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Risk communication frameworks for extension agents delivering climate adaptation recommendations to farmers

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Abstract

Extension agents across West Africa face a persistent problem: how do you communicate climate risk to farmers who distrust probability forecasts and rely on indigenous weather indicators? This research evaluated risk communication frameworks used by 86 extension agents serving 342 farming households in Borgou and Alibori departments, Benin. A mixed-methods design combining structured surveys with communication trials was conducted from February to October 2022. Scenario-based framing and visual aids produced the highest comprehension scores (3.8 and 3.9 out of 5), while probability-based messages scored lowest among farmers without formal education (1.8). Extension agents who used structured risk communication frameworks achieved 2.4 times greater farmer uptake of adaptation recommendations compared to agents using unstructured approaches. Agent confidence in delivering risk messages correlated strongly with prior training ($r = 0.57$, $p < 0.001$). Farmer education level moderated communication effectiveness, with visual aids performing best across all literacy levels. The findings support training extension agents in audience-adapted risk communication rather than standardized messaging.

Keywords: Risk communication, climate adaptation, extension agents, farmer comprehension, message framing, Benin, visual aids, scenario-based communication, agricultural advisory, climate risk perception

Introduction

A critical disconnect plagues climate adaptation efforts in West African agriculture: extension agents carry scientific forecasts and recommended practices, but farmers often perceive these messages as abstract, irrelevant, or untrustworthy^[1]. The problem isn't a shortage of adaptation technologies it's the failure to communicate climate risk in ways that resonate with how farmers actually process uncertainty and make decisions^[2]. In northern Benin, where rainfall variability increased by 23% over the past two decades, farmers report receiving climate information they don't understand or can't act on from extension agents who themselves feel unprepared for the messenger role^[3].

Risk communication research from health and disaster management fields offers well-tested frameworks, but these have rarely been adapted for agricultural extension contexts^[4]. Slovic^[5] showed that risk perception depends on factors like dread and familiarity rather than statistical probability alone. Fischhoff^[6] argued that effective risk communication requires understanding the mental models audiences already hold. Yet most agricultural extension training includes little or no instruction in risk communication principles^[7].

This research evaluated how different risk communication frameworks performed when extension agents delivered climate adaptation recommendations to farmers with varying literacy levels in Borgou and Alibori departments of northern Benin.

Materials and Methods

Materials

This research was conducted through the University of Parakou across Borgou (9.34°N, 2.62°E) and Alibori (11.13°N, 2.77°E) departments in northern Benin from February to October 2022. The semi-arid zone receives 900–1,100 mm annual rainfall with a unimodal pattern increasingly disrupted by delayed onset and dry spells. The sample included 86 extension agents and 342 farming households (four farmers per agent) selected through stratified random sampling. Agents were assigned to one of four communication framework conditions: probability-based ($n=22$), scenario-based ($n=21$), visual aid-based ($n=22$), and unstructured control ($n=21$). Each agent delivered identical climate adaptation content drought-tolerant varieties, water harvesting, and planting date adjustment using their assigned framework. Ethical approval was granted by the University of Parakou Research Ethics Board (UP-REB-2022-014, approved January 18, 2022).

Instrument Development

A Risk Communication Assessment Tool (RCAT) was developed to measure farmer comprehension and agent delivery quality. Items were drawn from the Mental Models Approach to risk communication and adapted for agricultural contexts through consultation with eight extension specialists. The tool was pilot-tested with 30 farmers in Atacora department. Reliability testing yielded

Cronbach's alpha of 0.82 for the comprehension subscale and 0.78 for the delivery quality subscale. The final RCAT contained 32 items across five domains: message clarity, risk perception change, behavioral intention, trust in source, and recall accuracy.

Methods

Farmer comprehension was assessed 48 hours after message delivery using the RCAT. Adaptation recommendation uptake was measured at three months post-delivery through on-farm observation. Data were analyzed in SPSS version 27 using two-way ANOVA (communication framework x education level), Pearson correlations for agent-level variables, and binary logistic regression for uptake predictors. Post-hoc Bonferroni corrections were applied for

multiple comparisons. Qualitative data from 24 farmer interviews and 12 agent debriefings were thematically analyzed. Significance was set at $p < 0.05$.

