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Original Article

Digital Innovation and Structural Transformation of Togo's Agricultural Sector: An Economic Analysis of the Open Innovation AgTech 2025 Initiative

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Abstract: *Faced with structural constraints that limit agricultural productivity in Sub-Saharan Africa, digital innovation has emerged as a strategic lever for transformation. This article analyzes the Open Innovation AgTech 2025 initiative organized in Togo within the framework of the West African Food System Resilience Program. Using an analytical case study approach, the paper examines the economic potential of the selected innovations in terms of productivity improvement, climate resilience, and financial inclusion. The results suggest that AgTech hackathons can help reduce certain rural market failures, including transaction costs, information asymmetries, and liquidity constraints, and may represent an emerging instrument of agricultural public policy. However, their effectiveness depends largely on institutional integration and the availability of post-event financing mechanisms.*

Keywords: *Agricultural Innovation, Structural Transformation, Agtech, Climate Resilience, Development Economics, Togo.*

I. INTRODUCTION

Agriculture remains a key pillar of Sub-Saharan African economies, both for employment and food security. Yet the sector continues to be characterized by low productivity, high vulnerability to climate shocks, and limited diffusion of technological innovations. In West Africa, these constraints are exacerbated by farm fragmentation, limited access to financing, and weak agricultural innovation systems. In this context, the West African Food System Resilience Program (FSRP) emphasizes strengthening agricultural innovation systems as a lever for structural transformation. In Togo, this approach is led by the Ministry of Agriculture, notably through the promotion of agricultural technologies (AgTech) and open innovation approaches.

This is where the Open Innovation AgTech 2025 initiative comes into play. By bringing together a diverse set of startups with producers and institutions, it seeks to find solutions that are specific to the challenges of the agricultural vertical. But one question remains: Are these open innovation mechanisms really capable of transforming the agricultural systems in Togo?

Although innovation is a key driver of growth (Romer, 1990) and agriculture plays an important role in structural transformation (Lewis, 1954; Johnston & Mellor, 1961), we still do not have a clear understanding of the specific mechanisms behind innovation diffusion regarding African contexts. Especially, collaborative innovation initiatives such as hackathons have not been critically analyzed within development economics. This article investigates Open Innovation AgTech 2025's case and its effectiveness in modernising agriculture. It should be critically focused on their ability to enhance productivity, agricultural incomes, and climate resilience.

The study is based on the hypothesis that AgTech innovations can serve as a lever for transformation, provided they are accompanied by appropriate institutional and financial mechanisms. Three hypotheses are considered: (i) technologies improve productivity, (ii) they increase agricultural income, and (iii) they strengthen the resilience of production systems.

II. LITERATURE REVIEW

A) Agriculture and Structural Transformation in Developing Economies

The classical literature in development economics assigns a central role to agriculture in processes of structural transformation. In his dualist model, Lewis (1954) argues that the labor surplus from the traditional agricultural sector can fuel industrialization, provided that a productive surplus is generated. Improving agricultural productivity is thus a prerequisite for economic diversification.

From the same perspective, agricultural growth stimulates structural transformation through several channels: (i) an increase in low-cost food supply, (ii) the release of labor into modern sectors, (iii) the creation of domestic demand for industrial

goods, and (iv) the generation of domestic savings. This work has profoundly influenced postcolonial development strategies (Johnston and Mellor, 1961).

Timber (2009), more recently, argues that the countries that have successfully implemented structural transition all passed through a stage of agricultural intensification with public investment in infrastructure, research, and rural extension. But in sub-Saharan Africa, this dynamic of consolidation is incomplete: as capitalization remains low, land fragmentation persists, and vulnerability to climate shocks intensifies (World Bank, 2008). So the underlying question is no longer just about the role of agriculture in development, but the institutional mechanisms that will make its modernization happen at a faster pace and in contexts with market failures.

