

Digital Transformations in Agri-Food Systems: Innovation Drivers and New Threats to Sustainable Rural Development

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Abstract. The paper proves that sweeping digital transformations are a global trend in agri-food development. Significantly improved economic efficiency, rational use of natural resources, operational exchange of relevant information, new markets, and economic opportunities under modern climate change are possible owing to digital transformations. It is grounded that the elimination of world hunger based on the provided internal food security and secured rural communities should be the primary goal of the digital innovations in agri-food systems within Sustainable Development Goals (SDGs). The paper states that along with the significant benefits of digital technologies, the great destructive impact on the overall societal development is possible due to the corporate monopolization of digital processes. Thus, there is the risk of the development of food systems, which are characterized by decreasing in the food supply, loss of biodiversity and rural livelihoods. Proposals to mitigate the threats of digitalization, strengthen internal food security and enhance the development of rural communities through information and communication technologies (ICT) are substantiated. The specific of the agri-food digitalization in Ukraine is outlined, which is determined by the duality of the organizational structure of agriculture (corporate and individual sector) with a tendency to the concentration of land, power, and financial resources in favor of corporations expanding opportunities for digitalization. Appropriate safety measures to mitigate the negative impact on the development of small producers, rural areas, and Ukrainian society are identified.

1 Introduction

The introduction of digital technologies is a global trend of modern world development that has no alternatives. Digitalization is cross-border in nature and free of any restrictions on the area of application. Its rapid growth is explained by a range of solutions for efficient management, rational use of limited natural resources, improved transparency, information exchange, and so on. Meanwhile, the implementation of digital technologies towards better profit margins and economic benefits destroys existing food chains, restricts freedom of choice, and increases inequalities in social development. An adverse effect is also shown in that the involvement in the appropriate processes does not require personal consent. Even opponents of the digital transformations being registered regular users become participants by default. Digital technologies bring people to new chains of responses developing massive databases. For instance, participating in different platforms means subject/user's (companies, governments, citizens) respond to numerous requests with digital tools (message in Twitter, like a Facebook post, send an e-mail, use cloud storage service, hail a ride with Uber, create new apps, etc.). Such data

“reserves” go through algorithmic computation to further commercial use [1].

At the 43-rd session of the Human Rights Council, the United Nation Secretary-General António Guterres noted, “the digital age has opened up new frontiers of human welfare, knowledge and exploration” [2]. However, the use of new technologies leads to violations of human rights and privacy through surveillance, repression, online harassment, and the spread of hatred. Advances in technologies, such as facial recognition, robotics, digital identification, and biotechnology must not lead to weakening human rights, rise in inequality, or discrimination [2].

The digital reconstruction of food systems amid growing food insecurity under the COVID-19 pandemic is being activated with the focus on the concentration of power and development of globalized value chains [3].

Agri-food digital transformations show that consumers will have to continue to participate in the data exchange, delegating control over their food preferences to corporate structures. Developments “behind-the-scenes” in Amazon’s corporate headquarters or Samsung, Nestlé, Pepsi research laboratories are oriented towards using information technologies to secure future profits of food producers.

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Results of their experiments will be reflected in alterations of the internal super-markets layouts, restrictions in flavors or styles of food consumption, impacts on customers' experience of buying food, and strengthening the food industry expanded power to shape farms' activity worldwide [1].

The abovementioned warns of the possible emergence of food systems where supply is quite limited and significantly dependent on consumer characteristics [4], which, in turn, will contribute to the loss of biodiversity in food and agriculture that currently degrades at an alarming rate because of ecosystems destruction [5].

The purpose of this paper is to reveal the relationship between digital transformations and digital inequity in agri-food systems centered on the harmonization of rural social and economic relations as well as on the equal access to food produced by small family farms that can contribute to the mitigation of the effects of uncontrolled agri-food digital transformations.

The **information resources** for the study are comprised of publications of UN [6, 7], FAO, IFAD, UNICEF, WFP, and WHO [8, 9], OECD [10], data of LAND MATRIX [11], State Statistics Service of Ukraine (the economic activity of large-scale agricultural enterprises, private and farming households) [12], studies of national and foreign researchers.

