Sustainable development and women's empowerment:

the challenges and opportunities of digitalization

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Abstract

This study looks at digitalization from a gender and development perspective. It investigates which countries and, within countries, which segments of the population have been able thus far to benefit from the dynamism provided by digitalization, especially through e-commerce and technological advances in agriculture. The study points to digital divides between developed and developing countries, as well as to other divides linked to gender, age and socioeconomic factors that determine individuals' ability to have access to digital technologies and use them in a productive and beneficial manner. The analysis zooms in on the potential opportunities that digitalization provides to women, especially in the developing world, and on the obstacles they face to benefit from it. The study makes a distinction between having access to technology, using it and using it in a productive manner, and highlights the link with gender and other gaps in society and the economy. In the conclusions, the study puts forward some suggestions to help digitalization provide shared benefits and leave no one behind.

Introduction

New technological solutions, such as mobile social and trade solutions, data analytics and digitalization of manufacturing and agricultural production, offer a new range of opportunities for people, governments and businesses. These technologies hold the potential for individuals to develop new knowledge, upskill and reskill, find new jobs, set up social and professional networks, interact with national and local authorities, and have access to a broad variety of goods and services that until recently required physical proximity. Digitalization allows governments to raise the quality and the speed of the services they deliver to citizens and businesses, resulting in closer connections between public authorities and communities and in increased accountability. Digitalization holds huge potential for businesses, by opening new market opportunities and potentially leading to enhanced productivity and profitability, more sustainable production practices and greater competitiveness. The COVID-19 pandemic has accelerated the digital transformation of the economy and society. Digital divides, however, remain between countries at different levels of development, and long-standing gender gaps risk being exacerbated by new gender digital gaps. If such divides are not addressed, the potential that digitalization holds for human and economic development will not benefit everybody equally, with the risk of leaving behind countries and people that are already at the margin of globalization and international trade.

This study starts with an overview of the digital economy and its potential benefits. It then looks at the factors that allow people to gain from it. It presents existing divides in access and use of digital solutions between countries at different levels of development, between

urban and rural areas and between men and women. It zooms in on the specific difficulties that women face in tapping the opportunities arising from digitalization and highlights the overall and women's empowering benefits of overcoming them. Considering the potential that digital technologies hold to improve the productivity and sustainability of the agricultural sector, this study examines digitalization in agriculture with a focus on the specific challenges and opportunities for women in developing countries. In the conclusions, the study offers some ideas to ensure that the opportunities provided by digitalization are equally shared.

An overview of digitalization and digital transformation

According to the Organisation for Economic Co-operation and Development (OECD), "Digitalisation is the use of digital technologies and data as well as interconnection that results in new or changes to existing activities. Digital transformation refers to the economic and societal effects of (…) digitalisation" (OECD, 2019a). These processes lead to shape what is commonly referred to as the digital economy. There is not a universally agreed definition of the digital economy; the OECD (2020) defines it as "all economic activity reliant on, or significantly enhanced by the use of digital inputs, including digital technologies, digital infrastructure, digital services and data. It refers to all producers and consumers, including government, that are utilizing these digital inputs in their economic activities". Digital technologies appeared first in the information and communication technologies (ICT) sector itself, and subsequently spread into related activities, such as media and leisure.[1] The digital transformation that was experienced over the last 20 years has not only changed the way that people communicate, but also impacted the way the economy functions (Grau-Sarabia and Fuster-Morell, 2021).

Major global and regional commitments to overcome the digital and gender divides

According to Kularski and Moller (2012), "the digital divide is composed of a skill gap and a gap of physical access to Information Technology (IT) and the two gaps often contribute to each other in circular causation. Without access to technology, it is difficult to develop technical skills and it is redundant to have access to technology without first having the skill to utilize it". The gender digital divide is referred to by Thystrup (2020) as the "impaired access to IT infrastructure or IT skills education based on gender".

Over the last two decades, countries have taken steps to close digital divides. In this process, however, the long-standing gaps between men and women have remained unresolved and digitalization has contributed to widening them. More recently, countries have begun to make commitments to simultaneously address digital and gender divides, as evidence shows that one magnifies the other and that addressing one divide can help overcome the other.

"The long-standing gaps between men and women have remained unresolved and digitalization has contributed to widening them.

The World Summit of the Information Society (WSIS) was set up as a two-phase UN conference that defined the issues, policies, and frameworks to deal with ICT as a tool for development.[2] In 2015, the United Nations General Assembly called for a close alignment between the WSIS process and the 2030 Agenda for Sustainable Development, stressing that ICT could be instrumental to the realization of several Sustainable Development Goals (SDGs).

The global framework set up by the 2030 Agenda for Sustainable Development highlights that technological capabilities are critical to support women's empowerment, economic productivity, international cooperation, and more sustainable patterns of production and consumption (see Box 1).

Commitments, programmes and initiatives recognize the key role that digitalization can play for human and economic development and to help overcome gender gaps. They also indicate that, if gaps are not identified and appropriate measures are not taken, some countries and people are at risk of being excluded from the digital revolution.

Box 1: United Nations Sustainable Development Goals

Among the Sustainable Development Goals (SDGs), SDG 5 aims at achieving gender equality and empowering all women and girls. Target b sets a clear link between ICT and women's empowerment: "Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women". Progress towards its fulfillment is tracked by measuring the "Proportion of individuals who own a mobile telephone, by sex". SDG 8 promotes sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all. Digitalization can prove instrumental in achieving higher levels of economic productivity through diversification, technological upgrading and innovation (Target 2). They can also contribute to promoting productive activities and decent jobs, spurring entrepreneurship, and encouraging the formalization and growth of micro, small and medium-sized enterprises (MSMEs) (Target 3). SDG 9 aims to foster industrialization and innovation. Digital solutions can be leveraged to increase MSMEs' access to financial services and markets and enable their integration into value chains (Target 3). Finally, digitalization can play an important role in fulfilling Target 11 of SDG 17 – Partnership for Sustainable Development – by facilitating the exports of developing and the least-developed countries (LDCs).

The Doha Programme of Action for the Least Developed Countries for the Decade 2022-2031 extensively addresses gender and digital divides across its focus areas, and in some cases links them.*

* It was adopted in March 2022 at the Fifth United Nations Conference on the Least Developed Countries. It outlines a plan towards fulfilling the SDGs, based on a commitment between the LDCs and their development partners, including the private sector, the civil society and governments.

