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Digital Agriculture, Invisible Land: Global Mergers and Smallholders in Latin America

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Digital Agriculture, Invisible Land: Global Mergers and Smallholders in Latin America

Abstract. Digital technologies have been gradually penetrating agricultural production systems, especially, in the last two decades, generating both expectations and concerns because of the unknown technological scope and the speed of the transformations. The embeddedness, conditions, and usage of digital technologies in the agriculture sector raise questions on how and who participates in global production networks and shapes governance structures and policies. In the current landscape, just a few global networks with different forms of economic and political power are dominating digital agriculture worldwide. Governmental institutions both at the international and national levels foster financial and market policies to invest and promote digitalisation. While some sectors are enthusiastic about the potential of digital tools to contribute efficiently to food production, achieve agri-food sustainability and mitigate climate change, there are major concerns about the challenges digital technologic will bring to smallholders. This article examines the power concentration wielded by global production networks observing the digital value chains in agriculture's dynamics and the challenges digital systems pose to the different smallholder segments and food systems, particularly in Latin America. Digital technologies and the capture of big data reinforce the control of land in a few hands and legitimise techno-scientific knowledge as a tool for decision-making and rules for global governance. The concentration and control of data has important effects at both political and social levels, reducing the participation of small-scale farmers on the one hand, and delegitimising their local knowledge on the other, which affects local and regional governance decision-making processes.

Keywords. Digitalisation small-holders; digital agriculture in Latin America; Digital Value Networks Global Networks; data grabbing

Resumen. Las tecnologías digitales han penetrado paulatinamente los sistemas de producción agrícola, especialmente en las últimas dos décadas, generando tanto expectativas como inquietudes por el desconocido alcance tecnológico y la

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velocidad de las transformaciones. La integración, las condiciones y el uso de las tecnologías digitales en el sector agrícola plantean preguntas sobre cómo y quién se participa en las redes de producción global y las estructuras y políticas de gobernanza. En el panorama actual, unas pocas redes globales con diferentes formas de poder económico y político dominan la agricultura digital en todo el mundo. Las instituciones gubernamentales, tanto a nivel internacional como nacional, fomentan políticas financieras y de mercado para invertir y promover la digitalización. Si bien, algunos sectores están entusiasmados con el potencial de las herramientas digitales para contribuir de manera eficiente a la producción de alimentos, lograr la sostenibilidad agroalimentaria y mitigar el cambio climático, existen grandes preocupaciones sobre los desafíos que la tecnología digital traerá a los pequeños agricultores. Este artículo examina la concentración de poder ejercida por las redes globales de producción observando las cadenas de valor digitales en la dinámica de la agricultura y los desafíos que los sistemas digitales plantean a los diferentes segmentos de pequeños productores y sistemas alimentarios, particularmente en América Latina. Las tecnologías digitales y la captura de *big data* refuerzan el control de la tierra en pocas manos y legitiman el conocimiento tecnocientífico como herramienta para la toma de decisiones y reglas para la gobernanza global. La concentración y control de datos tiene efectos importantes tanto a nivel político como social, reduciendo la participación de los pequeños agricultores por un lado y deslegitimando su conocimiento local por el otro, lo que afecta los procesos de toma de decisiones de gobernanza tanto a nivel local como regional.

Palabras claves. digitalización de pequeños agricultores; agricultura digital en América Latina; redes de valor digital; redes globales; acaparamiento de datos

Introduction

Digital technologies have become indispensable instruments to improve, optimize and transform processes, systems and even ecosystems. The incorporation of new digital tools has led to significant changes in production, communication and transport at the global level, transforming our concepts and perceptions of space and time. Those processes have thus exerted a strong influence on the way how humans relate to and define their old and new realities. Furthermore, the permanent change and progress of new technologies have also challenged human-to-human interaction, bringing new understandings of reality: non-physical and virtual realities. In almost all spheres of our daily life, digital technologies are increasingly present, acting as indisputable instruments to streamline the pathway

to achieve more efficiency, higher productivity and development. The constant interaction of digital technologies has taken place in services, products and systems in the agricultural sector. The techniques for collecting large amounts of data, which are collected in precision farming equipment, are input for the design of future parameters in production and feeding systems. A similar process to land grabbing is occurring in using and grabbing data. Power is concentrated in a few big tech companies, which use data to design future scenarios in the agricultural sector and legitimise their products and services, thus creating an emporium of digital power in the agricultural and food sectors

The concentration of land distribution and the acquisition of large tracts of land in the global South has been noted in several studies (McMichael 2013; Verma 2014, Borras and Franco 2013). Not only transnational corporations but also states from both the North and the Global South have acquired land for food and non-food production in the continents of Latin America, Asia and Africa (Borras and Franco, 2013). Asymmetries in land distribution go hand in hand with the concentration of power in a few hands, as imbalances in land provisioning led to major transformations in land use change and access to natural resources (Cotula et al. 2008; Cotula 2013). Various forms of leases, deals, purchases and acquisitions are strategies of control and land grabbing. Additionally, powerful transnational networks are increasingly gaining control, creating new products, services and channels in the value chain with the data collected through digital technologies.

