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Using digital technologies to improve agricultural production in the Sahel countries of West Africa

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Abstract

Agriculture in the Sahel faces major challenges, but the integration of digital technologies offers encouraging prospects. The aim of the research is to explore how the integration of digital technologies can not only increase productivity, but also transform farmers' interactions with markets. This literature review identifies the benefits of digital technologies, such as precision farming and geographic information systems, while analysing the obstacles to their adoption, including limited access to the Internet, inadequate infrastructure and lack of training. The investigation shows that, despite the opportunities offered by these technologies, their adoption is hampered by financial and awareness challenges, particularly for small-scale farmers, who make up a majority in this part of Africa. The article also proposes strategies to enhance the adoption of digital technologies, highlighting the importance of public-private partnerships and innovation. In conclusion, a successful digital transformation in Sahelian agriculture could help improve food security and strengthen the resilience of agricultural systems in the face of growing challenges.

Keywords: Agriculture, digital technologies, innovation, Sahel, West Africa

1. Introduction

Agriculture is an essential pillar of the global economy, playing a crucial role in food security, job creation and sustainable development. However, the agricultural sector is facing unprecedented challenges, exacerbated by climate change, population growth and economic pressures. These challenges are particularly acute in vulnerable regions such as the Sahel in West Africa, where agriculture is highly dependent on climatic conditions and natural resources. The situation is all the more worrying in countries such as Burkina Faso, where the majority of the population relies on subsistence farming.

The issue of food security in the Sahel is at the heart of international concerns. According to a recent study by Mbaye & al (2021) ^[1], the region is subject to frequent droughts, political instability and increasing pressure on natural resources. These factors contribute to a situation of high vulnerability for farmers, who have to cope with increasingly erratic yields and growing economic uncertainty. At the same time, to meet growing food demand, it is imperative to increase agricultural productivity while preserving the environment. The integration of digital technologies into agriculture is emerging as a potential solution to these complex challenges.

Recent studies, such as those by Abdulai & al (2023) ^[1], highlight the role of digital technologies in agricultural transformation in Africa. These technologies, which include

precision farming, geographic information systems (GIS) and mobile applications, offer tools to optimise farming practices, improve resource management and strengthen farm resilience.

In the Sahelian countries of Africa, the World Bank Group (2024) points out that '64% of the population lives in rural areas and depends mainly on rain-fed agriculture for its livelihood. Despite a potential of 2 million hectares of irrigable land, only 3% of cultivated land is irrigated'. Against this backdrop, the importance of integrating digital technologies is paramount. According to a study by Bair (2020) ^[5], the adoption of digital technologies could not only improve productivity, but also transform the way farmers interact with markets. However, despite the opportunities offered, a number of obstacles remain.

Faced with these obstacles, the aim of this article based on the literature review is to explore how the use of digital technologies can improve agricultural production in Sahelian countries.

This work is structured around several major sections. First, it provides an overview of agriculture in the Sahel, highlighting the specific challenges facing the region. This is followed by a definition of digital technologies applied to agriculture. An analysis of the benefits that these technologies can bring to farmers is also carried out, followed by an exploration of the obstacles to their adoption. Finally, proposals for the future are put forward.

2. Overview of agriculture in the Sahel region of West Africa: Agriculture in the Sahel plays a crucial role in the economic and social life of the population (Nieuwkoop & al., 2012) ^[13]. The sector is dominated by essential food crops, notably millet, sorghum, maize and rice. These crops are often grown in mixed cropping systems, where farmers integrate different species to diversify income sources and improve resilience to environmental shocks. Production is largely for local consumption, but some is also sold on regional markets.

However, agriculture in the Sahel faces many challenges that compromise food security and farm profitability. Climate, in particular, is a major issue (Alliance Sahel, 2024) ^[3]. Variations in rainfall patterns, frequent droughts and rising temperatures are having a serious impact on agricultural yields. These extreme weather conditions, exacerbated by climate change, reduce the predictability of growing seasons, making agricultural planning more difficult.

