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Digital Divide and Digital Inequality in Global Food Systems

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Abstract. The article explores the impact of the digital divide and digital inequality on the transformation processes in the world's food sector through the lens of a new paradigm developed in preparation of the September 2021 UN Food Systems Summit. The purpose of the study is to identify the main causes of the deepening digital inequality in the food sector and ways to overcome it. The authors' methodology of interdisciplinary comprehensive analysis of socio-economic processes makes it possible to identify the most disruptive points that inhibit food provision to the global population in the context of digitalization. It is argued that the digital inequality in various food systems is based on the multi-speed nature of digitalization processes in individual countries and among groups of economic entities, and this creates new competitive landscape and, consequently, a new ratio of market advantages and risks. It is concluded that the digital inequality in the global food systems has implication beyond the market profoundly affecting social outcomes. It exacerbates the food security problem in terms of economic affordability of food due to a decrease or loss of income of the rural population, who lose their jobs in the digitalization context, and also generates new risks of functioning in digital ecosystems. This situation makes it difficult to achieve the 2030 Sustainable Development Goals (SDG), namely SDG-2 and related goals. However, the impact of government regulation of the food sector on overcoming digital inequality remains ambiguous.

Key words: food systems, food security, digital divide, digital inequality

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Цифровой разрыв и цифровое неравенство в продовольственных системах мира

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Аннотация. Исследуется влияние цифрового разрыва и цифрового неравенства на процессы преобразований в продовольственном секторе мира через призму новой парадигмы, выработанной в период подготовки состоявшегося в сентябре 2021 г. Саммита ООН по продовольственным системам. Целью исследования является выявление основных причин углубления цифрового неравенства в продовольственной сфере и путей его преодоления. Используемая авторами методология междисциплинарного комплексного анализа социально-экономических процессов позволяет выявить места формирования наиболее «разрывных» точек в процессах обеспечения населения мира продовольствием в контексте цифровизации. Обосновывается тезис о том, что в основе проявления цифрового неравенства в различных продовольственных системах лежит разноскоростной характер процессов цифровизации в отдельных странах и среди групп хозяйствующих субъектов, что создает новые условия конкуренции и, соответственно, новое соотношение рыночных преимуществ и рисков. Делается вывод о том, что в продовольственных системах мира цифровое неравенство имеет не только рыночные, но и явно выраженные социальные аспекты, поскольку оно обостряет проблему продовольственной безопасности в части экономической доступности питания из-за снижения или потери доходов сельского населения, теряющего работу в условиях цифровизации, а также порождает новые риски функционирования в цифровых экосистемах. Такая ситуация затрудняет достижение Целей устойчивого развития (ЦУР) до 2030 г., а именно ЦУР-2 и связанных с ней целей. При этом воздействие мер государственного регулирования продовольственного сектора на проблему преодоления цифрового неравенства носит неоднозначный характер.

Ключевые слова: продовольственные системы, продовольственная безопасность, цифровой разрыв, цифровое неравенство

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Introduction

Information and communication technologies (ICT), having rapidly burst into the economic life of the world, transform the conditions and factors of the reproductive process at all its stages and in all industries. Their disruptive nature, worked out in detail at the macroeconomic level, requires analysis in sectoral, regional, market, and social aspects. There are spheres of human being where the ICT impact is the most acute in the context of both obtaining undeniable benefits and acquiring very significant risks, fraught with the threat of destabilizing the lives of certain categories of population.

It is reputed that the provision of population with food is the most sensitive area in this regard. Despite the attention of the world community to eradicating hunger, the indicators of global food security are deteriorating. In 2020, the global undernutrition rate increased from 720 to 811 million people, that is, it became 70—161 million people more than in 2019.[1] The COVID-19 pandemic is one of the causes for such a dramatic change in the situation, but it is not the only one.

The comprehensive nature of the causes of the food security deterioration and, as a result, the impossibility of achieving SDG-2 of the

[1] The State of Food Security and Nutrition in the World 2021. Transforming Food Systems for Food Security, Improved Nutrition and Affordable Healthy Diets for All. Rome : FAO, 2021. P. 8, 11, 15. URL: https://www.fao.org/3/cb4474en/cb4474en.pdf (accessed: 28.12.2021).

Sustainable Development Goals (SDGs) caused the convening of the UN Food Systems Summit in September 2021, where new approaches to their transformation were formulated. The totality of the proposed concepts formed the basis of the modern paradigm of food systems (FS) (Revenko, Soldatenkova & Revenko, 2021, p. 99). With a variety of views on this problem, there is a need to rely on innovations and their inclusive use in the FS transformation.

Improving the FS, bearing in mind the use of innovative solutions in the food production, distribution and consumption, implies consideration of unequal technological opportunities and risks for different categories of economic entities and individuals. It is estimated that 4 billion people are directly or indirectly employed in the food production and distribution.[2] Accordingly, the balance of benefits and risks from the ICT use has not only an economic, but also a social context for those who create food and for those who consume it.

The purpose of this study is to identify the main causes of the digital divide and digital inequality in the food sector, and to find ways to bridge them.