Source: Adapted from Box 1 of UNCTAD (2023).

The resources and appropriation theory and its relevance for the gender digital divide

Along with the increased use of digital tools for production, health, education, social and other purposes, the analytical and policy frameworks on digitalization have evolved.

The resources and appropriation theory argues that social inequalities are associated with an unequal distribution of resources, and that an unequal distribution of resources leads to disparities in access to and use of the Internet (Van Dijk, 2005). Van Deursen and Van Dijk (2019) find that personal and positional inequalities, according to the theory, produce access to different types of resources, such as possession, income and access to social networks (among others). The process of "appropriation" to the Internet is influenced by personal/social and positional inequalities; age, gender and ethnicity are frequently observed as the cause of the digital divide, along with education attainment and occupation. The differences in Internet access reinforce inequalities of participation in society, and this contributes to greater inequalities between individuals, positions and resources (Van Deursen and Van Dijk, 2019).

Based on this framework, approximately until the first decade of 2000, analysis and policy efforts were focused on enlarging the availability of hard and soft digital devices (e.g. computers, tablets, mobile phones, printers, software) and ensuring connection to the Internet. Availability and access were regarded as key to bridging digital divides. Between the early 2000 and 2015 attention shifted to ensuring that, beyond availability and access, people would acquire the necessary skills and knowledge to use new technologies. Since then, there was an emergence of positive but also negative outcomes from digitalization, such as cybercrime, hacking, violation of private data, hate speech, game addiction, and the diffusion of disinformation and "fake news" through the Web and social media. Currently, the focus of analysis and policymaking is on how to make access to digital technologies beneficial to individuals and more broadly to society, expanding the positive outcomes and reducing the negative ones (Van Dijk, 2020).

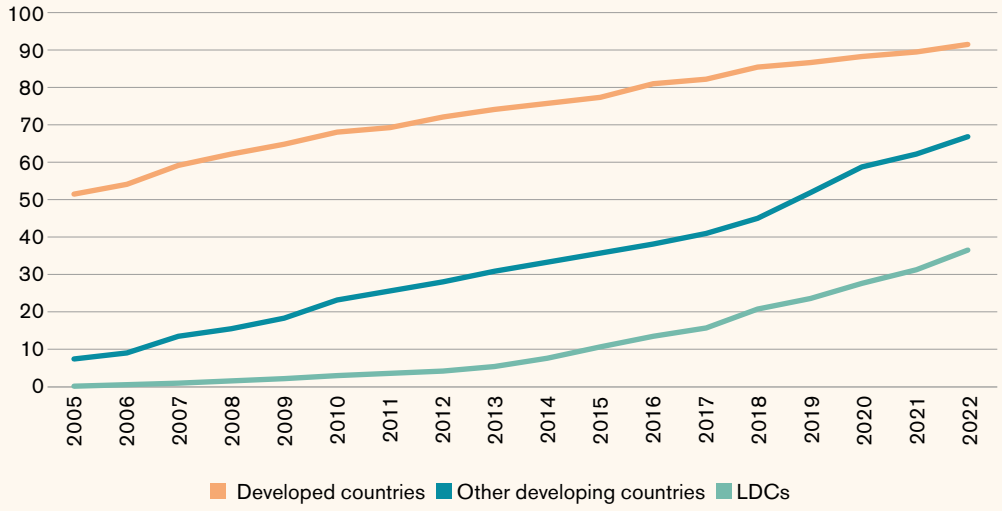
The shift from an emphasis on availability and access to knowledge and skills was prompted by the recognition that digital divides exist even when availability and access are guaranteed. Digital divides are linked to individuals' education and skills, which in turn have a bearing on the use of technology. Giving a person a computer or a mobile phone and Internet access does not guarantee that he or she will use it, and that it will be used in a beneficial manner. While individuals with a good level of education and digital literacy tend to use the Internet for improving their skills, exploring career opportunities, and accessing information for personal and professional growth, people with lower levels of education and digital skills tend to access the Internet mainly for communication and entertainment, resulting in limited personal development, productive and income-generation outcomes. It is also evident that there is a positive relationship between the degree of sophistication and complexity of ICT and the magnitude of the usage gap (Van Dijk, 2020).

It is estimated that approximately 5.4 billion people, or about 60 per cent of the world's population, used the Internet in 2022 (ITU, 2022). Box 2 shows differences in Internet use between regions since the early 2000s; as of now, 92 per cent of the population in developed countries is using the Internet, compared to 66 per cent in other developing countries, and only around 36 per cent in least-developed countries (LDCs).[3]

Box 2: Digital divide between regions

Even though 95 per cent of the world's urban population is now living within range of a mobile broadband network, important blind spots remain. For example, 30 per cent of Africa's rural population still lacks mobile broadband coverage (ITU, 2021a). In addition, the large availability of broadband coverage does not mirror Internet use, thus confirming the "usage gap". Merely having access to the Internet does not automatically imply its utilization, let alone using it for personal and business development.

Internet use, 2005-2022 (percentage of population)



Source: UNCTAD calculation based on ITU World Telecommunication/ICT Indicators Database, Jan. 2023.

Note: In this study, Internet users are individuals who have used the Internet (from any location) in the last three months, when being surveyed. For 2022, not enough data points are available for developing countries to calculate the group average, thus for 2022 ITU forecasts are used.

An ITU study (2022) identifies lack of digital literacy, limited understanding of the benefit of Internet usage, and high cost as the main reasons for not using the Internet. Two additional factors play a role behind limited "appetite" for the Internet and the more widespread use of cellphones for voice and text services in least-developed countries (LDCs). First, many people living in LDCs own analogue phones rather than smartphones, as smartphones tend to be unaffordable (ITU, 2021b). For example, it is estimated that in East Africa only 10 to 20 per cent of informal cross-border traders (a particularly vulnerable societal group) own a smartphone (Hadley and Aoko, 2022). Second, there is a lack of content that is relevant to people, relates to the communities in which they live and work, and is offered in languages they are familiar with (ITU, 2021b). The empirical evidence shows a strong correlation between the development of network infrastructure and the growth of local content, even after controlling for economic and demographic factors (ISOC/OECD/UNESCO, 2012).

