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Governing digital innovation in livestock systems: institutional gaps and coordination challenges in Benin

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Digital technologies offer transformative potential for livestock systems by enhancing productivity, resource efficiency, and market access. However, institutional and governance challenges often constrain the adoption of such innovations. This study explores how national policies, legal frameworks, and actor configurations influence the development and use of digital tools in Benin's livestock sector. A qualitative exploratory design was adopted using Ostrom's Institutional Analysis and Development (IAD) framework. Data were collected through documentary analysis of key legal instruments and strategic plans and unstructured interviews with a diverse group of stakeholders, including public officials, farmer organizations, NGOs, and agri-tech startups. Thematic coding and triangulation were used to analyze how institutional arrangements influence digital innovation in livestock systems. While Benin has established digital and agricultural policies, they lack specificity for livestock systems. Regulatory voids, fragmented governance, and unclear data protection frameworks undermine stakeholder trust and coordination. Stakeholders operate under divergent logics—bureaucratic, commercial, and advocacy-driven—resulting in isolated pilot projects that are unable to scale or integrate into national systems. Institutional exclusion of farmer voices further limits the relevance and uptake of digital tools. The study highlights that without coherent regulatory frameworks, coordinated governance platforms, and inclusive stakeholder participation, digital innovations in livestock systems are unlikely to achieve systemic impact. Effective digital transformation requires sector-specific policy development, multi-stakeholder engagement, and integration of digital services into extension systems. These institutional reforms are essential for realizing digital agriculture's potential in supporting resilient and equitable livestock livelihoods.

KEYWORDS

livestock system, digital innovation, institutional analysis, policy coherence, Benin

Introduction

Agriculture is changing as a result of digital technologies increased sustainability, efficiency, and productivity. Innovations like automated monitoring systems, mobile advisory tools, and remote sensing have emerged as crucial instruments for agricultural production management in recent years (Gouroubera et al., 2024; Jarial and Sachan, 2021; Klerkx et al., 2019). Digital solutions in the livestock industry can lower environmental effects, improve animal health, and streamline farm operations (Guzaliya et al., 2022; Leong et al., 2024). According to Finger (2023), these technologies can boost productivity and lower expenses by improving resource management (Kumar et al., 2023), and enhance market accessibility (Bahn et al., 2021). By lowering greenhouse gas emissions, they also help achieve environmental goals (Wang et al., 2024), enhancing the use of feed and water, and aiding in the preservation of biodiversity (Garske et al., 2021).

Many farmers in sub-Saharan Africa still encounter difficulties implementing digital agriculture technologies, despite the growing interest in this field (Bashiru et al., 2024; Gouroubera et al., 2024). Poor internet access, exorbitant prices, a lack of digital skills, and a lack of faith in technology are some of the obstacles (Cui and Wang, 2023; Fragomeli et al., 2024). Adaptive tools and knowledge-based practices are more important because the region's agriculture is extremely vulnerable to climate change. In this regard, digital innovations present fresh opportunities to enhance resilience when obstacles to adoption are removed. Numerous factors have been found to influence adoption, including anticipated financial gains (Fragomeli et al., 2024), digital literacy (Lima et al., 2018), and peer pressure (Marshall et al., 2022), but these are frequently insufficient to get past systemic barriers, particularly in rural areas.

The livestock sector deserves special attention in digital transformation strategies. Livestock production is important for food security, income generation, and rural development in Africa. However, it is also highly exposed to climate risks and resource constraints. While some digital tools for animal identification, disease monitoring, and veterinary services have emerged, the livestock sector remains largely absent from national digital strategies. This limits the ability of farmers and institutions to benefit from innovations. Studying this sector can help identify the specific challenges and opportunities of digital transformation in a critical but often neglected area of agricultural development.

Digital transformation in agriculture depends not only on access to technology, but also on the institutional environment in which it takes place. The design and implementation of digital tools are influenced by policy frameworks, regulations, coordination mechanisms, and organizational practices (Rotz et al., 2019). Factors such as infrastructure development, data governance, and public-private collaboration are essential for adoption (Kok and Klerkx, 2023; Rotz et al., 2019). Political and institutional decisions shape who benefits from digital innovations and under what conditions. While institutional and political factors can facilitate digital transformation, they can also create challenges, such as unequal access to technology and the risk of exacerbating existing inequalities in the agricultural sector (Fragomeli et al., 2024; Kok and Klerkx, 2023). Addressing these issues requires a balanced approach that considers both technological advancement and social equity. To better understand these dynamics, this article examines the extent to which institutional and governance frameworks affect the development and adoption of digital innovations in the livestock sector in Benin.

Benin's livestock sector is a vital component of its agricultural economy and rural livelihoods. As of 2021, the national herd comprised approximately 2.5 million cattle (ECOWAS Commission, 2022). This sector contributes roughly 13% of agricultural GDP, equivalent to about 6% of Benin's national GDP, underscoring its economic significance (ECOWAS Commission, 2022). Livestock is also a critical source of income for rural households—over 60% of farm families engage in livestock farming, with many depending primarily on it for their livelihoods (Akouegnonhou and Demirbaş, 2021). Despite this importance, the sector faces persistent challenges, including limited productivity, degraded pastures, recurrent diseases, and underdeveloped value chains. These constraints highlight the urgency of introducing digital solutions—such as advisory tools, market platforms, and precision monitoring—to strengthen decision-making, enhance productivity, and bolster the resilience of Benin's livestock systems.

This study uses the Institutional Analysis and Development (IAD) framework to analyze the formal and informal rules that structure digital agriculture (Ostrom, 2009). The IAD approach is useful for identifying how laws, policies, and institutional practices influence interactions between actors and the outcomes of digital innovation. By applying this framework to the case of livestock in Benin, the study contributes to the growing literature on digital agriculture governance in the Global South and provides practical insights for improving institutional support for sustainable digital transformation.