Literature Review and Methodology

Methodological approaches to the review of the goal to be sought are based on the interdisciplinarity principles, since technological, economic, environmental, and social aspects converge in this subject matter. An integrated approach to the analysis of the socio-economic system, which includes the use of methods for studying trends, comparison and systematization, historical comparative studies, can serve as the basis of the applied research methodology.

In theoretical terms, the study draws on the works of foreign and Russian researchers on the FS digitalization. Thus, a group of British researchers (Brewer et al., 2021) believes that the digitized potential of the food system can only be unlocked if data flows seamlessly along the entire supply chain from producers to consumers. The impact of environmental problems and nutritional inequalities in various countries on the food system today is explored by M.E. Brassesco, M. Pintado and E.R. Coscueta (2022). In their view, the restructuring of supply chains and the introduction of digital technologies are necessary to restore this system.

M.V. Shatilov, R.A. Meshcheryakova and M.I. Ivanova (2021) give an example of the introduction of digital platforms and products that reduce the costs of agricultural producers and increase the operational efficiency of this market players. The analysis of the base data systems of the agro-industrial complex in the context of managing the food supply system and promising vectors for the development of digitalization of the agricultural sector was made by V.I. Kharitonov (2021a; 2021b). The key factors hindering the digitalization of the agro-industrial complex were identified by T.P. Maksimova and O.A. Zhdanova (2018).

The research of K. Bronson and I. Knezevic (2019) focused on inequality in access to big data by farmers and representatives of Canada's large agribusiness should be highlighted among few studies on the impact of digital inequality and the digital divide in food systems. The same problem is analyzed by A. Weersink, E. Fraser, D. Pannell, E. Duncan and S. Rotz (Weersink et al., 2018). The shaping of sustainable and unsustainable production methods by digital technologies is explored by S.L.R. Kruk, S. Kloppenburg, H.M. Toonen and S.R. Bush (Kruk et al., 2021). Their study also focuses on the processes of overcoming existing barriers to production growth or building new ones by means of digital technologies.

The analysis of research papers made it possible to single out the widest possible range of discussions on the digital divide. J. van Dijk's studies (van Dijk 2005; 2012) explain the causes of the widening and deepening of the digital

[2] The State of Food and Agriculture: Agriculture Food Systems Transformation: from Strategy to Action. Conference, Forty-second Session, 2021 // Food and Agriculture Organization of the United Nations. URL: https://www.fao.org/3/nf243en/nf243en.pdf (accessed: 06.01.2022).

divide, and show that it consists not only in the Internet access, but also in the ability to professionally use new media or create a new culture. He also identified three levels of the digital divide: physical access to the Internet, digital skills of users and a new one — the social benefits received by users through the competent use of ICT, which he called the digital divide outcomes. The latter level, in his opinion, on the one hand, creates additional potential, for example, in the social and political spheres, on the other hand — negative outcomes (loss of security, cybercrime, etc.) (van Dijk, 2020). Three levels of digital inequality in Russia are also explored by of A.A. Gladkova, V.Z. Garifullin and M. Ragnedda (2019), and the role of the third level in the context of identifying the subjects that are the main recipients of benefits from online access in the study by A. van Deursen and E. Helsper (2015).

The digital divide through the prism of Internet access and social inequality is analyzed by M. Ragnedda and G.W. Muschert (2013). E. Hargittai (2003) explored the individual-level inequality in access to the Internet and in gaining audiences by content producers for their material online. The digital inequality from the standpoint of unequal conditions of access to the Internet was considered by B. Reisdorf, W. Dutton, W. Triwibowo and M. Nelson (Reisdorf et al., 2017).

The digital divide in the context of socio-cultural changes and the dynamics of decision-making on the ICT introduction in qualitative and quantitative terms is analyzed by P. Tsatsou (2011). She suggests viewing the digital divide within a complex context where decision-makers problem solving interact with ordinary people attitudes and their life cultures.

A clarifying modern interpretation of the digital divide is contained in the UNCTAD Digital Economy Report 2021. It notes that its traditional understanding as Internet connectivity, access and use needs to be supplemented with new dimensions in connection with the "data value chain."[3]

The problems that, due to digital inequality, hinder social, economic and political progress in Africa are explored in the study by B. Mutsvairo and M. Ragnedda (2019).

Research on the formation of digital capital with the widening of digital divide is also important. Thus, S. Park (2017) introduced the concept of digital capital, referring to the conditions that determine access, use and interaction of people with digital technologies, and analyzed how new forms of digital inequality arise depending on the user's digital ecosystem.

M. Ragnedda, based on the works of P. Bourdieu where the concept of "information capital" was introduced, defined the digital capital. He believes that it is "the accumulation of digital competencies (information, communication, safety, content-creating and problem-solving) and digital technology" (Ragnedda, 2018, p. 2367). At the same time, the level of the user's digital capital influences the quality of the Internet experience, and it, in turn, can be converted into economic, cultural, social, political and other forms of capital. Conceptual issues and fundamentals of the digital capital theory are also explored by M. Ragnedda and M.L. Ruiu (2020), E.L. Vartanova and A.A. Gladkova (2021).

