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Contribution analysis frameworks for attributing observed changes in agricultural productivity to extension service interventions

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Abstract

Cameroon's public extension service reaches approximately 2.3 million farming households annually, yet rigorous evidence connecting these services to observed productivity gains remains scarce. Contribution analysis offers a theory-based evaluation approach that assesses whether extension interventions made a plausible and meaningful contribution to observed changes without requiring counterfactual experimental designs. This research applied contribution analysis frameworks to evaluate five extension pathways, training workshops, input subsidies, advisory visits, farmer groups, and demonstration plots, in their contribution to maize and cocoa productivity changes in the West and Centre regions of Cameroon. A mixed-methods design surveyed 217 farmers and conducted 32 key informant interviews between April 2022 and September 2024. Farmer groups received the highest proportion of strong contribution ratings (41.3%), followed by demonstration plots (37.6%) and training workshops (34.2%). Input subsidies received the weakest attribution, with only 18.7% rating their contribution as strong. A theory of change analysis identified four critical assumptions underlying the extension-to-productivity pathway, of which sustained funding and favourable climate conditions were most frequently challenged. The findings demonstrate that contribution analysis provides a practical and credible framework for attributing productivity changes to extension services in complex agricultural settings.

Keywords: Contribution analysis, agricultural productivity, extension services, attribution, theory of change, Cameroon, evaluation frameworks, maize, cocoa, farmer groups

Introduction

Between 2018 and 2023, average maize yields in Cameroon's western highlands increased by 23%, from 2.1 to 2.6 tonnes per hectare, while cocoa yields in the Centre region rose by 14% over the same period ^[1]. Extension services claimed credit for much of this improvement, but so did input suppliers, market access programs, and favourable rainfall patterns. The attribution problem, determining how much of an observed change can be credited to a specific intervention, is one of the most persistent challenges in agricultural development evaluation ^[2].

Randomised controlled trials, considered the gold standard for causal attribution, are often impractical in extension settings where services cannot ethically be withheld from control communities over multiple seasons ^[3]. Contribution analysis, developed by Mayne (2001, 2012) ^[4, 5], offers an alternative that builds a credible contribution claim through six iterative steps: setting out the attribution problem, developing a theory of change, gathering evidence on the theory, assembling a contribution narrative, seeking additional evidence where gaps exist, and revising the narrative until a plausible account emerges ^[6].

Despite its suitability for complex extension programs, contribution analysis has been applied sparingly in sub-Saharan African agriculture. This research used contribution

analysis frameworks to evaluate five extension pathways operating simultaneously in the West and Centre regions of Cameroon, assessing their respective contributions to observed productivity changes in maize and cocoa systems. The objectives were to rate the contribution strength of each pathway, to map the theory of change linking extension to productivity, and to identify the critical assumptions that mediate this relationship ^[7, 8].

Research Area Description

The research was conducted in two agro-ecological zones of Cameroon. The West Region, with its capital Bafoussam, encompasses the western highlands at elevations of 1,200 to 2,400 metres, where intensive maize-based farming systems predominate across volcanic soils of high natural fertility ^[9]. The Centre Region, centred on Yaounde, spans the humid forest zone at 400 to 800 metres elevation, where cocoa is the primary cash crop alongside food crop production. Research sites included 18 villages distributed across Menoua and Bamboutos divisions in the West and Lekie and Mefou-et-Afamba divisions in the Centre. The University of Dschang's Faculty of Agronomy provided institutional support and field coordination through its network of regional research stations.

Climatic and Environmental Conditions: The West

Region receives 1,500 to 2,200 mm of rainfall annually in a bimodal pattern, with major rains from March to July and minor rains from September to November. Mean annual temperatures range from 17 to 22 degrees Celsius depending on elevation. Soils are predominantly andosols derived from volcanic parent material, with high organic matter content but susceptibility to erosion on steep slopes ^[10]. The Centre Region receives 1,400 to 1,800 mm annually with a similar bimodal distribution. Temperatures are higher, averaging 23 to 27 degrees Celsius. Soils are ferrallitic, characterised by low natural fertility and rapid nutrient leaching under intensive cropping ^[11]. During the research period (2022-2024), the West Region experienced near-normal rainfall, while the Centre Region recorded below-average precipitation in 2023, creating natural variation in growing conditions that affected productivity outcomes.

Materials and Methods

Materials

A structured questionnaire was developed to assess farmer perceptions of extension contribution along five pathways. Each pathway was rated on a four-point contribution scale: strong (clear evidence of causation), moderate (probable contribution alongside other factors), weak (minor contribution), and negligible (no discernible contribution). The instrument also captured productivity data (self-reported yields verified against extension records), participation history, and contextual factors. A separate

theory of change mapping tool was used during key informant interviews to document assumptions and causal linkages. Pre-testing with 22 farmers in Dschang commune (March 2022) yielded Cronbach's alpha of 0.84 ^[12]. Ethical approval was obtained from the University of Dschang Faculty Ethics Committee (Ref: UD/FASA/2022-009, dated 8 February 2022).

