Gender Participation in Agricultural Digitalization: Prospects and Challenges

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ABSTRACT

Agricultural digitalization offers new opportunities across the world, and holds promises for enhanced productivity growth and improved well-being of all citizens. However, a significant gender gap in the access, use and ownership of digital technologies is still present in many economies and beyond, limiting the equitable realization of the benefits of digital transformation. Gender access to digital tools and digital competencies affect rural smallholders' participation in agricultural digitalization. Total harmonization of both men and women in agricultural digitalization is a road map to agricultural sustainability and food security. Placing gender divide gaps among farmers in terms of access to technological tools will not only create a lacuna in the field of agriculture but also will subject the people to hunger and starvation. Gender-inclusive solutions that help address barriers related to access, knowledge and skills, among others, are highlighted in this paper. Closing the gender gap in agriculture would produce significant gains for society by increasing agricultural productivity, reducing poverty and hunger, and increasing economic growth of the nation. Gender participation in agricultural digitalization is hampered by structural challenges, such as access to internet connectivity, poor or weak infrastructure, policy environment and regulations, and the limited ability of individuals to use the digital solutions. Despite all these challenges, women generally have great potentials for sustaining agricultural production and family income, if given adequate incentives and gender equity. Improvement in their social status and productivity is to increase output. Therefore, women should be allowed to have access to all the productive resources necessary for agricultural production. This paper looks at digitalization in agriculture from gender perspective. It investigates the prospects and challenges of gender participation in agricultural digitalization and zooms in on the potential opportunities that digitalization provides to women, especially in the developing world, and on the obstacle they face to benefit from it.

INTRODUCTION

Agriculture is one of the main pillars of the society's sustainability and is thus shaped by digital era. There have been a great breakthrough, rapid development, high productivity and remarkable successes in the feeding of the world's teeming population curtsey of technologies such as big data, internet of things (IoT), augmented reality, robotics, sensors, 3D printing and others. However, this rapid proliferation of digital tools and services stands in stark contrast to the many systemic and structural barriers to technology access and

adoption that many people in rural Africa still face (FAO, 2021). Despite significant growth in information and communication technologies (ICT) and digitalization for agriculture (D4Ag) in sub-Saharan Africa (SSA) over the last ten years, progress has been somewhat slow in serving African smallholders, particularly women.

The Organization for Economic Co-operation and Development (OECD, 2018) defines digitalization as the use of digital technologies, data and their interconnection, resulting in new activities or changes to existing activities. According to CTA (2019), digitalization for agriculture (D4Ag) is "the use of digital technologies, innovations, and data to transform business models and practices across the agricultural value chain and address bottlenecks in, *inter alia*, productivity, postharvest handling, market access, finance, and supply chain management so as to achieve greater income for smallholder farmers, improve food and nutrition security, build climate resilience and expand inclusion of youth and women."

Digitalization, the socio-technical process of applying digital innovations, is an increasingly ubiquitous trend (Anitei *et al.*, 2020). Digitalization comprises phenomena and technologies such as big data, internet of things (IoT), augmented reality, robotics, sensors, 3D printing, system integration, ubiquitous connectivity, artificial intelligence, machine learning, digital twins and blockchain among others (Klerkx *et al.*, 2019; Alm *et al.*, 2016; Smith, 2018; Tilson *et al.*, 2010). Digitalization has the capacity to improve productivity, sustainability and resilience in many economic sectors of the world. The digitalization of agriculture is seen as the next agricultural revolution that has the potential to respond to the teeming needs of a growing population in the context of ongoing economic and environmental challenges (Trendov *et al*., 2019).