In their study, the authors also took into account the implementation in Russia of the federal project "Bridging the Digital Inequality"[4]

[3] Digital Economy Report 2021. Cross-Border Data Flows and Development: For Whom the Data Flows. Geneva: UNCTAD, 2021. P. 3. URL: https://unctad.org/system/files/official-document/der2021_overview_en_0.pdf (accessed: 08.05.2022).

[4] National Project "Bridging the Digital Divide" [Программа устранения цифрового неравенства в России] // TAdviser. December 20, 2021. (In Russian). URL: https://www.tadviser.ru/index.php/Статья:Программа_по_устранению_цифрового_неравенства_в_России (accessed: 08.05.2022).

and similar projects of the digital economy in other countries, in particular, "Digital India."[5]

It should be noted that the "digital divide" and "digital inequality" concepts are quite close, but there are some distinctions between them. Although there is no well-established official definition of the digital divide, according to the authors, its essence is most correctly formulated by OECD experts: it is "the gap between individuals, households, businesses and geographical areas at different socio-economic levels with regard both to their opportunities to access ICTs and to their use of the Internet for a wide variety of activities."[6] There is neither universally accepted definition of the "digital inequality" term. The authors of this article understand it as an unequal receipt of economic and social benefits due to the inability to adequately use the achievements of digital technologies. In some cases, however, the concepts become synonymous, and this reflects the actual situation in the economy and in scientific discourse.

When conducting this study, the authors rely on definitions and indicators developed mainly in international organizations of the UN system. Thus, the basic FS definition developed in the UN characterizes them as "... the entire range of actors, activities and the biophysical and socioeconomic environments involved in producing, processing, distributing, regulating and consuming food."[7] The FS inclusiveness is interpreted as their property, which implies ensuring access of all people, especially socially and economically disadvantaged individuals and groups in society, to affordable, safe and nutritious foods, as well as providing an opportunity for everyone to fairly enjoy their economic benefits.[8] The article explores the digital divide and inequality in the FS through the prism of these definitions.

Specifics of the Digital Divide in Food Systems

The digital divide manifests itself in multiple forms and types in global food systems. The degree of its manifestation depends on the country's development level, type of production systems, nature of the innovation ecosystem, educational background of the population, income, demographic structure and other conditions for the FS functioning.

In the current paradigm of FS development, the innovative component is dominant in the context of enhancing the production processes efficiency, reducing hunger and malnutrition, and solving environmental problems. As in other industries, the acceleration of scientific-and-technological advance in the food systems entails technological gaps, including digital ones. Many researchers agree that in the economy generally "the acceleration of the rate of current digitalization exacerbates the digital inequality problem" (Safiullin & Moiseeva, 2019, p. 27).

This problem is also extremely relevant for Russia, and it deserves a special detailed analysis available in the scientific community. In addition to academic research, reviews of consulting companies and official institutions address this topic (Arkhipov et al., 2019).

In virtue of the peculiarities of the reproductive process in food systems, it is important for the purposes of this study to identify the elements of the food chain. The diagram in Fig. 1 shows the food movement "from the field to the plate."

[5] Digtital India // Ministry of Electronics & Information Technology of India. URL: https://www.digitalindia.gov.in (accessed: 08.05.2022).

[6] How to Measure the Digital Divide? // Korea Agency for Digital Opportunities & Promotion. URL: https://www.itu.int/osg/spu/ni/digitalbridges/presentations/02-Cho-Background.pdf (accessed: 08.03.2022).

[7] Policy Brief: The Impact of COVID-19 on Food Security and Nutrition // UN Sustainable Development Group. June 2020. P. 2. URL: https://unsdg.un.org/sites/default/files/2020-06/SG-Policy-Brief-on-COVID-Impact-on-Food-Security.pdf (accessed: 24.12.2021).

[8] Global Food Policy Report: Building Inclusive Food Systems // International Food Policy Research Institute (IFPRI). 2020. P. 9, 11. URL: https://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/133646/filename/133857.pdf (accessed: 25.12.2021).

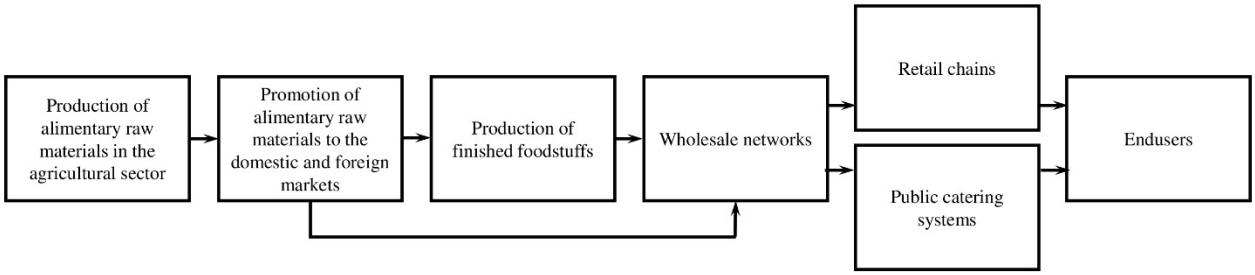

Fig. 1. Value Chain in the Food Sector
Source: compiled by the authors.