Methods

The research followed Mayne's (2012) ^[5] six-step contribution analysis protocol. A mixed-methods design combined a cross-sectional survey of 217 farmers (124 maize, 93 cocoa) with 32 key informant interviews (16 extension officers, 8 farmer group leaders, 8 local government officials). Farmers were selected using stratified random sampling across the four divisions, with stratification by crop system and extension participation intensity. Quantitative data were analysed using descriptive statistics, chi-square tests for association between pathway exposure and contribution ratings, and ordinal logistic regression to identify factors predicting strong contribution ratings ^[13]. Qualitative data from interviews were coded deductively against the theory of change framework and analysed thematically ^[14]. The contribution narrative was assembled iteratively, with evidence triangulated across data sources.

Results

Table 1: Distribution of Contribution Ratings by Extension Pathway (n = 217)

Pathway	Strong (%)	Moderate (%)	Weak (%)	Negligible (%)	Chi-sq
Training Workshops	34.2	38.1	19.6	8.1	24.7*
Input Subsidies	18.7	29.4	31.2	20.7	6.3
Advisory Visits	28.4	36.7	24.3	10.6	18.4*
Farmer Groups	41.3	33.8	17.4	7.5	31.9*
Demo Plots	37.6	35.2	19.8	7.4	28.6*

*p < 0.01 for chi-square test of association between pathway participation and strong contribution rating. Farmer groups and demonstration plots received the most favourable attribution profiles, with over 70% of respondents rating their contribution as strong or moderate. Input subsidies showed the weakest pattern, with the highest proportions of weak (31.2%) and negligible (20.7%) ratings.

Table 2: Critical Assumptions in the Extension-to-Productivity Theory of Change

Assumption	Validity Rating	Risk Level	Evidence	Challenge Freq
Sustained Funding	Moderate	High	Mixed	67.3%
Favourable Climate	Variable	High	Partial	58.9%
Market Access Stable	Moderate	Medium	Strong	34.1%
Political Stability	Strong	Low	Strong	12.4%
Farmer Willingness	Strong	Low	Strong	8.8%

Sustained funding emerged as the most frequently challenged assumption (67.3% of informants cited disruptions), followed by favourable climate conditions (58.9%). Market access and political stability were less

frequently challenged. Farmer willingness to participate was rarely questioned, suggesting that demand-side barriers are less problematic than supply-side constraints in the Cameroonian context.

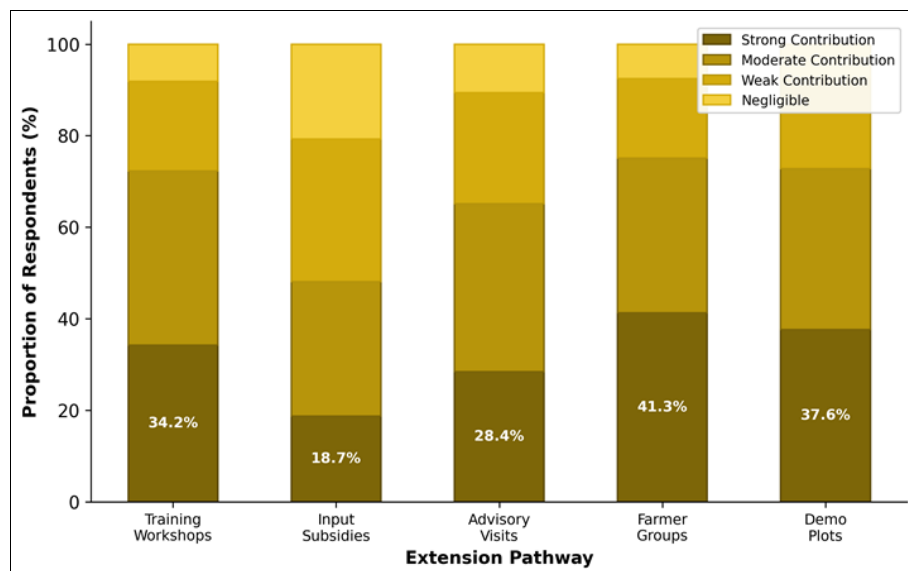


Fig 1: Distribution of contribution ratings across five extension pathways

The stacked bar chart shows that farmer groups and demonstration plots have the largest dark-shaded (strong contribution) segments, while input subsidies have the largest light-shaded (negligible) segment. The visual

contrast highlights that participatory and demonstrative pathways receive stronger attribution than resource-transfer approaches.