In addition, water resources are often limited. In a context where irrigation is not systematically developed, farmers are largely dependent on seasonal rainfall. This makes production vulnerable to the vagaries of the weather. In addition, soil degradation due to unsustainable farming practices, deforestation and over-exploitation of the land exacerbates the problem of fertility, limiting yields.

The market is also a challenge for farmers in the Sahel. Access to remunerative markets is often hampered by inadequate infrastructure, making it difficult to market produce (Dabat *et al.*, 2011) ^[6]. Smallholders, who make up the majority of farmers in the region, often find it difficult to organise themselves to meet demand, due to their size and lack of resources. Rapid urbanisation in many parts of the Sahel is increasing pressure on farming systems, with growing demand for food. However, this urbanisation can also offer opportunities in terms of outlets for agricultural products, provided that farmers can adapt to them.

To meet these challenges, the integration of digital technologies into agriculture is emerging as a promising solution. Digital technologies, such as mobile applications, data platforms and geographic information systems, can significantly improve farmers' access to information, training and markets. For example, mobile applications give farmers access to accurate weather forecasts, agronomic advice and information on market prices. This enables them to make informed decisions, adapted to climatic conditions and price fluctuations.

Digital technologies are also making marketing easier. Online sales platforms can put producers in direct contact with consumers, cutting out the middleman and boosting profits for farmers. This is particularly beneficial for small farmers, who can often feel excluded from traditional marketing channels.

Another important technological advance is the use of sensors and drones to monitor crops. These tools make it possible to monitor the condition of crops in real time, identify potential problems such as disease or nutrient deficiencies, and intervene quickly. Analysis of the data collected can also help to optimise farming practices, by providing specific recommendations on irrigation, fertilisation and phytosanitary treatments.

Despite these advantages, the adoption of digital

technologies is not without obstacles. Firstly, the infrastructure needed to support these technologies is often insufficient. In many rural areas, access to the Internet remains limited, hindering the use of digital solutions. In addition, electricity is not always available, making it even more difficult to use technological devices.

Another major challenge is the need to train farmers to use these new technologies. Although many solutions are intuitive, the lack of adequate training can lead to under-use of digital tools. Training programmes need to be adapted to local realities, taking into account farmers' levels of education and ensuring follow-up after the initial training.

The cost of digital technologies can also be a barrier for small-scale farmers. While some solutions are affordable, others require investments that many farmers cannot afford. Initiatives to subsidise these technologies or create accessible business models are essential to encourage widespread adoption.

Finally, the social dimension of adopting digital technologies must not be overlooked. Farmers, particularly in rural areas, may be reluctant to change their traditional practices. Community awareness and involvement are essential to create a favourable environment for innovation.

In this context, several initiatives have already shown promising results. Pilot projects using digital technologies in rural areas of Burkina Faso have improved yields and farmers' incomes. For example, agricultural cooperatives have started to use applications to optimise crop planning and facilitate access to markets. These initiatives demonstrate that, with the right support, digital technologies can transform agriculture in the Sahel.

In sum, the state of agriculture in the Sahel is marked by significant challenges, but the integration of digital technologies offers a potential pathway to more resilient and sustainable agricultural production. Public policy must encourage access to these technologies, while supporting farmer training and the development of the necessary infrastructure. This could not only improve food security in the region, but also strengthen the resilience of agricultural systems in the face of climate change and market dynamics.

3. Digital technologies in agriculture

The emergence of digital technologies in the agricultural sector represents an unprecedented revolution, particularly in Sahelian countries such as Burkina Faso. These technologies encompass a wide range of tools and solutions that make it possible to optimise farming practices, strengthen the resilience of farms and improve farmers' quality of life.

3.1. Definition of digital technologies

Digital technologies in agriculture refer to the use of information and communication-based tools to improve agricultural processes. These tools include:

- Mobile applications provide farmers with information on weather conditions, cultivation practices and market prices. They also provide access to training and technical advice.
- Used to monitor crops, drones can collect data on the condition of fields, detect disease and assess yields. Their ability to cover large areas quickly makes them a valuable tool for farmers.

