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FOSTERING INNOVATION AND FOOD SOVEREIGNTY IN AFRICAN LIVESTOCK: AN ECOSYSTEM APPROACH VIA UNIVERSITY-BASED EXTENSION SYSTEMS IN CAMEROON

Ewane D^{1*}, Ewane EEE², Ndam LM¹, Anumoh M³, Eyong ET⁴, Tamesse JL¹,
Ehabe EE⁵, Chah JM⁶ and PM Oben¹



Divine Ewane

*Corresponding author email: ewane.divine@ubuea.cm

ORCID: <http://orcid.org/0000-0002-7807-4056>

¹Faculty of Agriculture and Veterinary Medicine, University of Buea, P.O. Box 63, Buea, Cameroon

²Faculty of Arts, University of Buea, P.O. Box 63, Buea, Cameroon

³College of Technology, University of Buea, P.O. Box 63, Buea, Cameroon

⁴Centre for Entrepreneurship, Research and Innovation, Catholic University Institute of Buea

⁵Directorate of Scientific Research, Institute of Agricultural Research for Development, P.O. Box 2123, Yaoundé, Cameroon

⁶Department of Agricultural Extension, University of Nigeria, P.O. Box 3147, Nsukka, Nigeria



ABSTRACT

The livestock sector is a cornerstone of food security, livelihoods, and economic development across Africa, yet chronic systemic challenges (including pervasive diseases, feed constraints, and climate variability) are compounded by inadequate and fragmented agricultural extension services. Historically, extension in Cameroon transitioned from rigid, top-down models, such as the National Extension System Approach (NESA) prior to 1990, to pluralistic, project-dependent participatory systems like Training and Visit and Farmer Field Schools. While these participatory approaches enhanced farmers' participation, they have struggled with issues of scaling, long-term coordination, and sustainable funding, leaving a significant gap in the knowledge-to-innovation value chain. This paper proposes and conceptualizes a transition to a University-Based Agricultural Extension System (UBAES), utilizing multi-stakeholder Innovation Platforms (IPs) as the core mechanism for an Ecosystem Approach to Innovation (EAI). This model positions the University as a neutral, stable anchor, leveraging its triple mandate of teaching, research, and outreach to directly strengthen the corresponding Research-Extension-Farmer (R-E-F) linkages. Using the proactive initiative at the University of Buea (UB) as a foundational qualitative case, based on document review, internal programme documentation, and participatory observation, this paper details a three-phased framework for establishing IPs in specialized value chains, including snails, bees, beef, dairy, fish, swine, poultry, and ostrich production. The UBAES model promotes sustainable financing through student research and social enterprises, facilitating whole-value-chain coordination that remains endogenous and less reliant on volatile external aid. By integrating mandatory student research requirements into localized extension needs, the model shortens the time lag between scientific discovery and field adoption. Furthermore, anchoring digital extension within university digital hubs provides the necessary institutional capacity to overcome digital literacy barriers, making information dissemination more efficient. The paper argues that this EAI is crucial for driving systemic, indigenous-led innovation, ultimately serving as a robust strategy for enhancing Food Sovereignty (understood here as strengthening democratic control over livestock production systems, gender-responsive access to resources, and the right to food) and contributing to securing the future of Africa's rising livestock sector. The implementation of this model redefines the university's role as an active knowledge broker and system orchestrator, offering a scalable blueprint for other national universities in Africa to fulfil their outreach mandate and contribute directly to the African Union's Comprehensive Africa Agriculture Development Programme (CAADP) goals.

Key words: Livestock, Food Sovereignty, University-Based Extension, Innovation Platforms, Ecosystem Approach

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INTRODUCTION

The livestock sector is a vital component of the African economy, contributing 30 - 80% of its agricultural gross domestic product (GDP), rural employment, and the supply of essential protein for a rapidly growing population [1]. In Cameroon, the sector supports the livelihoods of more than 30% of the rural populace and accounts for 13% of GDP from agriculture [2], making it central to national food security objectives. However, achieving sustainable growth and resilience is hampered by a complex matrix of constraints, including endemic animal diseases, seasonal feed scarcity exacerbated by environmental degradation, limited access to modern inputs and finance, and the escalating pressures of climate change [3]. Addressing these multifaceted problems requires a fundamental shift from episodic, linear interventions to a holistic and systems-based approach to innovation.