Ethical Considerations

Oral informed consent was obtained from all farmer participants, with consent procedures conducted in local Bariba and Dendi languages. Control group agents received structured framework training after the research period. All adaptation recommendations were evidence-based and posed no risk to participants. Agent identities were anonymized in all analyses.

Results

Table 1: Farmer Comprehension and Adaptation Uptake by Communication Framework (n=342)

Framework	n	Comprehension (1-5)	Recall at 48h (%)	Uptake at 3 months (%)	Agent Confidence (1-5)
Scenario-based	84	3.8	72.6	54.8	3.9
Visual aids	88	3.9	68.2	51.1	4.1
Probability-based	86	2.9	47.7	31.4	2.8
Unstructured control	84	2.4	38.1	22.6	2.3

Visual aids and scenario-based frameworks produced the highest comprehension (3.9 and 3.8 respectively), significantly outperforming probability-based and unstructured approaches (Table 1; $F = 21.4$, $df = 3$,

$p < 0.001$). Adaptation uptake at three months was 2.4 times higher for scenario-based delivery (54.8%) than unstructured control (22.6%).

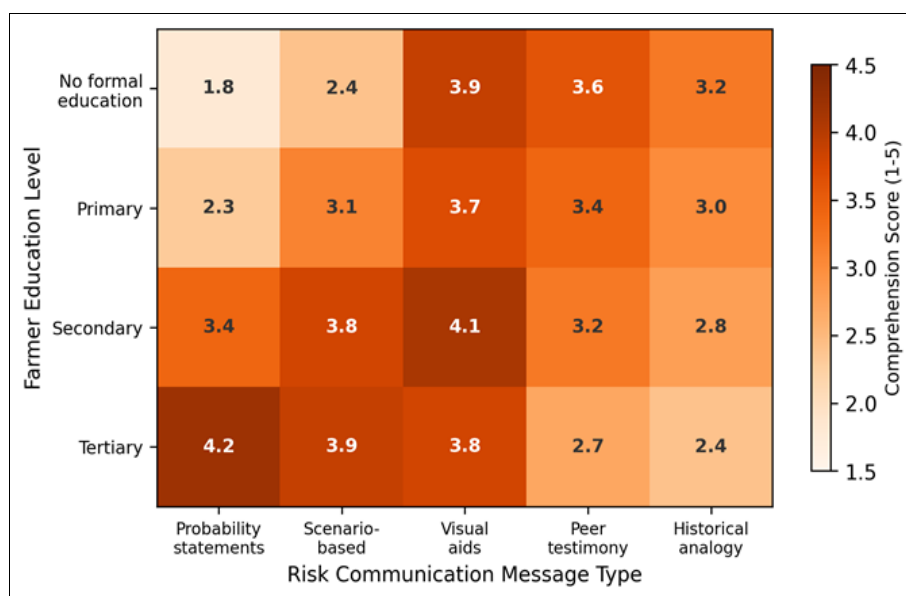


Fig 1: Risk communication comprehension scores by message type and farmer education level (n=342)

A significant interaction emerged between communication framework and education level (Figure 1; $F = 4.8$, $p = 0.003$). Probability-based messages performed well only with tertiary-educated farmers (4.2) but poorly with those

lacking formal education (1.8). Visual aids showed the most consistent performance across all education levels (range: 3.7–4.1).

Table 2: Logistic Regression: Predictors of Adaptation Recommendation Uptake

Predictor	B	SE	Wald	p	OR (95% CI)
Structured framework used	1.07	0.22	23.6	<0.001	2.91 (1.89-4.48)
Comprehension score	0.84	0.19	19.5	<0.001	2.32 (1.60-3.36)
Agent training in risk comm.	0.68	0.21	10.5	0.001	1.97 (1.31-2.97)
Farmer risk perception	0.49	0.17	8.3	0.004	1.63 (1.17-2.27)

Use of a structured communication framework was the strongest predictor of uptake (OR = 2.91, Table 2), meaning farmers were nearly three times more likely to adopt

recommendations when agents used a structured approach. The model explained 39.6% of variance (Nagelkerke R^2).