This paper presents an analysis of the concentration of power through global mergers in the agricultural sector and the role of digital technologies. It critically discusses the narratives supporting digital technologies in terms of their contribution to rural development and environmental governance. The paper argues that digital technologies and data capture reinforce the control of land in a few hands and legitimise technoscientific knowledge as a tool for making decisions and rules for global governance. It also discusses how the concentration and control of data reduce the participation of small-scale farmers and de-legitimises their local knowledge, thus affecting socio-cultural settings, and local and regional governance. This analysis draws on theoretical approaches such as Global Production Networks, Digital Value Networks and Large-Scale Land Acquisition, as well as approaches to land grabbing. The paper consists of the following sections. First, a review of the theoretical approaches to Global Production Networks and the relationship to Digital Value chains, addressing digital agriculture. The second section documents the developments taking place in big mergers in the agricultural sector, their vertical integration and the use of digital technologies. The third session deals with the analysis of LSLAs by discussing the approaches to land grabbing, analysing them in combination with the role of data grabbing and the power concentration in the agricultural sector.

The last section examines the implication of land and data grabbing and how small holders and local food systems in Latin America became disempowered by Big Mergers.

Digital Value Chains

In the second half of the twentieth century, the interconnection of economies and sectors reached a global scale. The geographical impacts of growing economic interplay has extended and connected along different world regions, resulting in Global Production Networks. The GPNs are transnational systems which control capital flows and build coordinated circuits connecting operations and transactions whereby products and services are produced, distributed and consumed (Dicken, 2011). Fragmentation both in terms of organisation as well as the location is one of the main features of GPN. Since outsourcing and offshoring are key strategies for economic competition, transnational systems are in a permanent spatial reconfiguration to increase their value-added activities. Vertical fragmentation for specialised tasks is functional to capital, so that manufacturing, production and supply processes are selectively determined in different regions of the world. The geographical landscape of GNP usually extends the value chain activities and poses challenges for local environmental, social and political ecosystems.

Howson et al. (2021) analyse the characteristics of Global Production Networks (GPN) and Global Value Chains (GVC) to explore power unbalances and value extraction by introducing the concept of Digital Value Network proposed previously by Coe et al. (2008). These scholars have tackled the DVN analysing digital labour platforms and argue that 'logics of coordination and value extraction are taken to new extremes in DVC' (Howson et al. 2021: 2), as they allow firms to optimize production while externalizing ownership and cost. They concentrate on both monetary and non-monetary value producing overconcentration of global power in established sectors as well as in emerging ones. DVC play a crucial role and are directly involved in service and productive segments, many of whom were resistant to global coordination in the past. Digital expansion wields impacts on local geographies and models of governance and is potentially responsible for exacerbating uneven outcomes at the local level.

At the beginning of the twenty-first century, the introduction of digital technologies in different fields and sectors was accompanied by a strong belief in the advantages and benefits they would bring. The underlying assumption associated with the boom in the digital world is the usefulness that technological tools will provide in finding more effective responses to optimise production processes—that means higher efficiency—and as very suitable solutions to

environmental and poverty issues. The possible risks and challenges those technologies represent remain still open today, as much of them are just in the first phase of development and social embedding. Digital tools have become highly relevant not just for the industry but for many other domains having impacts on policy design and institution building. While the introduction of various digital systems is making great strides, their regulatory frameworks and governance structures are a bit blurred.

ICT and technological chains have become key instruments to strengthen globalization oriented to economic activities within social and institutional embeddedness. Their outcomes bring new organizational and geographical structures sustaining the global economy analysis approaches both on GCV and commodity chain reckon technology to be a key variable to fostering inter-firm dynamics and industrial governance to have control of suppliers' activities and obtain value produced (Gereffi et al., 2005).

Technology and digitalisation are acknowledged to exert a crucial role in shaping Global Networks by connecting the different axes that make up eco-systems. (Foster and Graham, 2017). Networks' structures build more optimal frames for transaction cost than markets since they are ideal forms of action and decision coordination where actors are rather oriented towards entering into a bargain (Williamson, 1991). Granovetter (1985) points out the relevance of structural embeddedness action, which is a process in which actors manage to influence resulting in a "network effect". While governance forms have a coordination function acting as—or in the name of—institutions, governance mechanisms represent key elements aimed at managing the reduction of transaction costs. Some scholars conceive networks as entities with rather horizontal relationships, that could construct a hybrid system between markets and hierarchies in which elements from both could be combined. Coe et al. (2008: 272), on the contrary, conceived networks as highly complex and dynamic groups 'in process of flux—in the process of becoming—both organizationally and geographically'. According to Coe et al. (2008: 274), 'global production network is one whose interconnected nodes and links extend spatially across national boundaries and, in so doing, integrates parts of disparate national and subnational territories'. To achieve arrangements GPN struggle between autonomy and adaptation, as nodes are embedded in wider sets with a multi-dimensional nature. Digital technologies are not just tools but have become important socio-technical infrastructures that enable GPNs and global commodity chains to perform network governance. Digital technologies aim to turn the complexity of interconnectedness between GPN processes by optimising costs, providing new services, creating value and controlling in the flow of digital information. Such scope in technological management makes it possible to link coordinated interdependencies between sectors, actors and institutions across different

geographies at global scale.