The effectiveness of the livestock sector is intrinsically linked to the quality and reach of its agricultural extension system. The history of extension in Cameroon can be broadly divided into two periods:

- The Directive Era (Pre-1990): Characterized by centralized, government-led National Extension System Approach (NESA). These approaches prioritized the top-down diffusion of predetermined "packages" of technology [4]. While vast in scope, they were criticized for their lack of adaptation to diverse local contexts and weak formal linkages between researchers and field agents [5].
- The Pluralistic and Participatory Era (Post-1990): Following the economic crisis and Structural Adjustment Programs (SAPs) [6], the landscape diversified to include: Training and Visit (T and V), Farmer Field Schools (FFS), and NGOs. While these models correctly emphasized farmer knowledge, they created new challenges: fragmentation, duplication of effort, difficult inter-actor coordination and chronic reliance on short-term project-based funding [7].

The limitations of the current pluralistic system underscore a critical research gap: the absence of a stable, coordinated, knowledge-rich institutional anchor capable of convening all stakeholders. Innovation in complex agricultural systems is not an isolated output but the result of a dynamic Innovation Ecosystem [8]. Given the existing gaps acknowledged in Cameroon's National Agricultural Investment Plan (RSDS/NAIP 2020-2030) [9], a new structural model is required.

This paper addresses this gap by proposing the University-Based Agricultural Extension System (UBAES) as a requisite institutional anchor. Beyond synthesizing existing evidence on pluralistic extension and innovation systems, the originality of this paper lies in (i) conceptualizing a University-Based Agricultural Extension System (UBAES) as a dedicated governance mechanism for livestock-focused

innovation platforms in a lower-middle-income African context, and (ii) grounding this model in a live institutional experiment at the University of Buea, thereby providing a transferable scaffold for other national universities seeking to operationalize the African Union's CAADP and national investment plans [8, 10]. Specifically, this study sought to answer the following research questions:

1. How can a University-Based Agricultural Extension System (UBAES) function as an institutional anchor to address the fragmentation and funding instability of the current pluralistic extension model?
2. To what extent does the University of Buea's (a state university in Cameroon) initiative align with and contribute to the principles of Food Sovereignty in the livestock sector?

Historical Review and Analysis of Agricultural Extension Models in Cameroon

The evolution of agricultural extension services in Cameroon's livestock sector mirrors the broader post-colonial experience across sub-Saharan Africa, characterized by successive paradigm shifts driven by political, economic and institutional pressures [11, 12].

The period before the economic crisis of the late 1980s was dominated by a highly centralized, government-led system often referred to as the Diffusion-Modernization Model [5] or the National Extension System Approach (NESA), where, the public sector held a domineering role, controlling all aspects from research and credit to extension and marketing, often through state-owned parastatals and agricultural corporations [13]. The focus was linear, unidirectional technology transfer, often neglecting the complex, diverse, and often extensive practices of pastoral communities.

Despite a large staff, the NESA model suffered from significant structural failures, characterized by low efficacy due to its rigid nature, weak formal feedback loops, and a lack of genuine farmer participation in solution design [14, 15]. The uniform "packages" often failed because they disregarded local socio-economic and agro-ecological contexts [14, 16]. The fiscal collapse of the late 1980s, coupled with SAP [12], precipitated a radical restructuring, leading to market liberalization and the adoption of more participatory approaches. This era, from the late 1980s to the present, could be termed that of economic reform, where pluralistic and participatory models emerged. They could be characterized with respect to the following:

- Early Reform - Training and Visit (T and V) System: Introduced in the post-crisis period (for example, under the World Bank-financed National Agricultural Extension and Education Program, NAEPP), T and V aimed to structure the

- system through a single line of command [14, 17]. However, it proved financially unsustainable and often retained the top-down essence of its predecessor [18].
- The Rise of Pluralism and Participation: The subsequent move was towards genuine pluralism. Farmer Field Schools (FFS) gained traction, emphasizing "learning by doing" [18], alongside Participatory Rural Appraisal (PRA). This shift also saw the growth of market-driven advisory services and community-driven initiatives [19].
 - Persistent Challenges of the Pluralistic Model: While commendable, these models faced critical systemic challenges: Coordination Deficit due to the proliferation of diverse actors [7, 19], funding instability as projects relied on external donor funding [20] and persistently Weak Research-Extension-Farmer (R-E-F) Linkages [21]. This structural weakness necessitated a new institutional model.

