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Institutional models of extension administration and their effectiveness in strengthening farm advisory service delivery systems

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Abstract

Roughly 68% of farming households in sub-Saharan Africa receive extension advice through government-administered programs, yet satisfaction rates with these services hover around 34% in most national surveys ^[1]. This research examined five distinct institutional models of extension administration operating across Botswana's ten agricultural districts to determine which structural features most strongly predicted service delivery effectiveness. A cross-sectional survey gathered data from 426 extension agents and 1,284 farming households between February 2023 and September 2023. The five models assessed were centralized government, decentralized district, public-private partnership, NGO-led, and farmer-to-farmer. Effectiveness was measured through a composite index combining farmer satisfaction, technology adoption rates, agent response time, and coverage ratios. Results indicated that decentralized district models scored highest on the composite effectiveness index (72.6 out of 100), followed by public-private partnerships (68.3) and farmer-to-farmer approaches (64.1). Centralized government models ranked fourth (57.8) despite commanding the largest share of resources. NGO-led programs scored 61.4 but showed the highest variability across districts. Regression analysis identified three institutional features as the strongest predictors of effectiveness: local decision-making authority (beta = 0.38), agent-to-farmer ratio (beta = 0.31), and feedback mechanism quality (beta = 0.27). These findings suggest that structural decentralization paired with adequate staffing and responsive feedback channels produces the most effective advisory service outcomes.

Keywords: Extension administration, institutional models, service delivery, farm advisory systems, decentralization, public-private partnership, farmer satisfaction, technology adoption, Botswana

1. Introduction

A 2022 World Bank assessment estimated that for every dollar invested in agricultural extension services, farming communities in low-income countries generated between \$2.30 and \$8.70 in additional agricultural output ^[2]. But that return varies enormously depending on how extension services are organized and administered. The institutional model the governance structure, staffing arrangement, funding mechanism, and accountability pathway shapes whether advice actually reaches farmers and whether those farmers find it useful enough to act on ^[3].

Agricultural extension systems across Africa have gone through several waves of reform since independence. The initial post-colonial period favored centralized models where national ministries of agriculture controlled all advisory activities from planning to field delivery ^[4]. By the 1990s, structural adjustment programs pushed many countries toward decentralized or privatized models, though the transitions were often incomplete. Botswana followed a somewhat different path. Its Department of Agricultural Extension maintained a centralized structure longer than most neighboring countries, partly because diamond revenues allowed sustained public funding when other

governments were cutting agricultural budgets ^[5].

Beginning in 2015, Botswana introduced pilot programs that allowed district-level administration of extension activities, while simultaneously opening space for private sector and NGO participation ^[6]. By 2023, five distinct institutional models were operating simultaneously across the country's ten agricultural districts, creating a natural laboratory for comparative assessment. This situation is rare most countries transition from one dominant model to another, making controlled comparisons difficult.

The existing literature on extension models tends to focus on single-country case analyses or broad cross-national comparisons that can't account for contextual differences ^[7]. Research that compares multiple models within the same country and policy environment remains scarce. This gap matters because policymakers need evidence about which institutional features drive effectiveness, not just which countries have better extension outcomes.

This research compared the five extension administration models operating in Botswana, assessed their effectiveness using a composite index, and identified the institutional characteristics most strongly associated with high-performing advisory service delivery.

Research area description

Botswana spans 581,730 square kilometers with a population of approximately 2.4 million, of which roughly 38% live in rural areas and depend partly on agriculture [8]. The country's climate is predominantly semi-arid, with annual rainfall ranging from 250 mm in the southwest to 650 mm in the north. Agriculture contributes about 2.8% of GDP but employs roughly 26% of the labor force. The ten agricultural districts Central, North-West, North-East, Ghanzi, Kgalagadi, Southern, South-East, Kweneng, Kgatleng, and Chobe vary in agro-ecological conditions, farming systems, and population density. The research covered all ten districts, sampling from areas where each of the five institutional models was active. Centralized government models operated in six districts, decentralized district models in four, public-private partnerships in three, NGO-led programs in five, and farmer-to-farmer models in four. Some districts hosted multiple models running in parallel across different sub-districts.