Source: Adapted from UNCTAD (2023).

The kind of mobile network coverage that is available in different geographical regions may also have a bearing on the way the Internet is used. Wide availability of 4G permits much faster access to the Internet, which facilitates using it for different purposes. As shown in Figure 1, there is a gap in the use of the Internet between urban and rural population in all country groups. However, the gap is minimal in developed countries (4 percentage points), whereas it is significant in the developing countries and LDCs (38 and 34 percentage points, respectively). In the developing regions, lack of network coverage is a contributing factor behind limited use of the Internet by rural population.

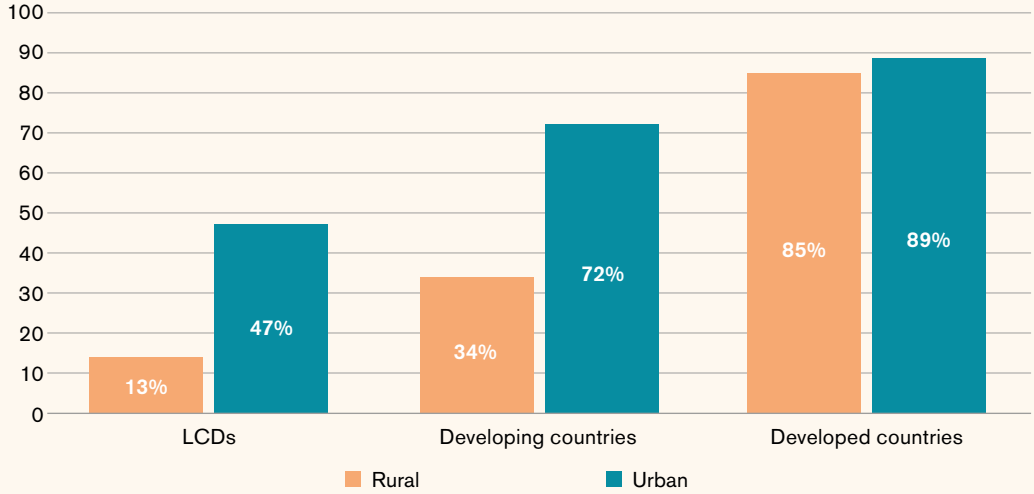
The benefits of digitalization for women

In principle, women can benefit from digitalization in various ways. An important component of the digital economy is e-commerce (see Box 3).

As consumers, women can access a variety of goods and services with benefits in terms of choice and price, and without the need for physical proximity. ICT-enabled services include, for example, medical treatments and maternal health care that may not always be available where women live.

As producers, women can benefit from production processes that are more efficient, more sustainable and less burdensome. As workers, they can find fewer barriers to entering the labour market, enjoy more flexible work conditions and have less physically demanding tasks. As traders, they can benefit from digitalized customs procedures and digitally available information on trade rules and customs procedures. Digital trade facilitation can reduce the complexity and length of clearing processes for goods, which is burdensome for small traders, especially women, and it also reduces the need of face-to-face interactions.

Figure 1: Internet use by rural-urban population in 2020
(percentage of population)



Source: ITU estimates, 2021.

Note: In this figure only, the developing countries group includes both LDCs and other developing countries. In this study, Internet users are individuals who have used the Internet (from any location) in the last three months, when being surveyed.

Box 3: E-commerce opportunities

E-commerce can help small businesses – many of which in developing countries are owned by women – by reducing the initial investment costs needed to begin operations. The greater time flexibility associated with online versus offline trade and the possibility to work from any location represent advantages for women who are time and mobility constrained (World Bank and WTO, 2020). Digital solutions that remove the need for face-to-face interactions can also help women overcome discrimination (OECD/WTO, 2017; World Bank and WTO, 2020).

Digitalization can help women access financial services, for example via the use of mobile money for digital payments, overcoming the difficulties linked to their limited access to formal financial institutions. According to a survey of entrepreneurs using Jumia, Africa's largest e-commerce platform, women-owned enterprises tend to rely on their personal savings to start their business and when they approach a financial institution they tend to apply for small loans (IFC, 2021).

During the pandemic, e-commerce opened up opportunities for women negatively impacted by job losses, providing them with a gateway to kick-start an entrepreneurial activity even with a small capital, and to earn a living outside the sectors where they had been employed. E-commerce also came to the rescue of small-scale women entrepreneurs who already had a fairly established business activity and saw in online markets an alternative to keep businesses afloat during the COVID-19 crisis.

Source: Adapted from UNCTAD (2023).

Some empirical evidence from Africa shows that women cross-border traders are more vulnerable to physical and verbal harassment and abuse than men, and the former spend longer hours, sometimes days, clearing their goods away from home, owing to prolonged inspections (UNCTAD, 2019).

As individuals, women can access online education and training. While this is potentially beneficial for everybody, it can be a game changer for women and girls who often have limited access to quality education and information. Research has shown that increased access to information ultimately makes women feel safer, more autonomous and more self-confident (OECD, 2018).

As citizens, women can interact with national and local administrations in a more streamlined, transparent and less time-consuming manner. Technology has the potential to improve efficiency, transparency, and accountability of public administration, which can improve women' access to information, upon condition that investments are made to help women acquire digital skills at par with men (Ganapathy and Mahindru, 2023).

The gender digital divide: drivers and barriers

In addition to digital divides between countries at different levels of development, access and use of digital technologies are also affected by gender. Low levels of use of ICT by women are, to some degree, linked to inadequate infrastructures (which determines access) and to affordability. Table 1 shows the cost of two types of Internet subscriptions; basic subscription (data-only) and advanced (fixed broadband). While the cost of a fixed broadband subscription is widely affordable in developed countries, in the LDCs it is very expensive. Women are on average poorer than men and tend to have limited control of household income, they may therefore opt for a basic subscription that allows only limited use of the Internet (see Box 4). They may also have less access to devices, such as smartphones or laptops, which has an impact on the possibility to use the Internet for business or educational purposes. Among the 23 LDCs where statistics on gender disaggregated mobile phone ownership are available, ownership among women is 13 per cent less than that of men (ITU, 2021b).

Table 1: Subscriptions price (percentage of gross national income per capita)

	Data-only mobile subscription basket*	Fixed broadband basket subscription**
LDCs	6.44	24.43
Other developing countries	1.42	2.92
Developed countries	0.47	1.02

Source: UNCTAD calculation based on ITU World Communication database.