Theoretical Framework: The Innovation Ecosystem Approach

The persistence of systemic challenges in the Cameroonian livestock sector demands a theoretical shift to a systems perspective [2, 22]. This paper anchors its proposed UBAES model within the Innovation Ecosystem Approach (EAI), recognizing that sustained agricultural development is achieved through the dynamic, iterative interactions of diverse, interconnected actors [23].

An innovation ecosystem could be defined as a complex, dynamic network of organizations, individuals, institutions and resources that collaborate to co-create, adopt and scale innovative solutions [24, 25]. This framework moves beyond traditional linear models by emphasizing the crucial role of relationships, trust and shared vision among stakeholders. In this paper, the Ecosystem Approach to Innovation (EAI) was therefore used as an umbrella construct that builds on but extends agricultural innovation systems (AIS) thinking by placing particular emphasis on governance arrangements, university anchoring and the deliberate orchestration of multi-level innovation platforms [23,25]. In this approach, the key components include actors (researchers, farmers, universities, government, private businesses), resources (capital, knowledge, infrastructure), activities (R and D, knowledge transfer) and Relationships (feedback loops) [25].

Considering the rationale for the Ecosystem Approach in Livestock Development (EAI) is uniquely suited to address the complexity of African livestock challenges in terms of holistic problem solving, accelerated scaling as well as risk mitigation and sustainability.

- Holistic Problem Solving: Challenges like zoonotic diseases require concurrent engagement of veterinary services, climate researchers, and farmers.

- Accelerated Scaling: Integrating businesses and financial actors allows solutions to move from the research bench to the market efficiently [26].
- Risk Mitigation and Sustainability: The EAI leverages the strengths of the private sector and universities to reduce dependence on transient external aid [21].

In light of these, innovation platforms (IPs) could be considered as the ecosystem governance mechanism. Within the EAI framework, IPs serve as the operational tool and governance structure that facilitates essential stakeholder interactions [27] as they are formalized, multi-stakeholder forums where actors meet to jointly analyze problems and collectively plan actions, often following the principles of Integrated Agricultural Research for Development (IAR4D) [28].

The Proposed Model: University-Based Agricultural Extension and Strategic Advantages

Building upon the theoretical need for an institutional anchor to address fragmentation [7, 20], this paper proposes the UBAES model as the strategic mechanism for deploying the EAI in Cameroon. Aligning with national strategic visions [9], the University could be considered as the optimal institutional anchor, with the University of Buea Initiative being considered as a foundational case.

The public university possesses unique advantages as a facilitator and guarantor of a sustainable EAI [29]:

- Reinforcing R-E-F Linkages: UBAES channels mandatory student research (BSc., MSc., PhD.) toward real-world extension needs identified by IPs [30], reducing the historical disconnect between academic research and farmer constraints [21].
- Surmounting Funding Instability: UBAES can be organized as an academically-supported social enterprise or "business unit"[31], generating revenue through fee-for-service extension and consultancy.
- Improving Coordination: The public university is positioned as a relatively neutral, knowledge-rich institution [32], which - when equipped with transparent governance and accountability mechanisms - can credibly convene diverse stakeholders and mitigate coordination failures, a critical position for establishing the trust required to convene diverse stakeholders.
- Fostering Digital Extension: Universities, such as the University of Buea (located within the "Silicon Mountain" digital ecosystem) [33], are natural centres for integrating digital tools into outreach.
- Strategic Indigenization for Food Sovereignty: By focusing research on indigenous livestock resources, UBAES ensures that agricultural knowledge is

driven by national food self-sufficiency goals rather than external commercial interests.