2 Background

2.1 Global situation.

Climate change, conflicts, recessions, the spread of transboundary animal diseases and pests have exacerbated the food crisis, reduced the well-being of rural communities, and increased the number of hungry people around the globe. The COVID-19 pandemic has aggravated existing problems of malnutrition and food insecurity. One of the key factors inducing severe food crises and particularly hunger is conflicts [13].

According to FAO (2020), there are about 690 million people, or 8.9% of the world's population who suffered from hunger last year. Over the previous year, the number has increased by 10 million people and almost by 60 million people in the last five years respectively. The growing tendency is also confirmed with the indicator of food insecurity: about 750 million people or almost every tenth planet inhabitant suffered from hunger in 2019. Approximately two billion people do not have permanent access to sufficient, safe, and nutritious food. If the trend continues, the global number of starving people may exceed 840 million people [9].

The results of the one-third term spent to implement the Agenda for Sustainable Development show that the

world is out of schedule to achieve the global Goals by 2030 [7]. Before the COVID-19 outbreak, the progress had been uneven, and more proactive measures were needed to settle the situation. The pandemic abruptly disrupted implementation towards many of the SDGs and, in some cases, turned back decades of progress [6]. Preliminary assessments show that the last year of the COVID-19 pandemic may increase the famished population from 83 to 132 million people [9].

2.2 An FAO initiative to reduce poverty based on digital transformations.

Early in 2020, the Food and Agriculture Organization of the United Nations (FAO) presented a new Hand in Hand Initiative [8] with a focus on regions with high agricultural potential. The Initiative should unite the capacities of developed countries in the transfer of new digital knowledge and technologies to those with extreme levels of poverty and hunger. Partner selection may refer to attracting new donors or private sector investments, as well as identifying investment gaps to work with existing donors, multi- and bilateral agencies.

The Initiative aims to help poor and the least developed landlocked countries, the least developed small island states, developing countries, countries experiencing food crises, as well as large countries with significant outbreaks of destructive phenomena. It is based on a multilateral approach focused on accelerating the growth of agriculture and sustainable development of the participating countries through the use of digital technologies. The focus lies in strengthening the capacity of food systems and their ability to provide quality food and a healthy diet for everyone, as well as to increase households' incomes to reduce extreme poverty.

The introduction of state-of-the-art instruments, including advanced methods of geospatial modeling and analytical tools, such as the Geospatial Data Platform, the Data Laboratories to support innovations in statistics have been envisaged in the framework of Initiative implementation. They provide high-quality, accessible, time-bound, and reliable data that help countries make sound strategic decisions based on objective information. To create the platform, FAO has gained the support of leading tech companies and open data providers, including Google, IBM, and the World Bank. FAO provides coach training activities for participating countries to ensure the tools of the Hand in Hand Initiative are available and widely used. The FAO's new form of cooperation is being introduced based on the Initiative and under the direct leadership of participating countries interested in accelerating agricultural transformation, promoting sustainable rural development, ending poverty (SDG 1), eliminating hunger and all forms of malnutrition (SDG 2).

Dietary optimization remains a global challenge that dictates the urgent need to create sustainable food systems adequately addressing current challenges. Called to raise public welfare, food digital transformations may improve the situation significantly.

2.3 Overview of current trends in digitalization of agri-food systems.

Over the last years, digitalization extended in all parts of the agri-food system, such as agricultural production, processing, storage, packaging, distribution, food exchange, etc. Digital transformations are characterized by the use of both relatively simple apps such as map data and direct online marketing, and complex digital innovations used in agribusiness "to change the business model suggesting the development of new profits and opportunities to create a novel type of value chains" [14].

It is worth mentioning that currently introduced digital innovations change the modern design of agri-food systems at a rapid pace. Among them digital land registers; sensors in farm robotics; harvesting robots; genetic modifications; information control in global value chains; artificial intelligence in plant growing and animal care, and round-the-clock health monitoring; satellite determination of fish concentration and distribution of fishing rights; automated trade and food distribution; e-commerce; development of personalized diets; etc.

Digital transformations in agri-food systems integrate advanced technologies (artificial intelligence, sensors, robotics, drones, etc.), devices and communication networks into one system towards use in production, management, processing, and marketing. As such, agricultural production, energy and resource management, and economic operations are highly efficient with these technologies promoting the creation of new markets and economic opportunities under climate change (considering climate-adapted methods of management). Digital transformations seem too attractive to the private corporate sector in terms of improving productivity, increasing production and exports, excluding and replacing human labor with robotics. Thus, such technologies and infrastructure of digital transformations in agriculture are practically usurped by corporations, focused mainly on profit maximization rather than food security.