*Includes 44 least-developed countries (LDCs); 92 other developing countries; and 53 developed countries.

**Includes 34 LDCs, 92 other developing countries and 53 developed countries.

In several LDCs, such as Kiribati, Sao Tomé and Principe and the Lao People's Democratic Republic, the share of women using the Internet is limited; and the share that possesses adequate digital skills is even smaller (ITU, 2021b). Low digital skills in most cases lead to a less beneficial use of the Internet.

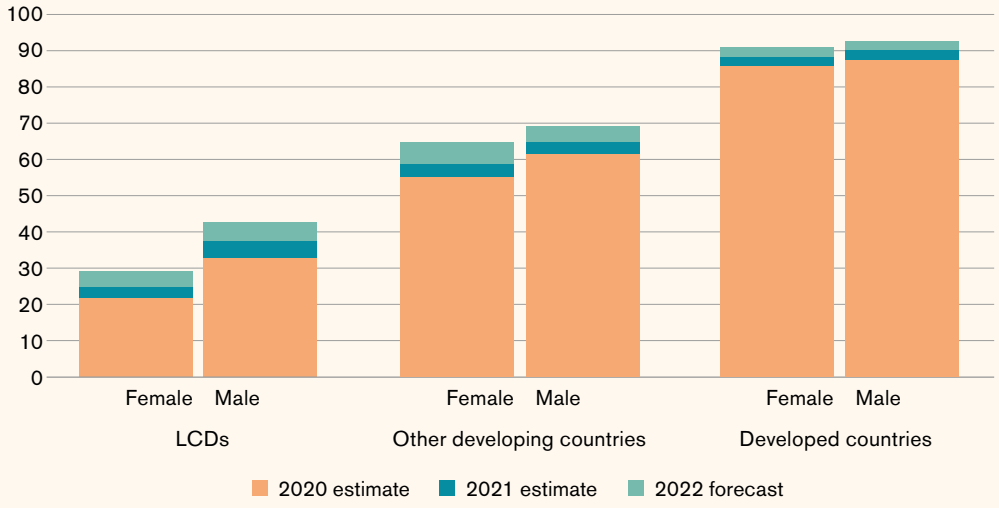
Gender gaps can also be found in the use of financial services. In Chile, for example, there is a 10 per cent gap between women and men in accessing online banking. Access and use are not an issue in this case, but rather the ability to use the Internet for more complex operations than, for example, social contacts (Mohiuddin *et al.*, 2020). Figures 2 and 3 provide data on how many women and men in developed, developing and least-developed countries have received digital payments and have used a mobile phone or the Internet to make a purchase online. The data can be considered proxies of productive and income-generating use of the Internet. In all groups, men outperform women, though the gender gaps are considerably smaller in developed countries. The data also show a significant North–South digital divide, with less than 30 per cent of adult population in the LDCs receiving payments online, as opposed to around 70 per cent in developed countries. When it is about making a purchase online, the share for the LDCs is around 5 per cent, as opposed to almost 60 per cent in developed countries.

Box 4: Gender digital divide

Besides access and affordability, socio-economic factors – including social class, age, ethnicity, income, assets and cultural origin – contribute to explaining how and for which purposes people use the Internet (Hosman and Pérez Comisso, 2020). Younger people, for example, exhibit the highest frequency and diversity in Internet use (Zillien and Hargittai, 2009). Additionally, community norms that link mobile and Internet use with reputational risk, undermine women's use of digital technologies (Ganapathy and Mahindru, 2023). These factors lead individuals – especially, women – to face multiple and compounding interrelated obstacles to using technology for business purposes (UNCTAD 2023, Van Dijk, 2021).

Gender gaps in using the Internet have almost been eliminated in developed countries; however, as shown in the figure, large gaps persist especially in least-developed countries (LDCs). The gender gap in Internet use is estimated at 1 per cent in developed countries, below 6 per cent in other developing countries and 13 per cent in LDCs in 2022.

Internet use by female and male population (percentage of population)



Source: UNCTAD calculation based on ITU World Telecommunication/ICT Indicators Database, Jan. 2023.

Note: In this study, Internet users are individuals who have used the Internet (from any location) in the last three months, when being surveyed. For 2022, not enough data points are available for developing countries to calculate the group average, thus ITU forecasts are used.

Anecdotal evidence suggests that women-owned MSMEs are less likely to seize the opportunities offered by the Internet, even when access is not a constraint because of the gendered and socio-economic barriers discussed above.

A survey conducted by the World Wide Web Foundation (WWWF, 2015) estimates that women are 30-50 per cent less likely than men to use the Internet for income-generating activities. A survey carried out by UNCTAD in 2019 among women farmers in Myanmar indicates that there are obstacles to using the Internet to access crucial business information; women farmers across various supply chains stated to be reluctant to use the Internet to seek information about prices and potential new markets for their produce, although having access to mobile Internet (UNCTAD, 2020a).

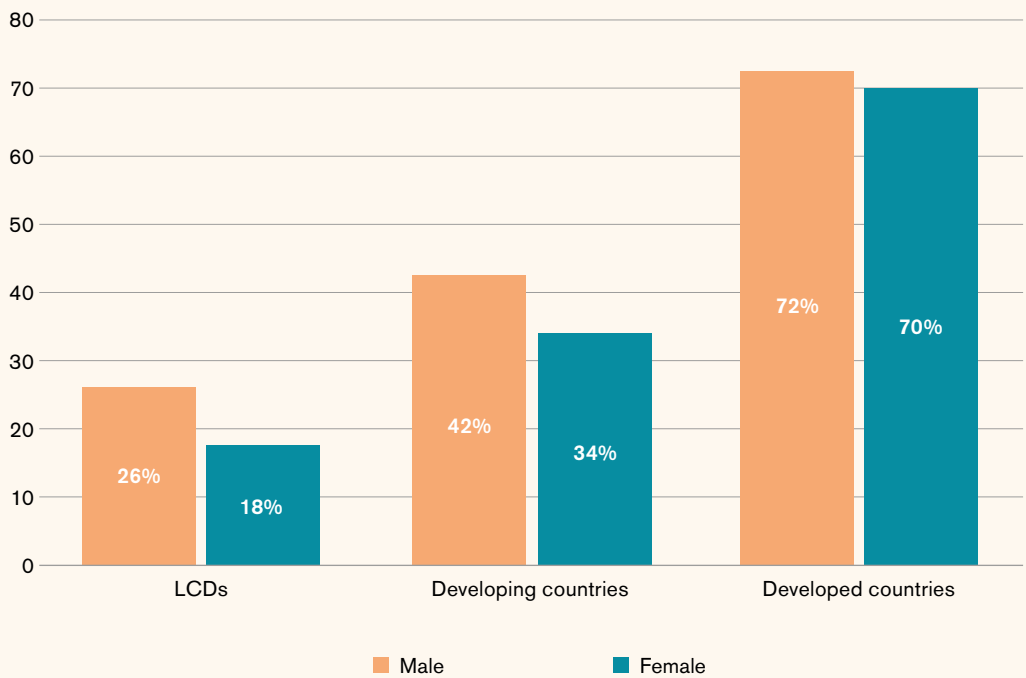
Source: Adapted from UNCTAD (2023).