In the context of agricultural and rural development, digitalization can offer various value propositions and have been proven with the credentials of exerting a positive impact on activities, processes and stakeholders at different levels (OECD, 2018). Digitalization can also enhance the ability of agricultural producers for poverty reduction and other livelihood improvements (Izuogu *et al.*, 2023). The benefits of agriculture digitalization are humongous, but some challenges seem to limit farmers of these benefits brought about by these sophisticated technologies (Anitei *et al.*, 2020). Gender inequalities, intersecting with and compounded by other social differences such as class, race, age, to disability, etc., shape the extent to which different rural women and men are able not only to access but also use and benefit from these new technologies and ways of delivering information and services (FAO, 2021). There are gender gaps for a wide range of agricultural inputs and technologies (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 (Simonetta *et al.*, 2022). A survey conducted by Antei *et al.* (2020) revealed that 100% of the participants agreed that digitalization is an opportunity for their activity; none of them consider digitalization a threat. Digitalization in farmer's view is a real help, which will lead to maximum efficiency in the carried-out activity.

A significant gender gap in the access, use and ownership of digital technologies is still present in many G20 economies and beyond, limiting the equitable realization of the benefits of digitalized agriculture. Recognising both the opportunities that digitalization is providing for the economic empowerment of all, including women, and the challenges of ensuring that the benefits of the digital transformation are being equitably shared.

DIGITIZATION IN AGRICULTURE

Digitization is the non-theoretical procedure of changing analogue messages into digital data. It involves the social, mental and economic process of adopting improved technologies (Rolandi *et al*, 2021; Brennen and Kreiss, 2021). Malabo Montpellier Panel Report (MMPR) (2019) has reported that Nigeria has a prospective supporting sphere for digitalization in agriculture with a score of 4.5 out of 9 in the World Banks' Ease of Business in Agriculture (EBA), Information and Communications Technology (ICT) as well as ensuring affordable phones and mobile-specific taxation (Global System for Mobile Communications (GSMC), 2019).

Digitalization of agriculture has reduced the role of middlemen, provided opportunities for farmers to expand their markets, and improved the linkage between extension and research centers, and productivity and livelihood of small-scale farmers (Izuogu *et al.*, 2023). As digitalization is impacting each component of our lives, different forms of digitalization started to be introduced in agriculture like: sensors, IoT (internet of things), big data, 3D printing, artificial intelligence, digital twins, augmented reality, system integration and the list may go on (Anitei *et al.*, 2020).

One of the prospects of women participation in digitalized agriculture is decision making to equate the gender balance. A clear look at the Nigerian agricultural sector indicates that the decision making machinery is monopolized by the male gender (Effiong, 2013).Consequent upon the traditional gender division of labour, which myopically assigns women the greater percentage of unpaid care work relative to the men piloting and performing the leading role as income providers, women are less involved in commercial agriculture than men and, when they do get involved, they tend to hold lower-skilled, lower-pay positions (Simonetta *et al.*, 2022). 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). Sharon (2008) viewed that both women and men play critical roles in agricultural production throughout the world, producing, processing and providing the food we eat.

GENDER DIVIDES IN AGRICULTURAL DIGITALIZATION

The benefits of digitalization in agriculture are currently not equally balanced between societal groups and genders and also the access, use and ownership of digital tools are not gender-neutral. The term "digital gender divide" is frequently used to refer to these types of gender differences in resources and capabilities to access and effectively utilize ICTs within and between countries, regions, sectors and socio-economic groups (UN Women, 2005). In the field of AI, gender segregation is observed in skills, roles, and sectors. Skills related to information retrieval, natural language processing, and data structures are prevalent among women, while women are less likely than men to have emerging skills, such as deep learning, neural networks, and computer vision (World Economic Forum, 2018).

CAUSES OF GENDER DIVIDES IN AGRICULTURAL DIGITALIZATION

There are a number of root causes of the digital gender divide, including hurdles to access, affordability, education (or lack thereof) and lack of technological literacy, as well as inherent biases and socio-cultural norms that lead to gender-based digital exclusion (OECD, 2018d; OECD, 2015a; Hilbert, 2011).

Affordability so to speak, is a challenge for all but affects disproportionally more women and girls than the male counterparts and remains one of the key hurdles in accessing ICTs. The digital gender divide is found to increase as technological sophistication and functionality grows and with the cost of ownership (BMZ, 2017). Case in point is the study by Intel and Dalberg (2012) who found out that affordability plague not only those who are not yet Internet users, but further prevents internet users from using the World Wide Web in its fullest.