Table 1

Typology of Digital Inequality in Food Systems

Main links of the food chain	Types of digital inequality
Production of alimentary raw materials in the agricultural sector	— In access to information about resources, operating conditions — In access to digital geospatial, market, distribution, and training platforms — In the possibilities of using the Internet of Things, precision farming technologies and smart animal husbandry — In the ways of forming new organizational forms of doing business
Production of finished products in the food industry	— In the level of automation and robotization of the main and auxiliary production processes — In the possibilities of using the Internet of Things — In the ability to regulate the qualification structure and the number of personnel involved — In optimizing costs per unit of output
Merchandise flow and sales of alimentary raw and finished products	— In access to distribution infrastructure — In the possibility to be "visible" to counterparties — In the ability to supply products in the optimal volume to the points of demand creation — In the ability to monitor the market — In the possibility to track the prices of own products and the required resources

Source: compiled by the authors.

Participation in global value chains (GVC) provides undeniable competitive advantages to market players. The possibilities of embedding in GVC largely depend on the potential and practice of ICT use by FS subjects. At the global level, it is in this area that digital inequality manifests itself as an impossibility for many economic entities to be integrated into the global exchange processes.

Despite the fact that the contradictions of the digital age in the global food systems are most clearly emerge in the exchange area, they mature (and in many ways have already been formed) at the production stage. Therefore, there is a need to identify the main types of digital divide and inequality in individual parts of the chain (Table 1).

The raw materials sector, that is, the crop production, animal husbandry, and fisheries, is the first part in the production chain of the food sector. Since its characteristic property is the close relationship with the social life of the population producing such products, the digitalization processes here are particularly clearly show their dualism, unity of benefits and risks. That is why the authors focused on this part of food creation.

Digital Divide in the Raw Materials Sector of Food Systems

There are a number of universal indicators for all industries designed to assess the digitalization level. Internet access for urban and rural

Table 2

The Main Indicators of Urban and Rural Digitalization 2015—2021, %

Indicator	2015		2020		2021*	
	Urban	Rural	Urban	Rural	Urban	Rural
Population covered by at least an LTE/WiMAX mobile network						
World	64.1	19.3	95.3	71.7	97.0	75,392.3
Developed Countries	92.3	60.6	100.0	88.9	100.0	93.4
Developing Countries	54.8	15.7	93.9	70.2	96.1	73.8
Least Developed Countries	31.2	7.9	73.4	28.6	89.0	33.6
Percentage of individuals using the Internet						
World	n/a	n/a	75.6	38.8	n/a	n/a
Developed Countries	n/a	n/a	89.4	85.1	n/a	n/a
Developing Countries	n/a	n/a	71.7	33.8	n/a	n/a
Least Developed Countries	n/a	n/a	47.1	12.9	n/a	n/a

Notes: * assessment; n/a — not available.
Source: Key ICT indicators by urban/rural area (penetration rates) // International Telecommunication Union. URL: https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx (accessed: 10.01.2022).

populations, as it appears from the analysis in the scholarly works of predecessors and data from international organizations, is the basic indicator of the digital divide (Table 2).

According to these indicators, the rural population has less access to the ICT. Rural areas are characterized by an infrastructure shortage, ineffective institutions in charge for the ICT implementation, lack or limited access to digital services. In addition, there is a large variance between countries with different development levels for all indicators, with the exception of the coverage of the urban population by 2G mobile network. At the same time, an increase in the volume of agricultural production in the world by 500 million tons and a reduction in losses by 65 million tons by 2030 are predicted only through the use of mobile communication technologies.[9]

While providing relatively equal opportunities for the FS subjects requires not only access, but also content, network connectivity is nevertheless at the heart of bridging the digital divide in this area. According to experts from FAO and other international organizations, the growing digital divide may become the "new face of inequality," since the lack of access makes almost half of the world's population autonomous.[10] A. Borhan, representative of the Bangladesh agricultural community, spoke very emotionally, but accurately at the FAO Regional Conference for Asia and the Pacific: "We do not just need digitalisation, we also need digital justice," understood by Asian smallholder farmers as the most basic technologies that connect with the external environment to obtain basic information about the weather, markets, access to education.[11]

Connecting rural areas to the Internet underlies digital inclusion as a phenomenon opposite to the digital inequality and means smoothing the gap in the economic and social

[9] Bytes to Sustain Our Bytes: Leveraging Digital Agriculture for Sustainable Development Goals (SDGs). FAO Regional Conference for Asia and the Pacific. Thirty-fifth Session, 1—4 September 2020 // Food and Agriculture Organization of the United Nations. URL: https://www.fao.org/3/nb844en/NB844EN.pdf (accessed: 21.12.2021).

[10] The Digital Divide Risks Becoming the "New Face of Inequality" // FAO Liaison Office in New York. April 27, 2021. URL: https://www.fao.org/new-york/news/detail/es/c/1397201/ (accessed: 08.03.2022).