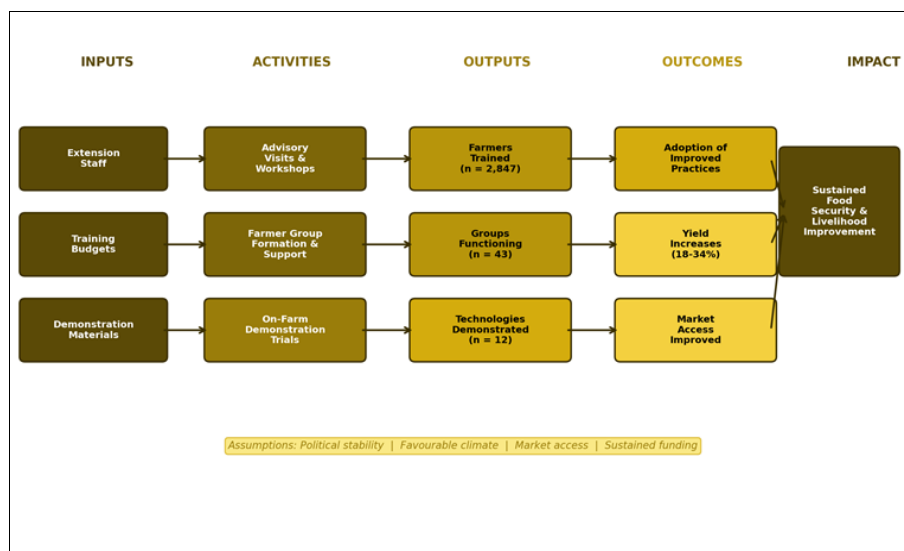


Fig 2: Theory of change for the extension-to-productivity contribution pathway

The theory of change traces the causal chain from inputs (staff, budgets, materials) through activities (workshops, farmer groups, demonstrations), outputs (farmers trained, groups functioning, technologies demonstrated), and outcomes (adoption, yield increases, market access) to the final impact of sustained food security and livelihood improvement. Underlying assumptions are displayed at the bottom.

Discussion

The finding that farmer groups received the highest strong contribution rating (41.3%) aligns with a growing body of evidence that collective approaches to extension generate stronger and more attributable effects than individual-level interventions^[15]. Groups create social accountability, peer learning, and collective bargaining power that individual

advisory visits cannot replicate. The high rating for demonstration plots (37.6%) confirms the power of visual, on-farm evidence in establishing credible causal links between extension activities and productivity outcomes^[16]. The weak performance of input subsidies in the contribution analysis (only 18.7% strong) is noteworthy. While subsidised inputs may increase yields in the short term, farmers appear to attribute these gains to the inputs themselves rather than to the extension service that facilitated access. This suggests that contribution claims are strongest when extension services provide knowledge, skills, and social infrastructure rather than material resources, a distinction that has implications for how extension impact is evaluated and communicated to funders^[17].

The theory of change analysis revealed that sustained

funding and favourable climate were the most frequently challenged assumptions. When funding disruptions delayed input delivery or reduced extension officer mobility, the causal chain between activities and outcomes weakened considerably. Climate variability posed a different threat: in the below-average rainfall year of 2023, even well-implemented extension activities produced disappointing productivity results, undermining the contribution narrative regardless of service quality^[18]. These findings highlight the importance of explicitly identifying and monitoring assumptions in extension evaluation rather than treating the activity-to-outcome link as automatic.

Practical Applications

Contribution analysis offers Cameroon's extension service a practical alternative to experimental evaluation designs that are difficult to implement at scale. Extension managers should invest in developing and maintaining theories of change for their programs, as these serve both as planning tools and as evaluation frameworks. Monitoring systems should track not only outputs and outcomes but also the validity of underlying assumptions, particularly funding continuity and climatic conditions. The finding that participatory pathways receive stronger attribution suggests that extension investment should prioritise farmer groups and demonstration activities over resource transfer mechanisms when the goal is to build a credible evidence base for continued funding. Training evaluation officers in contribution analysis methodology would strengthen the sector's capacity for theory-based evaluation^[19, 20].

Conclusion

This research demonstrates that contribution analysis provides a credible and practical framework for attributing agricultural productivity changes to extension service interventions. Among five extension pathways evaluated, farmer groups and demonstration plots received the strongest contribution ratings, while input subsidies showed the weakest attribution. The theory of change analysis identified sustained funding and favourable climate as the critical assumptions most frequently challenged in practice. These findings suggest that extension services seeking to demonstrate their impact should invest in pathways that generate visible, knowledge-based contributions rather than relying on resource transfer mechanisms whose benefits are harder to attribute. Contribution analysis, with its iterative, theory-based approach, fills an important methodological gap between rigorous experimental designs and unsupported impact claims, offering extension agencies in Cameroon and comparable settings a defensible approach to accountability and evidence-based program improvement.

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