



Pluralistic Extension-Service Exposure and Perceived Knowledge, Skills, Adoption and Livelihood Outcomes among Smallholder Farmers in Liberia

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Abstract: Background: Pluralistic extension may widen farmers' learning opportunities, but cross-sectional associations between exposure and outcomes can be distorted by selection, geography and common-method reporting. This study examined the relationship between named-provider exposure and perceived knowledge, attitude, skills, adoption and livelihood-improvement breadth among smallholders in five districts of Bong County, Liberia. Methods: The verified analytical sample contained 232 respondents. Exposure was the count of seven named providers from which services were reportedly received. Outcomes were respondent-level percentages of 37 coded items endorsed as improved across four parallel dimensions. Ordinary least-squares models with HC3 robust standard errors adjusted for age, farming experience, education, farmer-organization membership, bank-account ownership and district. Results: Mean scores rose from approximately 36 among respondents reporting no provider to approximately 50 with one provider and 91 with two to three providers, before plateauing near 86 with four or more. In adjusted models ($n = 230$), each additional provider was associated with 6.29 points higher knowledge breadth (95% CI [4.68, 7.90]), 6.31 higher attitude breadth (95% CI [4.69, 7.92]), 6.21 higher skills breadth (95% CI [4.60, 7.82]) and 6.30 higher adoption breadth (95% CI [4.67, 7.94]); all $p < .001$. Results persisted after excluding BRAC-Liberia and when exposure was represented as any-provider contact. Conclusions: Broader provider exposure was consistently associated with broader perceived improvement, particularly in human-capital and adoption-related domains. The findings do not demonstrate causal impact because exposure and outcomes were measured simultaneously and by self-report. Longitudinal, practice-labelled and independently measured outcomes are required.

Keywords: pluralistic extension, provider exposure, knowledge, skills, adoption, livelihoods, Liberia

INTRODUCTION

Agricultural extension is expected to influence livelihoods through a sequence of information, learning, capability and behavioural pathways. Farmers first encounter ideas and recommendations, interpret their relevance, develop practical competence and decide whether to adopt or adapt promoted practices. These processes may then affect production, market participation, risk management and livelihood assets. Diffusion of Innovations and Agricultural Innovation Systems perspectives both recognize learning as relational rather than a simple one-way transfer (Rogers, 2003; Klerkx et al., 2012).

Pluralistic systems potentially widen these learning opportunities because providers contribute different mandates, knowledge bases and delivery channels. Exposure to several

organizations may reinforce messages, offer complementary services and enable farmers to compare options. It may also generate fragmented or contradictory advice when coordination is weak. Provider count is therefore best understood as breadth of institutional contact, not an automatic measure of quality or dosage. This distinction is consistent with best-fit and system-performance approaches that examine context, governance, reach and outcomes together (Birner et al., 2009; Blockeel et al., 2023).

Empirical evaluation of extension outcomes is methodologically difficult. Farmers who receive more services may differ from others in motivation, assets, education, organization membership, accessibility or commercial orientation. Programmes may target communities with favourable infrastructure or existing groups. Cross-sectional surveys also risk common-method bias when respondents report both exposure and improvement at the same interview. Recent reviews emphasize the need to distinguish associations from identified impacts and to consider multiple information and learning pathways (Spielman et al., 2021).

The Sustainable Livelihoods Framework broadens the outcome question beyond production or income. Extension may contribute to human capital through knowledge and skills, social capital through organizations and relationships, financial capital through credit or markets, physical capital through productive resources and natural capital through soil or climate-risk management. Yet evidence strength can differ across these capitals, especially when monetary fields have mixed units or outcomes are perceived rather than objectively measured.

Liberia's extension policy seeks a pluralistic, participatory, market-oriented and inclusive system capable of strengthening production, value addition and decision-making (Government of Liberia, Ministry of Agriculture, 2023). That ambition must be interpreted against documented personnel and institutional-capacity constraints in post-conflict Liberia (Moore & Harder, 2015). Evidence from Bong County can clarify whether wider provider exposure is associated with the perceived learning-to-adoption sequence while identifying the limits of available outcome measurement.

This article asks whether the number of named providers from which farmers report receiving services is associated with perceived knowledge, attitude, skills and adoption breadth after adjustment for available social, human, financial and geographical covariates. It also examines categorical exposure patterns and alternative exposure specifications. The study deliberately uses association language and does not interpret provider count as a causal treatment.