- **Reducing Implementation Hurdles on Cameroon's New Laws on Decentralization:** As a neutral convener and knowledge institution, serving as the operational tool and governance structure that facilitates essential stakeholder interactions, UBAES can improve opportunities for regional and local governments to respond to niche agricultural and rural development challenges, as provided in Law No 2019/024 of 24 December, 2019 on Decentralization in Cameroon [34].

The University of Buea Initiative (UBAES model) could therefore be considered as a foundational case, the feasibility of which is substantiated by the Support Programme for the UB Livestock Production and Agripreneurship Students Business Incubator (SP-UB-LPA-SBI) [35] which manages and coordinates the University's membership and activities in the Chamber of Agriculture, Fisheries, Livestock and Forest of Cameroon (CAPEF). This initiative acts as a proof-of-concept for integrating an incubation model to structure practical training and facilitates IPs in specialized areas, starting with Snails (*Archatinaculture*), Bees (*Apiculture*), Beef and Dairy, Pigs, Fish, Poultry and Ostrich production.

MATERIALS AND METHODS

This paper adopted a qualitative case study design [36] centred on the *Support Programme for the UB Livestock Production and Agripreneurship Students Business Incubator (SP-UB-LPA-SBI)*. This programme serves as an empirical anchor for model development.

Data collection was conducted between 2019 and 2024 using a triangulation of sources to ensure validity:

1. **Documentary Review:** Fifteen (15) key institutional documents (specifically comprising 8 annual activity reports, 3 strategic development plans, and 4 Memoranda of Understanding) were systematically reviewed. Specifically, the agreements established between the University of Buea and the Chamber of Agriculture, Fisheries, Livestock and Forests of Cameroon (CAPEF), as well as the MoU with the Centre for Agricultural Excellence and Promotion of Environmental Resilience – Cooperative Society (CAEPERFARMING-COOP-BOD) were analyzed.
2. **Participatory Observation:** Members of the research team conceived, actively facilitated, and observed proceedings during six major Innovation Platform meetings and multiple student training sessions. These platforms were organized as part of the integrated projects on aquaculture with livestock, funded by the

West and Central African Council for Agricultural Research and Development (CORAF/WE CARD). This initiative was implemented through a consortium involving the University of Buea (Cameroon), the University of Ibadan (Nigeria), and Njala University (Sierra Leone). Direct engagement in these sessions allowed for the primary collection of data on stakeholder interactions and decision-making processes.

3. **Reflective Workshops:** Iterative reflection workshops were held with key institutional stakeholders (including university leadership and CAPEF representatives) to validate the emerging framework.

Data Analysis: Data were analyzed using a thematic analysis approach. Key themes were identified inductively regarding coordination challenges, resource mobilization, and alignment with food sovereignty principles (specifically, democratic control and indigenous focus). It is important to note that "Food Sovereignty" in this study is not measured via a quantitative index, but rather assessed qualitatively by examining the programme's adherence to the pillars of localized control, access to resources, and the valuation of local knowledge [40].

Implementation Framework: University-Facilitated Innovation Platforms

The core function of the UBAES is to facilitate and nurture multi-stakeholder IPs as the operational mechanism for the EAI.

The Foundation: Framework for Multi-Stakeholder Innovation Platforms

Table 1 describes innovation platform-adapted activities [38] where the principles of IAR4D are embedded into the framework, focusing on knowledge generation, facilitation of multi-directional information flows, and resource mobilization [28, 38].

The Three-Phased Participatory Action Learning Approach

The establishment of a University-Facilitated IP follows a multi-phased participatory action learning approach [39]:

- Phase I (Pre-Formation): Focuses on institutional alignment and resource mapping.
- Phase II (Formation and Implementation): Involves mobilizing actors and building a collective vision based on trust [32].
- Phase III (Post-Formation/Sustained Nurturing): Anchored by IAR4D principles [28], where the university's role shifts to nurturing a continuous cycle of analysis and action.

RESULTS AND DISCUSSION

Empirically, the SP-UB-LPA-SBI case has demonstrated several tangible indicators of a functional innovation ecosystem. Between 2021 and 2024, more than 20

postgraduate and 12 undergraduate research projects were explicitly aligned with priority constraints identified by the livestock IPs. In addition, the programme facilitated the signing of two Memoranda of Understanding (MoU) with the Chamber of Agriculture, Fisheries, Livestock and Forests of Cameroon (CAPEF) and CAPERFARMING-COOP-BoD. Furthermore, it supported the incubation of 41 student-led agribusiness initiatives [35].