Shaping the global food system, corporate investments involve practices of non-transparent automated data capture, which complicate democratic control over corporate activities. The ethical responsibility for the security and reliability of the food system they form is entirely entrusted to software developers, lawyers, and managers.

The public concern about such seizure by a limited number of global digital industry players has activated

debates about the role of "Big Data" in the food systems reformation. On the one hand, "Big Data" is seen as a kind of basis for the development of new views, prospects, and opportunities; on the other, it is being criticized for specifics of data collection and management, the commodification of many aspects of everyday life and lack of attention to digital technologies in society in terms of the labor process and respect for fundamental civic rights and freedoms.

The asymmetry of the data collection/capture process is a means of capitalist "accumulation by dispossession", that colonizes everyday life in previously impossible ways [4]. As such, a new discriminatory relationship system evolves between data that shape managerial decisions on human nutrition and a man who needs a safe and diversified diet as a precondition of physical existence.

2.4 How digital transformations contribute to food security, rural development, and hunger elimination?

The need to feed the world stems from the lack of access to food resulting from the social, economic, and political power imbalance. Meanwhile, food security is closely linked to social marginalization, poverty, and gender inequality. The power within the agri-food system is exercised primarily through the concentration of land resources, market power and the capitalization, which allow large producers to exert a dominant influence on price, affordability, food quality, and access to productive resources. Such processes narrow agricultural employment for members of rural communities, restrict their livelihoods, deepen poverty, provoke hunger, and so on.

The balanced non-discriminatory arrangements in food systems are a crucial element in fighting hunger. Serious inequalities in access to land, water, capital, health services, and education significantly inhibit rural development and malnutrition elimination. Digital and tech solutions do not have appropriate responses to the raised question. Handling a power imbalance has a much greater impact on the living standards and nutrition of rural communities than digital transformations of agricultural corporations and increased productivity based on information systems.

Digital transformations with no other purpose than to increase agricultural productivity, lead to the concentration of corporate political and economic power, come with depriving rural communities of resources and knowledge, become a threat to sustainable development at all, and, consequently, unable to solve the global problem of hunger. Alternatively, the support of innovative processes in small producers and local communities to be activated towards the development of sustainable, healthy, and equal food systems. This is the

only way to secure food sovereignty and achieve the economic well-being of small farms.

Small producers and marginalized social groups can benefit significantly from digital innovations since the expanded window of opportunities becomes available: digital land management provides land tenure security; the satellite distribution of fishing rights ensures the transparency and safety of fishers; blockchains connect producers with consumers simultaneously excluding intermediaries; digital agriculture helps reduce input costs under increasing irrigation and production efficiency; e-commerce promotes the development of new markets and farm sales channels [15].

Such agri-food digitalization, to be noted, should become a conscious choice of society and be enshrined in the relevant state policy. Digital apps and related solutions should be focused primarily on meeting the needs of small producers, rather than protecting corporate interests focused on increasing agricultural and food sales (including exports) and making consumers contingent upon this basis.

As part of FAO's new global Hand in Hand Initiative the equality, digital inclusion, and the protection of the rights of farmers, family farms, indigenous peoples, and other people working in rural areas should be promoted. During the implementation of programs and projects related to digital transformations, it is necessary to recognize and protect individual and collective economic rights to digital innovations for indigenous peoples, peasants, fishers, pastoralists, food workers, consumers, etc. Appropriate regulatory mechanisms for the digital food and agricultural economy should be

introduced at the international level to avoid the destructive impact of monopolistic information ecosystems and the concentration of digital power; encourage efforts combination by international organizations and donors to protect family farms and authentic knowledge from data capture; to promote the food sovereignty of small food producers and indigenous people by supporting the implementation of digital agriculture policies and practices.

The United Nations should provide the necessary support through its organizations and programs to bridge “the digital gap between and within developing countries. Developing countries - in particular, the least developed countries - and vulnerable groups such as the rural population and women benefit significantly less from the development of new information technologies than people in industrialized countries do” [16].