Lack of awareness of the potential benefits that the Internet offers even at our closest comfort is yet another reason fewer women than men are found in the ICT world. Women are predominantly more likely than men to not use the Internet because of the misconception that they do not need it or does not benefit them any stretch (Fallows, 2005). Intel and Dalberg (2012) state it all when they found that25% of the women who disengaged themselves in online activities are generally not interested in using the Internet, and almost all of them believe that accessing the Internet profited them nothing. Evidently, lack of trust in digital devices may also be a decisive factor and low expectations about its usefulness and relevance to their local context (i.e. lack of use of local languages) can also be enlisted amongst many others.

Illiteracy further extends the bounds and hinders women's and girls' ability to access online services. Recent study have shown that about 83% of women worldwide are literate, compared to 90% of men (UNESCO, 2017), and illiterate women only appear to be using online platform services, such as Skype and YouTube, that are more familiar to them or are easier to access and use. In an attempt to address this hurdle, some search engines, such as Google, have installed voice navigation systems in local languages to make Internet search queries more accessible and inclusive.

The digital gender divide is also powered by digital illiteracy, which often translates in lack of comfort in usage of these technologies and the clear access to the Internet. Such "technophobia" is often a function of concurrent factors but not limited to education, employment status and income level. For instance, Intel and Dalberg's (2012) survey shows that more than half of the women with minimum formal education are of the view that they were not familiar or comfortable with the technology. Although, this percentage fell to 15% in the case of women with at least high school education.

Besides access, affordability, digital illiteracy, socio-cultural and socio-economic factors such as social class, age, ethnicity, income, assets and cultural origin can also play an exceptional role in elucidating the digital gender divide and also contribute to explaining how and for which purposes people use the Internet (Hosman and Perez Comisso, 2020). For Instance, a country like India and Egypt, around one-fifth of the women were found to believe that the Internet was not appropriate for them, for a greater number of cultural beliefs. In India, around 12 % of women report not to use the Internet because of the negative societal and social perception associated to its use, and 8% due to the lack of acceptance by family members (Inteland Dalberg, 2012). Practically speaking, community norms tend to link mobile and Internet use with reputational risk and as such undermine women's use of digital technologies (Ganapathy and Mahindru, 2023). These factors eventually find expression in people especially, women and so cause them to face multiple and compounding interrelated obstacles to the use of technology for business purposes (UNCTAD 2023, Van Dijk, 2021).

THE POTENTIAL BENEFITS OF DIGITALIZATION IN AGRICULTURE

UNCTAD (2020b) reports that digital agriculture popularly called "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).

Digitalization in agriculture has the potential to address the economic and environmental imbalances that have been noticed in global food markets (Simonetta *et al.*, 2022). Studies have shown as far back in the early 2000sthat developing countries were the net importers of agricultural raw commodities (FAO, 2022a, 2022b). 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. 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 disposition of raising both efficiency and productivity for many small-scale farmers in undeveloped countries by facilitating market transparency, access to extension services, resource optimization, and improvement in agricultural supply chain management (Deichmann *et al.*, 2016).

A more recent case is the rise in food and fuel prices stemming from the outbreak of war in Ukraine which affected and severely 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; IPBES, 2019; MacPherson *et al.*, 2022).

GENDER PARTICIPATION IN AGRICULTURAL DIGITIZATION

Gender is a term often associated with the responsibilities of males and females in the society as a social classification of sex (Udemezue and Odia, 2021). SinkaiyeJibowo (2005) viewed it as the socio-cultural differences between males and females against the biological differences. It is also described as a concept used in social science analysis to look at roles and activities of men and women (International Institute of Tropical Agriculture (IITA, 1996).