- Sensors can be installed in fields to collect real-time data on soil moisture, temperature and other environmental factors. This information helps farmers to make informed decisions about irrigation and fertilisation.
- Data platforms aggregate information from different sources to provide accurate analyses of agricultural trends, weather forecasts and market conditions.

These technologies enable a more scientific and accurate approach to agriculture (World Bank Group, 2019), which is essential as climate and food security challenges grow.

3.2 Examples of specific digital tools

The use of digital technologies in agriculture has resulted in the development of several specific tools that meet the needs of farmers in the Sahel. For example:

- M-Farm gives farmers access to information on the prices of agricultural products on local markets, enabling them to make more informed sales decisions.
- AgriWeather provides accurate weather forecasts and alerts to farmers, helping them to plan their activities according to climatic conditions.
- WeFarm (a social network for farmers) enables advice and information to be shared, promoting the exchange of knowledge between peers.
- Several initiatives in African countries use drones to monitor crops, enabling problems to be detected before they become critical, such as the presence of pests or diseases (Africa Flying and Engineering, 2024) ^[2].

These specific tools are helping to modernise agriculture, making farmers more competitive and resilient in the face of today's challenges.

3.3. Importance of access to the Internet and telecommunications networks

Access to the Internet and telecommunications networks is essential if we are to reap the full benefits of digital technologies in agriculture. In many rural areas of the Sahel, this access remains limited, which hinders the effective use of digital tools.

Infrastructure challenges, such as the lack of robust telecoms networks and internet connectivity, can create a digital divide that leaves many farmers outside the innovation process. Initiatives to improve the digital infrastructure in rural areas are therefore crucial to ensure that all farmers can benefit from technological advances.

The importance of Internet access cannot be underestimated. Access to real-time information via the Internet can significantly improve agricultural productivity (Hudson, 1995) ^[10]. In addition, telecommunications technologies, such as mobile telephony, also enable direct communication between farmers and experts, facilitating access to technical advice and support services.

4. Benefits of digital technologies for farmers

The integration of digital technologies into agriculture offers a number of significant benefits that can transform the sector, particularly in fragile contexts such as the Sahel.

4.1. Improving productivity

One of the key benefits of digital technologies is their ability to improve farm productivity. Through the use of data collected by sensors, drones and other digital tools, farmers can optimise crop yields. For example, Shortt & al (2011) ^[14] argue that analysis of soil moisture data can determine the most opportune times to irrigate, avoiding wasted water and maximising production.

Precision technologies, which use geospatial data to guide agricultural interventions, also make it possible to identify specific areas of fields that require particular attention. This results in more targeted farming practices, reducing costs and increasing yields.

4.2. Access to information

Digital technologies provide farmers with unprecedented access to critical information that can influence their decisions. Applications such as AgriWeather provide detailed weather forecasts, allowing farmers to plan their planting and harvesting based on upcoming climate conditions (Gommes, 1994) ^[7].

In addition, agronomic advice accessible through digital platforms helps farmers adopt sustainable farming practices, providing recommendations on crop management, disease control, and fertilizer use.

Access to data on market trends is also crucial. By being informed of price fluctuations, farmers can better negotiate their sales, improving their profitability. Digital marketplace platforms, such as M-Farm, provide real-time insight into prices, allowing farmers to make informed decisions on when and how to sell their products.

4.3. Facilitating marketing

Marketing agricultural products is often a major obstacle for farmers in the Sahel, due to limited transport infrastructure and the lack of direct links to markets. Digital technologies facilitate this marketing by connecting producers with consumers and distributors.

Online sales platforms allow farmers to present and sell their products directly to consumers. For example, Mutualia (2024) ^[12] shows that the use of social networks and e-commerce applications allows farmers to reach a wider audience, increase their visibility and maximize their income.

In addition, the establishment of traceability systems via digital technologies can reassure consumers about the quality and origin of products. This is particularly relevant in a context where demand for certified and quality agricultural products is increasing.