Methodology

Analytical framework: institutional analysis and development (IAD)

We employ the Institutional Analysis and Development (IAD) framework developed by Ostrom (2005) to examine how institutional arrangements influence the development and adoption of digital innovations in Benin's livestock sector. The IAD framework provides a structured approach to understanding the interactions among actors, rules, and

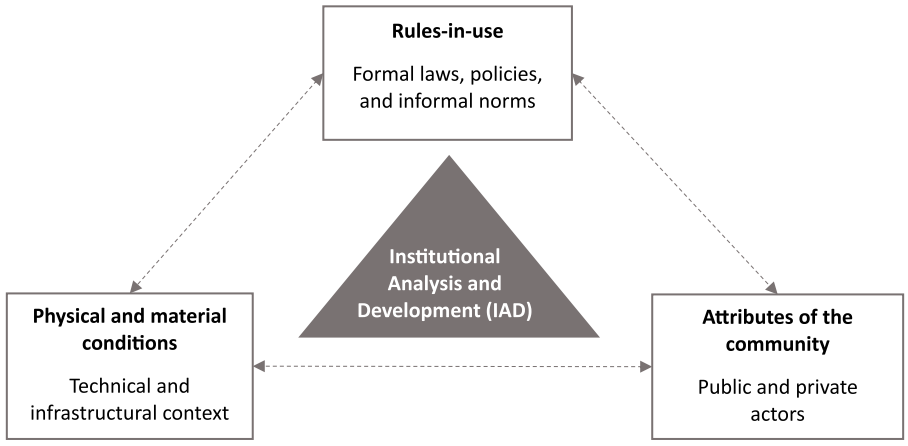

FIGURE 1
Analytical framework of assessing the governance of digital livestock. Source: Adapted from Ostrom (2009).

contextual factors within a governance system, leading to specific outcomes.

The action arena, where people and organizations interact, make decisions, and affect results, is at the heart of the IAD framework. These interactions are shaped by three main components: rules-in-use, attributes of the community, and physical and material conditions (Figure 1).

Rules-in-use encompass formal laws, policies, and informal norms that govern behavior (Montes et al., 2022; Ostrom, 2009). In this study, they include national digital strategies, legal frameworks such as the Digital Code, sectoral development plans, and regulations (or their absence) concerning data governance, tool certification, and platform coordination in agriculture and livestock. Attributes of the community refer to the characteristics of actors involved in digital agriculture, including public institutions, private companies, NGOs, farmer organizations, and donors (Montes et al., 2022; Ostrom, 2011; Raheem, 2014). These actors possess varying resources, mandates, values, and levels of influence, which shape their actions and interactions. Physical and material conditions pertain to the technical and infrastructural context in which digital innovations operate (Ostrom, 2009; 2011). This includes access to internet and mobile services, availability of digital platforms and devices, and the state of livestock farming systems (Montes et al., 2022).

The IAD framework also emphasizes the importance of outcomes and evaluation criteria, such as efficiency, equity, sustainability, and adaptability. In the context of this study, the key outcomes concern the adoption and integration of digital innovations in the livestock sector. The framework facilitates the identification of how institutional arrangements affect actors' incentives and constraints, and how these arrangements may support or hinder digital transformation.

The IAD framework has been applied in various agricultural contexts to analyze institutional dynamics (Boru et al., 2025; Ohashi et al., 2024; Téno and Cadilhon, 2017). For instance, it has been used to study the adoption of smart livestock technologies in Japanese small-farm systems, highlighting the interplay between individual farmer values, farm management policies, and social relations (Ohashi et al., 2024). In Africa, the framework has informed analyses of innovation platforms in Burkina Faso, focusing on stakeholder participation and institutional embedding in agricultural research for development (Téno and Cadilhon, 2017). Additionally, the IAD framework has been used to assess governance structures in Ethiopian integrated agro-industrial parks, emphasizing the role of stakeholder coordination and resource sharing in driving innovation (Boru et al., 2025).

This study attempts to offer a structured lens to evaluate the institutional aspects of digital agriculture by applying the IAD framework to the Benin livestock case. In order to add to the expanding body of research on digital agriculture governance in the Global South and provide useful advice for strengthening institutional support for long-term digital transformation, it looks for governance gaps, coordination issues, and possible areas for policy improvement.

Research design

This study adopts a qualitative exploratory research design to investigate how digital agriculture, particularly in the livestock sector, is integrated into Benin's legal and institutional frameworks. The research aims to understand the roles and interactions of various stakeholders in shaping the adoption and implementation of digital innovations in agriculture.

The choice of a qualitative approach is justified by the complexity of the subject matter, which involves multifaceted institutional arrangements, policy documents, and stakeholder dynamics. Such an approach allows for an in-depth exploration of the contextual factors influencing digital agriculture policies and practices (Cordella and Paletti, 2018). To capture the nuanced perspectives of key actors, the study incorporates unstructured interviews with various categories of stakeholders, including government agencies, farmer organizations, NGOs, and digital innovation projects. This method facilitates the collection of rich, qualitative data that reflects the experiences and insights of those directly involved in the digital transformation of agriculture. The use of unstructured interviews is particularly suitable for exploratory research, as it allows respondents to express their views freely and provides the flexibility to probe deeper into emerging themes.

This qualitative exploratory research design, combining document analysis and unstructured interviews within the IAD framework, offers a comprehensive approach to understanding the integration of digital agriculture into Benin's institutional landscape. It enables the identification of key factors that facilitate or hinder the adoption of digital innovations in the livestock sector, providing valuable insights for policymakers, practitioners, and researchers interested in digital governance and agricultural development.

Data sources

Documentary analysis

The core of the analysis is grounded in a comprehensive review of national-level policy and legal documents relevant to digital transformation in Benin. To identify the primary legislative texts, an exhaustive screening was conducted using the official government platform "Lois promulguées | Secrétariat général du Gouvernement du Bénin." The search focused on texts that establish legal and institutional frameworks for digital development, particularly those with potential implications for agriculture and livestock systems. Six legal instruments were selected including:

- Law No. 2017-20: Digital Code, which sets the legal foundation for digital governance;
- Decree No. 2016-684: Sector Policy Declaration for the Digital Economy, outlining strategic orientations;
- Decree No. 2023-060: Regulation on the Protection of Critical Information Infrastructure;
- Decree No. 2018-531: Governance framework for digital programs and projects;
- Decree No. 2020-492: Establishment of the School of Digital Professions;
- Decree No. 420/2016: Organizational structure of the Ministry of Digital Economy.

In addition to legal texts, the analysis incorporated three key strategic policy documents in agriculture sector, including the National Strategy for e-Agriculture (2020–2024), the Strategic Plan for Agricultural Sector Development (PSDSA), and the National Agricultural Investment and Food Security Programme (PNIASAN). These documents were selected for their relevance to the promotion of digital innovation in agriculture and their influence on national development planning.

To complement the analysis and better understand the institutional landscape, the study also reviewed institutional documents, such as organizational charts, mandates, and official reports from relevant ministries—particularly the Ministry of Digital Economy and the Ministry of Agriculture. Additionally, materials produced by key implementation agencies, notably the Agence des Systèmes d'Information et du Numérique (ASIN), were examined to assess the operationalization of digital strategies.

Documents were selected based on their relevance to one or more of the following criteria: digital governance, agricultural and livestock policy, or institutional responsibilities in digital innovation. This document-based approach provided the basis for identifying the rules-in-use and institutional structures that shape the digital transformation of the livestock sector in Benin.