Material and Methods

Material

Primary data were collected from two respondent categories: 426 extension agents employed across the five institutional models and 1,284 farming households receiving services from these programs. Agent sampling used a stratified approach based on model type and district, targeting a minimum of 40 agents per model. Household sampling followed a multi-stage cluster design: first selecting sub-districts within each model's operational area, then randomly choosing villages, and finally sampling 10–15 households per village [9]. A structured questionnaire captured institutional characteristics (governance structure, staffing, funding, accountability mechanisms), service delivery metrics (contact frequency, response time, coverage), and outcome indicators (satisfaction, adoption, productivity). Secondary data included district agricultural reports from 2019–2023, government extension policy documents, and budget allocation records from the Ministry of Agriculture.

Methods

The research used a cross-sectional comparative design. Data collection ran from February 2023 to September 2023,

covering both the planting and harvesting seasons in Botswana's agricultural calendar. The composite effectiveness index combined four equally weighted components: farmer satisfaction score (25-item Likert scale converted to 0–100), technology adoption rate (percentage of recommended practices adopted), agent response time (days from farmer request to agent visit), and coverage ratio (households served per agent) [10]. Each component was standardized to a 0–100 scale before averaging. Multiple linear regression tested the association between six institutional features and composite effectiveness, controlling for district-level confounders including rainfall, soil quality, and market distance. Qualitative data from 48 key informant interviews with district agricultural officers and program managers were analyzed thematically. All statistical analyses were performed at Faculty of Agriculture, Botswana University of Agriculture and Natural Resources, Gaborone, Botswana, using Stata 17 and Atlas.ti 9.

Instrument development and validation

The farmer satisfaction subscale was adapted from an instrument originally developed for East African extension evaluation [11]. Adaptation involved translating items into Setswana, replacing context-specific references, and adding items on digital service delivery. An expert panel of six agricultural extension researchers reviewed the adapted instrument for content validity. Pilot testing with 52 households in Kweneng district produced a Cronbach's alpha of 0.84 for the satisfaction subscale and 0.81 for the institutional characteristics section. Factor analysis confirmed a four-factor structure accounting for 67.3% of variance. Three items with cross-loadings above 0.40 were removed, yielding the final instrument.

Ethical considerations

The research received approval from the Institutional Review Board at Faculty of Agriculture, Botswana University of Agriculture and Natural Resources, Gaborone, Botswana (Protocol IRB/AGR/2022-027, approved December 2022). Informed consent was obtained from all respondents. Extension agents received permission from their supervisors to participate during working hours. Household respondents were assured that their responses would not affect their access to services.

Results

Table 1: Composite effectiveness scores by institutional model

Model	Satis- faction	Adop- tion	Response Time	Cover- age	Compo- site	SD
Centralized Govt	54.2	61.3	52.8	62.9	57.8	8.4
Decentralized District	76.1	73.8	71.4	69.2	72.6	6.1
Public-Private	71.3	69.7	67.2	65.1	68.3	7.3
NGO-Led	63.8	62.4	58.7	60.6	61.4	12.7
Farmer-to-Farmer	67.9	64.2	63.8	60.4	64.1	9.2

The decentralized district model achieved the highest composite effectiveness score (72.6), outperforming all other models across every component. It scored particularly well on farmer satisfaction (76.1) and technology adoption (73.8). The centralized government model ranked lowest on