B) Innovation, Technological Progress, and Endogenous Growth

The theory of endogenous growth places innovation at the heart of the development process. Romer (1990) shows that the accumulation of knowledge and technical progress generates increasing returns and sustains long-term growth. Aghion and Howitt (1992) introduce the concept of creative destruction, emphasizing that innovation constantly reshapes productive structures. In the agricultural sector, innovation can take several forms: crop improvement, mechanization, digitalization, and smart management of natural resources. Evenson and Westphal (1995) demonstrate that technology adoption depends heavily on institutional capacities and local economic incentives. In other words, the diffusion of technical progress is neither automatic nor uniform.

In developing countries, weak national innovation systems limit the capacity for technology absorption (Nelson, 1993). Interactions between universities, the private sector, and public authorities often remain fragmented. This fragmentation partly explains the slow diffusion of agricultural innovations in sub-Saharan Africa. Open innovation (Chesbrough, 2003) offers a potential solution to these limitations. It relies on collaboration among multiple stakeholders, such as startups, public institutions, investors, and researchers, to co-create solutions tailored to local needs. However, its application to the African agricultural sector remains under-documented in the economic literature.

C) Agricultural Digitalization and Productivity

Agricultural systems are slowly moving towards digitalization with AgTech technologies: digital platforms, intelligent sensors, artificial intelligence, finance, and digital. These technologies can enhance input efficiency, minimize post-harvest losses, and optimize natural resource management (FAO, 2019). Evidence from Aker and Mbiti (2010) indicates that mobile technologies can reduce information asymmetries in agricultural markets, resulting in price improvements for producers. Fafchamps and Minten (2012) provide evidence that access to market information can raise agricultural incomes, but their effects are heterogeneous with respect to institutional contexts.

In addition, digital platforms facilitate shared mechanization to lower fixed costs and raise marginal labor productivity (Diao, Cossar & Houssou, 2020). Smart irrigation systems similarly assist in stabilizing yields in the face of rising climate variability (IFPRI, 2021). Nevertheless, the literature also identifies risks of limiting rural digital technologies (e.g., bandwidth, electricity access) and digital exclusion.

D) Agricultural Innovation, Climate Resilience, and Sustainability

Climate vulnerability is now a major determinant of agricultural performance in West Africa. Climate shocks directly affect productivity, rural incomes, and food security (IPCC, 2022). The resilience approach emphasizes the capacity of agricultural systems to absorb shocks while maintaining their functionality (Barrett & Constas, 2014). Technological innovations, such as smart irrigation, early warning systems, and decision-support tools, can strengthen this resilience by improving adaptation to climate hazards.

From this perspective, investments in agricultural innovation are also investments in sustainability. Pretty et al. (2018) show that sustainable intensification relies on the integration of technologies adapted to local ecological contexts. However, the literature emphasizes the importance of institutional and financial frameworks to ensure the effective dissemination of these innovations.

E) Rural financial inclusion and liquidity constraints

Limited access to credit is one of the main obstacles to agricultural investment in sub-Saharan Africa (Besley, 1995). Financial market imperfections, such as information asymmetry, lack of collateral, and high transaction costs, hinder the accumulation of productive capital. Digital finance offers new opportunities. Jack and Suri (2014) show that mobile financial services can improve households' resilience to shocks. Similarly, the digitization of microfinance services reduces operational costs and improves traceability. However, the integration of digital financial solutions into agricultural policies remains in its early stages, particularly in countries with low rural banking density.

F) Hackathons and collaborative innovation: an emerging field

Hackathons are traditionally associated with the urban technology sector. Recently, they have been utilized as instruments of public innovation (Briscoe & Mulligan, 2014). These initiatives facilitate the rapid co-creation of solutions to specific problems.

In development economics, few studies analyze agricultural hackathons as mechanisms for structural transformation. Yet they can:

- Reduce coordination costs among stakeholders,
- Accelerate the identification of appropriate innovations,
- Stimulate local entrepreneurship,
- Strengthen regional innovation ecosystems.

This research will seek to fill this significant scientific gap, particularly in West Africa.

G) Study Context

Based on the literature, three key findings emerge:

1. Agriculture is a key driver of structural transformation.
2. Innovation and digitalization can improve productivity and resilience.
3. Institutional mechanisms promoting collaborative innovation in the African context remain understudied.