These results suggest that the UBAES/EAI model has the potential to overcome structural failures of fragmentation and resource instability described in previous eras [7, 14]:

- Addressing the Directive Era (Pre-1990): The IPs mandate joint agenda setting, which supports locally adapted solutions.
- Mitigating Fragmentation (Post-1990): The University's role as a neutral convener offers the stability required to sustain coordination [32].
- Resolving the Funding Crisis: The shift toward endogenous financing via social enterprises is a critical step toward long-term scalability [31].

From a food sovereignty perspective, these governance shifts are significant. By re-centering decision-making power over livestock knowledge within national institutions, the UBAES contributes to strengthening democratic control over production systems. By prioritizing indigenous livestock resources and co-creating curricula with farmers' organizations, the model aligns with the pillars of food sovereignty regarding equitable access to productive resources and the recognition of local knowledge systems [40]. However, full realization of these goals will require sustained policy support and scaling.

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

The current pluralistic agricultural extension system in Cameroon faces significant limitations. The University-Based Extension System, anchored by multi-stakeholder Innovation Platforms, presents a viable evolutionary step. By aligning the university's research mandates with practical extension needs, the model offers a robust pathway to professionalize service delivery and contribute meaningfully to Food Sovereignty.

It is recommended that the Government should consider formally incorporating the UBAES model into the national extension strategy. The University leadership should provide the administrative flexibility necessary to structure extension services as revenue-generating social enterprises. Furthermore, International development partners and donor agencies should pivot their funding models away from transient, project-based interventions towards sustainable, long-term investments that build the core institutional capacity of university-led extension units.



Declarations

Corresponding author: Divine EWANE, Faculty of Agriculture and Veterinary Medicine, University of Buea Cameroon.

Data availability: Data are available from the corresponding author upon reasonable request.

Author contribution: Conceptualization: Ewane D, Ewane EEE; Methodology: Ewane D, Ndam LM, Eyong ET, Anumoh M, Tamesse JL, Chah JM, Oben PM, Ehabe EE. Writing -Original Draft: Ewane D, Ewane EEE Writing-Review and Editing: Ewane D, Ewane EEE, Ndam LM, Ehabe EE, Tamesse JL, Chah JM, Oben PM.

Consent to publish: All Co-authors have given their full consent to publish.

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Ethics: This manuscript was based on secondary analysis of institutional documents and reflective accounts from the SP-UB-LPA-SBI. No new individual-level data were collected specifically for this study. All programme activities involving students, farmers and other stakeholders were conducted under the oversight of the University of Buea's institutional procedures and applicable national regulations on research ethics.

Competing interests: The authors declare that they have no commercial or financial relationships that could be construed as a potential conflict of interest.



Table 1: Innovation Platform activities (adapted [38])

Support Platforms	Innovation	Description
	Knowledge generation	Experimentation, learning, and knowledge development as central elements of innovation, with better integration and synergies among technical, organizational and institutional options.
	Facilitation of multi-directional information flows	Exchange of information and views of those concerned through networks, allowing information to spread.
	Creation of, or an increase in, momentum for change	Generating solutions in context, on the basis of shared expectations and vision, creates buy-in and unity among Innovation Platform members and legitimacy for the innovations being generated. It motivates collective action to address complex challenges, enhances learning processes, and generates solutions with multiple benefits.
	Guidance of research, policy, and investment priorities	Prioritization of innovation options based on preferences or expectations of informed stakeholders, for targeted resource allocation.
	Market formation	Facilitation of (niche) market creation, in marginal areas, post-conflict zones, illustrating market opportunities, creating trust in market agents, transportation of produce to faraway markets
	Building entrepreneurial skills	Creation of business opportunities by deploying new technologies, markets, learning and networking.
	Policy development	Involving policy advocates and decision makers in an Innovation Platform is a way to sensitize effectively about policy gaps and generate evidence.
	Resources mobilization	Assembly of diverse resources (for example financial, human, social, and physical resources) required to leverage change.

Source: **Hekkert et al. [38])**

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