From these documents, the following data were collected:

- Formal rules and regulations governing digital infrastructure, services, and platforms
- Policy orientations and strategic objectives related to agriculture and digitalization
- Institutional mandates and organizational roles in digital agriculture governance
- Gaps, inconsistencies, or overlaps between regulatory texts and strategic visions
- References (or lack thereof) to livestock-specific digital innovation or infrastructure

This documentary base provided a foundational understanding of the legal and policy environment structuring digital agriculture in Benin. From each document, we extracted information on policy objectives, institutional responsibilities, and references to digital agriculture, with particular attention to livestock-specific measures. Relevant passages were summarized and coded thematically to identify rules, actors, and governance mechanisms. This process allowed us to compare how different documents frame digital innovation and the role of livestock within broader agricultural strategies.

Unstructured interviews

To complement the desk review, twelve unstructured interviews were conducted with selected key informants across key sectors involved in digital agriculture. Interviewees included:

- Representatives from state institutions: Ministry of Agriculture, Ministry of Digital Economy, ASIN, Agence Territoriale de Développement Agricole (ATDA);
- Members of producer organizations: Fédération des Unions de Producteurs (FUPRO), local livestock cooperatives including Union Communale des Organisations Professionnelles d'Eleveurs de Ruminants (UCOPER);
- Staff from development projects and NGOs: Eclosio, ACED NGO, DigiCla project, Programme d'Appui au Secteur du Développement Rural (PASDeR)

The conversations were guided by broad themes rather than standardized questions, allowing respondents to share their perspectives in depth. The interviews explored perceptions of digital agriculture in livestock farming, existing policy and governance frameworks and their gaps, and the degree of stakeholder involvement in digital initiatives. Specific attention was given to identifying digital applications already introduced in the livestock sector, the actors who initiated them, and the challenges encountered in their implementation.

Data analysis procedures

The analysis followed a qualitative and iterative approach, structured around the components of the Institutional Analysis and Development (IAD) framework. The process involved three main phases: thematic coding, triangulation, and interpretive synthesis. Each phase contributed to identifying how institutional arrangements and actor dynamics shape the development and adoption of digital innovations in the livestock sector in Benin.

Thematic coding

All collected data—documentary and interview-based—were subjected to manual thematic coding. An initial codebook was developed based on the core elements of the IAD framework, including:

- Rules-in-use (formal regulations, informal norms, strategic policy instruments)
- Actors and community attributes (stakeholder roles, mandates, capacities, coordination)
- Physical and material conditions (infrastructure, digital tools, sectoral characteristics)
- Outcomes and constraints (adoption barriers, implementation gaps, coordination failures)

Additional inductive codes emerged during the reading of materials, especially from unstructured interviews, such as: "lack of leadership," "pilot fragmentation," "regulatory uncertainty," and "producer mistrust." This dual approach—combining deductive codes from theory and inductive codes from the field—ensured both conceptual coherence and empirical sensitivity.

From this coding process, we further clustered recurrent patterns of reasoning and justification used by actors into distinct "logics of action" (institutional, commercial, advocacy, and experimental). These logics represent the practical ways in which stakeholders mobilize rules, resources, and narratives within the IAD framework, thus linking abstract institutional arrangements to observed governance practices.

Triangulation and cross-validation

To ensure reliability and depth, findings were triangulated across data sources. Information from legal texts, policy strategies, and institutional reports was compared with stakeholder narratives collected through interviews. This triangulation helped:

- Validate the presence or absence of livestock-specific digital policies,
- Compare formally assigned mandates with actual practices,
- Identify discrepancies between policy discourse and field-level implementation,
- Capture different perspectives on coordination, leadership, and tool adoption.

Where inconsistencies appeared, additional interviews or re-analysis of documents were conducted to clarify and refine interpretations.

Synthesis and interpretation

The final stage involved synthesizing coded themes into broader analytical categories aligned with the IAD framework. Patterns were examined across stakeholder groups and institutional levels to identify structural gaps, enabling conditions, and systemic constraints.

The analysis focused particularly on:

- How rules-in-use (laws, decrees, strategies) influence or fail to influence digital livestock governance;
- How the configuration of actors affects coordination and adoption outcomes;
- What institutional or regulatory reforms are needed to support inclusive digital transformation.

The synthesized findings were then organized to inform the results sections of the article, structured around two main axes: (1) institutional frameworks and implementation gaps, and (2) actor configurations and governance mechanisms.

This approach allowed for a comprehensive understanding of the institutional environment shaping digital agriculture in Benin and provided evidence-based insights to support policy dialogue and reform efforts.

TABLE 1 Comparative analysis of digital and agricultural policy instruments in Benin: scope, sectoral fit, and regulatory gaps.

Policy or legal document	Main objectives	Sectoral specificity	Governance gaps/Overlaps	Relevant provisions or articles
Law No. 2017-20 (Digital Code)	Establish a comprehensive legal framework for digital governance, including cybersecurity, personal data protection, and electronic services	Very general. No direct reference to agriculture or livestock	No specific framework for agricultural or zootechnical data; lacks certification mechanisms for digital tools in livestock	Art. 3 (personal data); Art. 426 (sanctions for system breaches)
Decree No. 2016-684 (Digital Economy Sector Policy Declaration)	Define strategic orientations for digital transformation in Benin	General. Agriculture is listed as a priority sector but without detailed focus	No specific digital provisions for livestock value chains; potential overlaps with agricultural policies	Strategic focus on rural connectivity; no numbered articles (policy declaration)
Decree No. 2023-060 (Protection of Critical Information Infrastructure)	Strengthen the security and resilience of critical national digital infrastructures	General. Agriculture and livestock are not explicitly mentioned as critical sectors	No explicit categorization of agricultural or veterinary systems as critical infrastructure	Art. 2 (definition of critical systems); Art. 4 (operator responsibilities)
Decree No. 2018-531 (Governance of Digital Programs and Projects)	Establish coordination mechanisms for national digital programs via sectoral committees	Applicable to all sectors, including agriculture	Absence of an integrated mechanism for agricultural digital governance; overlapping responsibilities between ministries	Art. 3 (steering committee roles); Art. 5 (project approval process)
Decree No. 2020-492 (Creation of the School of Digital Professions)	Create a national institution for digital skills development	Generic. No clear linkage to agricultural or veterinary sectors	Missed opportunity to align digital training programs with agriculture-specific needs	Art. 1 (establishment of the school); Art. 4 (pedagogical organization)
Decree No. 420/2016 (Organization of the Ministry of Digital Economy)	Define the structure and responsibilities of the digital economy ministry	General. No sectoral breakdown	Potential institutional silos between digital and agricultural ministries; no dedicated agricultural digital unit	Art. 3 (ministry responsibilities); Art. 5 (organizational structure)
PSDSA 2025 (Strategic Plan for Agricultural Sector Development)	Long-term vision for agricultural development, including livestock	Directly targets agriculture and livestock; mentions modernization via digital tools	Digital integration is treated in general terms; lacks measurable targets for digital innovation	Section *Unstructured interviews* (production systems modernization); Section 3.5 (ICT promotion)
PNIASAN (National Agricultural Investment and Food Security Plan)	Guide public and private investment in agriculture, including livestock	Targets agriculture; includes livestock but limited digital components	Weak alignment between digital investment and food security objectives	Result Area 2.1 (productivity improvement through ICT)
e-Agriculture National Strategy (2020–2024)	Provide a roadmap for ICT integration in agriculture, including services and entrepreneurship	Directly targets agriculture; livestock is included as an application sub-sector	Strong strategic vision but limited institutionalization for livestock-specific tools or platforms	Axis 3 (digital services); Axis 5 (open agricultural data)