2.5 Digital transformations in agri-food systems in Ukraine.

The spread and application of digital technologies in the agri-food of Ukraine have special characteristics associated with a distinctive duality of the agricultural organizational structure and unequal development of two sectors: corporate, much of which is represented by powerful horizontally and vertically integrated structures (agricultural holdings); individual, represented by two types of individual subjects: farms and farming households.

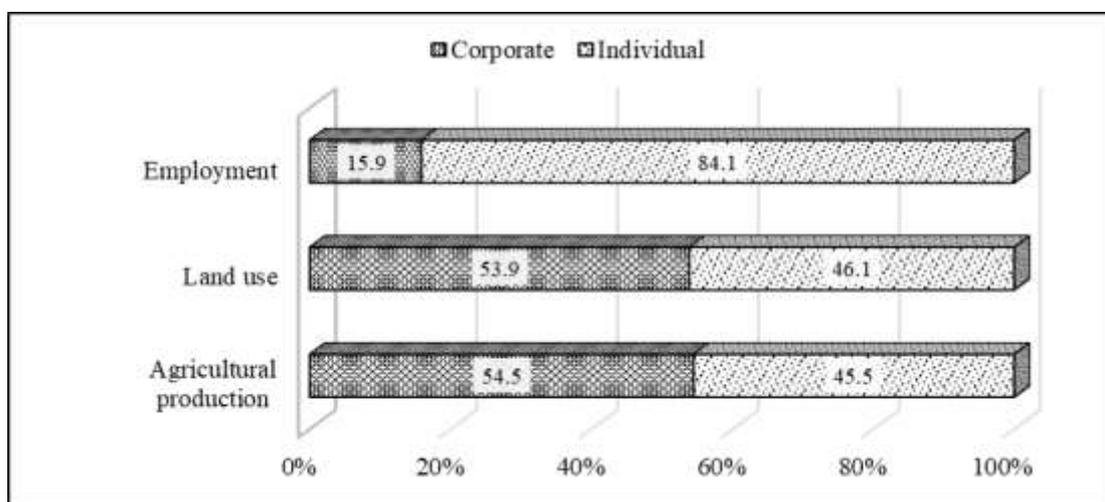


Fig. 1. Share of corporate and individual sectors by indicators of agricultural production in Ukraine, 2019
 Source: Agriculture of Ukraine. Statistical Yearbook. State Statistics Service of Ukraine, Kyiv, 2020 [12].

The corporate and individual sectors produce approximately the same number of agricultural outputs (54.5% and 45.5%, respectively) (see Fig. 1). Agricultural cultivated area here is of nearly-equal size (53.9% and 46.1% respectively) [12]. However, the number of employed economically active rural

population in the individual sector is dramatically higher than those employed in the corporate sector. The labor employment imbalance is caused by many factors, including the active corporate implementation of industrial technologies and, as a consequence, the release of a significant number of workers. Moving to a

self-employed sector for the majority of the economically active rural population is a forced step since they have no other alternative for employment in the home area. Self-employment in farming households is less productive, largely based on manual labor, and provides a minimum level of subsistence needs. Hence, digitalization can significantly expand the scale of negative impact on the social dimensions of rural development. It requires additional state regulations.

According to the independent global land monitoring initiative Land Matrix, over recent years there has been a significant increase in foreign investors in the agriculture of Ukraine, including UK companies (Rohini Finch, 30 th. ha; Tommy International Trading Limited, 23 th. ha, etc.), Saudi Arabia (Public Investment Fund (PIF) of Saudi Arabia, 189 th. ha; Saudi Grain and Fodder Holding Co. LC, 34 th. ha,

etc.), the United States of America (NCH Capital Inc., 360 th. hectares, TNA Corporate Solutions LLC, 132 th. ha, etc.), and many other countries [11]. The People's Republic of China is particularly interested in Ukrainian lands (particularly the Xinjiang Production and Construction Corps (XPCC), the China National Corporation for Overseas Economic Cooperation) [11].

Well-known in Ukraine agricultural holdings being registered in "tax havens" and with the support of transnational financial institutions currently consolidate significant amounts of land, including Ukrlandfarming - 500 th. ha, Kernel - 530 th. ha, MHP S.E. - 370 th. ha, Astarta Holding M.V. - 235 th. ha, and others [11]. Expert evaluations show that the total area of land under cultivation away back in 2011 was about 5.1 mln ha or 12% of the total farm area of Ukraine [10].

