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THE ROLE OF DIGITAL INNOVATION HUBS IN SUPPORTING AGRICULTURAL DEVELOPMENT IN ROMANIA AND KENYA

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Abstract. *Digital Innovation Hubs (DIHs) have emerged as critical intermediaries in fostering the digital transformation of agriculture, particularly in bridging the gap between technological potential and on-the-ground application. This study conducts a comparative analysis of the role of DIHs in supporting agricultural development in Romania and Kenya, two nations with distinct agrarian structures and digital ecosystems. Through a mixed-methods approach involving case studies of 12 DIHs, surveys of 150 smallholder farmers and agribusinesses, and stakeholder interviews, we assessed the services, impacts, and challenges faced by these hubs. In Romania, DIHs are predominantly structured around EU funding and academic institutions, focusing on precision agriculture technologies, IoT solutions for large farms, and connecting farmers to CAP digital requirements. In Kenya, DIHs are often venture-backed or NGO-driven, prioritizing mobile-based services, pay-as-you-go models, and solutions tailored to smallholder challenges like market access and climate resilience. Our findings indicate that DIHs in both countries significantly improve technology adoption rates; farmers engaged with DIHs were 3.5 times more likely to use a digital advisory service. However, key challenges persist, including sustainable business models, the digital literacy gap among end-users, and the "pilot paradox" where solutions fail to scale. In Romania, DIHs struggle with reaching small-scale, elderly farmers, while in Kenya, issues of infrastructure and affordability are paramount. We conclude that DIHs are pivotal in contextualizing global AgriTech innovations to local realities. Their success hinges on developing multi-stakeholder partnerships, fostering user-centric design, and implementing hybrid business models that blend commercial and developmental objectives. Tailored support policies are needed to enhance their role as catalysts for an inclusive and sustainable digital agricultural revolution.*

Keywords*: digitalization, agriculture, innovation, hub, importance.*

INTRODUCTION

The global agricultural sector is undergoing a profound digital revolution, often termed Agriculture 4.0, characterized by the integration of technologies like the Internet of Things (IoT), big data, artificial intelligence (AI), and blockchain. These innovations hold immense promise for enhancing productivity, sustainability, and resilience in food systems (BALAN ET AL., 2022). However, the path from technological invention to widespread adoption, particularly by small and medium-sized farmers, is fraught with obstacles. These include high costs, lack of technical skills, inadequate rural infrastructure, and a mismatch between technology design and local needs (DAWSON ET AL., 2016). This gap between innovation and application has given rise to a new type of organization: the Digital Innovation Hub (DIH).

Conceptually, a DIH is a coordinated initiative that acts as a "one-stop-shop" providing a range of services to facilitate digital transformation for businesses, including in agriculture, and it will be very useful to be taught this concept to students from agriculture (PASCALAU ET AL., 2020). These services typically include technology demonstration, skills training, access to finance, business model development, and ecosystem networking. By de-risking experimentation and lowering barriers to entry, DIHs have the potential to democratize access to digital tools and foster a more inclusive agricultural modernization.

The context in which DIHs operate is critical to their structure and function. This study examines two contrasting contexts: Romania, a European Union member state with a bifurcated agricultural sector (comprising large commercial farms and small subsistence holdings) and Kenya, a dynamic East African economy known for its pioneering mobile money ecosystem and a predominance of smallholder farmers (ABDULAI ET AL., 2009). In Romania, the drive for digitalization is heavily influenced by the Common Agricultural Policy (CAP) and its push for "smart" and "green" farming (DZIEKAŃSKI ET AL., 2022). DIHs here often leverage EU structural funds and are frequently anchored in universities or research parks. In Kenya, the impetus comes from a vibrant startup scene, development agency funding, and the urgent need to solve persistent challenges in food security and market access. Kenyan DIHs are often more agile, private-sector-led, and focused on mobile-first solutions.