Results

Institutional and legal frameworks for digital agriculture in Benin

Overview of regulatory instruments

The regulatory and strategic landscape for digital agriculture in Benin has evolved significantly over the past decade, reflecting the government's ambition to position digital technologies as levers of socioeconomic development. Since 2016, a series of legal instruments and policy documents have been adopted to structure the country's digital transition. These texts establish the foundational rules, mandates, and institutional arrangements that define the national digital ecosystem. This section presents an overview of the key legal and strategic documents relevant to digital agriculture, with a focus on their scope, coherence, and relevance to the livestock sector.

Table 1 summarizes the main legal and strategic documents governing digital agriculture in Benin, highlighting their objectives, sectoral scope, and institutional limitations. It provides a comparative lens to assess the degree of integration of livestock concerns within the broader digital policy landscape.

One of the cornerstones of Benin's digital governance is Law No. 2017-20 on the Digital Code, enacted in April 2018. This comprehensive legislation governs the use of information and communication technologies (ICTs) and aims to promote a secure, inclusive, and innovation-friendly digital environment. It includes provisions on cybersecurity (Art. 74), data protection (Art. 20), liability of digital service providers (Art. 443), and international cooperation against cybercrime (Art. 586–594). While broad in its application, the law does not include sector-specific provisions for agriculture or livestock, nor does it address the certification or governance of digital tools used in animal health and production. Its generalist approach reflects a common trend in emerging digital policy regimes where

foundational legislation prioritizes cross-sectoral infrastructure over domain-specific regulation.

Complementing the Digital Code, several government decrees have sought to operationalize digital governance and infrastructure development. The Decree No. 2016-684, which articulates the Sectoral Policy Declaration for the Digital Economy, outlines strategic orientations for digital transformation and identifies agriculture as a priority sector for digitization. However, the document remains vague on mechanisms, targets, or implementation pathways specific to agriculture or livestock. Similarly, the Decree No. 2018-531 establishes the institutional governance of digital programs through sectoral committees and centralized steering bodies. While this framework promotes inter-ministerial collaboration, it lacks provisions for harmonizing digital initiatives across agriculture and digital economy portfolios, which is crucial for integrated digital agriculture.

A more targeted initiative is the National Strategy for e-Agriculture (2020–2024), developed with support from the FAO. This strategy aims to digitize agricultural value chains through capacity building, digital extension services, access to financial services, and improved market linkages. It explicitly includes the livestock sector as one of its application areas and aligns its interventions with the National Agricultural Investment Plan (PNIASAN). Nevertheless, the strategy remains aspirational in parts, with limited institutional anchoring and no dedicated provisions for livestock data governance, animal health platforms, or veterinary teleconsultation systems. Moreover, coordination responsibilities between the Ministry of Agriculture and the Ministry of Digital Economy are not clearly delineated.

The Strategic Plan for the Development of the Agricultural Sector (PSDSA) provides a long-term vision for agricultural transformation in Benin. It emphasizes productivity gains, rural employment, and sustainable development, and acknowledges digital innovation as a potential enabler. However, the PSDSA and the associated PNIASAN (2017–2021) mention ICTs primarily in relation to crop production and input management, with limited references to livestock systems or digital animal health solutions. These plans prioritize structural interventions (e.g., irrigation, seed systems, infrastructure) over digital transition mechanisms. As a result, digital agriculture remains peripheral rather than central to sectoral planning.

In summary, Benin's legal and policy landscape shows a progressive but uneven integration of digital agriculture. Foundational texts such as the Digital Code and sectoral strategies like the e-Agriculture Strategy provide a broad framework for digital innovation. However, the lack of specificity regarding livestock systems, coupled with institutional overlaps and vague implementation mandates, reveals a fragmented governance structure. From an IAD perspective, while the "rules-in-form" (formal policies) demonstrate intent and vision, the "rules-in-use" (actual coordination and sectoral alignment) remain weak or underdeveloped. This fragmentation potentially undermines the systemic scaling of digital livestock innovations and highlights the need for more integrated, sector-sensitive policy instruments.

Livestock-specific gaps and institutional fragmentation

While Benin has established several national strategies and legal instruments to promote digital transformation, their operational relevance to the livestock sector remains limited. Across all policy and legal documents reviewed—such as the Digital Code, the e-Agriculture Strategy, and the PSDSA—references to livestock systems are either marginal or entirely absent. Although agriculture is broadly mentioned, the specific challenges and requirements of digital innovation in livestock production are rarely addressed. This lack of sectoral specificity reflects a broader tendency to approach digital agriculture as a generic category, overlooking the distinct technical, biological, and governance needs of livestock systems.

A critical gap lies in the absence of dedicated digital governance instruments for animal data and health systems. For instance, there is no national framework regulating the collection, storage, or sharing of zootechnical data. Likewise, the emerging digital tools for animal identification, disease surveillance, and veterinary services—such as Souba, GléGan, or DigiVet—operate without formal accreditation procedures, technical standards, or oversight mechanisms. The lack of a certification system for digital veterinary solutions creates uncertainty about the reliability and safety of these tools, limiting their trustworthiness and potential for scale-up.

Institutionally, the governance of digital agriculture is marked by fragmentation and overlapping mandates. The Ministry of Agriculture oversees agricultural extension and sectoral planning, while the Ministry of Digital Economy manages digital infrastructure and strategy. However, there are no permanent coordination mechanisms linking the two domains. This disconnection has led to siloed interventions, where projects are initiated independently without cross-sectoral integration. Interviews revealed confusion over responsibilities and weak collaboration between departments, particularly in the deployment of digital tools for animal health and production.

The implementation of strategic documents is also constrained by the absence of sector-specific indicators or monitoring tools. Neither the e-Agriculture Strategy nor the PSDSA includes measurable targets for digital livestock innovation—such as traceability coverage, mobile veterinary service uptake, or data integration in extension systems. Without such indicators, tracking progress or adapting policy based on evidence remains difficult.