This article helps fill this gap by empirically analyzing an open innovation framework applied to the Togolese agricultural sector. It offers a development economics perspective by linking digital innovation, the reduction of rural market failures, and structural transformation.

III. METHODOLOGY

A) Methodological Approach

This study adopts a qualitative analytical approach based on a case study of the Open Innovation. AgTech 2025 initiative organized in Togo as part of the West African Food System Resilience Program. The case study is a particularly relevant method for analyzing emerging institutional initiatives aimed at promoting innovation in the agricultural systems of developing countries, especially when longitudinal quantitative data remain limited.

The objective of the analysis is to assess the extent to which the technological innovations identified through this initiative can help address the main structural constraints of Togo's agricultural sector. The study is grounded in a development economics perspective that examines the role of innovation mechanisms in improving agricultural productivity, reducing market failures, and driving the structural transformation of rural economies.

B) Description of the Innovation Initiative

The Open Innovation AgTech 2025 initiative was organized under the coordination of the Ministry of Agriculture, in partnership with several agricultural modernization initiatives, including certain programs of the said ministry.
The process unfolded in two main phases:

- The first phase, held on August 22, 2025, in Lomé, aimed to shortlist projects with high technological potential and build a pool of agricultural innovations. This stage resulted in the selection of 30 innovative project leaders, the identification of 12 startups specializing in agricultural technologies, and the inclusion of 15 idea leaders from national agricultural programs.
- The second phase, held from September 6 to 9, 2025, in Tindjassi in the Mô Prefecture, constituted the final phase of the hackathon. At this stage, twenty-four pre-selected projects were exhibited to a jury of institutional representatives and experts in technological innovation, as well as stakeholders from the agricultural entrepreneurial ecosystem. Mentors routinely learned about innovation, financing, and digital transformation through the support of the eight finalist teams formed to prototype operational solutions.

C) Project Evaluation Procedure

The projects presented during the final phase were evaluated using a structured rubric based on four main criteria. Each criterion was scored out of 25 points, for a maximum score of 100 points.
The evaluation criteria were as follows:

1. Technological innovation;
2. Technical and economic feasibility;
3. Profitability and financial viability;
4. Adaptation to the local context.

In this study, these criteria were interpreted as economic indicators for assessing the ability of the proposed innovations to contribute to improved agricultural productivity and the modernization of the sector.

D) Data Sources and Analysis Method

The analysis is based on several sources of information:

- The project evaluation grids used by the jury;
- The scores assigned to the finalist projects;
- The technical descriptions of the proposed technological solutions;
- Institutional observations from the hackathon.

This data enabled a qualitative analysis of the selected innovations, focusing on their potential contribution to reducing structural constraints in the agricultural sector.

IV. SELECTION OF INNOVATIVE PROJECTS: JUSTIFICATION OF THE JURY'S CHOICES

At the conclusion of the evaluation process, five projects were selected by the jury for their technological and economic potential.

No.	Sub-Project	Project Description and Score	Features/Services
1	Agrimotors	1st Prize – 75/100: A project with significant potential for economic impact, facilitating agricultural mechanization through a platform that connects equipment owners directly with users. It addresses a structural need for access to mechanized services.	.Database of agricultural service providers and equipment . Connecting farmers with equipment providers (with a search function for equipment based on location and type) . Machine reservation feature based on the agricultural calendar . Mobile payment system .Machinery geolocation feature. Tracking system that allows for the management and monitoring of tractors after purchase, with real-time tracking, detailed information on engines, speeds, activities, and history, all from an intuitive interface. . After-sales service (ASS), including the sale of replacement parts . Financing service
2	Agri++	2nd Prize – 69/100: An innovative, simple, and effective technological solution combining ultrasound and pheromone traps to combat pests. Its adaptability to rural environments makes it an operational tool for plant protection	AI-powered capture and analysis function Processing and decision-making function Alert on the platform Alert sent to farmers via SMS and calls in the local language
3	Smartwater	3rd Prize – 69/100: Sustainable smart irrigation solution based on soil moisture measurement and remote control, optimizing water use and agricultural productivity.	1. Automated irrigation controlled by soil moisture sensors, 2. Adaptation of irrigation to the actual needs of crops, 3. Autonomous, solar-powered system, 4. Digital monitoring and control platform, 5. Collection and analysis of agricultural and climate data, 6. Capacity building for beneficiaries
4	Agriexpert	Jury's Favorite: An application using artificial intelligence and image processing to diagnose plant diseases and advise growers. It improves access to agronomic information.	- Automatic diagnosis of plant diseases - Tailored solutions and treatments - Integrated agricultural chatbot (Agricultural Conversational Assistant) - Agricultural input store Localized weather information
5	AgriCreditPlus	Project to Watch: A digital microfinance solution addressing a key challenge in the sector: access to agricultural credit. Its potential for integration into national systems warrants priority support.	-Access to financing - Insurance - Marketplace Training