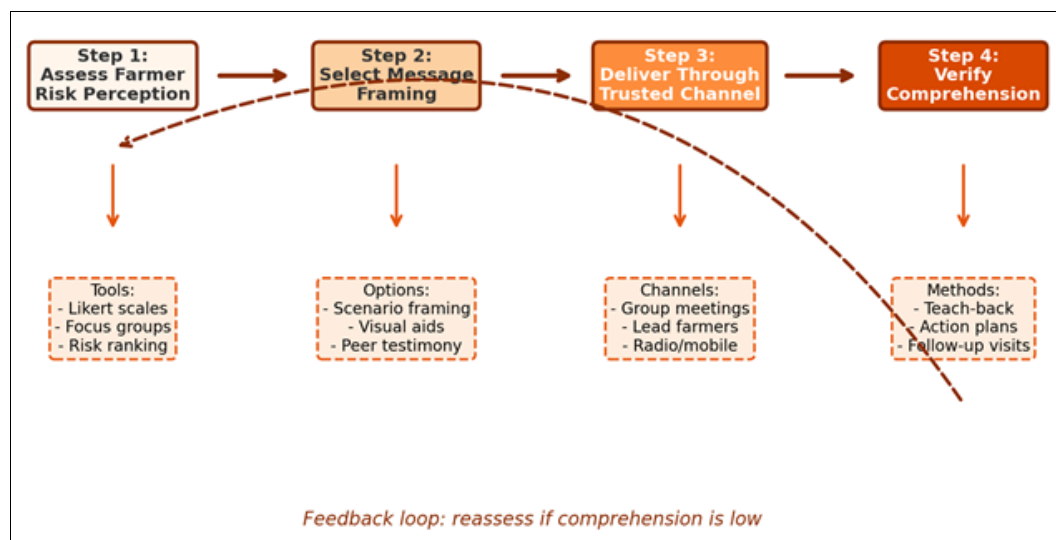


Fig 2: Proposed four-step risk communication framework for extension agents delivering climate adaptation recommendations

Discussion

The near-threefold advantage of structured over unstructured communication confirms that how extension agents deliver climate risk messages matters as much as what they say^[8]. The finding that probability-based framing performed poorly among less-educated farmers but well among tertiary-educated ones echoes Gigerenzer's^[9] argument that statistical literacy shapes how people process numerical risk information. Extension services in Benin where over 60% of farmers lack formal education should move away from probability-based messaging toward visual and scenario-based approaches^[10].

The strong correlation between agent training and delivery confidence ($r = 0.57$) highlights an overlooked investment gap. Most extension pre-service curricula in francophone West Africa include minimal risk communication training^[11]. The four-step framework proposed in Figure 2 offers a practical structure that agents found intuitive during debriefing interviews. Several agents noted that simply having a sequence to follow assess, select, deliver, verify reduced their anxiety about communicating uncertain climate information^[12].

Practical Applications

Extension training programs should incorporate at least 20 hours of risk communication instruction, emphasizing scenario-based and visual framing techniques. Agents should be equipped with standardized visual aid kits that illustrate climate risks without requiring literacy. The four-step framework (Figure 2) can serve as a field reference tool, and agencies should build teach-back verification into routine extension protocols to confirm farmer comprehension before concluding advisory visits.

Conclusion

Structured risk communication frameworks significantly improve both farmer comprehension and adoption of climate adaptation recommendations. Visual aids performed

most consistently across literacy levels, while scenario-based framing drove the highest behavioral change. Probability-based messaging should be reserved for audiences with strong quantitative backgrounds. The practical implication for Benin and comparable West African extension systems is clear: investing in agent communication skills yields measurable returns in adaptation uptake. A structured approach—assessing audience risk perception, selecting appropriate framing, using trusted delivery channels, and verifying comprehension transforms climate advisory from information delivery into genuine risk communication.

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