TABLE 2 Typology of stakeholders involved in digital agriculture in Benin.

Stakeholder Type	Key institutions/Examples	Mandates and functions	Roles in digital agriculture
Public Institutions	Ministry of Agriculture (MAEP), Ministry of Digital Economy, ASIN, Veterinary Services	Policy development, regulation, investment, oversight	Define policy frameworks, support infrastructure, regulate data systems (weak livestock focus)
Farmer and Producer Organizations	FUPRO, local livestock cooperatives	Farmer representation, service delivery, advocacy	Disseminate digital tools, mobilize members, voice local needs (limited strategic role)
NGOs and Development Agencies	Enabel, FAO, GIZ, ACED, Technoserve	Project implementation, technical assistance, capacity building	Design and pilot digital solutions, support adoption, train users
Research and Training Institutions	INRAB, University of Parakou, Ecole des Métiers du Numérique	Research, training, policy advising	Assess impacts, train experts, contribute to tool development (limited engagement in co-design)
Private Sector and Startups	AgroSfer, GléGan, DigiCla, mobile network operators	Technology development, service provision, innovation	Develop and deploy platforms, sensors, and digital services (limited integration in national systems)

Finally, the lack of institutional leadership has hindered the creation of a national vision for digital livestock development. Although ASIN plays a central role in coordinating digital initiatives, its engagement with agricultural content is minimal. Meanwhile, livestock departments within the Ministry of Agriculture often lack the digital expertise or resources needed to guide innovation efforts. This situation results in a governance vacuum where innovation occurs, but without guidance, harmonization, or sustainability planning.

The digital transformation of Benin's livestock sector is limited by a combination of regulatory voids, sectoral neglect, and institutional fragmentation. Addressing these gaps will require not only the inclusion of livestock in national digital strategies but also the development of dedicated regulatory frameworks and stronger coordination across ministries and agencies.

Actor configurations and logic of actions

Typology of stakeholders

The digital transformation of agriculture in Benin involves a wide range of stakeholders operating at different levels and with diverse mandates. These include public institutions, farmer organizations, non-governmental organizations (NGOs), research and training institutions, and private actors such as startups and mobile operators.

As shown in Table 2, these actors contribute to digital agriculture through roles that range from policy design and regulation (e.g., ministries and digital agencies), to service delivery and advocacy (e.g., farmer cooperatives, NGOs), and technological development (e.g., startups and innovation hubs). Their involvement, however, remains highly fragmented, with limited coordination across sectors and institutional levels.

Notably, public institutions often operate in silos, while producer organizations lack the resources to influence digital strategies meaningfully. NGOs and development partners play a key role in experimentation but are constrained by project-based logic and weak institutional anchoring. Private innovators are dynamic but face integration challenges due to regulatory uncertainty and limited public collaboration.

This fragmented configuration reflects broader governance weaknesses, where roles are distributed but not harmonized, and where platforms for coordination and dialogue are either absent or informal. Understanding the specific functions and limitations of each actor group is therefore essential to designing more inclusive and effective digital governance frameworks.

Logics of action: institutional, commercial, advocacy and experimentation

The diverse constellation of actors involved in digital agriculture in Benin—ranging from public institutions to NGOs, startups, and producer organizations—operate under different and sometimes competing logics of action. Understanding these underlying motivations is key to analyzing the fragmentation and partial coordination observed in the development and governance of digital tools in the livestock sector.

Institutional logic: mandate-driven planning and control

Public institutions such as the Ministry of Agriculture and the Ministry of Digital Economy operate primarily under an institutional logic, characterized by formal mandates, hierarchical decision-making, and a focus on regulatory oversight. Their orientation emphasizes national sovereignty over data, structured planning and sectoral development, as well as the standardization and control of technological innovation.

However, in practice, this logic often translates into top-down project design, limited responsiveness to grassroots needs, and an emphasis on compliance rather than adaptation. For example, while the Ministry of Agriculture acknowledges the importance of digitalization, it has yet to develop sector-specific guidelines for the certification or integration of livestock-related digital tools. Coordination with digital agencies is minimal, and

digital infrastructure investments are often made without input from technical livestock departments.

Commercial logic: market orientation and scalability

Startups and telecom companies are primarily driven by a commercial logic. Their orientation emphasizes efficiency, profitability, and scalability, while prioritizing customer satisfaction through user-centric design. They also frame technological innovation as a market-based solution to the challenges faced by the agricultural sector.

Firms like GléGan and AgroSfer are developing digital platforms for veterinary services, animal traceability, and smart feeding systems. These solutions are often highly innovative but lack institutional anchoring or regulatory recognition. Moreover, many private actors perceive government regulations as slow-moving and ill-adapted to the speed of digital innovation, creating tension between entrepreneurial dynamism and bureaucratic inertia.

One consequence is the emergence of parallel digital ecosystems, where private solutions operate independently of public infrastructure. This fragmentation undermines data interoperability and weakens systemic integration—especially problematic in sensitive sectors like animal health, where standardization is critical.

Advocacy logic: inclusion, empowerment, and social justice

Non-governmental organizations and farmer associations tend to follow an advocacy logic, grounded in values of empowerment, participation, and rights-based development. Their interventions are often oriented toward enhancing digital literacy and access for vulnerable groups such as women, youth, and smallholders, while also promoting food sovereignty and localized innovation. At the same time, they emphasize the importance of safeguarding producer autonomy in data governance, ensuring that farmers retain control over the information they generate. This logic drives NGOs like ACED and development partners like FAO to support inclusive platforms, open data principles, and community-led experimentation. However, their initiatives are often project-based, fragmented, and weakly institutionalized, making long-term sustainability a challenge. Furthermore, their priorities may conflict with commercial imperatives or institutional timelines, creating friction in multi-actor settings.

Experimental logic: learning-by-doing and adaptive innovation

A fourth and increasingly visible logic is experimentation, particularly among hybrid actors such as innovation hubs, research centers, and pilot initiatives (e.g., DigiCla, Souba). This logic values:

- Iteration and prototyping
- Local adaptation and feedback loops
- Co-design with end-users

These actors serve as "connective tissue" between rigid institutional structures and agile private initiatives. However, the experimental logic often lacks political authority or financial stability, leaving successful pilots with no pathway to scale. As one interviewee put it, "many tools are tested, few are absorbed."

Enablers and barriers to adoption of digital livestock innovations

Despite growing policy interest and localized experimentation, the adoption of digital tools in livestock systems in Benin remains modest and highly uneven. This section explores the key factors enabling or constraining the diffusion of digital livestock innovations, drawing on institutional analysis, stakeholder narratives, and field-level observations. It highlights three interrelated dimensions: the innovation landscape, the regulatory and institutional environment, and the scaling challenges associated with transitioning from niche experiments to system-wide transformation.