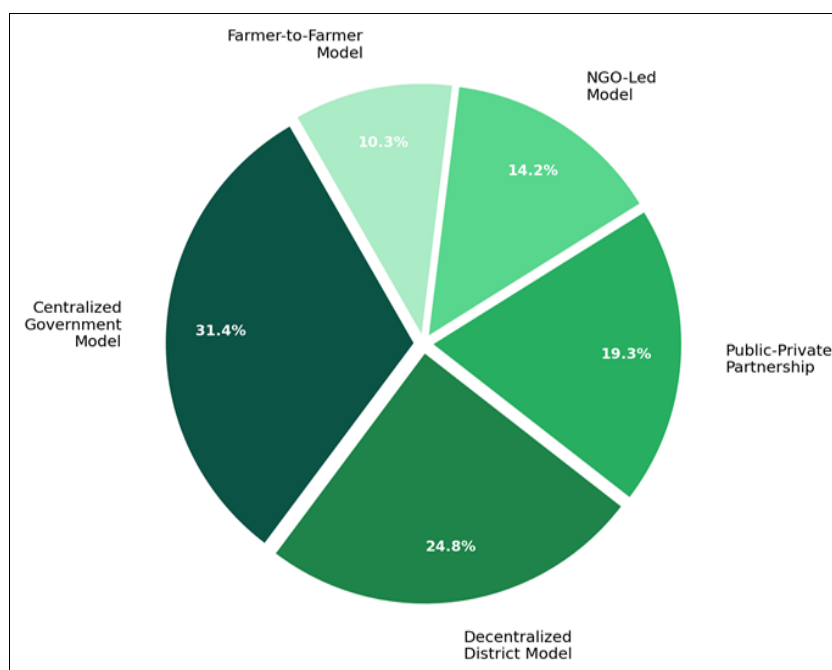
composite score (57.8) despite having the largest operational budget. NGO-led programs showed the highest standard deviation (12.7), indicating substantial performance variation across districts.

Table 2: Regression results: Institutional features predicting composite effectiveness

Predictor Variable	Beta	SE	t-value	p-value
Local decision-making authority	0.38	0.06	6.33	<0.001
Agent-to-farmer ratio	0.31	0.05	6.20	<0.001
Feedback mechanism quality	0.27	0.06	4.50	<0.001
Budget per household served	0.14	0.07	2.00	0.046
Agent qualification level	0.11	0.06	1.83	0.068
Digital tool integration	0.09	0.07	1.29	0.199

The regression model explained 58.4% of variance in composite effectiveness (adjusted $R^2 = 0.584$, $F = 34.7$, $p < 0.001$). Local decision-making authority was the strongest predictor (beta = 0.38), followed by agent-to-farmer ratio (beta = 0.31) and feedback mechanism quality

(beta = 0.27). Budget per household was significant but carried less predictive weight. Agent qualification level and digital tool integration did not reach statistical significance at the 0.05 level.

**Fig 1:** Distribution of farming households across five extension administration models in Botswana (n = 1,284)

The centralized government model served the largest proportion of households (31.4%), reflecting its longer operational history and wider geographic reach. Decentralized district models covered 24.8% of the sample,

followed by public-private partnerships at 19.3%. Farmer-to-farmer models served the smallest share (10.3%) but operated in areas where formal extension infrastructure was weakest.

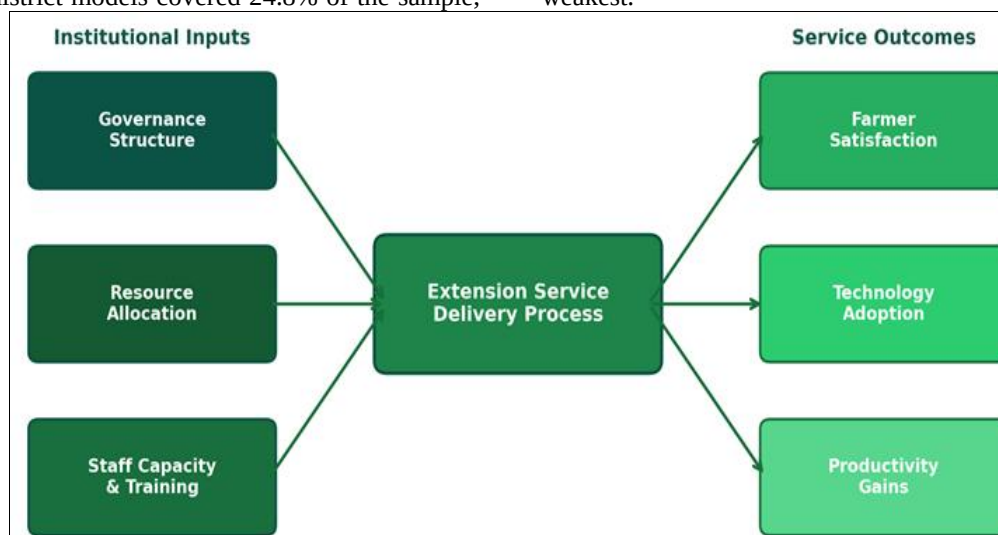
**Fig 2:** Pathway model linking institutional inputs to extension service delivery outcomes