MATERIALS AND METHODS

Design, Setting and Sample

A cross-sectional farmer survey was conducted in Fuamah, Jorquelleh, Kpai, Salala and Zota districts of Bong County. From 326 exported records, 232 mapped unambiguously to the five declared districts and formed the primary sample. The district distribution was Jorquelleh 102, Salala 43, Fuamah 41, Kpai 26 and Zota 20. Models used 230 complete cases. The achieved sample was unweighted and is not assumed to represent all Liberian smallholders.

Exposure Measure

Exposure was the number of Yes responses to reported receipt from seven authenticated providers: Catalyst Liberia, STCRSP/IFAD, ZOA Liberia, Educare Liberia, Bong County University, BRAC-Liberia and Mercy Corps-Liberia. The resulting count ranged from zero to seven. Sensitivity measures included any-provider contact, a count excluding BRAC-Liberia and categories of none, one, two to three, and four or more providers. Count breadth does not capture contact frequency, service content, duration or quality.

Outcome Construction

The export contained 37 coded livelihood or practice rows repeated across Knowledge, Attitude, Skills and Adoption dimensions, yielding 148 binary variables. A Yes response indicated that the respondent perceived pluralistic extension as having improved that dimension for the coded item. For each dimension, the outcome was the percentage of available items endorsed Yes (0-100). Because the export did not preserve reliable substantive labels for the 37 rows, scores are described as perceived improvement breadth; no item names or livelihood-capital assignments were invented. The scores are not objective percentage changes.

Covariates and Analysis

Covariates were selected from the conceptual framework: age, farming experience, education, farmer-organization membership, bank-account ownership and district. Four parallel ordinary least-squares models used HC3 heteroskedasticity-consistent standard errors. Coefficients represent adjusted mean score differences. Model fit, leverage, Cook's distance and variance-inflation factors were examined. Alternative models used the provider count excluding BRAC-Liberia and an any-provider indicator. Categorical means were used to inspect functional form. Two-sided $\alpha = .05$ was used, but interpretation emphasized magnitude, confidence intervals, robustness and design limitations.

Ethics

The Njala University Research Ethics Committee approved the study (NUREC432) on 10 May 2025. Written consent was obtained after information was read and explained in farmers' local languages. Fieldwork was authorized by the Department of Agricultural Extension and Rural Sociology, Njala University.

RESULTS

Exposure Distribution

Providers received	Respondents n	Percentage
0	42	18.1
1	66	28.4
2	55	23.7
3	26	11.2

4	5	2.2
5	7	3.0
6	10	4.3
7	21	9.1

Mean exposure was 2.22 providers (SD = 2.10; median = 2). The distribution combined a sizeable no-provider group with a smaller cluster reporting all seven providers. This non-normal pattern motivated categorical checks and robust uncertainty estimation.

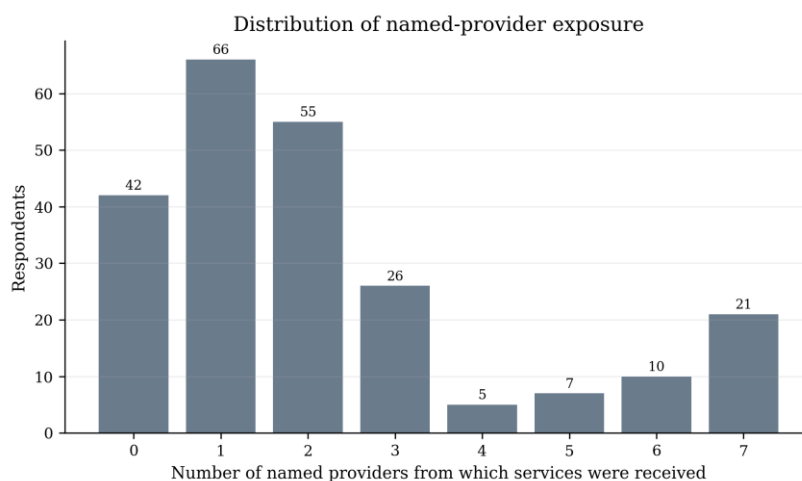


Figure 1: Distribution of reported receipt from seven named providers.