Gender participation gives insight into the issues affecting women with the primary focus on the relationship of both men and women to the social and economic structure of a society (Agada *et al.*, 2018). In most parts of rural Nigeria, division of labour within the households is gender specific and according to age. Men and women do function in different capacities; have unequal decision-making power as well as differences in access to land, ICT technologies and control over agricultural productive resources (Udemezue and Odia, 2021). Gender report in Nigeria by the British Council, has it that women own 4% of land in the North-East, and just over 10% in the South-East and South-South has less than 10% of land allocated to women (Karl, 2005). Sequel to these differences, their views, needs, priorities and constraints to improving their productive potentials differ which eventually will affect their various outputs even in agricultural development.

Under social structures and political systems, dominated by men, women are not given equal access to land, technology, education and other resources (Tanko, 1994). The problem of food shortages and scarcity in Nigeria has been ascribed to an acute dearth of gender equality and a corresponding shift of farm responsibilities to the women (Uwadie, 1993; Chinasaokwu, 2021). Socio-economic and political obstacles have for long been magnifying gender inequality and exacerbating poverty among women (Rahman and Aruna, 1999; Chinasaokwu, 2021) should equal opportunity be given to all farmers devoid of gender bias, that is, allowing both men and women to grow whatever crops he/she wants to crop, have access to sophisticated agro - technological tools without gender disparity, there is this tendency that the result will lead to a potential boost in food security in Nigeria and the world in general.

The understanding of gender participation in agricultural digitalization: the prospects and challenges(constraints in food production, processing and marketing among rural farmers) in Nigeria is important owing to the current threat to food security as a result of the economic recession, upsurge in prices of essential commodities faced in the country and this calls for the urgent need to increase workforce (men and women participation) and sustain the enterprise among farmers (Udemezue and Odia, 2021).

DIGITALIZATION IN AGRICULTURE: PROSPECTS AND CHALLENGES

Digitalization can potentially pave the way for improving the efficiency and functioning of food systems, which in turn can have positive impacts on the livelihoods of women and men farmers and agripreneurs, through the creation of digital job opportunities for young women and men in rural areas (FAO, 2022). In this effect, an increasing number of solutions are being developed to improve the livelihoods and resilience of farmers by taking advantage of the decreasing cost of digital technologies.

Digital agriculture can help women and other smallholder farmers in developing countries overcome or offset for the barriers they face by providing tools that can help raise productivity, competitiveness, and access to export markets (Simonetta *et al.*, 2022). At farm level, the application of specific digital technologies can lead to positive impacts on productivity, improve farmers' incomes and livelihoods and make farmers more resilient to the effects of climate change (International Bank for Reconstruction and Development and World Bank, 2019). For example, digitalization through mobile technologies can connect farmers to supply chains, service provision, and directly to markets and consumers, maximizing profitability by avoiding intermediaries. That was shown in the case of a recent review of pilot e-voucher programmes for subsidized farm inputs in Guinea, Mali, and Niger (FAO, 2022).

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)

Digitalization of the agricultural sector has helped enhance the transfer of information and ideas especially as it relates to market information. This has helped in facilitating the profit maximization for the farmers (both male and female) (Oke *et al*, 2019). Generally speaking, farmers need real time information dissemination for efficient agronomic practices as this can also assist significantly in reducing production cost and wade off the risk as farmers are authorized to make sound decisions (Pesce *et al.*, 2019; Ibukun *et al.*, 2021). Digitalization of the agriculture will importantly aid in bridging knowledge gaps thereby narrowing the gender divide gap. The implication is the fact that majority of the farmers can access advisory services not regarding the insufficiency in the number of extension staff (Olagunju *et al.*, 2021).

Digitalization can result in increased food security while reducing agricultural environmental footprint (Fraser and Campbell 2019; Basso and Antle 2020). According to Fabregas *et al*. (2022) digital tools improve productivity, enhances the standard of living of the remote masses while supplementing the indigenous extension approaches. Weather forecast using up-to-date meteorological equipment coupled with intelligent transfer of ideas through internet services or mobile phones enables farmers in making knowledgeable commitment on the periods of their agronomic practices (Pesce, *et al.*, 2019; MMPR, 2020). Innovations in the areas of other automated equipment for agricultural production such as irrigation, light and heat control, satellite photography, Unmanned Aerial Vehicles (UAVs) is altering decision making in the farm labour sector for good (MMPR, 2019; Hermanus, 2021).

