to facilitate access to financial services and reduce transaction costs. In practice, each actor in a supply chain (producers, processors and distributors) enters the traceability data which concerns them for each batch of information such as the origin, detailed attributes of products, dates for treatments, harvesting, processing, selling etc. It allows smart, self-executing contracts to be implemented, which can enhance trust between sellers and buyers. The transparency of the data can also improve food safety, since it allows for easier regulatory control to detect fraudulent behaviour, improved monitoring for compliance with sanitary and phytosanitary regimes, and even a strengthened ability to respond quickly to disease outbreaks and contaminated agri-food products (Tse *et al.*, 2017). Blockchain aims to strengthen the enabling environment for transactions with better informed policies. Some also say that it might replace certification for voluntary standards and reduce rejects at border crossings, especially for exports from developing countries.

Nevertheless, the required integration of all the actors in supply chains into blockchain is challenging, will take time and involves numerous social and economic risks in developing countries.

The main obstacles to the implementation of this technology are the paucity of resources and skills. First, this technology can only be used with a computer network and will thereby exclude billions of people who do not have access to the internet (Map 10). This is a particular problem in Africa and Asia where coverage is patchy, with only 25 percent of the population having access, and connectivity is the most expensive in the world (A4AI, 2018). Second, while blockchain promises to make it possible for participants to incorporate better analytics in their operations, most small enterprises in the world do not keep a clear handwritten accounting register as many operations and transactions fall within the informal economy. However, the fast rise of mobile payments in the region could facilitate the deployment of these technologies.

Until now, cooperatives or exporters have taken on responsibility for the complex and time- consuming red tape linked to transparency in the agri-food export sector. However, unless smallholder farmers, as well as micro-, small- and medium-sized enterprises, increase their capacity at least initially, blockchain may lead to greater marginalisation for some market participants. The reasons could be similar to those which tend to exclude diversified, small-scale farming from standards: third-party certification has a high cost, due to the work related to the certification procedure, the bureaucratisation and analysis of data, the cost of auditing, skills and travel expenses, which favours monoculture productions and agri-food industries; and the centralisation of the design of the system (Lemeilleur and Allaire, 2018). Depending on the precise blockchain characteristics, these could be more-or-less mitigated.

Finally, challenges appear at the public governance level, particularly with regards to data access. Access



Map 10: *Access to the Internet: still patchy in most LMI countries.*

to data in blockchains can be private or shared, depending on the rules adopted, the purpose of the platform and the preferences of the users. In some 'closed' blockchains, a central actor controls permission to enter the system and access the data, and could exert undue market power. The choice among these different tools must juggle data accessibility so that all users can enjoy the benefits of the tools and, simultaneously, manage the protection of confidential information, such as personal data. Inter-governmental organisations and governments require clear regulations on data protection to determine how data should be stored and shared between public and private actors (World Bank, 2019).

Most of today's innovations in ICT for agri-food systems are based on access to the internet. Although more than half of the world population is now connected, network coverage is still missing or limited in most LI and LMI countries, currently hampering their development. This map shows estimates of the percentage of individuals who do not use the internet (data from ITU, map from Tripoli and Schmidhuber, 2018). In most African and Asian countries, more than half of the population is absent from the network. The main reasons are the uneven coverage, as well as the high cost of equipment and lack of required knowledge (A4AI, 2018).

BOX 13

SITE-SPECIFIC SOIL FERTILITY MANAGEMENT RECOMMENDATIONS: GENERAL IMPROVEMENT BUT ALSO WIDENING OF THE GAP BETWEEN FARMERS[1]

In sub-Saharan Africa soil fertility recommendations given to farmers are usually generic enough to be able to target a large area. In the maize belt of Nigeria, an ICT-based system has been tested, which tailors advice to make it site-specific at the farm or field scale. *Ex-ante* and *ex-post* surveys have been conducted to evaluate how this technology was received by farmers. According to the *ex-ante* study, most farmers were very interested by this tool, irrespective of their economic resources and farming model. They recognised the heterogeneity in their farming system and the use they could make of tailored recommendations. However, the *ex-post* survey shows that actual adoption of the technology varies widely, as is classically found in studies on the use of agricultural innovations.

