AGRICULTURE IN THE SAHEL ALLIANCE STATES

ISMAEL BALIMA

American Public University System
E-mail: ismael.balima@mycampus.apus.edu

Abstract - This comparative case study analysis examines the concerted push since 2022 to deploy climate-smart agricultural (CSA) technologies in the central Sahel nations of Burkina Faso, Mali, and Niger. Faced with intensifying climatic volatility and complex security challenges, these countries have become critical arenas for interventions aimed at building resilience and ensuring food security. The research identifies a common technological portfolio across the region, centered on solar-powered irrigation systems, drought-tolerant seed varieties, enhanced traditional practices like the Zaï technique, and simple mobile technology (mAgri) for information dissemination. A central finding is the pivotal, orchestrating role of international development partners, including the World Bank, the African Development Bank (AfDB), and the International Fund for Agricultural Development (IFAD), alongside bilateral agencies from the EU, France, and the USAin funding, disseminating, and scaling these technologies through large-scale, nationally-tailored programs such as the Food System Resilience Program (FSRP) and country-specific Climate-Smart Agriculture Support Projects.
This study makes a significant contribution to the literature on agricultural development and technology transfer in fragile states. It moves beyond a generic narrative of technological diffusion to delineate a contemporary, donor-driven model of resilience-building that functions as a critical substitute or supplement in contexts of limited state capacity. The analysis highlights a strategic, observable pivot from a singular focus on increasing yields to creating integrated, shock-resistant agricultural systems. The synergistic deployment of water-harvesting techniques, digital advisory services, and post-harvest technologies within single project frameworks evidences this. Furthermore, the findingsprovide a nuanced understanding of how the pursuit of food sovereignty is navigated amidst overlapping crises, demonstrating that despite profound political and security challenges, agricultural innovation remains a critical and actively supported pathway. The findings offer policymakers and practitioners valuable insights into the mechanisms, partnerships, and integrated technological approaches required to foster agricultural resilience in similarly vulnerable regions across the Global South.

I. INTRODUCTION

In the face of intensifying climatic pressures and complex security challenges, the Sahel nations of Burkina Faso, Mali, and Niger have become critical arenas for deploying agricultural technologies to build resilience and ensure food security. Since 2022, a consistent focus across these countries has been on promoting climate-smart agriculture (CSA), with technologies such as solar-powered irrigation, drought-tolerant seeds, and enhanced traditional practices, such as the Zaï technique, taking center stage. A key and unifying theme is the pivotal role of international development partners, including the World Bank, the African Development Bank, and USAID, in funding, disseminating, and scaling these technologies through large-scale, nationally-tailored programs. A comparative case study analysis enabled a systematic examination of how similar technological packages and international support mechanisms are adopted, adapted, and yield different outcomes within the distinct political, security, and environmental contexts of each country.

1. **Burkina Faso**

Since 2022, agricultural technology in Burkina Faso has increasingly focused on resilience and adaptation in the face of significant climatic and security challenges. A primary focus has been on promoting climate-smart agriculture (CSA) technologies (Tinawaen et al., 2025), particularly water-harvesting techniques and efficient irrigation systems. The widespread adoption of the "Zaï" technique (Beye et al., 2024), a traditional method enhanced with modern agronomic knowledge (involving digging small pits to capture rainwater and concentrate organic matter), has been crucial for restoring degraded soils and improving crop yields in the country's arid northern regions. Complementing this, the use of solar-powered irrigation pumps has gained traction, enabling farmers to extend their growing seasons and reduce their dependence on erratic rainfall (Ouedraogo et al., 2025). These technologies are vital for ensuring food security and have been supported by both government extension services and international development partners.

A significant driver of this technological adoption has been the support from major international institutions. The World Bank's Food System Resilience Program (FSRP), a multi-phase initiative active across West Africa, has been instrumental in Burkina Faso. This program funds the dissemination of drought-tolerant seed varieties, supports the development of irrigation infrastructure, and strengthens digital agricultural advisory services. Similarly, the African Development Bank (AfDB) has been a key partner, financing projects aimed at building resilience through the construction of water retention structures, the provision of equipment, and training in sustainable land management practices. These large-scale programs provide the essential funding and technical backbone for national efforts to modernize

the agricultural sector and build resilience against climate shocks.