Digital Agriculture and Smart Farming

Smart farming narratives support the assumption that digital agricultural tools are exclusively oriented to achieve more efficient production systems, and inclusiveness as well as to enhance environmental sustainability. Understanding efficiency is linked to the creation of intensive-information digital tools able to hold systems to steer the automatic functioning of farming equipment such for milk production, pollinating, fertilizing, livestock etc and accordingly increasing their outputs and benefits. The production systems in agriculture have experienced different transition processes from more machine-dominant just some decades ago to more digital-centred systems in the recent two decades. The automatization process and control mechanisms in farming and agriculture transform farming and food production drastically as digital tools allow the creation of management webs to remotely control and sense farming machinery in different contexts. Although digital systems are created to achieve higher and better results in agricultural production, their impact and the created digital value extend far beyond the physical space and involve other activities beyond the farm sector. New concepts of valuation such as the worth of information and information management as well as value opportunities, inherent to imposing digital domain, reshape the decision-making process. Digital technology creates new conditions in the system of exchanges because they become elements of value. In Foucault's (2010: 213) terms, 'the value of goods is based on their utility or, what comes to the same point, on the use we can make of them', which raises questions on governance and participation processes in agriculture both at the local and regional level. Digital life creates new sociotechnical realities where just big tech companies whose domain functioning and knowledge can govern the automatic infrastructures (Fraser, 2022). The resulting new digital landscape empowers a few companies worldwide to continue keeping control of cutting-edge technologies for agriculture and data collection while placing other actors out of their decision on their digital regime.

Digital technologies have been touted to have the potential for improving significantly agriculture systems and optimising agriculture outcomes and production. Data servers connected with financial centres are part of the machine-machine ecologies that are responsible for the trading values and prices of crops and food. *Jon Der*, one of the Agricultural Transnational Corporations ATC have created a smart tractor capable of both functioning as a key instrument in the harvest and a key receptor of harvest data collection at the same time (Fraser,

2022). The data collected by tractors, sensors and other digital tools are stored in a digital platform set up by a service provider that by using algorithms showcases punctual farming recommendations. Most ATC-driven agricultural services are based on machine learning models that are designed to be predictable, so they collect data that should be used to create food, consumption and production patterns tailored to the interests of large technology companies. The fragile configurations or misconfigurations of smart agriculture overlap in different settings beyond the agricultural environment, involving also suppliers, retailers, supermarkets and food companies. This 'activates socio-technical relations' according to their visions and expectations, on the one hand disadvantaging actors who cannot integrate into their systems, and on the other hand exacerbating the asymmetric power relationship that results in few winners and many losers (Fraser, 2022).

The usage of cutting-edge technologies for food production, crop cultivation and agriculture in general, such as robots, sensors, analytical tools, and digital communication are not completely new; digital devices have been used for farming purposes at the end of the last century. Nevertheless, digital agriculture today is characterised not only by the use of specific equipment but mainly by the integration of various digital services as essential components in the agricultural production system. More advanced precision systems rely on tools such as global positioning systems, radio frequency identification (RFID) and even automated or robotic milking and feeding systems have been implemented in the hope to support the agri-food industry (Fraser, 2022, Schrijver et al., 2016). Software and artificial intelligence are designed to gather data that can provide predictive analysis on soil management, harvesting optimization, and plantation cycles among others.

It is not only the process of data collection that is of concern, but more importantly the appropriation of the data and information that is captured in an increasingly centralised way. In addition, the strong reliance on algorithms in important decision-making processes—from the simplest to the most—is implicit in the whole upstream and downstream agricultural dynamics. Visconti (2019: 1) describes digitalization as 'a process of converting data (not necessarily information) into a computer-readable format'. Digital platforms are 'software-based external platforms consisting of the extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it' (Tiwana et al., 2010: 675). The nature of digital technologies consists of a new architecture which makes it different—and therefore innovative—from previous technologies, they pose three 'unique characteristics: (1) the reprogrammability, (2) the homogenization of data, and (3) the self-referential nature' (Yoo et al., 2010: 726). Software platforms build an invisible meeting ground for technological applications where developers and end-users come

together (Evans et al., 2006).

Top-leaders in Global Agriculture: Integration Axis and Digital Tools

While the vast majority of farm and fishery workers are gradually being trained to navigate the digital world with dexterity, a just few companies that for about decades have made inroads into the digital world, are dominating digital services worldwide. According to reports on agriculture and food from 2017 and 2018, the industrial agriculture sector is dominated by a few hands: along the different stages of the food value chain companies' participation worldwide is just restricted to particular enterprises as follows: in the seed sector, four big companies capture the 67% of the global market; in the agrochemicals sector, four top companies account for the 70%; in the fertilizer sector, the top five companies worldwide with 18% of the market; the farm machinery and data are controlled by the top five enterprises with 41% of the participation; and for the grain trade, only 4 top companies account for 90% of the total market worldwide (Mundy and Mundy, 2017; Mooney, 2018).[2] Big mergers have propelled transnational networks such as ChemChina-Syngenta and Glencore to become the world's largest commodity and food traders (Mooney, 2018). [3]