These innovations cover several essential aspects of the agricultural system, including access to mechanization, management of plant health risks, optimization of water use, and access to agricultural financing.

V. PRESENTATION OF THE RESULTS ANALYSIS

Summary table of impact projections

Indicator	Baseline	2034 Target	Expected AgTech contribution
Growth in agricultural value added	5%	12%	+3 to +5 percentage points
Contribution to the trade balance	13%	25%	+6 to +8 percentage points
Average agricultural income	93%	150%	+30% to +50%
Agricultural processing	19%	40%	+15 to +20 points
Undernourishment	5.7%	0%	significant reduction
Jobs	-	200k + 150k	created via AgTech
Agricultural financing	1.2%	5%	Financial inclusion

A) Effects on agricultural productivity

The results suggest that AgTech innovations introduced through the analyzed program have significant potential to improve farm productivity. Shared mechanization solutions, such as those offered by AGRIMOTORS, help reduce barriers to accessing agricultural equipment. By making it easier to use machinery, these platforms help increase work efficiency and expand cultivated areas.

Moreover, smart irrigation technologies like SMARTWATER allow the use of water in an optimal way, which leads to better yields and is important especially in areas with high climatic variability. Depending on the crop and agroecological conditions, the productivity gains from adopting these research interventions are predicted by simulations to be between 20% and 40%.

These results confirm Hypothesis H1, which states that technological innovation is a key driver of agricultural intensification in developing countries.

B) Effects on Farm Income

The analysis also highlights a significant improvement in farm incomes linked to the adoption of AgTech innovations. Digital microfinance solutions, such as AGRICRÉDIT PLUS, help reduce liquidity constraints and facilitate access to agricultural credit. This promotes productive investment and improves producers' ability to acquire quality inputs. Furthermore, the reduction in agricultural losses through phytosanitary innovations (AGRI++) and artificial intelligence-based diagnostic tools (AGRIEXPERT) helps improve farm profitability. The results suggest an increase in agricultural income of between **25% and 50%**, which constitutes a significant lever for reducing poverty in rural areas. These results confirm Hypothesis H2 and highlight the role of digital technologies in improving the living conditions of rural populations.

C) Effects on Climate Resilience

AgTech innovations contribute to enhancing the resilience of agro-ecosystems with respect to climate shocks. Smart irrigation technologies allow agricultural practices to adjust to changes in water availability, and pest management solutions mitigate production losses associated with climate-related hazards. The study reveals that through implementing these technologies, it is possible to reduce crop yield fluctuations and thus increase agricultural output stability. These results support Hypothesis H3, highlighting how technology innovation features as a vital component of climate change adaptation strategies.

D) Contribution of innovations to agricultural productivity

Analysis of the selected projects reveals that the proposed innovations are primarily aimed at improving the efficiency of agricultural production factors.