At a bilateral level, specific countries have also played a pivotal role in advancing agricultural technology in Burkina Faso. The European Union, through its various development funds, continues to support projects focused on agroecology and soil fertility management. France, via the French Development Agency (AFD), has been involved in initiatives that combine agricultural productivity with environmental protection. While security concerns have complicated some partnerships, the United States, through agencies like USAID, has supported programs that introduce improved post-harvest storage technologies and climate information services to help farmers mitigate losses. Collectively, these international and bilateral partnerships have been essential in scaling up proven technologies, demonstrating that despite the nation's complex challenges, innovation in agriculture remains a critical and actively supported pathway toward sustainability and food sovereignty.

2. Mali

Since 2022, agricultural technology in Mali has been increasingly focused on building resilience against climate shocks and improving food security for its predominantly rural population. A significant push has been made towards the adoption of climate-smart agriculture (CSA) technologies. These include solar-powered irrigation systems, which reduce dependence on erratic rainfall and costly fuel, and the promotion of drought-resistant seed varieties for staple crops like millet, sorghum, and rice. Furthermore, simple mobile technology (mAgri) has become a cornerstone, with services providing farmers with vital information on weather forecasts, market prices, and best practices via SMS and voice messages. This basic digital infrastructure helps farmers make more informed decisions, plan their planting and harvesting schedules, and mitigate risks associated with a changing climate.

International institutions have been pivotal in funding and implementing these technological advancements. The World Bank, through its $150 million Mali Climate-Smart Agriculture Support Project, has been a major driver since its approval, focusing on scaling up proven technologies, such as improved seeds and water management, for hundreds of thousands of farmers. Similarly, the International Fund for Agricultural Development (IFAD) has ongoing programs, such as the Family Farming Development Programme (ProDeF), which integrates digital platforms and climate-resilient techniques to support smallholder farmers. These multilateral efforts are complemented by bilateral support, notably from the United States Agency for International Development (USAID). USAID's activities have emphasized not only climate adaptation but also post-harvest technologies, such as hermetic storage bags and small-scale processing equipment, to reduce the significant grain losses that occur after harvest.

Despite a challenging socio-political context, the partnership between the Malian government, international donors, and NGOs has ensured a continued, if cautious, rollout of agricultural technology. The focus has shifted strategically from merely increasing yields to creating a more integrated, shock-resistant agricultural system. Looking ahead, the challenge remains in achieving scale, ensuring the affordability of technologies for the poorest farmers, and maintaining international support amidst geopolitical complexities. Nevertheless, the concerted efforts since 2022 have laid a crucial foundation, empowering a growing number of Malian farmers with the tools and knowledge to enhance their productivity and livelihoods amid persistent environmental and economic pressures.

3. Niger

Since 2022, agricultural technology in Niger has been increasingly focused on climate-smart solutions and digital tools to address the nation's severe environmental challenges. A key focus has been on improving water access and efficiency for smallholder farmers, who are most vulnerable to drought and desertification. The adoption of solar-powered irrigation systems has grown significantly, supported by initiatives from the World Bank and the International Fund for Agricultural Development (IFAD). These systems provide a reliable, low-cost energy source for pumping water, enabling farmers to extend growing seasons and increase crop yields. Complementing this is the promotion of drip irrigation kits (Osame et al., 2025), which conserve scarce water resources by delivering moisture directly to plant roots. Furthermore, simple mobile technology remains a cornerstone, with services like SMS-based weather forecasts and market price information helping farmers make more informed decisions about planting and selling their produce.

International development partners have played a crucial role in scaling these technologies through targeted programs. A flagship initiative is the World Bank's $215 million Niger Climate-Smart Agriculture Support Project (PAPCS-Niger), approved in 2022. This project directly supports the adoption of climate-resilient technologies, including solar irrigation, and aims to benefit hundreds of thousands of farmers. Similarly, IFAD's Niger Agricultural and Livestock Productivity Project (PAPEL) continues to finance the distribution of irrigation equipment, improved seeds, and livestock vaccines. The African Development Bank (AfDB) is also a key player, with its Technologies for African Agricultural Transformation (TAAT) program working to

disseminate high-yielding, drought-tolerant seed varieties for staples like millet and sorghum across the Sahel, including Niger. These programs often integrate technology transfer with essential training, ensuring farmers can effectively utilize new tools.