Innovation landscape in the livestock sector

Benin has witnessed the emergence of several digital solutions targeting agriculture sector in general and livestock value chains in particular. To better illustrate the diversity of ongoing digital initiatives in Benin, we compiled an illustrative set of innovations (Table 3). While not exhaustive, the table highlights the relative scarcity of livestock-focused tools compared to the dominance of crop-oriented or cross-sectoral applications, thereby underscoring the marginal attention given to livestock in the country's digital transformation. The livestock sector is also represented through specific applications dedicated to animal health monitoring, digital identification, and remote management. Solutions such as E-animal identification, GIS for Animal Health, and Souba for remote monitoring of livestock conditions demonstrate a clear integration of digital technologies to support sustainable and efficient animal husbandry.

These innovations are often led by NGOs, startups, or development partners, with limited involvement from public institutions. They provide tangible value in areas such as animal health tracking, disease control, and market access. However, their coverage remains narrow, with adoption largely confined to pilot areas and early adopters. Moreover, few of these tools are interoperable or aligned with national systems, limiting their scalability and institutional integration.

Institutional barriers and regulatory voids

The lack of sector-specific regulations constitutes a major barrier to adoption. As detailed in Section *Governance as a*

TABLE 3 Illustrative Innovation landscape in digital transformation in agriculture in Benin.

No.	Application/Digital platform	Promoter[a]	Description of the innovation	Application sector
1	Agricef maize	Digicla	Mobile applications, training platforms, voice systems against the fall armyworm	Crop production
2	Ag4all	Enterprise art creativity	Farm monitoring and management, easier market access and agricultural service provision	Agriculture
3	Agrimap	Agrimap	Land mapping and phytosanitary monitoring	Crop production
4	Agrimétéo	Help of Disable (hedi ong)	Monitoring of climatic parameters	Crop production
5	Agrithèque	National Chamber of Agriculture	Digital library	Agriculture
6	Agriyara	TIC-Agrobusiness Enterprise	Online buying and selling of agricultural products	Agriculture
7	Agro mobile	TIC-Agrobusiness Enterprise	Dissemination of good agricultural practices	Crop production
8	Agrosfer survey	Private company: Agrosfer	Used for data collection and producer support	Agriculture
9	Appcereal	Private enterprise: Steve Hoda	Field monitoring, notifications via text, images, videos, audio	Crop production
10	Agrimission	Agrimission SARL	Mobile application for marketing and traceability of products	Agriculture
11	Agropay	Agrosfer	Online payment and financial tracking	Crop production
12	Agro mapping	Agrosfer	Mobile application for mapping agricultural holdings	Crop production
13	Atingi4ag	GIZ	Online courses on various agricultural topics	Agriculture
14	Benagri	Benin Revealed	Online agricultural marketplace	Agriculture
15	Benin rice	Hedi ONG	Mobile application for agricultural advice and rice marketing	Crop production
16	Benin logis	Benin Logis SARL	Geolocation platform for agricultural producers	Crop production
17	Sensors (drones, satellites)	Global Partner	Optimizes input dosages for large crops such as cotton	Crop production
18	Crop management	Agrosfer	Agricultural advice and monitoring of production activities	Crop production
19	Drone analyst	Benin Drone Lab	Field monitoring (phytosanitary monitoring) and agricultural planning	Crop production
20	Digitfin	Ferme Pastena	Web platform for crowdfunding agricultural projects	Agriculture
21	Dyra	Dyra	Phytosanitary monitoring	Agriculture
22	E-agri	MAEP	Platform for management and monitoring of farms	Crop production
23	E-advice	MAEP	Adapted agricultural mechanization, pest management, climate change adaptation, agroforestry, and individual forestry	Crop production
24	E-animal identification	LIVRMOI SERVICES (LMS)	Digital monitoring of cattle using electronic chips or digital IDs	Livestock
25	E-pinea	Biolife Tech	Connects actors in the pineapple sector for guaranteed market access	Crop production
26	Edjo	Art Creativity	Application to technically support rice processors	Crop production
27	Agrosfer Farmer education	Agrosfer	Agricultural advice	Agriculture
28	Glégan	Private company: Anicet Semassa	Shop for selling agricultural inputs and equipment: seeds, fertilizers, amendments, phytosanitary products, materials and equipment, animal feed	Agriculture
29	Goura	TIC-Agrobusiness Enterprise	Digital support platform (weather, farm management)	Agriculture

(Continued on following page)

TABLE 3 (*Continued*) Illustrative Innovation landscape in digital transformation in agriculture in Benin.

No.	Application/Digital platform	Promoter[a]	Description of the innovation	Application sector
30	Jinukun store	Jinukun SARL	Marketing of agri-food products	Agriculture
31	Ki@	Bomef-Agridi project (Africa Green Corporation and Fupro-Benin)	Voice message dissemination for agricultural advice and market prices of maize and rice in Benin	Agriculture
32	Nanan	Global Partners	Agricultural calendar monitoring and advice	Crop production
33	Our voice	TIC-Agrobusiness	Voice message dissemination in local language	Agriculture
34	Oja	Oja SARL	Platform for selling agricultural products specific to maize and soy sectors	Agriculture
35	Pal	Noworri	Application for remote payments and savings tracking	Agriculture
36	Preci-agri	Preci Agri	Crop irrigation automation	Crop production
37	Rndes	Vart-Lab	Selection of climate-sensitive varieties	Crop production
38	Souba	Souba	Remote monitoring of feeding, temperature, and water quality in ponds or fish tanks	Livestock
39	Sim	IFDC	Platform for collecting, analyzing, and disseminating market information	Agriculture
40	Sift	IFDC	Mobile app for dissemination of digitalized agricultural advice	Crop production
41	Geographic Information System for Animal Health (GIS-Animal Health)	FAO	Used to track geographic distribution of animal diseases, vaccines, or veterinary product sales points	Livestock
42	Trotrociva	Prociva (GIZ)	Application for tractor reservation and geolocation	Crop production
43	Connected tractor	SLI Afrika	GPS monitoring of agricultural tractors	Crop production
44	Zoom agro	Zom Agro	Agricultural communication agency	Agriculture

[a]*Promoter* refers to the organization responsible for developing, implementing, or managing the innovation.
Source: Authors.

foundational challenge in digital agricultural transformation, current policies do not provide guidelines for data protection in zootechnical systems, standards for digital veterinary diagnostics, or protocols for platform certification. This creates uncertainty for both users and developers, discouraging investment and uptake.