[11] Statement by Spokesperson of the Civil Society Consultation. FAO Regional Conference for Asia and the Pacific. Thirty-sixth Session, 8—11 March 2022 // Food and Agriculture Organization of the United Nations. URL: https://www.fao.org/3/ni500en/ni500en.pdf (accessed: 08.05.2022).

opportunities of individual entities. In the food systems, digital inclusion also means improving physical and economic access to food. International organizations pay special attention to this pool of digitalization problems in the food sector. For example, FAO identifies the need to ensure digital inclusion through the digital divide bridging in the food systems on a global scale to correct food market imbalances, information asymmetry on prices on produce and input, and to ensure access to financial services and government support. It also highlights the dangers of the digital divide between urban and rural populations, as well as its gender dimension. Based on information from the Broadband Commission that investments of USD 428 billion will be required to connect everyone to the Internet by 2030,[12] the FAO concludes that this is comparable to the costs of the digital divide.

It is impossible to disregard the historical context of digital inequality in the process of the FS evolution. There is an approach to analyzing the causes of digital inequality through the prism of traditional land relations. The findings of a study by the Research ICT Africa analytical center are that the result of the historical development in South Africa is the stratification of the land resource between large highly efficient landowners of the colonial era, who have the opportunity to use infrastructure, banking and insurance products due to the economies of scale, and small farms of the indigenous population, who are deprived of such an opportunity. Accordingly, large and small farms have different access to digital technologies due to the scale of activity determined by the size of the cultivated land.[13]

Because of high costs, only large-scale farms in South Africa use modern ICT. Small farms benefit from the use of digital technologies only from primitive applications, such as agricultural and market information dissemination systems accessible via mobile devices.

The relationship of digital inequality with geospatial factors is also emphasized in the studies of other researchers. Thus, J.T. Bartels and M. Bennice (2020), analyzing the causes of digital inequality in Alaska, move beyond its purely technological aspects. They note the combination of open landscapes and the presence of small indigenous settlements mainly along the coastlines as an economic obstacle when the development of digital infrastructure is technically possible, but economically unprofitable. A detailed study edited by F.W. Gatzweiler and J. von Braun (2016) is also devoted to the problems of technological gaps in the field under consideration.

The assessment of the overall level of digital inequality is carried out using indices of the ICT availability. For example, in Russia, it was made by M.Y. Arkhipova, V.P. Sirotin and N.A. Sukhareva (2018). Regional aspects of the digital divide in the BRICS countries are explored in the study by A.K. Morozkina (2020).

Bridging the digital divide is one of the priorities among measures taken by many countries to successfully solve the food security problem through the FS transformation. They encourage public-private partnership for anytime and reliable Internet connectivity in rural areas, expansion of 3G and 4G mobile networks coverage to work with service providers, and the operation of the Internet of Things. An important measure is to increase the digital literacy of farmers. However, the task for several regions is more modest, i.e. to provide farmers with an economic opportunity to use smartphones and to train them in the use of basic applications for these devices.

[12] G20: FAO DG Calls for Closing of Digital Divide in Agriculture // AgriculturePost. August 5, 2021. URL: https://agriculturepost.com/g20-fao-dg-calls-for-closing-of-digital-divide-in-agriculture/ (accessed: 28.12.2021).

[13] Aguera P., Berglund N., Chinembiri T., Comninos A., Gillwald A., Govan-Vassen N. Paving the Way Towards Digitalising Agriculture in South Africa. Cape Town : Research ICT Africa, 2020. P. 12—13. URL: https://researchictafrica.net/wp/wp-content/uploads/2020/09/PavingthewaytowardsdigitalisingagricultureinSouthAfricaWhitepaper272020105251.pdf (accessed: 28.12.2021).

Smartphones in many rural communities around the world are the only equipment that allows you to use professional information through platforms, applications, and to participate in the process of selling your goods in a new competitive environment. Their impact on the FS functioning in various regions of the world is being studied from an economic and social points of view. Thus, D. Prabha and R. Arunachalam (2019), based on empirical studies in Indian regions, came to the conclusion that these devices have significantly helped farmers to improve access to government advisory services. This affected the technological equipment of farms, the social climate, but did not significantly affect the economic component of the production process.

An interesting experience in the building of a local innovation environment in Kenya, initially based on the use of smartphones, is explored in the study by H. Baumüller (2016). Due to government support for this sector, Kenya has become an ICT leader in sub-Saharan Africa.

The search for ways to bridge digital inequality is the goal of many academic studies. For example, in the work on regional digitalization in India (Upadhyaya et al., 2019) differentiated access to ICT tools, low digital literacy, relevant content not always suitable for farmers, lack of stable Internet and even power availability are highlighted as the causes of inequality to be eliminated. Another study of these authors concludes that the ICT effectiveness in different regions of India depends not only on their affordability, but also on age, gender, awareness of opportunities, and participation in community life (Upadhyaya et al., 2018).

The digital inclusion is relevant not only for developing countries. Efforts are being made in Canada to implement digital development programs for indigenous peoples and marginalized communities. At the same time, discussions are underway about the impact of agricultural ICT on the labor market, namely on the employment and income level of agricultural workers. Jobs in the raw materials food sector are far from being filled by applicants due to the discrepancy between their skills and the ability to use ICT. It is difficult not to agree with the opinion of Canadian researchers that digital inequality can not only hold, but also widen social inequality in the field under consideration (Rotz et al., 2019, pp. 113, 115). The same can be said for the use of big data (Carolan, 2018, p. 171).