According to Mooney (2017) and Mundy and Mundy (2018), six top-leader companies dominate the agro-chemical sector in pesticide and seed markets worldwide: BASF, Bayer, Dow, DuPont, Monsanto, Syngenta.[4] "Horizontal integration"—where dominant companies in one market sector acquire other companies in the same sector to control a larger share of the market—has raised serious competition concerns in the commodity trade. While horizontal integration has allowed transnational corporations to consolidate their control over part of the value chain, a further concentration of power known as "vertical integration" is taking place, as along this horizontal axis, mega-companies buy up companies not only in their market and business sector, but attempt to acquire

[2] The authors represent the following reports: P. Mooney: the ETC Group; Mundy and Mundy: The Agri-food Atlas.

[3] Glencore is also very active in the mineral resource extraction business at places like the Cerrejón mine in Guajira, Colombia. Glencore operates the world's largest open-pit salt mine. Indigenous communities in the region have been displaced and environmental damage is severe. The company has faced serious allegations of environmental and social damage. For more information see https://www.glanlaw.org/cerrejon-coal to become the world's largest commodity and food trader.

[4] https://www.etcgroup.org/content/breaking-bad-big-ag-mega-mergers-play

dominant companies in different sectors both up and downstream in the value chain. As can be seen in the food industry, where large TCAs control a large part of both the transport and seed sectors.

The involvement and adjustments among different stages, sectors and companies in this new integration order in the industrial food chain seem to be closely related to the creation of new platforms and the continuous development of the digital world. The concentration of market powers goes hand in hand with the development of technology platforms; companies store and make use of big data to control not only international trade issues but to control also seeds, food production and distribution. Big data platforms have become essential sources that are transforming food systems and leading to profound changes in the integrations sectors of the global food chain:

This new Big Data platform invites—almost requires—cross-sectoral convergence, and those who control the platform can regroup the industrial landscape. Not only are new oligopolies or even monopolies created, but barriers are erected that discourage other entrants and suffocate innovation (P. Mooney, 2018: 5).

Technology platforms and digitalization processes in the food sector are presented as the best solutions for the future of the global industrial food chain. The optimisation process through digitalisation technologies along the whole food value chain represents huge benefits and revenues for the involved companies, which leverage decision-making processes and boost policies to accelerate agricultural settings towards digitalisation worldwide. These are decisive tools in enabling transnational firms to gain a foothold in new market segments and coordinate activity across different nodes of the value chain. Although full vertical integration in the industrial food chain is still a way off, transnational companies reinforced by mergers and acquisitions in different sectors of the chain are manoeuvring to take advantage of the benefits offered by big data and digitalisation techniques.

The development of global networks in the food industry, as well as in the vehicles and energy sectors, has been boosted by the intensification and implementation of digital processes. Digitalization systems have opened new windows for oligopolies to increase their wealth. Different sectors along the food chain have been introducing both hardware and software systems to increase production and therefore rise their utilities. Digital tools are probably contributing to opening new channels for information distribution relevant to agriculture but at the same time, they are producing significant impacts on local and regional productive economics and food systems. Even two decades ago, in 2001 *John Deere*, a worldwide and well-established company in the farm machinery industry, invested in telecommunications and energy sectors to offer commercial

satellites for mapping precision. In the same vein, *John Deere*, AGCO and CHN have arranged deals with agrochemical corporations to have access to Big Data hardware. Furthermore, conglomerates from the agrochemical and farm machinery industry have dealt partnerships and sealed acquisitions for digitalisation in precision planting and harvesting, planting prescription, apps for fertilizers, satellite for natural resources, agricultural software, and sprayer manufacture among other applications.

Arguably, the "Climate-Smart Agriculture" these companies fiercely promote will play a dominant role in products' market prices as well as in quality standards. Digitalisation technologies can control the industrial food chain by intervening in different sectors, crops, soils and seeds. The transformative and changeable technologies used in the food chain put also pressure on the big giants which get into competition modus to gather as much information as possible from aquatic, aerial fields and land areas. The collected information on water and land is combined with weather predictions, -in some cases with information on genetics- which is intended not solely to understand food systems but mainly to reshape/ transform them/adjust them to their interests.

The huge amount of information mergers has access to, is leading to disproportional power concentration, since new corporation are those who can use the gathered information to set in motion political decisions and to create legal mechanisms to favour their goals. Digital technologies are not only used to obtain information from terrestrial areas but to explore even more unknown places such as the oceans. Currently, aquatic drones are designed to monitor, transport and, to some extent, encroach on the planet's common water space, such as the experimental open-ocean fish farming by the Norwegian company, SalMar:

> Ocean Farm 1's sensor system: 12 echo sounders mounted on the bottom of the frame, high-definition cameras dangled into the water at different depths, oxygen sensors and movable, submerged feeding tubes ("Net gains" 2018). [5]

Both hardware technologies and software systems are being used in the reconstruction of DNA sequences, DNA synthesizers for editing genes, as has been done for Ethiopian cereal, it is also applied for plant breeding and crop production. Precision and accuracy are issues that critical big data scholars have addressed. While digital tools capture a large amount of information, the quantity of data collected cannot provide results on its own. This information is subject to interpretation and therefore cannot be considered as indicators that determine

[5] "Net gains. Open-ocean fish farming is becoming easier"
https://www.economist.com/technology-quarterly/2018/03/19/net-gains

indisputable deterministic truths (Visser et al., 2021). In digital technologies, Visser et al. offer an analysis providing examples of inaccuracy in precision agriculture, both in hardware systems, such as GPS, sensors and performance mapping in general and in software, especially that related to algorithms.