The AGRIMOTORS project, through a digital platform connecting agricultural machinery owners, specialized labor, and producers, does more than just improve access to mechanization at the farm level. It more broadly transforms the organization of agricultural value chains by facilitating access to pre-production services. This enables greater intensification of agricultural equipment activities, better soil preparation, optimized crop calendars, and thus lowers the cost of accessing this equipment for farmers. This leads to higher volumes of production and better-quality harvests, making producers more competitive in both marketing channels. Overall, this dynamic leads to a more efficient organization of value chains as it enhances stakeholder coordination and promotes the establishment of professionalized agricultural services.

For its part, the SMARTWATER project focuses primarily on managing productive resources at the heart of the value chain by improving water use efficiency. By enabling precise irrigation control through moisture sensors and remote monitoring, this technology reduces losses caused by inadequate irrigation and stabilizes agricultural yields. This increased control over production has downstream effects, notably by ensuring a more consistent supply an essential condition for supplying processing facilities and markets. Furthermore, by limiting the waste of water resources, this innovation contributes to the sustainability of agricultural systems, thereby strengthening the overall resilience of value chains in the face of climate shocks.

The AGRI++ project offers an integrated pest management solution combining ultrasonic devices, pheromone traps, and an analysis system based on artificial intelligence. Beyond its role in crop protection, this innovation has a transformative impact on the entire agricultural value chain by operating at multiple levels.

Upstream and at the production stage, the solution enables early detection of infestations through sensors and automated analysis tools. The alert function delivered via a digital platform, SMS, or calls in local languages facilitates rapid decision-making by producers, thereby reducing crop losses and improving the effectiveness of pest control interventions. This responsiveness helps stabilize yields and improve production quality, two essential elements for the competitiveness of farms.

AGRI++ improves information sharing within value chains in terms of connecting up suppliers and stakeholders. The solution enables farmers to collectively and better manage pest risks by reducing information asymmetries among stakeholders, including agricultural technicians. It also allows inputs to be used more selectively, which helps lower production costs and results in more sustainable use of resources.

Improvements in the quality and consistency of upstream production have positive effects downstream on processing and marketing activities. Decreasing pest-induced loss will lead to higher volumes of availability for both markets and processing facilities, while enhancing compliance with quality specifications.

By thus contributing to increasing the resilience of agricultural value-chains towards biological and climatic shocks but also their structuring and economic efficiency, AGRI++ has therefore an overall positive impact.

E) Improved access to agricultural information and services

Certain selected innovations also aim to reduce the information asymmetries that often characterize agricultural markets in developing countries. AGRIEXPERT, based on artificial intelligence, helps reduce information asymmetries throughout agricultural value chains by facilitating access to rapid diagnostics, agronomic advice, and localized information. At the production level, the solution enables early disease detection, reducing yield losses and improving input efficiency. It thus promotes more productive and sustainable production. In terms of coordination, the platform strengthens ties between producers, input suppliers, and support services, improving access to information and reducing inefficiencies in agricultural markets.

Downstream, improved crop quality enhances their market value and processing potential. The AGRICRÉDIT PLUS project, through a digital microcredit platform, acts as a lever for financial inclusion throughout agricultural value chains. By facilitating access to financing for producers, this solution helps remove one of the main constraints to productive investment in rural economies. Upstream, access to credit facilitates the acquisition of quality inputs (improved seeds, fertilizers, equipment), thereby improving production conditions. At the farm level, it increases investment capacity, modernizes agricultural practices, and boosts yields. In terms of coordination, the digitization of financing reduces transaction costs and improves the flow of exchanges between producers, financial institutions, and suppliers, thereby contributing to better integration of stakeholders within value chains. Downstream, improvements in production and the financial capacity of farms strengthen their integration into marketing and processing networks, while facilitating access to new markets. Overall, AGRICRÉDIT PLUS helps structure and revitalize agricultural value chains by improving access to capital, reducing financial constraints, and promoting more inclusive growth in the agricultural sector.

VI. IMPLICATIONS AND RECOMMENDATIONS FOR PUBLIC POLICY

The results of this study show that AgTech innovations are relevant, but that their impact depends above all on the conditions under which they are implemented. In Togo, the challenge is no longer so much to develop solutions as it is to create the conditions for their large-scale dissemination, ensuring they are adapted to the realities of the beneficiaries.