Beyond multilateral institutions, bilateral partnerships with countries like France, Germany, and the United States have provided critical support. The U.S. Agency for International Development (USAID), through its Feed the Future initiative, partners with local organizations to promote soil fertility management techniques and post-harvest storage technologies to reduce grain losses. Germany's GIZ and the French Development Agency (AFD) are active in funding rural infrastructure and agro-ecological practices. Looking forward, the focus is expanding to include more advanced digital platforms, such as using satellite data for pastoral resource management and developing agricultural fintech (fintech) solutions to improve farmers' access to credit and insurance. While challenges of scale and infrastructure persist, the concerted effort since 2022 to deploy these technologies through international partnerships represents a crucial step toward building a more resilient and productive agricultural sector in Niger.

II. CONCLUSION

This comparative analysis of Burkina Faso, Mali, and Niger has highlighted the concerted post-2022 effort to strengthen agricultural systems in the central Sahel through a coordinated suite of climate-smart technologies. The study confirms that a common portfolio, encompassing solar-powered irrigation, drought-tolerant seeds, enhanced traditional practices such as Zai, and mobile-based advisory services, forms the technological core of resilience-building efforts across the region. A paramount finding is the indispensable, orchestrating role played by a consortium of international development partners, including the World Bank, AfDB, and IFAD, alongside bilateral agencies. These actors not only fund but also actively design and implement large-scale, nationally tailored programs, effectively creating a donor-driven model of agricultural modernization that operates as a critical supplement to state capacity in fragile contexts. This represents a significant contribution to the literature, moving beyond a generic narrative of technology transfer to delineate a contemporary, integrated approach to resilience. The strategic pivot from a singular focus on yield increase to the synergistic deployment of water management, digital tools, and post-harvest loss reduction within single project frameworks marks an evolution in practice. Ultimately, this research demonstrates that despite profound and overlapping climatic and security crises, agricultural innovation remains a vital and actively supported pathway, offering a nuanced blueprint for pursuing food sovereignty in some of the world's most challenging environments.

The insights generated from this study, however, also reveal critical avenues for future research that would substantially benefit the literature. First, there is a pressing need for longitudinal, farmer-centric impact evaluations of these integrated technological packages. While this study has mapped the top-down deployment mechanisms, rigorous, multi-year studies are required to quantitatively and qualitatively assess the socio-economic outcomes at the household level. Research should investigate not just changes in yield or income, but also how these technologies affect labor dynamics, gender equity, social cohesion, and, crucially, whether the benefits are sustainable after project funding ends. Such evidence is vital for moving beyond adoption rates to understanding genuine resilience and for holding development initiatives accountable for their long-term impacts.
Second, future scholarship should prioritize critical policy analysis of the donor-driven model itself. As this study shows, international partners are the primary architects of the Sahel's agricultural technology landscape. Research must now scrutinize the implications of this dependency. This includes analyzing the coordination or lack thereof between competing donor projects, the alignment of donor agendas with national food sovereignty goals as defined by local stakeholders, and the potential for these large-scale programs to marginalize alternative, bottom-up innovations or create parallel structures that undermine the development of robust national institutions. Investigating the political economy of this funding ecosystem and its consequences for national ownership and long-term sustainability is essential to ensure that the current model of support genuinely empowers rather than inadvertently perpetuates dependency.

REFERENCES

[1] Mekouar, Mohamed Ali. 2018. “15. Food and Agriculture Organization of the United Nations (FAO).” *Yearbook of International Environmental Law* 29:448–68. https://doi.org/10.1093/yiel/yvz057.