The inability to access the Internet completely blocks the use of modern technologies in the raw food sector, such as the Internet of Things, precision farming, “smart” animal husbandry, robotics, obtaining information and embedding in value chains using digital platforms, and others. The elements of such a development scenario were identified in the previous decade by researchers from Australia and the Netherlands (McBratney et al., 2005). Such technological solutions are available to entities, firstly, embedded in the most innovative digital ecosystems and, secondly, characterized by high efficiency and profitability, allowing them to update the active part of the fixed capital according to a high-tech scheme. S. Santos Valle and J. Kienzle systematized a list of crop production tasks that modern robots can perform independently under human supervision,[14] and this significantly changes the cost structure and competitive environment.

Despite all the nuances of the digital divide, an unambiguous approach to digitalization in the raw agricultural sector is its interpretation as “an effective way to increase productivity, improve product quality, optimize the use of all types of resources, promote the welfare of rural residents, improve business processes at all stages of product creation and promotion” (Konina, 2018, pp. 519—528).

[14] Santos Valle S., Kienzle J. Agriculture 4.0: Agricultural Robotics and Automated Equipment for Sustainable Crop Production // Integrated Crop Management. Vol. 24. Rome : FAO, 2020. P. 7. URL: https://www.fao.org/3/cb2186en/CB2186EN.pdf (accessed: 04.04.2022).

Risks and Challenges of the Digital Divide in the Food Sector

Technological transformations in the food systems bring not only positive effects, but also risks associated with digital inequality. They are primarily associated in the academic literature with a change in the employment nature. The "risk of automation," that is, the release of jobs due to the use of ICT and related equipment, is of the greatest importance for those areas where the proportion of routine work is high (Sasskind, 2021, p. 136). The so-called "digital trap" has been formed, when the inaptitude of skills for doing work is reinforced by attachment to the place of residence and society.

Of course, the topic of minimizing the use of human labor in regions with extensive land resources and low population density is not destructive. On the contrary, this vector generates pronounced advantages. Despite the fact that the topic of technological unemployment is not new to the global economy, it has acquired a new meaning in the current environment of the FS functioning and the need to solve the hunger problem on the planet.

Another group of risks is represented by the problem of human safety during production processes, i.e. the use of unmanned vehicles and robots in the fields, automated and robotic processes in "smart" farms and processing plants. The need for early adoption of rules to regulate such production processes is obvious, but there is still a time lag between their development and implementation, and this creates tension between economic entities and society.

Obtaining information about the quality of food and food safety with limited access for certain social groups is equally an important aspect of digital inequality in the food systems. A study on the relationship between food safety incidents and the digital divide concludes that there is an increasing inequality in the food risks prevention among the population with different access to the Internet (Chiu & Li, 2021).

It should also be noted the risks of erosion of traditional food consumption patterns, elimination of local crafts and industries. Schemes for embedding in product creation chains that are attractive to some entities, for example, through digital platforms (Revenko, 2021, p. 214), can deprive entire groups of small entrepreneurs of business prospects in the food sector at the global and national levels.

The problems of digital inequality in the food systems have aggravated by the pandemic, and its twofold impact is manifested in different ways in certain areas. If in the society as a whole, especially in an urban environment, one can observe, on the one hand, the complication of the activity of people without digital skills, and, on the other, their desire to expand their digital literacy (Toropova, Sokolova & Guseinov, 2020, pp. 459—460), this process does not move so linearly in the food systems due to the specifics of the agricultural sector. Since the digital ecosystems of urban and rural types show different development levels, and urbanization and globalization increase the outflow of digitally literate rural population to other areas, the risks of deepening inequality in access to the benefits of digitalization are also increasing.[15]

The decline in the physical mobility of farmers and small food businesses during the pandemic was devastating for those of them who did not rely on the ICT in the search for markets and in acquiring resources. At the same time, there is an incentive for a wider ICT use to ensure business stability in the food sector.

Conclusion

The fundamental cause of the digital inequality is the level of economic development of countries, entailing social, technological and other problems in their entire spectrum from the literacy level to readiness for transformation at the mental level. In the context of the FS digital inequality, different starting conditions for digital transformation and the ability of countries to

[15] Trendov N. M., Varas S., Zeng M. Digital Technologies in Agriculture and Rural Areas: Status Report // FAO. Rome : FAO, 2019. P. 2. URL: https://www.fao.org/3/ca4985en/ca4985en.pdf (accessed: 13.01.2022).

economically ensure a digital breakthrough or system evolution are of conceptual importance. Thus, the manifestation of digital inequality in the food systems is based on the multi-speed nature of digitalization processes in various countries and companies that have to operate in a new competitive environment.