Table 1. The largest agro holdings by land size in Ukraine, 2020

Agro holding	Registration country	Landbank, th. ha
Kernel Holding S.A.	Luxembourg	530
Ukrlandfarming PLC	Cyprus	500
MHP S.E.	Cyprus	370
AP Group	USA	300
Astarta Holding N.V.	Netherlands	235
Continental Farmers Group, beneficiary SALIC (UK) Ltd.	United Kingdom	195
TNA Corporate Solutions LLC	USA	132
HarvEast, under the control of System Capital Management (SCM) and Smart Holding	Cyprus	127

Source: based on sample survey [11].

Agricultural corporations being backed by significant resources and funds, access to state support, bank loans, including funds of international financial institutions, such as the World Bank, the European Bank for Reconstruction and Development, the European Investment Bank. rapidly implement digital innovations. They include updating the park of tillage machinery, equipped with computerized control, maps for differentiated seed sowing, GPS monitoring for crops, optimized fertilization, and machinery movement, automated control of technological operations, agricultural modeling. The use of complex analytical systems allows companies to summarize land characteristics, create field maps, track machinery and daily productivity, monitor photosynthesis intensity, form a real-time forecast of crop yields, etc [17].

The availability of such technological solutions for small producers in Ukraine is extremely limited, which leads to discrimination, unequal competitive positions,

and affects minimizing farm producers in the individual sector, raising rural unemployment, increasing migration, and so on. Due to the high level of costs of digital innovations, neither the domestic banking sector nor international financial institutions cooperate with small producers [18]. In order to prevent deepening inequality in Ukraine's agricultural development through digital transformations, state measures should be developed. Priority is to be given to the support of small producers in implementing digital advanced technologies to maintain competitiveness and prevent monopolization in the agri-food market, the introduction of economic control instruments, including taxation, over intensive corporate agricultural production. Preservation of the rural way of life and biodiversity, support of the population in the traditional industries, an increase of peasants' incomes, and improvement of their living standards should become a state priority of digital technology dissemination in agriculture (Fig.2).



Fig. 2. The conceptual framework for the digital development of Ukraine's agri-food system
Source: developed by the authors based on the Concept of Digital Economic and Social Development of Ukraine for 2018 – 2020 [19].

3 Conclusion

The majority of politicians and corporate actors are currently inclined to recognize digitalization achievements as an unalterable perspective of social and economic progress. The rapid development and application of information technologies, herewith, lead to changes in living standards, work, production, social interaction, trade, environment, public policy, and governance.

Strategy design of digital transformations calls for awareness of the process and its consequences for people and society. Moreover, it should be noted that such technologies are used under national and global inequality in access to basic goods and services, as well as information and digital technologies. Keeping mentioned inequalities will lead to the reproduction and deepening of existing discrimination models within the framework of the new technology introduction.

The impact of digital transformations in agri-food systems on food, social and economic, and ecological security has not yet been properly assessed. Digital technologies in food and agriculture may potentially be useful or dangerous depending on the preconditions (context) and purposes of their application. On the one hand, digital technologies open up innovative opportunities in the agri-food sector, and, on the other, new challenges for society are being actualized due to the uncontrolled application of these technologies.

In an environment where agricultural corporations tend to seize control over technology, markets, consumer preferences, and able to implement the latest technologies and innovative products themselves, the main task of the world community is to support small farms, indigenous peoples, and other populations in their efforts to use digital opportunities. to provide themselves with means of subsistence in rural areas. The country's population to be guaranteed with traditional safe food, preserved biodiversity, and sustainable development of ecosystems, etc.

Targeted government policies on the protection of interests balance and the implementation of regulatory mechanisms for digital changes in the food and agriculture to avoid monopolization of digital food systems and the concentration of digital power in Ukraine should be introduced as strong measures against the undesirable impact of digitalization on rural development, human communities, and society as a whole. Dissemination of information about the benefits and consequences of digital transformations, public awareness about the impact of these processes on daily nutrition will contribute to informed decision-making at the micro, macro, and global levels.

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