Moreover, the institutional environment lacks coherence and incentives for digital tool adoption. There are no subsidy schemes, tax incentives, or inclusion in official livestock support programs to encourage uptake. Livestock producers often bear the full cost of adoption, with no guarantee of technical support or compatibility with public extension systems.

Institutional actors interviewed also noted a mismatch between digital supply and field-level demand. Many tools are developed without user-centered design or participatory testing, resulting in low usability or relevance for small-scale herders. This is compounded by low digital literacy levels among rural producers, particularly among women and elderly livestock keepers.

Niche status and transition challenges

Most digital livestock innovations in Benin remain in "niche regime"—a protected but disconnected space where innovation occurs (Geels, 2002; Smith and Raven, 2012), but without systemic impact. These niches often emerge in donor-funded projects or isolated pilot programs. While they demonstrate technical feasibility, they fail to transition into mainstream agricultural systems due to lack of scaling pathways, policy anchoring, and institutional support. As summarized in Table 4, both enablers and barriers shape the adoption of digital innovations in the livestock sector.

Interviews with institutional actors revealed that the lack of scaling strategies is particularly visible in three domains. The first concerns governance: there is no national steering mechanism to systematically evaluate, coordinate, and support promising tools. The second relates to finance, as developers and farmer organizations face limited access to investment or credit to expand digital infrastructure. The third challenge lies in knowledge diffusion, since extension systems remain weak in disseminating digital tools, particularly in remote or pastoral areas. In most cases, dissemination efforts stop once the donor-

TABLE 4 Enablers and barriers to the adoption of digital innovations in the livestock sector in Benin.

Dimension	Enablers	Barriers
Technological	Emergence of pilot platforms (Souba, DigiVet, GléGan); growing mobile penetration	Low interoperability; weak infrastructure in pastoral zones; tools not tailored to livestock-specific needs
Institutional and Regulatory	Political will for digital transformation; existence of national strategies (e.g., e-Agriculture)	No livestock-specific regulations; lack of certification and data governance; weak inter-ministerial coordination
Financial and Economic	Donor and NGO support; interest from private startups	No public incentives; adoption costs borne by farmers; limited financing models for rural tech diffusion
Social and Organizational	Engagement of cooperatives and some local governments; innovation hubs as intermediaries	Low digital literacy; weak involvement of farmers in tool design; mistrust between public and private actors
Policy and Strategic	Visibility of digital in national development agenda; growing stakeholder awareness	No scale-up strategies; digital tools excluded from mainstream livestock policy and extension systems

funded project that introduced the tool comes to an end, leaving producers without continuity or long-term support.

At the same time, some enabling conditions are beginning to emerge, though they remain fragile. Increasing smartphone penetration in rural areas provides a favorable foundation for digital adoption. In addition, certain municipalities and livestock cooperatives have expressed strong commitments to digital inclusion, offering localized support for innovation. Innovation hubs and international donors are also showing growing interest in promoting livestock-specific solutions. However, these positive drivers remain fragmented and insufficient in the absence of structural reforms in regulation, institutional coordination, and farmer engagement.

Overall, the adoption of digital innovations in Benin's livestock sector is shaped by the coexistence of promising initiatives and systemic constraints. Several tools have been developed and tested, but their lack of regulatory recognition, institutional support, and integration into user practices continues to limit their scale and impact. Addressing these challenges will require a strategic realignment of digital agriculture governance. This should include the development of livestock-specific digital policy instruments, the introduction of incentive mechanisms such as subsidies, training programs, and bundled services, and the establishment of stronger feedback loops between users and developers. Equally important is the integration of digital tools into public extension and animal health systems to ensure sustainability and large-scale adoption.

Discussion

This study aims to explore how digital agriculture—particularly in the livestock sector—is governed in Benin, focusing on the interplay between institutional frameworks and actor configurations. The findings confirm the emergence of a dynamic but fragmented digital ecosystem, marked by ambitious policy aspirations, diverse stakeholder involvement, and pockets of innovation. However, they also reveal critical gaps in coordination, regulation, and sectoral integration that undermine the effectiveness and scalability of digital tools in livestock production.

Governance as a foundational challenge in digital agricultural transformation

The findings of this study confirm that governance constitutes a foundational constraint in the digital transformation of the agricultural sector in Benin, particularly within the domain of livestock development. While policy frameworks such as the Digital Code and the e-Agriculture Strategy articulate ambitious objectives, they often lack the specificity, operational mechanisms, and intersectoral coordination needed to support the effective implementation of digital technologies in livestock systems. This observation reflects a broader phenomenon described in the literature as institutional decoupling—where formal rules exist, but are not supported by corresponding practices, enforcement capacity, or context-sensitive adaptation (Peters and Pierre, 2016).

Interpreted through the lens of the Institutional Analysis and Development (IAD) framework, this situation highlights critical weaknesses in the rules-in-use that structure interactions among actors within the digital agriculture ecosystem. The absence of clear regulatory guidelines for digital veterinary services, data governance, and platform certification generates institutional uncertainty. This, in turn, limits the capacity of public agencies to manage digital innovation and undermines producers' trust in available technologies. As observed in other sub-Saharan contexts, the lack of clarity around data ownership and use further fuels reluctance among farmers to adopt digital tools (Jouanjean et al., 2020).

Moreover, the governance system tends to operate with limited engagement from key stakeholders, including livestock producers, farmer organizations, and local service providers. Digital strategies are often developed in top-down fashion, without mechanisms for structured consultation or

participatory design. This disconnect leads to policy instruments that fail to align with the actual needs and capabilities of end users. As recent studies underline, such gaps in stakeholder engagement can significantly reduce the relevance, uptake, and impact of digital solutions in agricultural systems (Byrne, 2024; Yuan and Sun, 2024).

In addition to regulatory uncertainty and participation gaps, the limited availability of digital infrastructure and low levels of institutional capacity represent further obstacles to effective governance. Many rural and pastoral zones still lack reliable internet connectivity, constraining the feasibility of deploying mobile-based platforms or cloud-enabled livestock tracking systems (Duc et al., 2024; Gouroubera et al., 2024). At the same time, public institutions often do not have the human or technical resources required to assess, support, or supervise digital innovation in livestock services.

These governance challenges are not unique to Benin. They echo observations made across several African countries, where digital agriculture is promoted rhetorically but constrained by fragmented mandates, siloed operations, and inconsistent political prioritization (Weitzberg et al., 2021). Addressing these structural issues requires more than infrastructure investments or tool development. It calls for a deliberate effort to strengthen the institutional environment by clarifying mandates, aligning legal frameworks with sectoral needs, and embedding inclusive participation in decision-making processes.

The transition to digital agriculture cannot succeed without parallel reforms in governance. Institutional inclusion—ensuring that producers and intermediary actors are involved in shaping digital policies and frameworks—is as important as technological inclusion. Without such institutional realignment, the transformative potential of digital agriculture for productivity, resilience, and equity will remain largely unrealized.