The digital divide in the global food system in the second decade of the 21st century perpetuated previously formed discrepancies in the competitive environment of the performance of the economic entities. At the same time, access to food for certain segments of the population has become increasingly dependent not only on income, but also on digital literacy, the ability to take advantage of relevant technologies, and this became especially evident during the pandemic. This indicates a pronounced social aspect of digital inequality in the food systems and suggests strengthening the regulatory role of states to solve the food security problem in the context of economic accessibility of food due to a decrease or loss of income of the rural population losing their jobs due to digitalization.

The authors share the approach to the need to bridge digital inequality in the context of transforming the global food sector as a whole and its individual elements as a systemic issue. Without its solution it is impossible to achieve such global goals as ensuring food security, increasing the innovative FS level, creating modern infrastructure, maintaining biodiversity and soil fertility, preserving traditional rural communities, embedding in a market system of food producers and consumers with different capabilities.

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References

Arkhipov, A. G., Kosogor, S. N., Motorin, O. A., Gorbachev, M. I., Suvorov, G. A., et al. (2019). *Digital transformation of agriculture in Russia*. Moscow: Rosinformagrotekh publ. (In Russian).

Arkhipova, A. Yu., Sirotin, V. P., & Sukhareva, N. A. (2018). Development of a composite indicator for measuring the value and dynamics of digital inequality in Russia. *Voprosy Statistiki*, 25(4), 75—87. (In Russian).

Bartels, J. T., & Bennice, M. (2020). Digital inequities in rural Alaska. In J. Traxler & H. Crompton (Eds.), *Critical mobile pedagogy* (pp. 50—63). New York: Routledge. https://doi.org/10.4324/9780429261572-4

Baumüller, H. (2016). Agricultural service delivery through mobile phones: Local innovation and technological opportunities in Kenya. In F. W. Gatzweiler & J. von Braun (Eds.), *Technological and institutional innovations for marginalized smallholders in agricultural development* (pp. 143—159). Cham: Springer. https://doi.org/10.1007/978-3-319-25718-1_9

Brassesco, M. E., Pintado, M., & Coscueta, E. R. (2022). Food system resilience thinking: From digital to integral. *Science of Food and Agriculture*, 102, 887—891. https://doi.org/10.1002/jsfa.11533

Brewer, S., Pearson, S., Maull, R., Godsiff, P., Frey, J. G., et al. (2021). A trust framework for digital food systems. *Nature Food*, 2(8), 543—545. https://doi.org/10.1038/s43016-021-00346-1

Bronson, K., & Knezevic, I. (2019). The digital divide and how it matters for Canadian food system equity. *Canadian Journal of Communication*, 44(2), 63—68. https://doi.org/10.22230/cjc.2019v44n2a3489

Carolan, M. (2018). *The real cost of cheap food*. New York: Routledge.

Chiu, Y.-C., & Li, F-Y. (2021). Effects of the digital divide on the prevention of food risk in Taiwan. *Health Promotion International,* 37(2), article 125. https://doi.org/10.1093/heapro/daab125

Gatzweiler, F. W., & von Braun, J. (Eds.). (2016). *Technological and institutional innovations for marginalized smallholders in agricultural development*. Cham: Springer. https://doi.org/10.1007/978-3-319-25718-1_1

Gladkova, A. A., Garifullin, V. Z., & Ragnedda, M. (2019). Model of three levels of the digital divide: Current advantages and limitations (as exemplified by the Republic of Tatarstan). *Vestnik Moskovskogo Universiteta. Seriya 10. Zhurnalistika*, (4), 41—72. (In Russian). https://doi.org/10.30547/vestnik.journ.4.2019.4172

Hargittai, E. (2003). The digital divide and what to do about it. In D. C. Jones (Ed.), *New economy handbook* (pp. 822—841). San Diego: Academic Press.

Kharitonov, V. I. (2021a). Tools to form digital agriculture in the context of the development of the food security management system. *E-Scio*, 9, 262—268. (In Russian).

Kharitonov, V. I. (2021b). Development of the food supply system in the context of the formation of information systems in the agro-industrial complex. *Modern Economics: Problems and Solutions*, 12, 177—190. (In Russian). https://doi.org/10.17308/meps.2021.12/2741

Konina, N. Yu. (Ed.). (2018). *Current problems of management, marketing and entrepreneurship*. Moscow: MGIMO-Universitet publ. (In Russian).

Kruk, S. R. L., Kloppenburg, S., Toonen, H. M., & Bush, S. R. (2021). Digitalizing environmental governance for smallholder participation in food systems. *Earth System Governance*, 10, 1—9. https://doi.org/10.1016/j.esg.2021.100125

Maksimova, T. P., & Zhdanova, O. A. (2018). The digitalization strategy implemented in the Russian agro-industrial complex: Possibilities and constraints. *Theory and Practice of Social Development*, 9, 63—67. (In Russian). https://doi.org/10.24158/tipor.2018.9.9

McBratney, A., Whelan, B., Ancev, T., & Bouma, J. (2005). Future directions of precision agriculture. *Precision Agriculture*, 6(1), 7—23. https://doi.org/10.1007/s11119-005-0681-8

Morozkina, A. K. (2020). Regional perspective of digitalization in BRICS. *International Organisations Research Journal*, 15(4), 70—90. (In Russian). https://doi.org/10.17323/1996-7845-2020-04-04

Mutsvairo, B., & Ragnedda, M. (2019). Comprehending the digital disparities in Africa. In B. Mutsvairo & M. Ragnedda (Eds.), *Mapping the digital divide in Africa: A mediated analysis* (pp. 13—26). Amsterdam: Amsterdam Press University. https://doi.org/10.5117/9789462986855

Park, S. (2017). *Digital capital*. London: Palgrave Macmillan.