The authors identified two groups of farmers. The first, which includes innovators and likely adopters of technology, are better-off, less sensitive to risk, more likely to invest in farm inputs and indifferent towards more-or-less intensive production techniques. The second group includes farmers with lower incomes, lower productive assets, who are more sensitive to yield variability and prefer less capital- and labour-intensive production techniques. They are also more reluctant to be early adopters of innovations. Therefore, the introduction of this new service tends to reinforce the existing gap in economic performance between farmers. Policies need to be designed to compensate for this effect, for instance by putting efforts into considering the specific needs of small-scale, diversified farmers.

1. Based on Oyimbo et al.*, 2018.*

References

A4AI. 2018. *New data: what's the price of 1GB of mobile broadband across LMICs?* [online]. https://a4ai.org/new-mobile-broadband-pricing-data-2018

ATA. 2019. EthioSIS: Ensemble model machine learning approach digital soil fertility map of soil-test results coupled with different satellite imageries has changed fertilizer advisory service in Ethiopia. In: *ATA* [online]. https://www.ata.gov.et/programs/highlighted-deliverables/ethiosis/

Au-Sénégal.com. 2018. L'agritech, l'avenir de l'agriculture africaine ? *Au-Sénégal.com,* 17 December 2018. [online] www.au-senegal.com/l-agritech-l-avenir-de-l-agriculture-africaine,15558.html.

Ekewe, N. 2017. How digital technology is changing farming in Africa. *Harvard Business Review,* May 18 2017.

FAO. 2017. F*ostering the uptake of labor-saving technologies. How to develop effective strategies to benefit rural women.* Rome. 8 pp.

Ge, L., Brewster, C., Spek, C.J., Smeenk, A. & Top, J. 2017. *Blockchain for agriculture and food. Findings from the pilot study.* Report 2017-112. Wageningen, Wageningen Economic Research and TNO.

Kim Dang, A., Tran, B.X., Nguyen, C.T., Le, H.T., Do, H.T., Nguyen, H.D., Nguyen, L.H., *et al.* 2018, Consumer preference and attitude regarding online food products in Hanoi, Vietnam. *International Journal of Environmental Research and Public Health,* 15(5), 981 [online]. https://doi.org/10.3390/ijerph15050981

Lemeilleur, S. & Allaire, G. 2018. Système participatif de garantie dans les labels du mouvement de l'agriculture biologique. Une réappropriation des communs intellectuels. *Économie rurale,* 365: 7–27.

Lin, C.-F. & Liu, H.-W. 2018. *Disruptive technologies and sustainable development.* Geneva, International Centre for Trade and Sustainable Development.

Oyinbo, O., Chamberlin, J., Vanlauwe, B., Vranken, L., Kamara, A., Craufurd, P. & Maertens, M. 2018. *Farmers' preferences for site-specific extension services: evidence from a choice experiment in Nigeria.* Working Paper 276175. Leuven, Belgium, Centre for Agricultural and Food Economics.

Tripoli, M. & Schmidhuber, J. 2018. *Emerging opportunities for the application of blockchain in the agri-food industry.* Rome, FAO, and Geneva, ICTSD.

Treinen, S. & van der Elstraeten, A. 2018. Gender and ICTs: *mainstreaming gender in the use of information and communication technologies (ICTs) for agriculture and rural development.* Rome, FAO.

Tse, D., Zhang, B., Yang, Y., Cheng, C. & Mu, H. 2017. Blockchain application in food supply information security. In *Proceedings of the 2017 IEEE IEEM,* pp. 1357–1361. Singapore.

World Bank. 2019. *Future of food. Harnessing digital technologies to improve food system outcomes.* Washington DC.