4.4. Resource management

Managing natural resources, particularly water and soil, is essential for the sustainability of agriculture in the Sahel. Digital technologies enable more efficient management of these resources, providing tools to monitor and optimize their use.

Soil moisture sensors, for example, provide real-time data on irrigation needs, allowing farmers to apply water in a targeted manner and reduce waste (Synox, 2024) ^[15]. This is particularly important in a changing climate, where water availability is becoming increasingly uncertain.

In addition, analyzing soil data can help determine nutrient

needs and adapt fertilization practices accordingly. This contributes to soil health, which is essential to maintain long-term productivity.

The integration of digital technologies in agriculture in the Sahel offers unprecedented opportunities to improve productivity, access to information, marketing, and resource management. However, addressing infrastructure, training, and internet access challenges is essential to ensure that all farmers can benefit from these advances.

5. Challenges and barriers to the adoption of digital technologies: The integration of digital technologies in agriculture in the Sahel represents a significant opportunity to improve productivity and sustainability. However, several challenges and barriers must be overcome to ensure their widespread adoption. Among these challenges, infrastructure, training, and cost issues are particularly critical.

5.1. Limitations of access to Internet and electricity

A major barrier to the adoption of digital technologies in agriculture in the Sahel is the lack of infrastructure, particularly access to the Internet and electricity. In many rural areas, network coverage is poor or non-existent. According to the World Bank Group (2019), only a small fraction of farmers in remote areas have a reliable internet connection. This limits their ability to access digital tools and information crucial for their agricultural activities.

Electricity is also a major issue. Farmers need a stable source of energy to run digital equipment such as sensors, drones and even smartphones. In many parts of the Sahel, power outages are frequent and access to electricity remains limited, complicating the use of digital technologies. Reliance on expensive generators or batteries can also make these solutions impractical and economically viable for smallholder farmers.

Furthermore, the lack of transport infrastructure further complicates access to markets and the distribution of technologies. Poor or non-existent roads prevent farmers from accessing services that could help them adopt these new technologies. As a result, investments in improving infrastructure are essential to support the development of digital agriculture in the region.

5.2. Need for farmer awareness and training

Another major barrier to the adoption of digital technologies is the need for farmer awareness and training. Most farmers, especially those in rural areas, lack the expertise to effectively use these digital tools. Even if applications and systems are designed to be intuitive, some training is often required to maximize their use.

Training programs should not only address the use of technologies, but also raise awareness among farmers of the benefits they can derive from them. Training initiatives should be adapted to local realities and farmers' education levels. This often involves developing practical and accessible learning methods, taking into account the diversity of skills and experiences of potential users.

Government agencies, NGOs, and private companies should collaborate to develop training programs that meet the specific needs of farmers. The use of practical field demonstrations can be particularly effective in encouraging

the adoption of new technologies.

5.3. Affordability of technologies for smallholders

The issue of the cost of digital technologies also poses a significant barrier, particularly for smallholders who represent the majority of farmers in the region (Alliance for Food Sovereignty in Africa, 2024) [3]. While some technologies are relatively inexpensive, others require significant upfront investments, which can be prohibitive for many farmers.

Moreover, even when the technologies themselves are affordable, the cost of data services, internet access, and electricity can quickly add up, making them difficult to use. Smallholder farmers, often already facing tight profit margins, may be reluctant to invest in technologies that they perceive as luxuries rather than necessities.

To overcome this barrier, initiatives to subsidize or finance access to digital technologies should be put in place. Microcredit programs, for example, could provide farmers with access to technologies they would otherwise be unable to afford. Partnerships with private companies could also help reduce costs and make technologies more accessible.

6. Future prospects

In the face of the challenges identified, it is crucial to develop future prospects that promote the adoption of digital technologies in agriculture in the Sahel. Several proposals can be put forward to strengthen this adoption, as well as the role of public-private partnerships and the importance of research and innovation.