Prabha, D., & Arunachalam, R. (2019). Mobile phone technology: An impact of farming community. *Journal of Pharmacognosy and Phytochemistry*, 8(2), 719—721.

Ragnedda, M. (2018). Conceptualizing digital capital. *Telematics and Informatics*, 35(8), 2366—2375. https://doi.org/10.1016/j.tele.2018.10.006

Ragnedda, M., & Muschert, G. W. (2013). *The digital divide: The internet and social inequality in international perspective*. New York: Routledge.

Ragnedda, M., & Ruiu, M. L. (2020). *The digital capital: A Boudieusian perspective on the digital divide*. Bingley: Emerald. https://doi.org/10.1177/1461444819869604

Reisdorf, B. C., Dutton, W. H., Triwibowo, W., & Nelson, M. E. (2017). The unexplored history of operationalising digital divides: A pilot study. *Internet Histories*, 1(1—2), 106—118. https://doi.org/10.1080/24701475.2017.1311165

Revenko, L. S. (2021). Global food system: Digital aspects of transformation. *Scientific Works of the Free Economic Society of Russia*, 230, 213—218. (In Russian). https://doi.org/10.38197/2072-2060-2021-230-4-217-222

Revenko, L. S., Soldatenkova, O. I., & Revenko, N. S. (2021). A new paradigm of food systems. *Horizons of Economics*, (5), 99—106. (In Russian).

Rotz, S., Gravely, E., Mosby, I., Duncan, E., Finnis, E., et al. (2019). Automated pastures and the digital divide: How agricultural technologies are shaping labour and rural communities. *Journal of Rural Studies*, 68, 112—122. https://doi.org/10.1016/j.jrurstud.2019.01.023

Safiullin, A. R., & Moiseeva, O. A. (2019). Digital inequality: Russia and other countries in the fourth industrial revolution. *St. Petersburg State Polytechnical University Journal. Economics, 12(6),* 26—37. (In Russian). https://doi.org/10.18721/JE.12602

Sasskind, D. (2021). *A world without work: Technology, automation, and how we should respond*. Moscow: Individuum publ. (In Russian).

Shatilov, M. V., Meshcheryakova, R. A., & Ivanova, M. I. (2021). Transformation of the food system in the context of agro-industrial complex digitalization. *Economics of Agriculture of Russia*, (1), 52—60. (In Russian). https://doi.org/10.32651/211-52

Toropova, N. V., Sokolova, E. S., & Guseinov, Sh. G. (2020). Trends in the digital divide in the digital economy: Features of international discrimination. *Economics: Yesterday, Today and Tomorrow*, 10(8A), 456—463. (In Russian).

Tsatsou, P. (2011). Digital divides revisited: What is new about divides and their research? *Media, Culture & Society*, 33(2), 317—331. https://doi.org/10.1177/0163443710393865

Upadhyaya, L., Burman, R. R., Sangeetha, V., Lenin, V., Sharma, J. P., et al. (2019). Digital inclusion: Strategies to bridge digital divide in farming community. *Journal of Agricultural Science and Technology*, 21(5), 1079—1089.

Upadhyaya, L., Burman, R. R., Sangeetha, V., Lenin, V., Sharma, J. P., et al. (2018). Factors affecting digital divide in ICT-led agricultural information delivery: A comparative analysis. *Agricultural Sciences*, 10(1), 47—50. https://doi.org/10.5958/2394-4471.2018.00007.2

Van Deursen, A. J. A. M., & Helsper, E. J. (2015). The third level digital divide: Who benefits most from being online? *Communication and Information Technologies Annual: Digital Distinctions and Inequalities (Studies in Media and Communications),* 10, 29—52. Bingley: Emerald. https://doi.org/10.1108/S2050-206020150000010002

Van Dijk, J. (2005). *The deepening divide: Inequality in the information society*. Thousand Oaks: Sage Publications.

Van Dijk, J. (2012). *The network society*. London: Sage.

Van Dijk, J. (2020). *The digital divide*. Cambridge: Polity.

Vartanova, E. L., & Gladkova, A. A. (2021). Digital divide, digital capital, digital inclusion: Dynamics of theoretical approaches and political decisions. *Vestnik Moskovskogo Universiteta. Seriya 10. Zhurnalistika*, (1), 3—29. (In Russian). https://doi.org/10.30547/vestnik.journ.1.2021.329

Weersink, A., Fraser, E., Pannell, D., Duncan, E., & Rotz, S. (2018). Opportunities and challenges for big data in agricultural and environmental analysis. *Annual Review of Resource Economics*, 10, 19—37. https://doi.org/10.1146/annurev-resource-100516-053654

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