Other gender-specific barriers play a role in observed low levels of ICT adoption among women. The lack of online content that is useful to them, relevant to their life and work, and delivered in languages they are proficient in, makes their interest in using the Internet decline (ITU, 2021b).

Traditional gender roles play a role in how much women can benefit from the digital transformation as well. Some societies may perceive women's use of ICT as a challenge to traditional roles. A survey conducted by the World Wide Web Foundation (WWWF, 2015) in nine developing countries shows that patriarchal norms replicate in the digital economy. For example, over half of the surveyed men in New Delhi and Manila, and over a third of men in Yaounde, Jakarta and Kampala, agreed with the statement that men have the responsibility to restrict what women access on the Internet.

UNCTAD (2023) reports that women's limited participation in science, technology, engineering and mathematics disciplines, as compared to their male counterparts, "has repercussions on their familiarity with digital technologies and on their capacity to

Figure 2: Individuals that received a digital payment in 2021
(percentage of population aged 15+)



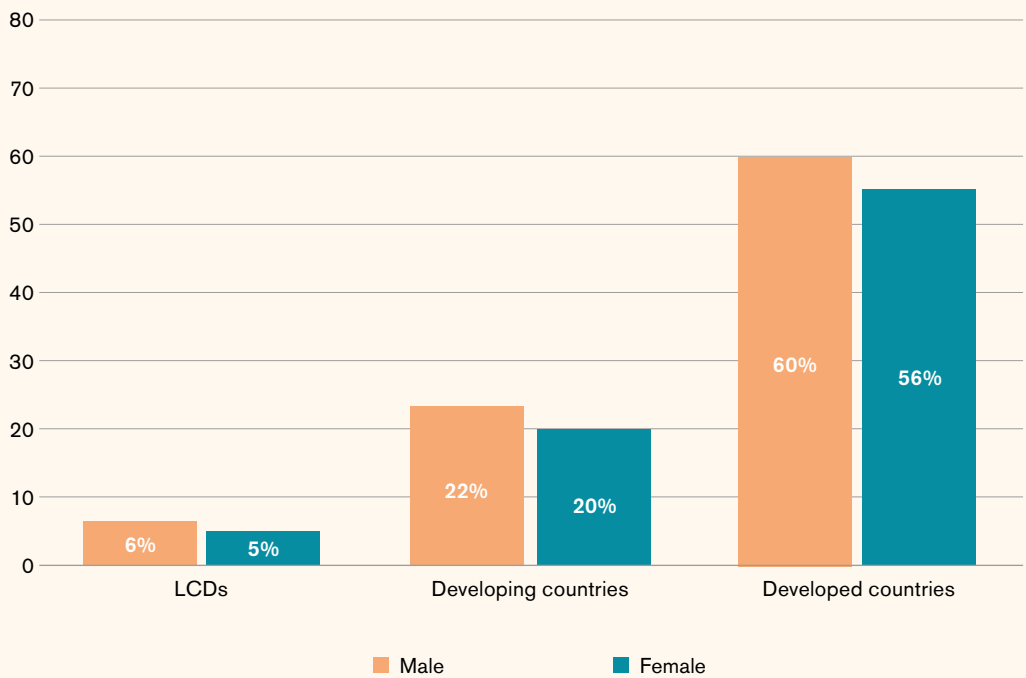
Source: UNCTAD calculation based on World Bank Global Findex Database, 2021.

Note: The percentage of respondents who report using a mobile money account, a debit or credit card or a mobile phone to receive a payment into an account in the past year. This includes respondents who report receiving remittances, receiving payments for agricultural products, receiving government transfers, receiving wages or receiving a public-sector pension directly into a financial institution account or into a mobile money account in the past year.

influence technological developments (United Nations Educational, Scientific and Cultural Organization, 2020)." In other words, on the one hand, women suffer from an overall lower level of education, digital literacy and technology skills; on the other, technology and digital solutions often do not meet women's needs, since in most cases they are developed without women's participation and without paying enough attention to women's needs and expectations. For example, globally only about one-third of positions are occupied by women in the technology sector (UNESCO, 2023).

UNCTAD (2023) finds that several developing countries still lack comprehensive national digitalization strategies, and seldom conduct surveys on ICT access, use and impact. For countries that have developed digitalization strategies, gender considerations have hardly been mainstreamed. Lacking reliable data on issues such as the contribution of women-owned digital businesses to the economy, the technologies women have access to for production and trade, and the purposes for which women use the Internet, digitalization policies risk remaining "gender blind".

Figure 3: Individuals who made a purchase online in 2021
(percentage of population aged 15+)



Source: UNCTAD calculation based on World Bank Global Findex Database, 2021.

Note: The percentage of respondents who report using a mobile phone or the Internet to buy something online in the past year.

The use of algorithms and their impact on women

An increasing number of decisions – from which products are advertised to which candidates are invited for job interviews, to which loans are approved and at what interest rates – are guided by algorithms. This automation of decision-making can be beneficial to less privileged segments of the population, including women, as it creates more transparency, and may reduce implicit and explicit biases. For example, a study in the United States shows that fintech algorithms[4] charge minority borrowers interest rates that on average are 40 per cent lower than those applied to face-to-face lenders (Bartlett *et al.*, 2022). Yet, artificial intelligence (AI) systems are human creations and mirror society (Collet and Dillion, 2019). People are those determining which data, variables and rules the algorithms should learn from to make forecasts. Algorithms use and learn from large datasets to find patterns on an individual's observed behaviour and make predictions. People can, on purpose or inadvertently, introduce biases that then become embedded in AI systems and discriminate against certain segments of the population (Smith and Rustagi, 2021). AI can amplify discrimination in society resulting in inefficiencies and losses in the economy and markets, in addition to furthering sources of inequalities (Smith and Rustagi, 2020).