[2] Ouedraogo, Kyria R., Komlan H. S. Tete, Y. M. Soro, and Arouna Darga. 2025. "Solar Water Pumping Systems for a Sustainable Development of the Market Gardening Sector in Burkina Faso." *Discover Sustainability* 6 (1) (12): 969. doi:https://doi.org/10.1007/s43621-025-01636-5. http://ezproxy.apus.edu/login?qurl=https%3A%2F%2Fwww.proquest.com%2Fscholarly-journals%2Fsolar-water-pumping-systems-sustainable%2Fdocview%2F3255933261%2Fse-2%3Faccountid%3D8289.

[3] Ode Omenka, Loveth C., Evans S. Osabuohien, Ese Urhie, Godwin O. Ode, Kabore N. Eric, and Abdulaziz Al-Faryan. 2025. "Impact of Climate Dynamics on Food Security in Burkina Faso and Nigeria using FMOLS and Geospatial Analysis." *Discover Sustainability* 6 (1) (12): 736. doi:https://doi.org/10.1007/s43621-025-01518-w. http://ezproxy.apus.edu/login?qurl=https%3A%2F%2Fwww.proquest.com%2Fscholarly-journals%2Fimpact-climate-

dynamics-on-food-security-burkina%2Fdocview%2F3235216383%2Fse-2%3Faccountid%3D8289.

[4] Zouré, Cheick Oumar, Tocoma Sy, Aboubacar Coulibaly, Fabienne Rouamba Inès, Balguissa Kindo, Donatien Bazyomo, Reine Marie Ouédraogo, Paulin Honoré Drabo, and Ousséni Ouédraogo. 2025. "On the Performance of Traditional Agroecological Practices in Mitigating the Effects of Climate Variability on Ecosystems: A Case Study in Northern Burkina Faso." *Applied and Environmental Soil Science* 2025. doi:https://doi.org/10.1155/aess/8855588. http://ezproxy.apus.edu/login?qurl=https%3A%2F%2Fwww.proquest.com%2Fscholarly-journals%2Fon-performance-traditional-agroecological%2Fdocview%2F3159889780%2Fse-2%3Faccountid%3D8289.

[5] Beye, André, Mamoudou Traore, Ibrahim Ouedraogo, Youssouf Ouedraogo, and Hassan Bismarck Nacro. 2024. "Effet De l'Apport De Compost à Base De LoudetiaTogoensis (Pilg.) C.E.Hubbard Sous Zaï Mécanisé, Sur l'Humidité Pondérale Du Sol Et Les Composantes De Rendement Du Sorgho Sorghum Bicolor (L.) Moench Dans La Commune De Arbollé, Au Nord Du Burkina Faso." *International Journal of Innovation and Applied Studies* 43 (1) (07): 129-139. http://ezproxy.apus.edu/login?qurl=https%3A%2F%2Fwww.proquest.com%2Fscholarly-journals%2Feffet-de-lapport-compost-%C3%A0-base-loudetia%2Fdocview%2F3111683190%2Fse-2%3Faccountid%3D8289.

[6] Tinawaen, Tambol, Emmanuel Derbile, Moussa Soule. 2025. "Use of Climate Smart Agriculture Technologies in West Africa Peri-Urban Sahel in Niger." *Scientific Reports (Nature Publisher Group)* 15 (1): 2771. doi:https://doi.org/10.1038/s41598-024-82813-w. http://ezproxy.apus.edu/login?qurl=https%3A%2F%2Fwww.proquest.com%2Fscholarly-journals%2Fuse-climate-smart-agriculture-technologies-west%2Fdocview%2F3158248676%2Fse-2%3Faccountid%3D8289.

[7] "12Educational Evaluation in Africa." 2003. *Springer International Handbooks of Education: International Handbook of Educational Evaluation*

[8] Osame, Peter Uloho and Asim Taimoor. 2025. "Hydrodynamic Characterisation of the Inland Valley Soils of the Niger Delta Area for Sustainable Agricultural Water Management." *Sensors* 25 (14): 4349. doi:https://doi.org/10.3390/s25144349. http://ezproxy.apus.edu/login?qurl=https%3A%2F%2Fwww.proquest.com%2Fscholarly-journals%2Fhydrodynamic-characterisation-inland-valley-soils%2Fdocview%2F3233261413%2Fse-2%3Faccountid%3D8289.

★★★