Exacerbating power: grabbing land & data

In recent decades the trans(national) land transactions and land speculation have exploded, particularly in the Global South. Companies and governments both from the North and the Global South have started to push a 'new cycle of enclosures and dispossession' (Borras and Franco 2011: 34). The pursuit of capital-intensive investments to reduce spending on agricultural inputs while intensifying smart agriculture has impacted small-scale farming, especially farmers from indigenous and afro-descendant communities, who are forced to leave or sell their land for large-scale industrial agricultural projects. Companies have not only stocked up on large tracts of land but also on new knowledge through digitalisation to steer future scenarios of planetary agriculture. Borras et al. (2013) raise attention to how large-scale land investments have been introduced and popularized in the mainstream international institutions and government recasting semantically global land-grabbing phenomena and presenting LSLA and investment as an opportunity to overcome rural poverty. The waves of global land grabbing affect in distinctive directions changing land uses. Transformations linked to change in land use on rural population and the environment shift socio-cultural patterns and have impacts on food security.

During the second half of the twentieth century, there was a mismatch between the suitable arable land and the population distribution. The uncertainties and concerns about food security and food distribution that were raised under Malthusian theory in relation to global population growth could now be explored through the lens of Large-Scale Land Acquisition. Large-Scale Land Acquisition particularly in the Global South has been presented as key strategic to tackle food security concerns, as Giger et al. (2019: 257) state: 'the perceived urgency to achieve food security leads both important donors and governments in the South to opt for large scale agricultural production in the global South'. However, national governments of several countries in the Global South have adopted international policies, driving their decisions on flex commodity crops such as sugar cane, soybean and palm oil, that can be used in multiple uses and in different industries. These transformations are associated with 'changing dietary preferences, […], public health and socio-ecological narratives around climate change' (Borras, 2014: 4)

The control over the territories, as well as the use of monocultures, has led to the drying up of other problems. In not few cases, land destinated for large-

scale production was used as Common Pool- Resource (CPR) by smallholders and pastoralists Haller (2010). Since Large-Scale Land Acquisitions impose a different production system, small farmers tend to be excluded as local productive economies are not consistent with the capital-intensive business industrial agriculture corporations are striving for. According to Haller's research (2010), CPRs play a determinant role not only concerning food security but also in terms of providing additional goods and services for the local communities to meet their needs. Formerly, the CPRs have been embedded within the legal frame of communal lands, private lands or state property regimes or some combination of the three. Large-Scale Land Acquisition (LSLA) strategy means that small farmers lose access to land as well as to other natural resources. Giger et al. (2019) refer to an exhaustive analysis conducted by Nolte et al. (2016) to review the broad patterns and frequent processes of LSLA. The dynamics of land grabbing for large extensions of industrial agricultural crops or for use in other sectors is detrimental to the agricultural development possibilities of small farmers and in turn prevents the use of so-called common lands, which have been part of the organisational system of rural agricultural cultures in several areas of the global South. Some insights on deals over land reveal the trends in LSLA, as described below:

> The production of food crops (38 per cent of total area), unspecified agricultural products and non-food commodities (32 per cent), agrofuels (21 per cent), and livestock (9 per cent). The most important crop types across all continents are oilseed, including oil palm and jatropha (44 per cent), cereals (20 per cent), and sugar crops (10 per cent) (Giger et al., 2019: 260).

Scholars argue LSLA impact CPR regimes since this mechanism exacerbates the appropriation of communitarian land by private actors and states. The LSLA promote highly productive agricultural systems that, on the one hand, are capital intensive and on the other, are devoted to cash crops. The high pressure on how to tackle food security is closely linked to the rise of foreign farmland acquisition.[6]

Agrarian studies have carefully addressed the developments in smart farming pointing out a major concern on the effects of land grabbing. LSLA in the global south is normally related to capital-intensive industrial agriculture to produce commodities particularly and relies on Digital Agriculture. Precision

[6] China 40 years ago was a net food exporter, and during the last decade, it has become a food importer. The increase in China's per capita protein consumption resulted in 40% of grain imports in the year 2015. China had acquired lands in Australia, but these processes of acquisition were blocked in 2015. Nonetheless, Chinese companies have been also in the search of farmlands, especially in African countries, such as Congo, Mozambique and Angola.

Agriculture are used to commodify data as discussed by Fraser:

> Per the straightforward notion that grabbing is an opportunistic endeavour, this "data grab" is about using data to inform innovations and direct strategic investment for a changing context. A form of dispossession occurs when users do not manage to have control over their generated data (Fraser 2019: 896).