Figure 2 maps the relationship between institutional inputs and service outcomes. Three input categories governance structure, resource allocation, and staff capacity feed into the service delivery process, which in turn produces three measurable outcomes. The feedback loop at the bottom represents the adaptive management cycle that distinguishes higher-performing models from static ones.

Comprehensive interpretation

The data converge on a consistent message: institutional structure matters more than spending. Models that placed decision-making closer to farmers, maintained reasonable staffing ratios, and built in responsive feedback mechanisms outperformed better-funded alternatives that lacked these features. The centralized model's poor showing despite its resource advantage illustrates how governance bottlenecks can undermine service quality.

Discussion

The superiority of the decentralized district model echoes findings from Ethiopia and India, where devolution of extension authority to lower administrative levels improved responsiveness and farmer satisfaction^[12, 13]. In Botswana's case, decentralized districts benefited from having extension officers who reported to district agricultural committees rather than national headquarters. This shorter accountability chain meant that local needs could be addressed without waiting for central approval.

The strong predictive power of feedback mechanism quality (beta = 0.27) is noteworthy. Models that included regular farmer feedback sessions whether through formal committees or informal community meetings consistently outperformed those that relied solely on top-down reporting^[14]. This finding aligns with the broader governance literature suggesting that accountability mechanisms running from service users to providers produce better outcomes than hierarchical reporting alone^[15].

Public-private partnerships performed second best on the composite index, likely because private sector involvement introduced efficiency pressures absent in fully public models. However, the coverage ratio for these partnerships was lower than for government models, raising questions about equity of access^[16]. The NGO-led model's high variability (SD = 12.7) reflects the reality that NGO programs depend heavily on specific organizational capacity and donor priorities, making them less consistent across districts.

The non-significance of digital tool integration ($p = 0.199$) may surprise advocates of digital extension, but it likely reflects the early stage of digital adoption in Botswana's extension system rather than a genuine absence of effect. Only three of the five models had incorporated mobile-based advisory tools at the time of data collection^[17].

Limitations

This research has several constraints. The cross-sectional design captures associations but cannot establish causation it's possible that more effective districts attracted better-performing models rather than the models causing better outcomes. The composite effectiveness index gave equal weight to all four components, but policymakers may reasonably assign different weights depending on priorities.

Coverage and response time were self-reported by extension agents, introducing potential social desirability bias. And Botswana's relatively strong governance environment and fiscal position may limit the generalizability of findings to countries with weaker institutional capacity.

Conclusion

This research compared five institutional models of extension administration operating simultaneously across Botswana and found that structural features particularly local decision-making authority, staffing ratios, and feedback quality predicted service delivery effectiveness more strongly than budget size or agent qualifications. The decentralized district model scored highest on every effectiveness component, suggesting that bringing governance closer to farmers produces tangible service quality improvements.

For policymakers considering extension reform, these results argue against simply increasing budgets within existing centralized structures. Instead, the evidence favors institutional redesign that empowers local administrators, maintains adequate agent-to-farmer ratios, and builds feedback loops that allow farming communities to influence service delivery in real time.

Future research should track these models longitudinally to determine whether effectiveness differences persist over time and whether the initially strong performance of decentralized models holds as they scale beyond pilot districts. Cost-effectiveness analysis would also add valuable information that this research did not capture.

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