An example of gender discrimination resulting from AI is in the banking sector. AI systems that determine creditworthiness learn from historical data; since historically women have had lesser access to credit and received lower credit limits than men, these patterns were automatically reproduced. As a result, women kept receiving lower credit limits than men, even at parity of incomes. The skew against women was so evident that a general consensus recognized the need for a different approach. As a result, algorithms now predict creditworthiness by relying on information different from credit history, for example by utilizing data on how people use their mobile phones for payments (Smith and Rustagi, 2020).

On the other hand, there are examples where AI has supported positive developments that can potentially benefit women. AI opens the possibility of using new data sources to measure poverty and vulnerability, and it could be trained to improve intervention targeting and facilitating crisis response. For example, by combining survey-based results with mobile phone data, AI identifies the household eligible for benefits within poverty alleviation programmes, which may include many women-led households (Smith and Rustagi, 2021).

Sectoral analysis: Digitalization in agriculture

Digitalization has the potential to improve productivity, sustainability and resilience in many economic sectors. We focus our analysis on the agricultural sector, which is the main employer of women in several developing regions and is a sector in which digitalization is a rapidly growing trend.

> People can, on purpose or inadvertently, introduce biases that then become embedded in AI systems and discriminate against certain segments of the population.

The potential benefits of digitalization in agriculture

The digitalization of agriculture is seen as the next agricultural revolution that has the potential to respond to the needs of a growing population in the context of ongoing economic and environmental challenges (Trendov *et al.*, 2019; see Box 5).

UNCTAD (2020b) reports that digital agriculture (also known as "agriculture 4.0" or "smart farming") refers to the use of modern technologies (e.g. AI, the Internet of Things, drones, big data analytics, mobile technologies and devices, and digitally-delivered services and apps) to target precision agriculture, which focuses on optimizing agricultural production processes by utilizing a set of information technologies and automated equipment (MacPherson *et al.*, 2022; Wolfert *et al.*, 2017). For instance, automation can help farming businesses free up the time, energy and effort that used to be invested in monitoring the crops; weeds can be controlled at the exact moment they start to form; and innovations such as robot harvesters (powered by machine learning) can help farmers during the harvesting stage (Miskinis, 2019).

Box 5: Digital technologies and agriculture

Among the key technologies, there are devices and applications that provide access to information and services, such as drones, GPS, geographic information systems (GIS), sensors and mobile phones. Some of these devices can increasingly store, share and analyse "big data" to support agricultural forecasting and inform smarter decision-making, especially in terms of resource use efficiency (Braun *et al.*, 2018).

Some technologies, such as mobile applications, are already commonly used and accessible to farmers. Others are knowledge-intensive and costly to operate and maintain, so their utilization varies depending on the commodity and scale of a farming operation. Potential users must be willing and able to invest in the acquisition of the required skills, and organizations must be in place to support the transition to more digitalized operations (both in terms of financing arrangements and training and advisory services).

Sophisticated digital agricultural technologies offer opportunities for farmers to increase productivity, sustainability, competitiveness, market linkages and food security. Consumers may also be able to receive more detailed and transparent information on production characteristics and nutritional content of the food they buy. The increased flow of information enabled by digital technology can also create incentives for smallholders to add value to their products, as information about production practices, quality or other dimensions that might bring a price premium can be recorded and passed along to consumers. One example is being piloted for coffee exports from Ethiopia and Uganda. Bext360 combines all machine vision and blockchain technologies. The "bextmachine" at coffee collection points evaluates the coffee cherries when farmers deposit them, provides a market price along with advice on how to improve the quality, and then tracks the coffee to the end consumer. This increases farmers' return for investing in high-quality production practices (ICO, 2018; OECD, 2019b).

Source: Adapted from UNCTAD (2020b).

> It is crucial that policy measures accompany the digital transformation to ensure that enough employment opportunities are created to provide for the displaced workers.

Digital agriculture, however, is also about connected and knowledge-based production systems with a focus on automation, improved management processes, and more effective policies and programmes. Digital solutions can improve access to finance, advisory, insurance and other services for millions of smallholder farms (Chandra and Collins, 2021).

The issue of potential labour replacement with a wide adoption of digital technologies must be addressed too. There is some general understanding that digitalization may displace some positions (entailing low-skilled work, experiential knowledge, advisory capacity, among others) while creating new highly skilled jobs. It is crucial that policy measures accompany the digital transformation to ensure that enough employment opportunities are created to provide for the displaced workers.

Labour remains especially central to sustainable farming, such as ecological or organic agriculture, which requires a greater labour intensity because of the lack of dependence on artificial inputs (Christiaensen *et al.*, 2020; Prause, 2021). Findings indicate that the impact of digital technologies on labour is linked to whom controls them. A qualitative study conducted in Germany between 2020 and 2021 finds that independent farmers see digital technologies as supportive for their work; in contrast, the workers who are required to adopt them without any control on their part tend to see digitalization a source of disempowerment and intensification of their work (Prause, 2021)

Digitalization in agriculture has the potential to help address the economic and environmental imbalances that have been observed in global food markets. Since the early 2000s, developing countries (as a group) have become net importers of agricultural raw commodities (FAO, 2022a, 2022b; OECD, 2019b). In 2021, their imports accounted for over 65 per cent of world imports of cereals and oilseeds, and over 30 per cent of meat and dairy imports (FAO, 2022b). In 2020, African countries imported about 80 per cent of their food and 92 per cent of their cereal from abroad.[5] Asia is now the world's largest net food importer (FAO, 2021). This outcome is largely due to a productivity gap between developing and developed countries in a context in which industrial agriculture has become dominant and exports from developed countries have become cheaper (primarily, as a result of both technological innovation and subsidy programmes). Lower access to modern technologies and inputs (such as seeds, pesticides, fertilizers) in developing countries represent a major contributing factor to the observed productivity gap, which is increasingly challenged by the disproportionate impact of climate change in developing countries and civil unrests that may occur in those countries. Based on FAO (2022a), the top 10 per cent of the richest countries produce about 70 times more output per worker than countries in the bottom 10 per cent of the income distribution. Digitalization has the potential to help raise both efficiency and productivity for many small-scale farmers in developing countries by facilitating market transparency, access to extension

services, resource optimization, and improvement in agricultural supply chain management (Deichmann *et al*., 2016).