In the long run, the profits from the information provided by technological tools become the exclusive business of large mergers and Biotechs working in alliance. Large-scale farms for soybean such as in Brazil are managed by using guidance systems VRT which can capture data which is sold to the US. Fraser 2019 argues that just as the expansion of the agricultural frontier has pushed forward, so too has the frontier of information capture, leading to high levels of usurpation of sensitive data in the agricultural sector as well as in many other spheres. The large emporiums that manage various facets of the global agricultural sector are interested in gathering information through land records, mapping, and GPS satellite imagery, as well as the use of Geographic Information Systems (GIS), which in a way makes data usurpation possible. Corporate dominance and control over sensitive information over data management becomes a crucial issue as rural-local population does not get access to the digital information about their territories. This fact disempowers small scale farmers as the lack of adequate knowledge instruments has impacts on land governance. Digital technologies used GIS to map land from 10,000 feet high to catalogue the availability of what is legible in digital form. Thus, the data interpretation gathered through digital tools when mapping land is characterized as "unused" and "empty" land. Rural communities' view of the land is quite different to the corporation approach, as "empty" and "unused" are incompatible categories in terms of the diverse socio-economic and cultural functions their territories have as well as the historical meaning for the community tradition and the relationship to well-being of rural communities (Millar, 2016). The power of big corporations in controlling land is supported through the data over local land they collect and legitimacy they attribute to digital information.

Technological knowledge encrypts new information about the land, which delegitimises the communities' knowledge. On the one hand, the historical experience of communities with their land, as a social, cultural and economic resource, is being silenced. On the other hand, the material collected becomes the property of the corporations that will then use this information on the mapping of local territories for investment or extraction purposes gaining both territorial and sectorial expansion. This information is very attractive to investors, as it is sensitive data to better calculate the transaction costs and risks of their portfolio. Digital technologies are increasingly playing a role in the development of agricultural production and food systems. Data collected via Precision Agriculture devices has a big potential in providing key material needed to develop new

services and products with the scope for patents to be privatized and commercialized. As Fraser (2019: 897) states 'this new "data revolution" —this data grab—in agriculture holds out the possibility of altering food production systems and agrarian relations more generally in potentially profound ways.'

Land Concentration, Smallholders and Food Systems in Latin America

In Latin America, land concentration has worsened in the last decades since the 1960s. In his analysis of the imbalances that undermine the enormous inequality in the distribution of wealth, Guereña and Burgos (2016) observes that the results of agricultural censuses in Latin America are more than alarming, with the top 1% of large farms holding more than half of the agricultural land. "One per cent of the farms own more land than the remaining 99 per cent" (23). Scholars such as Dario Fajardo have addressed the inequality in land distribution through the proliferation of little *minifundios* in contrast to the big *latifundio*s, in which Colombia is at the top of the list followed by Paraguay and Chile. Oxfam (2016: 25) contends that 'small farms hold less than 13 per cent of productive land, and the average area of a small farm is nine hectares in South America and 1.3 hectares in Central America'.

Revich et al. (2016: 4), takes up Thomas Malthus' theory on food shortage and suggest that today 'the end of the analogue age for farming' brings the long-awaited solution, in which precision farming—fertilizer application, irrigation, spraying and autonomous driving applications become key drivers for yield growth over 70% to 2050. Some other scholars argue that smart agriculture could provide great contributions to agriculture development and would have a significant effect on increasing agricultural food production whilst reducing their transaction costs (see reports Loukos and Arathoon, 2021; ECLA, 2021). Artificial intelligence devices are built to boost farming efficiency. For this purpose, different technological tools have been developed to provide predictive models to collect sensitive information on weather, diseases, yields etc. aimed at facilitating farm management processes and accordingly, tackling better irrigation, fertilization, and weather fluctuation.

According to the Inter-American Institute for Cooperation on Agriculture (IICA, 2021), Latin America plays a key role in terms of food security as the region represents the largest net exporter of food in the world. Latin America's agroecological and socio-cultural conditions make it one of the regions with the greatest potential for agricultural growth in the future. While on topics such as the diversity of the agricultural landscape, products and producer profiles, Latin America shares similarities with other regions of the world, while regarding to

ecosystem service provision, it is unparalleled. According to the FDAO report, food insecurity has worsened during the last six years affecting 30% of the world's population. The IICA report stresses the need to transform food systems in Latin America through digital agriculture whose narrative presents as the optimal pathway to achieve transformation. The final report's recommendation insists that 'the potential negative results of a digital transformation process must be addressed to guarantee a positive outcome' (IICA, 2021: 8). The report is not comprehensive in determining how smallholders could cope with managing the impacts of digitisation. However, topics such as Large-scale production and the need for capital investments overshadow to a certain extent the debate on land concentration and distribution, especially, considering that 'the smallest 80% of farms occupy less than 13% of agricultural land' (Guereña and Burgos, 2016: 25). Regarding the impacts and/or benefits of digitalisation in agriculture, two aspects need to be taken into account: (1) the size of the farm varies within the region and (2) small farmers do not form a homogeneous group. Digital agriculture outcomes cannot be considered without distinguishing the specificities the various groups within small-scale and farmers. Furthermore, family farming, which is so common in the Latin America should be considered as a small famer category as the farm's size for production area is sometime similar, even though, it is not and included as such.