Categorical Exposure Gradient

Exposure category	n	Knowledge mean (SD)	Attitude mean (SD)	Skills mean (SD)	Adoption mean (SD)
None	42	36.10 (20.18)	36.16 (20.01)	36.04 (20.15)	35.80 (20.26)
One	66	50.20 (19.34)	49.92 (19.69)	49.96 (19.31)	49.71 (19.96)
Two to three	81	90.72 (18.26)	90.79 (18.06)	90.89 (18.20)	90.89 (18.11)
Four or more	43	86.05 (13.83)	85.98 (13.44)	85.85 (13.91)	85.98 (13.68)

All four dimensions displayed the same broad pattern: modest scores with no or one provider, a sharp increase at two to three providers and a plateau or slight decline at four or more. The non-monotonic upper category cautions against treating every additional provider as equally beneficial. It may reflect ceiling effects, differing provider mixes, geographical concentration or selection into high exposure.

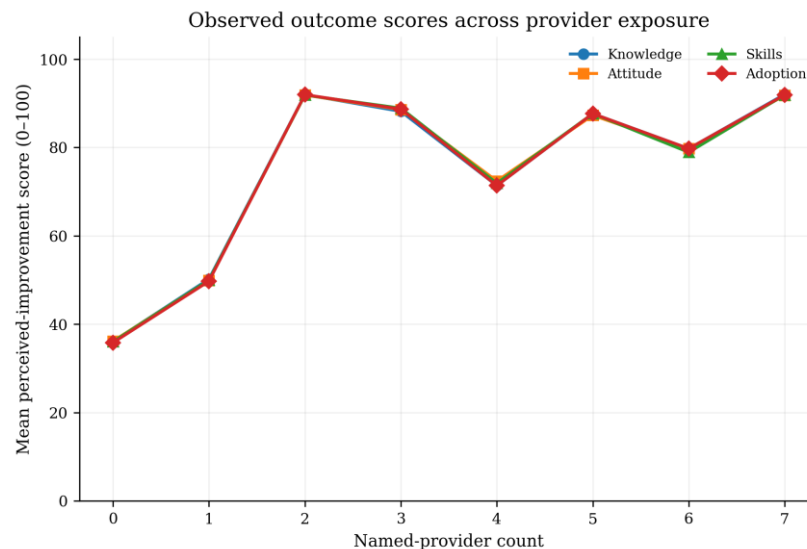


Figure 2: Observed mean perceived-outcome scores across exact provider counts.

Adjusted Associations

Outcome	n	B per additional provider	HC3 SE	95% CI	p	R ²
Knowledge	230	6.288	.818	4.675-7.900	<.001	.556
Attitude	230	6.308	.820	4.693-7.923	<.001	.553
Skills	230	6.208	.816	4.601-7.815	<.001	.564
Adoption	230	6.302	.829	4.667-7.937	<.001	.562

Each additional provider was associated with approximately 6.2-6.3 points greater perceived-improvement breadth after adjustment. The near-identical coefficients reflect the strong alignment of the four response dimensions and should not be treated as four independent replications. Model R² values were between .553 and .564.

Model Diagnostics and Sensitivity Analyses

RMSE values ranged from 19.24 to 19.45. Maximum leverage was .123 and maximum Cook's distance ranged from .038 to .067; 16-18 cases exceeded the 4/n influence-screening threshold, prompting robust rather than deletion-based analysis. All VIFs were below 2.5, with named-provider count at 1.81. When BRAC-Liberia was excluded from exposure, coefficients remained positive (5.65-5.75 points; all $p < .001$). Any-provider contact was associated with 27.05-27.51 points higher perceived breadth across dimensions (all $p < .001$). The consistency indicates that the main association was not solely an artefact of the dominant provider or one exposure coding choice.

Livelihood Interpretation

The data most directly support human-capital and adoption-related interpretations. Social capital is implicated by the close relationship between farmer organizations and provider access. Financial, physical and natural-capital claims are weaker because income units were inconsistent, comprehensive asset change was unavailable and soil/weather services were

rarely identified. A single general livelihood-impact claim would therefore exceed the evidence.

Livelihood capital	Verified signal	Interpretive strength
Human	Knowledge and skills breadth	Strong perceived association; no competency test
Social	Organization membership and provider access	Strong access gradient; temporal direction unresolved
Financial	Credit visibility and perceived breadth	Limited; monetary income withheld
Physical	Selected support and service access	Indirect; asset change incompletely measured
Natural	Production, soil and weather-related domains	Partial; risk services weakly visible

DISCUSSION

The central finding is a strong, consistent association between wider provider exposure and broader perceived improvement across the knowledge-attitude-skills-adoption sequence. Respondents reporting two or more providers endorsed many more coded improvements than those reporting none or one. Adjustment for measured respondent and district characteristics reduced some observable confounding but did not eliminate the association. Evidence that farmers' satisfaction and perceived outcomes can depend on the number and fit of services received provides a relevant comparison, although service context and measurement differ (Kenfack Essougong et al., 2024).