The environmental crisis, especially driven by climate change, biodiversity loss, land degradation and water shortages, is indicative that ecological considerations must be integrated into economic decision-making. As the COVID-19 pandemic has increased poverty to a significant degree for the first time in twenty years, especially in rural areas (it is estimated that over 120 million people around the world have been pushed into extreme poverty in 2020), food security has been brought to the forefront (Brett and Canziani, 2021). More recently, the rise in food and fuel prices stemming from the war in Ukraine has especially hit the world's poorest countries, and the poorest segments of the population in those countries who tend to spend a disproportionately high share of their income on food. These ongoing challenges have led to an increased focus on sustainable food production to integrate social and environmental goals in the process of economic development, and digital technologies can be leveraged to achieve sustainability principles across food systems (FAO, 2022a; IAASTD, 2009; IPBES, 2019; MacPherson *et al*., 2022; UNCTAD, 2013).

As data become more central in the agri-food sector, a critical issue is data ownership, which is not yet significantly addressed in most policy discussions. Currently, data are typically collected by large agriculture technology corporations. Empowering farmers and local governments by protecting their legal rights regarding the control of the data is critical to enhancing sustainability (MacPherson *et al*., 2022). As discussed in the first part of this chapter, other prominent issues that need to be addressed to benefit from the full potential of climate-smart farming include the connectivity gap in developing countries, affordability, literacy and technology skills, and the design of timely and spatially relevant data for small-size farms (Chandra and Collins, 2021; Deichmann *et al*., 2016).

Digitalization in agriculture: the challenges and opportunities for women

According to ILO data, the agricultural sector employs 55 per cent of women in LDCs; the share drops to 35 per cent and 3 per cent in other developing countries and in developed countries, respectively (see Box 6).

In certain cases, as observed in some African countries, women do not have the legal or customary right to own land. Women may also have limited access to financial and banking services. Also, lack – or limited availability – of agricultural extension services for women farmers is often a factor that hinges on women's productivity as well (UNCTAD, 2020b). All these factors indicate the importance of policy interventions to ensure that gender disparities are overcome, and women are provided with equal opportunities as men to take advantage of digital solutions. The conclusive section provides policy suggestions towards these goals.

Digital technologies can expand access to information on market opportunities (including foreign markets and how to access them), extension and advisory services, prices and products. By doing so, digital technologies can facilitate the integration of smallholders into the domestic and global value chains, both upstream and downstream, in turn becoming an important instrument for reducing rural poverty and contributing to more sustainable and inclusive development (Antonio and Tuffley, 2014; OECD, 2019b). As financial considerations

can be a constraint for the adoption of digital technologies, especially in the LDCs, government policies (in collaboration with the relevant stakeholders and in a context in which digital cooperation at the global level is enhanced) are critical to help support safe and affordable access to the Internet (UN DESA, 2021; UNCTAD, 2023).

The potential of digital technologies is also confronted with a gender gap in technology adoption, which contributes to perpetuating women's lower productivity and segregation into positions of economic vulnerability in agriculture (see Box 7).

In Kenya, women farmers can use smartphones to watch weather trends. This information allows them to forecast optimal planting and harvesting – especially for the crops that need to be dried. Digital technologies can also support logistics, payments, certification processes, marketing and sales. They can build on women's indigenous knowledge of local and agroecological production as well (Dugbazah *et al.*, 2021).

In Ghana, women shea nut farmers, traditionally working in informal shea processing – thanks to digital technology – could disengage from intermediaries, directly connect to a new market of international buyers through the Shea Network Ghana and increase their profits by even 80 per cent (Cline, 2019).

Box 6: Women and digital agriculture

Women are involved in trade in the agricultural sector in multiple ways: as contributing family workers, as farmers on their own account, as entrepreneurs running on- and off-farm businesses, and as wage workers. Women are highly involved in family farming, which remains by far the most predominant form of agriculture worldwide; almost 90 per cent of all farms globally (providing about 80 per cent of the world's food value) are run by families and rely primarily on family labour (FAO/FAD, 2019).

Although agriculture is key for women's livelihood, men and women tend to hold different economic roles in the sector due to various sources of gender bias. Following the traditional gender division of labour, which assigns to women the lion's share of unpaid care work and to men the leading role as income providers, women tend to be disproportionately involved in those subsistence activities that can be more easily managed alongside household responsibilities, such as cultivating vegetables and taking care of homestead gardens. Consequently, women are less involved in commercial agriculture than men and, when they do get involved, they tend to hold lower-skilled, lower-pay positions. Women often exhibit lower productivity in agriculture than their male counterparts, as they tend to be disadvantaged in access to education and training, coupled with time and mobility constraints (FAO, 2015; Glazebrook *et al.*, 2020).

Digital agriculture can help women and other smallholder farmers in developing countries overcome or compensate for the barriers they face by providing tools that can help raise productivity, competitiveness, and access to export markets.

Source: Adapted from UNCTAD (2020b).

Box 7: Agricultural technologies and productivity

Even though specific local conditions matter, evidence suggests that men tend to adopt new agricultural production technologies at higher (and faster) rates than women (Aduwo *et al.*, 2019; Ragasa, 2012; Rola-Rubzen *et al.*, 2020). There are gender gaps for a wide range of agricultural inputs and technologies, including machines and tools, fertilizers, crop protection products, animal breeds, improved plant varieties and irrigation schemes (Croppenstedt *et al.*, 2013; FAO, 2018; Peterman *et al.*, 2014). These differences apply across the spectrum of technologies from basic to sophisticated digital agriculture technologies and information and communication technologies. This low-productivity trap, in turn, inhibits the efficient functioning of value chains and an expansion of trade, as women input providers miss out on potential markets, and agribusinesses miss out on the potential for high-quality and reliable supplies of produce from women farmers and agro-processors.