Institutional fragmentation and the limits of innovation ecosystems

A central finding of this study is the fragmented nature of institutional arrangements surrounding digital agriculture in Benin. Although multiple actors are involved—ministries, public agencies, farmer organizations, private developers, NGOs, and donors—the governance landscape is characterized by limited coordination, overlapping mandates, and isolated initiatives. This fragmentation hinders the emergence of a coherent national innovation system capable of supporting the scale-up and sustainability of digital solutions in the livestock sector.

This configuration reflects a broader trend observed across sub-Saharan Africa, where digital agriculture ecosystems tend to develop in fragmented ways due to weak policy coherence and inconsistent institutional leadership (Kitole et al., 2024). In such contexts, innovation often occurs in an environment disconnected from public policy frameworks, resulting in limited impact and poor integration with extension services or rural infrastructure.

In Benin, many promising initiatives—such as mobile veterinary services, traceability platforms, or livestock market apps—remain at the pilot stage, with little prospect of scaling beyond the original intervention area. This condition corresponds to what Geels (2002) describes as a "niche regime": a protected space where innovation occurs, but lacks the enabling environment to influence the dominant system. Without institutional support, digital tools fail to transition from experimentation to consolidation (Geels, 2002; Grant et al., 2020).

Furthermore, the absence of structured coordination mechanisms leads to inefficient use of resources and unclear leadership in implementation. Stakeholders interviewed during this study emphasized the lack of dialogue between actors and the difficulty in aligning innovations with existing agricultural and veterinary policies. While some coordination exists informally or within specific projects, it is often *ad hoc* and person-dependent rather than systemic.

These findings reinforce recent calls for the development of multi-actor and multi-level governance platforms to manage digital transformation in agriculture (Cordella and Paletti, 2018; Klerkx and Rose, 2020). Such platforms are needed to align innovation with public objectives, ensure interoperability of tools and databases, and promote accountability in the deployment of digital services.

Rethinking digital inclusion

The debate on digital inclusion in agriculture has traditionally focused on technological access, emphasizing the availability of infrastructure such as mobile phones, internet connectivity, and digital devices (Duc et al., 2024; Gouroubera et al., 2024; Rackwitz et al., 2021; Yuan and Sun, 2024). While these elements are necessary, they are far from sufficient to achieve meaningful transformation in rural agricultural systems. The findings of this study suggest that the real challenge lies not only in connectivity but in what can be called institutional inclusion—the extent to which different actors, particularly producers, are integrated into the governance, design, and deployment of digital innovations.

Institutional inclusion is shaped by asymmetries in digital literacy and organizational capacity. As the findings show, many producers lack the skills to engage with digital technologies meaningfully, while their representative organizations often lack the institutional leverage to influence digital agendas. This dynamic creates a double exclusion: one based on individual competencies, and the other rooted in systemic marginalization within policy frameworks. Similar patterns have been observed in other African countries, where the

absence of participatory mechanisms leads to the reproduction of digital divides despite expanding coverage (Van der Burg et al., 2019; Voss et al., 2021).

In addition, the absence of clear data governance structures contributes to mistrust among users. Farmers remain skeptical about who owns, controls, or benefits from the data they generate. According to Wilson (2019) Without robust mechanisms for data protection, transparency, and consent, digital tools risk being perceived not as enablers of empowerment, but as instruments of surveillance or exclusion. The absence of producer-oriented governance standards, particularly in relation to animal data, amplifies this mistrust and limits the willingness to engage with digital platforms.

Limitations and future research

This study contributes to the emerging literature on the governance of digital agriculture in sub-Saharan Africa, with a particular focus on the livestock sector—a domain that remains underexplored compared to crop production. One of its main strengths lies in its original focus: by systematically reviewing national legal frameworks, strategic policies, and institutional mandates, combined with qualitative evidence from interviews, the study offers a comprehensive overview of how digital innovation is governed in Benin. This dual approach allowed us to link formal governance arrangements with the lived perspectives of actors, highlighting gaps between policy ambitions and implementation realities. Another strength is the application of the Institutional Analysis and Development (IAD) framework, which provides a structured analytical lens to capture the complexity of actor interactions and governance dynamics in the digital agriculture ecosystem. The study thus lays the groundwork for future policy dialogue and comparative research on institutional governance of digital transformation in livestock systems.

At the same time, the study faces certain limitations. It is exploratory and primarily qualitative, relying on documentary analysis and unstructured interviews. While this approach enabled rich contextual insights, it restricts the generalizability of findings beyond the Beninese case. The number of interviews conducted was modest, limiting the breadth of perspectives, especially from grassroots actors such as smallholder livestock keepers and women producers. In addition, the unstructured nature of interviews, while flexible, makes systematic comparison across respondents more difficult. Finally, the analysis largely emphasized formal policies and institutions, whereas informal governance mechanisms, local power relations, and micro-level adoption practices require further investigation.

Future research could build on this foundation by adopting mixed-method or comparative designs to test the robustness of findings across contexts. Quantitative approaches would help assess the magnitude of governance effects on digital adoption, while cross-country studies would provide insights into institutional variation. More attention should also be given to gendered and generational dynamics of digital adoption, as well as the mediating role of local authorities and community-based organizations. Such research would deepen the understanding of inclusive and effective digital governance in livestock systems.

Conclusion

This study has examined how institutional and governance frameworks shape the development and adoption of digital technologies in Benin's livestock sector. Despite national efforts to promote digital agriculture, the livestock domain remains marginal in both policy design and implementation. The analysis reveals significant gaps in regulatory frameworks, coordination mechanisms, and stakeholder inclusion.

The findings underscore the need for a shift from fragmented innovation toward an integrated governance model. Institutional misalignment, lack of livestock-specific policies, and weak stakeholder coordination limit the scalability and sustainability of digital tools. Addressing these barriers requires regulatory reforms, the establishment of multi-actor platforms, and the integration of digital services into mainstream agricultural policies and extension systems.

Beyond infrastructure and innovation, digital transformation depends critically on the quality of governance. In livestock systems, where production risks and rural inequalities are particularly acute, inclusive and coherent institutional arrangements are essential. By fostering alignment across actors and policies, Benin can move from isolated experimentation to transformative digital adoption in its livestock sector.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Conseil Scientifique of Université de Parakou. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

Conceptualization: CO and SAA. Methodology: CO, SAA, JE, and ASA. Software: CO and SAA. Validation: MNB and ITA.

Formal analysis: CO and SAA. Investigation: CO and SAA. Writing – original draft preparation: CO and SAA. Writing – review and editing: MNB and ITA. Supervision: JE, ASA, and HSSW.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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