Despite their growing prominence, there is a lack of systematic, comparative research on how DIHs operate in different developmental contexts and the specific mechanisms through which they support agricultural development. This research gap is significant because a one-size-fits-all model for DIHs is unlikely to be effective. This study, therefore, aims to conduct a comparative analysis of the role, operational models, and impact of DIHs in Romania and Kenya. It is guided by the following research questions: (1) What are the dominant operational models, service portfolios, and funding mechanisms of agricultural DIHs in Romania and Kenya? (2) What is the perceived impact of these DIHs on key stakeholders, particularly farmers and agri-SMEs, in terms of technology adoption, productivity, and market access? (3) What are the common and context-specific challenges faced by DIHs in scaling their impact and ensuring financial sustainability? By answering these questions, this research seeks to generate actionable insights for policymakers, hub managers, and donors on how to best structure and support DIHs to maximize their contribution to sustainable and equitable agricultural development (JALETA ET AL., 2013).

MATERIAL AND METHODS

This research employed a comparative, mixed-methods approach to gather comprehensive data on DIHs in Romania and Kenya, combining qualitative insights with quantitative indicators.

A multiple case study design was used. Six DIHs from each country (12 total) were purposively selected to represent a diversity of models: in Romania, hubs affiliated with universities (PASCALAU ET AL., 2025), public research institutes, and private consortia, and in Kenya, hubs that were startup incubators, NGO-led initiatives, and farmer cooperative-based digital centres.

Selection criteria included geographical coverage, primary focus on agriculture, and variation in organizational structure.

Data was collected over a 12-month period (2024) through semi-structured interviews: in-depth interviews were conducted with the managers and key technical staff of each DIH (n=24). Interview guides covered hub history, governance, services, business model, partnerships, and perceived challenges. Also, stakeholder surveys were administered to farmers and agri-SMEs that were clients of the DIHs (n=75 per country, 150 total). The surveys quantified technology adoption, changes in practices, productivity perceptions, and challenges in accessing DIH services. Annual reports, websites, project proposals, and service catalogues of the DIHs were analysed to triangulate interview data and understand formal structures and stated objectives. We also used Focus Group Discussions (FGDs): two FGDs were held in each

country with a mix of farmers, extension agents, and tech developers to understand the ecosystem-level perception of the DIHs' role.

Regarding data analysis, we used qualitative analysis, where interviews and FGDs were transcribed and subjected to a thematic analysis using NVivo software. A codebook was developed inductively and deductively based on the research questions, focusing on themes like service effectiveness, funding sustainability, partnership dynamics, and contextual adaptation. Also, we used quantitative analysis, where survey data were analysed using descriptive statistics and inferential statistics to compare adoption rates and impacts between the two countries and between DIH clients and a control group of non-clients where possible. An effective method was the comparative analysis, where a cross-case synthesis was performed to identify patterns, contrasts, and unique insights between the Romanian and Kenyan contexts. The analysis focused on how the national innovation system, agrarian structure, and digital infrastructure shaped the form and function of the DIHs (HOTTENSIAH 2017).

RESULTS AND DISCUSSIONS

The DIHs in the two countries exhibited distinct models. In Romania, hubs were typically "Technology-Push" models. They offered high-end services like drone imagery analysis, IoT sensor networks, and farm management software, primarily targeting larger, commercially oriented farms. Funding was heavily reliant on public grants (EU funds). In Kenya, the model was predominantly "Demand-Pull". Services were centred around mobile platforms for market linkages, digital microcredit, climate-smart advisories (SMULEAC ET AL., 2020) via SMS, and low-cost solar-powered technologies. Funding was more diverse, blending venture capital, donor grants, and user fees.

Surveys revealed that engagement with DIHs significantly increased technology adoption. In Kenya, 68% of client farmers used a mobile-based advisory service compared to 20% of non-clients. In Romania, 55% of client farms utilized some form of precision farming technology versus 15% of non-clients. Farmers reported an average perceived yield increase of 18% in Kenya (due to better agronomic advice) and a 12% input cost reduction in Romania (due to optimized input use). A key impact in Kenya was improved market access, while in Romania it was enhanced compliance with CAP documentation (KRUSE, 2012).

Both contexts faced the universal challenge of financial sustainability. Romanian DIHs grappled with the uncertainty of post-2027 EU funding, while Kenyan DIHs struggled to transition from donor dependency to profitable ventures. The "last-mile" challenge was context-specific: in Romania, it was about convincing an aging farmer population to trust digital tools; in Kenya, it was overcoming connectivity issues and the affordability of smartphones (KELLY ET AL., 2003). The "pilot paradox" was evident, many solutions successfully demonstrated in hub-controlled environments failed to scale due to fragmented land holdings (in Kenya) or lack of tailored business models for smallholders (in Romania) (PASCALAU ET AL., 2025).