Nonetheless, there are many success stories showing how access to digital agriculture can be a source of both empowerment and higher productivity for women. In India, Nano Ganesh is a remote control for water pumps developed by an Indian company, Ossian Agro Automation. Its electronic hardware for turning pumps off and on can be activated remotely by mobile phone. This helps women (and men) farmers use water more efficiently. Without remote controls, farmers either must make special trips to the fields at night to turn pumps on (electricity is often available only during off-peak hours), or they must leave the pumps on to run on the intermittent electricity supply, wasting water, reducing income and eroding soil. Particularly for women farmers, nighttime trips can be risky and difficult. This innovation has also generated new activities, which provide additional sources of income for women in the company's rural call centres, electronics assembly, and marketing and training (Deichmann *et al.*, 2016).

Source: Adapted from UNCTAD (2020b).

Conclusions and policy recommendations

This study examined the opportunities that digitalization can provide. It has identified gaps between and within countries that, if not addressed, risk leaving behind countries and those segments of the population that are already at the margin of globalization. The focus of the analysis has been on the promises that digitalization can especially bring to women, but also on the gendered barriers and challenges they face. The agricultural sector was selected for sectoral analysis both because it remains a female-intensive sector in many developing countries and because digitalization is a rapidly growing trend within agriculture.

The 2030 Agenda and other global commitments affirm that technological capabilities, especially in ICT, are critical to support women's empowerment, as well as economic productivity, international cooperation, and more sustainable patterns of production and consumption. Technological capabilities set a virtuous circle between access to technology, women's economic empowerment and overall development. Since digitalization is expected

to keep expanding in the coming years, commitments to close gender gaps and digital divides need to be translated into concrete policies and initiatives.

There are clear economic benefits for countries to involve more women in the development and in the use of new technologies. However, these positive developments cannot be expected to happen without appropriate supporting measures. Obstacles that negatively impact women's participation in the digital world should be identified, quantified and addressed.

While the availability of digital devices (e.g. mobile phones, computers, tablets, among other things) and fast and reliable Internet coverage is now guaranteed in the developed world, the situation is different in the developing world, and especially in the poorest countries. Rural areas are particularly disadvantaged.

The capacity to use the Internet for personal development and income generation remains an issue in many countries and especially for women. Women's lower rates of technological literacy and awareness, lack of skills and knowledge about the benefits of digitalization, cost, limited relevance of the content they can find on the Internet, and some mismatch between their needs and the technological solutions available in agriculture, are primary reasons for the observed levels of low technology adoption and for limited productive use of the Internet.

While many stakeholders are involved in the process of digitalization, the primary responsibility to develop and implement appropriate policies and regulations stays with national governments. The following initiatives fall within governments' responsibilities: developing ICT infrastructure; bringing down subscription costs; investing in digital education; ensuring data protection and private security of online transactions; addressing cyber violence; improving national coordination among different stakeholders and different policies; and ensuring that the opportunities provided by digitalization are fairly shared among all actors.

There are areas where government, private sector, and development partners could effectively join forces. Partnerships could be especially useful to improve women's digital literacy, a pre-condition for using digital technologies safely and in a beneficial manner.

It is important to highlight that data and algorithms are not neutral, and they can discriminate against certain demographic groups. Partnerships between governments, ICT companies and gender experts could facilitate the integration of data that represent women and other under-represented groups, identify and tackle potential gender-discriminatory impacts of algorithms and monitor them.

Countries, especially developing countries and LDCs, very often lack data, including sex-disaggregated data, on the overall impact of digitalization on the economy and on who is benefiting from new digital opportunities. From a gender perspective, policymakers need quantitative data on women's access and use of technology, but also qualitative data on existing discriminatory laws and practices related, for example, to women's access to land, capital and credit, and access to digital technical information. Systematic data collection would be a first step towards designing digitalization strategies that address the needs of individuals and businesses with different resources and capabilities.

> Countries, especially developing and least-developed countries, very often lack data, including sex-disaggregated data, on the overall impact of digitalization on the economy and on who is benefiting from new digital opportunities.

In the agriculture sector, there is great potential for digitalization to help address rural poverty, as well as the economic and environmental imbalances generated by globalized food markets. To guarantee that the benefits of digital technologies are equally shared, gender-inclusive interventions are needed to tackle both social norms and economic sources of gender disparities in the sector, from gaps in land ownership, to access to finance, to technical knowledge. Desirable policy interventions include the following: supporting women's access to land; organizing gender-inclusive projects to facilitate household dialogue around family goals to help challenge traditional gender role stereotypes; designing advisory services in ways that address the specific needs and contexts of both men and women; integrating in-person support with digital training to help address digital literacy barriers; providing direct support to rural women farmers in opening mobile money accounts; engaging with community-based organizations to help identify the women farmers that can be supported (Chassin, 2022). Better access to agricultural technology for women could translate into both increased agricultural productivity and enhanced women's empowerment, creating a virtuous circle.

Finally, more women need to participate in the process of innovation to make digital technologies more attuned to their needs. Letting digital technologies widen gender gaps and ignoring the specific challenges that women face in the process of digitalization would contradict the hope for a world where opportunities are equally shared and nobody is left behind.

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Endnotes

1. The United Nations Educational, Scientific and Cultural Organization (UNESCO) defines ICT as a "Diverse set of technological tools and resources used to transmit, store, create, share or exchange information. These technological tools and resources include computers, the Internet (websites, blogs and emails), live broadcasting technologies (radio, television and webcasting), recorded broadcasting technologies (podcasting, audio and video players and storage devices) and telephony (fixed or mobile, satellite, visio/video-conferencing, etc.)" (see http://uis.unesco.org/en/glossary-term/information-and-communication-technologies-ict).
2. The first phase took place in Geneva in December 2003; the second phase took place in Tunis in November 2005. WSIS Forums are organized on a yearly basis.
3. This study follows the UN country classification for statistical use, with 47 countries currently listed as LDCs.
4. Fintechs companies have incorporated algorithmic technology into their solutions especially for applications that use large amounts of historical and real-time data. Algorithms are supporting fintech companies understand data by going beyond traditional reporting, help in predictive analytics, and allow firms to make quick decisions.
5. See https://www.ohchr.org/en/statements/2022/06/trade-and-right-food-path-sdg2.