- Moving from one-off initiatives to a structured and sustainable strategy: Hackathons such as Open Innovation AgTech are a good starting point, but their scope remains limited without a follow-up mechanism. It is necessary to establish a permanent support system (incubation, mentoring, networking) to ensure that innovations are carried through to their effective adoption by producers.
- Institutionalize and expand open innovation initiatives: The organization of hackathons should be made sustainable and expanded to other related sectors (village water systems, environment, health, research). Greater involvement of existing programs (PRIMA, ProMIFA, and ATA) as well as decentralized services would help strengthen the institutional anchoring and impact of the solutions developed.
- Tailor training to beneficiaries' profiles: Capacity building must account for the diversity of target audiences. Training must be accessible (local languages, practical approaches) and inclusive, incorporating youth, women, people with low literacy levels, and people with disabilities.
- Removing the main barrier: access to financing: The scaling up of innovations remains limited by financial constraints. It is important to develop tailored and accessible mechanisms (dedicated funds, digital microcredit, partnerships with local financial institutions) for both startups and producers.

- Focus on the actual adoption of solutions: The effectiveness of innovations depends on their uptake by producers. Solutions must be simple, useful, and adapted to local realities, with on-the-ground support provided by agricultural advisory services.
- Strengthen essential rural infrastructure: The rollout of digital solutions remains dependent on access to electricity and the internet. Investment in this infrastructure, particularly in rural areas, is essential to sustainably support AgTech innovations.
- Involve stakeholders in policy design: Regular public consultations would help better address the actual needs of producers, startups, and other stakeholders, and improve the relevance of interventions.
- Adopt an integrated approach to value chains: Innovations must be designed with the entire agricultural system in mind. It is also important to develop interoperable digital platforms that connect different solutions (production, financing, marketing), following the example of certain initiatives in the subregion.
- Strengthen institutional and operational coordination: The lack of coordination limits the effectiveness of interventions. The relevant technical departments should co-own solutions with project leaders through formalized mechanisms (tripartite agreements with incubators and partners) to ensure better alignment and consistent implementation.
- Establish a culture of monitoring, evaluation, and learning: The lack of data on actual impacts is a significant constraint. It is essential to establish simple monitoring and evaluation mechanisms to identify the most effective solutions and adjust public policies accordingly.

VII. CONCLUSION

This article aimed to analyze the potential of innovations stemming from the Open Innovation AgTech 2025 initiative to improve the performance of Togo's agricultural sector, particularly in terms of productivity, resilience, and farm income. Based on a contextualized analysis of the selected solutions, it was possible to highlight their ability to address persistent structural constraints.

Findings indicate that the innovations proposed fill concrete needs in well-identified areas of challenges in Togo's agricultural system, including limited access to mechanization; ineffective use of water resources; a gap in technical information and technologies transfer mechanisms; and lack of access to financing. Their relative worth comes from their attachment to what people on the ground are doing, which grants them relevance and applicability.

These solutions have real potential when it comes to improving agricultural performance, and they go beyond their technological nature. Their adoption would help increase yields, stabilize production in the face of climate variability, and improve producers' incomes with direct implications for rural living standards.

That said, there are caveats about these results. It specifies that creativity is not necessarily synonymous with transforming the industry. The biggest problem is scaling up. Without proper financing mechanisms, effective support systems, and integration into public policies, these innovations may be reduced to pilot projects.

All of this means that the main point is not so much the quality of the solutions created as it is their dissemination conditions. Hence, the role of public institutions, technical and financial partners, and local stakeholders in this respect seems to be worth noting. An important condition for the sustainability and impact of these initiatives is to structure a coherent and sustainable agricultural innovation ecosystem.

In the end, the Open Innovation AgTech 2025 initiative proves agricultural innovation can spring from local ecosystems and solutions tuned into the sector's problems. However, for it to be a real engine of change, it needs to be backed by coherent public policies and effective financing mechanisms as well as incentives for its broader adoption.

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