Many smallholders in Latin America are facing with lack of infrastructure and disproportional access to financial resources constraints in production and income among other obstacles. According to Tricarico et al. (2020), the average farms in Latin America are over 10 hectares, except in the Southern Cone, where farm sizes are approximately 2.5 hectares. The size varies depending on whether it is cropland or livestock. The same study estimates that digital transformation introduced in the 1990s has contributed to improving farming, having positive socioeconomic effects on smallholders in Low and Middle-Income Countries. In Low and Middle-Income countries agriculture is essential since it provides food, income and employment. The contribution of agriculture, forestry and fishing to the GDP and employment in LA reaches about 7% even though, there are some differences among Latin American countries.

Challenges in the Latin American Region: Smallholders and food systems

Rural poverty is probably the biggest challenge, particularly in rural environments in Latin America; in Guatemala, 75% of the smallholder must meet ends by receiving $1.90 a day or less. Some studies and reports that advocate digital technologies as instruments with great potential to generate benefits in agriculture are not comprehensive in their analysis and do not accurately address the distinction of who benefits and how. There is a compelling need to conduct

research analysis on agriculture and food systems approaching context-specific studies to determine explicit impacts on local smallholders. According to Mc Cullough et al. (2008), digital agriculture has contributed to increasing crop yield productivity and reshaping food systems organization, but they provide fewer insights on to what extent those technologies contribute to real improvements in rural farmers and households. Lioutas et al. (2021: 67) acknowledge the contributions of digital services could mitigate the challenges of poverty and climate change, however, the analysis raises questions about the 'disruptive nature of [digital technologies] since they can create new forms of value while disrupting the status quo of current agri-food production systems'. Both the benefits and unintended effects of digital agriculture are represented as a 'trolley dilemma' threatening the sustainability of agriculture, depleting natural resources and food security (Geislinger et al, 2021; Barque et al, 2021, Lioutas et al. 2021). The incorporation of digital technologies is expected to increase small farmers' capacity to cope with weather fluctuations, which could strengthen resilience so that innovative alternatives will fare better. On the same line, digital technologies are expected to improve yield production and in cases, such as cereal production, to effectively close the production gap. According to Tricarico et al. (GSMA, 2020) in 2017, the cereal yield in North America was 7,401 (kg/hectare) while in Latin America the production reached 3,305 (kg/hectare).

Coexisting Food systems and digitalisation

Within the diverse group of small farmers in Latin America, there are subgroups of farmers, fishermen and land workers whose local specificities are in line with the biological and population diversity throughout the various continent's regions. Diversity can also be seen in the systems of productive economies specific to each area. The products cultivated are distributed on different geographical scales, whether national, regional or sub-regional which shape the specificities of food systems. As stated by Yoo (2010) digitalization nature is linked to the homogenization of data and it is not different in digital agriculture. Homogenisation is to some extent a threat to the diverse forms and modes of agricultural production in the Global South, where different food systems coexist, serving different kinds of demands and, especially, supplying different consumption needs. Global food systems have built themselves into complex structures that are subject to broader political and economic forces, interests and power relations, and are framed by functional economic, political and legal systems. Digital technologies are key instruments to shape food and consumption patterns. Mc Cullough et al. (2008) suggest that economic development has significantly transformed consumption patterns, production and trade at the global

level: the rising incomes, demographic transformations, technologies and globalization are the major global shift drivers. Those scholars analyse the transformation process of food systems and provide a typology distinguishing three different food systems: traditional, modern and industrialized. Although they have identified specificities and similarities, they nevertheless note that the boundaries between them are not easily distinguishable.

Latin America's share in terms of the global food supply 'is an important source of food globally, generating 13.6 per cent of total agricultural exports' (IDB, 2021: 2). On the other hand, the participation of small farmers in food provision is of utmost importance, as for smallholders represent 60% of the global agricultural output worldwide. According to ETC Group, peasants produce more than two-thirds of world's food while industrial food chains occupy 75% of arable land (ETC Group, 2017: 6). Digital technologies would be an element of empowerment for small-scale farmers and the preservation of diversity in food systems if they were conceived in the framework of "data sovereignty", which is not currently the approach. Nevertheless, new technologies have some contributions to specify trading targets such as linking producers and consumers and improving the coordination within the supply chain by managing efficiently demands and responses. Additionally, the urbanisation's pace and development in Latin America is challenging the transformation of food systems due to the intensity of marketing of high-value products.

In Latin America, both subsistence and export-oriented systems coexist. The transition from traditional to modern or industrialized systems or even to digital systems will depend on different factors, such as the type of crop, export orientation, agroecological focus etc. In this regard, digital technologies should be oriented to provide helpful tools to strengthen the existing food systems by considering their specific opportunities, incentives and constraints. smallholders' patterns and practices should be integrated and included to facilitate organisational changes that could drive the transition from one food system to another. Governments and transnational corporations tend to overlook the coexistence of different food systems and the diversity within small farmers in the rural sector. As Digital technologies are designed to be homogeneous, it is highly questionable how diverse smallholders' patterns and practices could be integrated and included to facilitate organisational changes and face challenges. A successful transition to the implementation of digital technologies would imply addressing goal-oriented targets to identify subgroups' characteristics, needs and opportunities to upgrade food systems.