6.1. Proposals to strengthen the adoption of digital technologies

To increase the adoption of digital technologies in agriculture, several measures can be considered:

- Investing in telecommunications and electricity infrastructure is essential. Governments must collaborate with private companies to extend Internet coverage in rural areas and improve electricity supply;
- Develop practical and accessible training programs that meet the specific needs of farmers. This includes field demonstrations and small group training sessions to ensure that all farmers can acquire the necessary skills;
- Create business models that integrate smallholders into digital value chains. This could include establishing cooperatives that collectively purchase technologies or services, thereby reducing the cost for each member;
- Developing financing mechanisms, such as grants or low-interest loans, to help farmers acquire the necessary technologies.

6.2. Role of public-private partnerships in the development of digital agriculture

Public-private partnerships (PPPs) play a crucial role in the development of digital agriculture. These collaborations can help bring together the resources, expertise and innovation needed to overcome identified challenges.

Governments can work with technology companies to develop digital solutions tailored to farmers' needs. For example, private companies can provide their technical expertise to create applications and platforms that specifically address local realities.

In return, governments can provide a supportive regulatory environment that encourages innovation and investment in the agricultural sector. By establishing incentive policies, governments can attract private investment and build local capacity.

Partnerships can also be beneficial for the implementation of training programs. By collaborating with NGOs and civil society organizations, companies can help raise awareness and train farmers on the use of digital technologies.

6.3. Importance of research and innovation for the future of agriculture in the Sahel

Investments in agricultural research can help develop digital solutions that are adapted to local conditions, taking into account climatic, economic and cultural realities.

Research institutions should collaborate with farmers to identify their needs and design technologies that meet these needs. Open innovation, where farmers participate in the technology development process, can also be an effective approach to ensure that solutions are relevant and usable.

Furthermore, innovation should not be limited to digital technologies themselves. Sustainable and resilient agricultural practices, such as agroecology, can also benefit from a digital approach, using data to optimize yields while preserving natural resources.

Research initiatives that integrate social and economic aspects, in addition to technical ones, are also needed to ensure that digital technologies benefit all farmers, especially the most vulnerable.

In sum, the future of agriculture in the Sahel will largely depend on overcoming the challenges related to the adoption of digital technologies. By implementing strategies to improve infrastructure, training, financial accessibility and by promoting public-private partnerships, it is possible to transform agriculture in the region. Research and innovation will also play a key role in ensuring that digital solutions are appropriate and effective.

7. Conclusion

Agriculture in the Sahel, a region characterized by harsh climatic and socio-economic conditions, faces major challenges, including food security, sustainable resource management, and adaptation to climate change. However, the integration of digital technologies is emerging as a promising solution to transform these challenges into opportunities. Indeed, digital tools, such as crop management applications, marketing platforms, and geographic information systems, can revolutionize the way farmers operate, allowing them to optimize their production, access crucial information, and improve their incomes. To maximize the impact of digital technologies, it is essential to adopt a holistic approach. This requires proactive public policies that facilitate access to the Internet and technologies, as well as substantial support in terms of training and awareness raising. Farmers must be equipped not only with digital tools, but also with the skills to use them effectively. Collaboration between governments, the private sector, non-governmental organizations and research institutions will be crucial to create an enabling ecosystem for the adoption of these technologies.

In addition, the development of adequate infrastructure is essential. Access to electricity, communication networks

and internet services must be strengthened to ensure that farmers, especially those in rural areas, can benefit from digital innovations. The creation of training centers dedicated to digital agriculture can also play a key role in disseminating the necessary knowledge and skills.

The challenges of poverty and financial accessibility should not be underestimated. For smallholder farmers to adopt these technologies, it is crucial to develop viable business models and adapted financing solutions. Public-private partnerships can be used as a lever to mobilize the resources needed for this transformation.

Research and innovation are also at the heart of the future of agriculture in the Sahel. Digital solutions must be adapted to local realities, taking into account the specificities of cropping systems, farmers' preferences and environmental conditions. Collaboration between researchers, technology developers and farmers will allow the co-creation of relevant and effective tools and services.