Through digitalization, the rate of post-harvest losses on the agricultural value chain is minimized with a corresponding increase in access to value addition facilities (MMPR, 2020). With emerging synergetic

preparations which have given rise to increase in agricultural productivity and farm income, digitalization has made the agricultural sector more attractive to young farmers (Saiz-Rubio and Rovira-Más, 2020).

The adoption of digital technologies may come with negative alterations in the existing agricultural systems (Fielke, *et al*, 2019). For instance, Rose *et al.* (2021) opined that an increase in technology adoption may lead to the negligence of the former knowledge and detach farmers from the landscape. The digitalization of the agricultural sector may increase the level of unemployment in the rural areas. Trendov *et al.* (2019), Beirne and Fernandez (2022), Olomola and Nwafor (2018) and Osabohien *et al.* (2019) noted that the reduction in the cost of labour as a result of digitalization of the agricultural sector will invariably augment for the unemployment. Digitalization of agriculture has reduced the role of middlemen, provided opportunities for farmers to expand their markets, and improved the linkage between extension and research centers, and productivity and livelihood of small-scale farmers (Izuogu *et al.*, 2023)

Nonetheless, success stories abound showing how access to digital agriculture could boast and at the same time 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 (Simonetta *et al.,* 2022). 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).

The potential of digital technologies is 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 (Simonetta *et al.,* 2022). In a country like Kenya, women farmers can use smartphones to watch and predict 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 dealing on shea nut farming, thanks to digital technology – could disengage from intermediaries and 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).

E-commerce, many of which in developing countries are owned by women can help small businesses flourish by reducing the starting capital needed to initiate 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). More so, digital innovations that streamlined the need for face-to-face interactions can also help women overcome discrimination (OECD/WTO, 2017; World Bank and WTO, 2020). 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).

As individuals, women through digitalization can access online education and training. On one hand generally, this is potentially beneficial for everybody, but in the other hand, it can be a game changer for women and girls who are often constrained in access to quality education and information. Recent study by OECD (2018) have shown that increased access to information ultimately makes women feel safer, more autonomous and more self-confident. As citizens, women can interact with authorities at both the national and local levels in a more streamlined, transparent, friendly 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).

Several challenges are militating against the effective gender participation in digitalization of the agricultural sector. Foster *et al.* (2018) identified deficiencies in digital skill, poor financial strength as the core exclusionary barriers to digitalization. According to MMPR (2019), the absence of digital innovation hubs and other ICT public access spaces in rural areas is a major challenge of digitalization in many developing countries. Upon the creation of these hubs, they will facilitate the development of innovation habitat which

is very essential in stimulating the conversion of the agricultural system as well as availing the sector the convenience for youths' participation in agriculture. The absence of infrastructure is among the core challenges impeding the utilization of digital technologies in Nigeria (Nigerian Communications Commission, 2021). According to Izuogu *et al.* (2023), challenges of digitalization of agriculture in Nigeria were lack of technical skill, poor infrastructure and high cost of purchase and maintenance of equipment.

CONCLUSION

Agriculture plays vital role in reshaping the society and is key for women's welfare and livelihood. Men and women tend to perform different economic tasks in the sector due to various sources of gender bias.Technology is one of the fields where women are significantly underrepresented among academic staff, experts, and entrepreneurs, a gap that is even more pronounced in the fields of AI. Technologies have the potential to create opportunities for women to lead, participate in, and benefit from technology developments. However, without the right policy enablers, digital technologies can also reinforce gender stereotypes and deepen economic and social exclusion.

In conclusion, farmers are very much aware of the benefits associated with gender participation in agricultural digitalization and do want to digitalize their activities, but some challenges seem to limit them. An efficient support of the digitalization of the agricultural sectors in Nigeria will ameliorate the negative influence brought to bear by digital gender divide 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 that has hampered its success.

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