"Food Webs"

Food systems are made up not just of farmers and industrial food chains but they

are integrated also by fishers, livestock-keepers, pastoralist, hunters, gatherers etc. who build peasant *food webs*. This term—proposed by The ETC Group—encompasses different actors, and approach to the rural social ethos. Approaching smallholders or small farmers in terms of a web depicts more accurately the rural realities in the global South. This term includes all those who can produce for themselves and those who work for others; it comprehends also different environments such as land, and water where peasants work as farmers, fishers or in semi-urban locations in multiple labours to be able to feed their families. The *food web*'s contribution to food sovereignty tends to be under-valuated; small farmers possess an agriculture repertoire cumulated along generations; they have developed resilience mechanisms to face the challenging climate onslaughts. Likewise, farmers have an important contribution to the conservation of biodiversity, they provide more variety of species and crops than the industrial chains by using modified seeds to scale up their profits. Digital technologies create another new knowledge in agriculture that deprives farmers of information management because they do not have access to data, while the accumulation of data creates added value for companies on that information so that they can obtain economic benefits for their sales and services.

Agricultural digitalization transforms the modus operandi of the involved actors and sectors, by shifting social relations and social capital. According to Lioutas (2021: 67), 'there is no clear evidence that agricultural digitalization can meet societal expectations or achieve higher societal targets.' Similar to *sustainability's* meaning, the concept of *inclusion* has become a 'empty concept' to legitimise digitalization. The access to financial incorporation and participation of smallholders in mobile money services seems to become a dominant instrument for financial inclusion.

Arguably, the inclusion processes of farmers in digital services will result in some benefits such as less dependency on intermediaries, optimisation to sell their products to consumers and having a higher margin of the product's final price. Access to agriculture e-commerce is considered a tool to facilitate access to formal markets, saving time and cost transactions. Likewise, access to information on the weather forecast, and advisory tools on climate is expected to have an impact both in mitigating climate change and improving farmers' climate resilience capacity. However, farmers' access to formal value chains could not lead necessarily to the expected outcomes. On the one hand, since the cost of participation and transaction in formal chains and markets is considerably high, many small farmers are likely to be excluded from the income provided by the market segment. On the other, if disproportionate distribution and access to key resources and information for agriculture are linked exclusively to the linkage of

commercial farmers, most informal farmers are not likely to be favoured by established agricultural value chains. Since in in Low- and Middle-Income Countries only 7% of the 500 million smallholder farmer's households are operating within formal value chains, it means that the vast majority of small farmers remain still in disadvantageous conditions.

Digital agriculture in Latin America and the Caribbean is focused on smart farming, especially in large-scale settings and agribusiness in Argentina and Brazil. Among the digital services to implement technology for agriculture, E-commerce is the most dominant tool, whilst digital procurement services are not in high demand. An E-commerce example is the Application Smattcom,[7] a platform to consult prices and trade agri-food products and is present in eleven countries in the region. Smattcom provides different services to connect farmers and consumers and hands out information and training courses on agricultural production. In the process of implementing digital agriculture in Latin America, some countries are eagerly running to deploy different digital services, such as Colombia, which is becoming an important hub for digital agriculture.

Final remarks

Digital agriculture is transforming systems, patterns and chains in agri-food production and food supply value chains. The implication of these changes could either lead to development progress in food production or/and strongly compromise traditional food systems and family farming by jeopardising the participation of smallholder farmers. This would result in the concentration of power, control and information in the hands of merging conglomerates and large technology companies.

In the eagerness to highlight the benefits of digital agriculture, it is often overlooked to question to what extent it contributes to solving structural problems rooted in Latin America's agricultural history, such as land concentration. In socio-political terms, there are concerns regarding governance issues, as well as new sub-sectors, which are gradually becoming digitally dominant, that in the past were not in anyone's domain.

In addition, many of the digital technological systems are driven by algorithms, which represents a major challenge to governance models and systems, as well as to sovereignty as we have known it until now. This is happening with the emergence of large conglomerates managing key sectors in

[7] Smattcom is a Mexican e-platform whose services for users with Active Membership are: One-time payment effective Monthly-$89.00 / Quarterly $228.00 / Yearly $799.00.

agriculture, such as seeds, pesticides and transport. Access to big data and capital investment increases the dominance of oligopolies through vertical integration, influencing global policies and national agendas in the agricultural sector.

Agricultural policies should aim to encourage the coexistence of different food systems and strengthen decision-making processes and participatory mechanisms to decide on data sovereignty. Moreover, the improvement of traditional food systems is closely linked to the strengthening of local knowledge and capacities of farmers. Digital tools should therefore provide solutions that strengthen local connectivity among small-scale farmers and foster community-based, local farming structures, such as agro-ecological alternatives while encouraging interaction with other markets.

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