The future of agriculture in the Sahel therefore depends on a successful digital transformation. By overcoming barriers to technology adoption, strengthening infrastructure and promoting training, it is possible to build a more resilient and sustainable agricultural system. This will not only contribute to improving food security, but also to strengthening the resilience of communities in the face of growing economic and environmental challenges. With a collaborative and integrated approach, digital technologies can truly become a driver of change for agriculture in the Sahel.

8. References

1. Abdulai AR, Tetteh Quarshie P, Duncan E, Fraser E. Is agricultural digitization a reality among smallholder farmers in Africa? Unpacking farmers' lived realities of engagement with digital tools and services in rural Northern Ghana. *Agric Food Secur.* 2023;12(11):1-14. DOI: 10.1186/s40066-023-00416-6.
2. Africa Flying and Engineering. Les bénéfices de l'usage des drones dans l'agriculture en Afrique. 2024. Available from: <https://afe-drone.com/les-drones-pour-une-agriculture-durable/>.
3. Alliance pour la souveraineté alimentaire en Afrique. Digitalisation et marchés agro-écologiques en Afrique, 2024, 44.
4. Alliance Sahel. Priorité des membres de l'Alliance Sahel: résilience aux chocs grâce à la sécurité alimentaire; c2024. Available from: <https://www.alliance-sahel.org/actualites/agriculture-developpement-rural-et-securite-alimentaire/priorite-securite-alimentaire/>.
5. Bair S. Assessing the impact of the use of information and communication technologies in the agricultural sector in Africa: The case of mobile telephony. *Economics and Finance. Université Paris Sciences et Lettres*; c2020. p. 196.
6. Dabat M-H, Kiendrebeogo R, Zongo I, Degueurce S. Quand le dysfonctionnement des marchés favorise la sécurité alimentaire. *Étude de cas au Burkina Faso. Grain de Sel.* 2011;54-56:50-51. Available from: https://www.inter-reseaux.org/wp-content/uploads/GDS54-56_p50-51_Secu_Alim_Burkina.pdf.

7. Gomme R. L'agro-météorologie - Que peut l'agro-météorologie moderne pour l'agriculteur qui produit le minimum vital? FAO; c1994. Available from: <https://www.fao.org/4/x6721f/x6721f25.htm>.
8. Groupe de la Banque mondiale. Exploiter les technologies numériques pour renforcer durablement le système alimentaire mondial; c2019. Available from: <https://www.banquemondiale.org/fr/topic/agriculture/publication/future-of-food-harnessing-digital-technologies-to-improve-food-system-outcomes>.
9. Groupe de la Banque mondiale. Faire jaillir de l'eau pour contrer l'insécurité alimentaire et le changement climatique dans le Sahel; c2024. Available from: <https://www.banquemondiale.org/fr/news/feature/2024/03/20/afw-bringing-forth-water-to-combat-food-insecurity-and-climate-change-in-the-sahel>.
10. Hudson H. Banque Mondiale - Rapport sur Economic and social benefits of rural telecommunications. FAO; c1995. Available from: <https://www.fao.org/4/W6840F/w6840f06.htm>.
11. Mbaye AA, Braun JV, Mirzabaev A, Gueye F. Climate change and food security in West Africa: Challenges and opportunities. Global Environmental Change, 2021, 502.
12. Mutualia. Les médias sociaux, un atout pour les agriculteurs; c2024. Available from: <https://www.mutualia.fr/agriculteur/infos/economie-et-societe/news/les-medias-sociaux-un-atout-pour-les-agriculteurs>.
13. Nieuwkoop M, Goyal A, Agostini P, Saltiel G, Kamkawala J, Cervigni R, *et al.* Transformer l'agriculture au Sahel: comment y parvenir? World Bank, 2012, 8.
14. Shortt R, Verhallen A, Fisher P. Surveiller l'humidité du sol pour améliorer. AGDEX 753/560; 2011. 12 p.
15. Synox. Gestion intelligente des sols, des capteurs de température et d'humidité pour une agriculture adaptée. 2024. Available from: <https://www.synox.io/cat-smart-agriculture/capteurs-temperature-humidite-agriculture/>.