A plausible substantive explanation is complementarity. Different providers may repeat important messages, supply distinct expertise or connect learning with finance, organization and implementation support. Repeated exposure can also create opportunities for clarification and peer reinforcement. This interpretation is consistent with innovation-systems thinking, in which outcomes emerge through interactions among multiple actors rather than isolated technology transfer (Klerkx et al., 2012; World Bank, 2012).

However, the categorical pattern does not support a simple linear dose-response story at high exposure. Scores peaked among respondents reporting two to three providers and were slightly lower among those reporting four or more. More contacts may create diminishing returns, overlap or contradictory advice. Alternatively, the high-exposure group may be concentrated in particular programmes or districts. Coordination quality and portfolio complementarity may therefore matter more than maximizing provider count.

The near identity of the four outcome dimensions has both substantive and methodological interpretations. Knowledge, attitudes, skills and adoption may develop as an interconnected process, making aligned responses plausible. Yet identical yes/no formats presented together can encourage acquiescence or a common global judgement. Without timestamps or independent measures, the study cannot establish that knowledge preceded adoption or that each dimension represents a distinct latent construct.

Recent methodological literature on extension similarly warns that information exposure does not uniformly generate adoption or welfare change and that impacts depend

on delivery design, context, social networks and complementary resources (Spielman et al., 2021). Conservation-adoption reviews also emphasize interacting barriers rather than information alone (Lee et al., 2022). The Bong County association should therefore be understood as evidence that plural exposure accompanies perceived improvement, not that information automatically becomes practice.

The Sustainable Livelihoods interpretation must remain differentiated. Human capital has the clearest support because perceived knowledge and skills were measured directly. Social capital is relevant because organizations structure access. The data are less able to substantiate financial welfare, physical asset accumulation or natural-capital improvement. Withholding monetary-income analysis where units and reference periods could not be authenticated protects the article from an unsupported impact claim.

For policy, the results suggest that referrals and coordinated service bundles may be more valuable than isolated organizational contacts. A farmer receiving production advice should be able to reach complementary diagnostic, market, credit, processing and climate services. Monitoring should record the sequence, content, frequency and completion of these contacts and should include objective practice or livelihood indicators rather than relying solely on retrospective perceptions, consistent with extension-system assessment guidance (Swanson & Rajalahti, 2010).

Limitations

The cross-sectional design does not establish temporal order or causal effects. Provider exposure and perceived outcomes were self-reported at the same interview, creating recall and common-method risks. The provider count gives equal weight to organizations and omits contact intensity, timing and content. The 37 coded rows lacked authenticated item labels, limiting content validity and livelihood-capital interpretation. Outcomes were bounded and highly concordant; HC3 inference addresses heteroskedasticity but not selection or measurement error. Unequal district samples and absent weights limit generalization. Residual confounding may involve motivation, accessibility, prior ability, market orientation and provider targeting.

CONCLUSIONS AND IMPLICATIONS

Broader exposure to named extension providers was consistently associated with broader self-reported improvement in knowledge, attitudes, skills and adoption among the achieved five-district sample. The association remained after covariate adjustment and alternative exposure coding, but it is not a causal impact estimate. Policy should focus on coordinated, complementary and inclusive service pathways rather than provider counts alone. Future studies should recover practice labels, measure exposure intensity and timing, use objective competency and adoption indicators, follow farmers longitudinally and incorporate defensible counterfactual designs. Such evidence is required before attributing livelihood change to pluralistic extension.

DECLARATIONS

Ethics Approval and Consent to Participate

The study was approved by the Njala University Research Ethics Committee (NUREC432) on 10 May 2025. Written informed consent was obtained. Consent information was read and explained to farmers in their respective local languages before written consent was completed. Fieldwork was authorized by the Department of Agricultural Extension and Rural Sociology, Njala University.

Consent for Publication

The manuscript reports anonymized aggregate data and contains no personally identifying information.

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Competing Interests

The authors declare that they have no competing interests.

Data Availability

The de-identified analytical data and reproducible analysis syntax may be made available by the corresponding author subject to ethics, confidentiality and institutional data-governance requirements.

Author Contributions

CRedit statement: Mohamed Paul Ngegbe—conceptualization, methodology, supervision, validation and writing—review and editing; James Kamara—investigation, data curation, formal analysis and writing—original draft; Leroy Wanga Cegbe—methodology, validation and writing—review and editing. All authors approved the final manuscript and author order.

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