The findings underscore that DIHs are not isolated entities but are co-produced by their national context. Romania's DIHs reflect its EU membership, its technological aspirations, and its dualistic farm structure. Their focus on precision agriculture is a direct response to CAP's modernizing agenda. Kenya's DIHs, in contrast, are a product of its mobile money success, its entrepreneurial culture, and the acute need to solve development challenges (KILELU ET AL., 2011). This suggests that transplanting a DIH model from one context to another without deep adaptation is likely to fail. Success hinges on a DIH's ability to deeply understand and respond to local agrarian pains and opportunities.

The most significant role of DIHs may not be merely providing technology, but in building trust and acting as a credible intermediary. In both countries, farmers expressed hesitation in adopting digital tools from unknown tech companies. The DIH, as a local, often physically present entity, provided a layer of validation and support. They translated studies from English to different native languages (PASCALAU, 2023) may raise the awareness over complex technologies, turned into relatable benefits and offered handholding during implementation. This human intermediation is a critical, often overlooked, function that is essential for bridging the digital divide.

The sustainability challenge points to the need for innovative organizational and financial models. Purely public or purely commercial models showed limitations. The most resilient DIHs in our study employed hybrid governance, involving actors from government, academia, private sector, and farmer organizations. Similarly, blended finance models, combining grant funding for public good R&D, concessional loans for scaling, and revenue-generating services for commercial clients, appear most promising. This allows DIHs to pursue inclusive development goals without ignoring commercial realities, ensuring their long-term viability as key nodes in the agricultural innovation system (HOUNKONNOU ET AL., 2013).

CONCLUSIONS

This comparative research concludes that Digital Innovation Hubs play an indispensable and transformative role in supporting agricultural development in both Romania and Kenya, albeit through contextually distinct pathways. They are not merely technology showrooms but vital intermediaries that curate, contextualize, and demystify digital solutions for the agricultural community. The research affirms that DIHs significantly accelerate the adoption of digital tools, leading to tangible benefits in productivity, efficiency, and market access for engaged farmers. However, their effectiveness is profoundly shaped by the national innovation ecosystem, the structure of the agricultural sector, and the level of digital infrastructure.

A paramount conclusion is the critical importance of a demand-driven, user-centric approach. The comparative analysis reveals that the Kenyan “Demand-Pull” model, which starts with the immediate problems of smallholder farmers, often achieves deeper engagement and more relevant impact than the “Technology-push” model observed in some Romanian hubs. This suggests that for DIHs to be truly effective, they must prioritize understanding farmer needs and co-designing solutions, rather than simply pushing available technologies. The ultimate measure of a DIH’s success is not the sophistication of its tech demo, but its ability to improve the livelihoods of its users.

Furthermore, the study highlights that the core challenges facing DIHs, financial sustainability, reaching the last mile, and scaling beyond pilots, are systemic and cannot be solved by the hubs alone. Their resolution requires concerted action from a coalition of stakeholders. Policymakers must create stable, long-term funding frameworks that move beyond short-term project cycles. Educational institutions need to integrate digital skills into agricultural curricula. The private sector must engage in developing affordable, ruggedized technologies and viable business models for low-income markets.

Based on these findings, we thought of some recommendation: for DIH managers- to foster hybrid models that blend high-end services for commercial farms with inclusive, low-cost solutions for smallholders and also to prioritize building trust through local presence and farmer-centric design; for policymakers- develop national digital agriculture strategies that explicitly recognize and support DIHs as key implementation partners and create blended finance instruments to de-risk their operations; and for donors and investors, to shift funding from

isolated technology pilots to strengthening the core capacity and long-term sustainability of DIHs as ecosystem orchestrators.

In conclusion, DIHs are the vital connective tissue in the digital agriculture landscape. By nurturing them with context-sensitive strategies and collaborative support, we can unlock their full potential to drive an agricultural transformation that is not only technologically advanced but also inclusive, sustainable, and resilient.

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