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Assessing the effects of collaborative agricultural extension program design on smallholder productivity and rural livelihood outcomes

¹Dr. Chisomo Banda

¹Department of Agricultural Extension Education, Lusaka University of Rural Extension and Farming Systems, Zambia

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Corresponding Author: Dr. Chisomo Banda

Abstract

Picture a district planning room where smallholder farmers work alongside extension agents to collaboratively shape the upcoming season's advisory program. This research assessed collaborative extension program design's effects on smallholder productivity and livelihood outcomes in Central and Eastern Zambia. A quasi-experimental design compared 196 collaborative households with 182 conventional top-down extension households over two seasons (November 2020–October 2022). Collaborative households achieved 44.3% maize yield increase versus 21.4% in controls ($p < 0.001$). Input adoption reached 70.1% versus 41.2%. Food security indices improved from 0.47 to 0.75 versus 0.45 to 0.54. Cost-effectiveness showed \$4.20 income per dollar invested versus \$2.00 for top-down. Engaging farmers in extension design substantially enhances productivity and livelihood outcomes.

Keywords: Collaborative design, agricultural extension, smallholder productivity, Zambia, livelihood outcomes, farmer collaboration, extension design, food security, rural livelihoods, program evaluation

1. Introduction

Imagine two neighboring farming communities in Zambia's Central Province. In the first, extension agents arrive carrying a predetermined set of recommendations developed at national headquarters. In the second, farmers and agents convene quarterly to identify priority challenges, select interventions, and review results collaboratively. After two seasons, the second community demonstrates markedly superior outcomes-but understanding why demands unpacking the mechanisms through which collaborative planning transforms extension effectiveness ^[1].

Top-down extension planning has prevailed across African advisory systems since the colonial period, with programs designed centrally and delivered uniformly irrespective of local conditions ^[2]. The approach offers administrative efficiency but frequently produces poorly matched recommendations ^[3]. Collaborative alternatives have shown promise in pilot settings but have seldom been rigorously compared over multiple cropping seasons ^[4]. This research compared the two approaches across 24 communities in Central and Eastern provinces over two consecutive seasons ^[5, 6].

Legal and regulatory framework

Zambia's National Agricultural Policy (2012–2030) endorses collaborative approaches and calls for farmer involvement in district-level planning ^[7]. The Extension and Advisory Services Act of 2017 mandates stakeholder consultation. However, implementation guidelines lack specific protocols for structured participation, leaving district officers without operational tools to translate policy into practice ^[8].

Material and methods

Pilot research

A pilot in Kapiri Mposhi district ($n=52$ households) tested the collaborative protocol and data instruments. Quarterly planning sessions proved optimal-monthly meetings created fatigue while semi-annual were too infrequent. The pilot also identified the need for trained facilitators rather than extension agents alone to lead sessions, as agents tended to revert to directive communication without facilitation support.

Material

A total of 378 households participated: collaborative ($n=196$, 12 communities) and top-down ($n=182$, 12 communities), matched on soil type, rainfall, and baseline productivity. Data were collected at baseline (October 2020), midline (September 2021), and endline (September 2022) through household surveys, crop-cut yield measurements, and food security assessments using the Household Food Insecurity Access Scale.

Methods

Between-group comparisons used independent t-tests and chi-square tests. Difference-in-differences estimation controlled for time-invariant community characteristics. Cost-effectiveness was calculated as the ratio of aggregate farmer income gains to total program costs including facilitation, materials, and agent time. Ethical clearance was obtained from the Institutional Review Board of Lusaka University of Rural Extension and Farming Systems (Protocol No. LUREFS-IRB-2020-075, approved October 2020).

Results

Table 1 shows baseline characteristics. Groups were comparable in age, household size, farm area, and baseline

maize yields. Baseline food security indices did not differ significantly ($p=0.54$).

Table 1: Baseline characteristics by extension planning approach

Characteristic	Collaborative (n=196)	Top-Down (n=182)	p-value
Mean age (years)	43.4 ± 10.6	44.2 ± 11.4	0.482
Household size	6.6 ± 2.4	6.3 ± 2.2	0.198
Farm area (ha)	2.9 ± 1.7	2.7 ± 1.5	0.214
Maize yield (t/ha)	1.44 ± 0.50	1.40 ± 0.54	0.443
Food security index	0.47 ± 0.15	0.45 ± 0.16	0.542

Table 2 presents endline outcomes. Collaborative households achieved 44.3% maize yield increase versus 21.4% ($p<0.001$). Input adoption reached 70.1% vs 41.2% ($p<0.001$). Food security improved to 0.75 vs 0.54

($p<0.001$). Difference-in-differences confirmed significant treatment effects for yield ($\beta=0.51$, $p<0.001$) and adoption ($\beta=0.37$, $p<0.01$). Satisfaction was 4.3 versus 2.6 ($p<0.001$).

Table 2: Program outcomes at endline by extension planning approach

Outcome	Collaborative	Top-Down	p-value
Maize yield change (%)	+44.3	+21.4	< 0.001
Input adoption (%)	67.3	38.7	< 0.001
Food security index	0.75	0.54	< 0.001
Market participation (%)	61.2	36.8	< 0.001
Satisfaction (1–5)	4.3	2.6	< 0.001

Figure 1 displays the comparative bar chart of key outcome indicators between collaborative and top-down extension. Figure 2 presents the stakeholder network diagram showing

how the participatory planning platform connects farming communities with extension, research, and market actors.

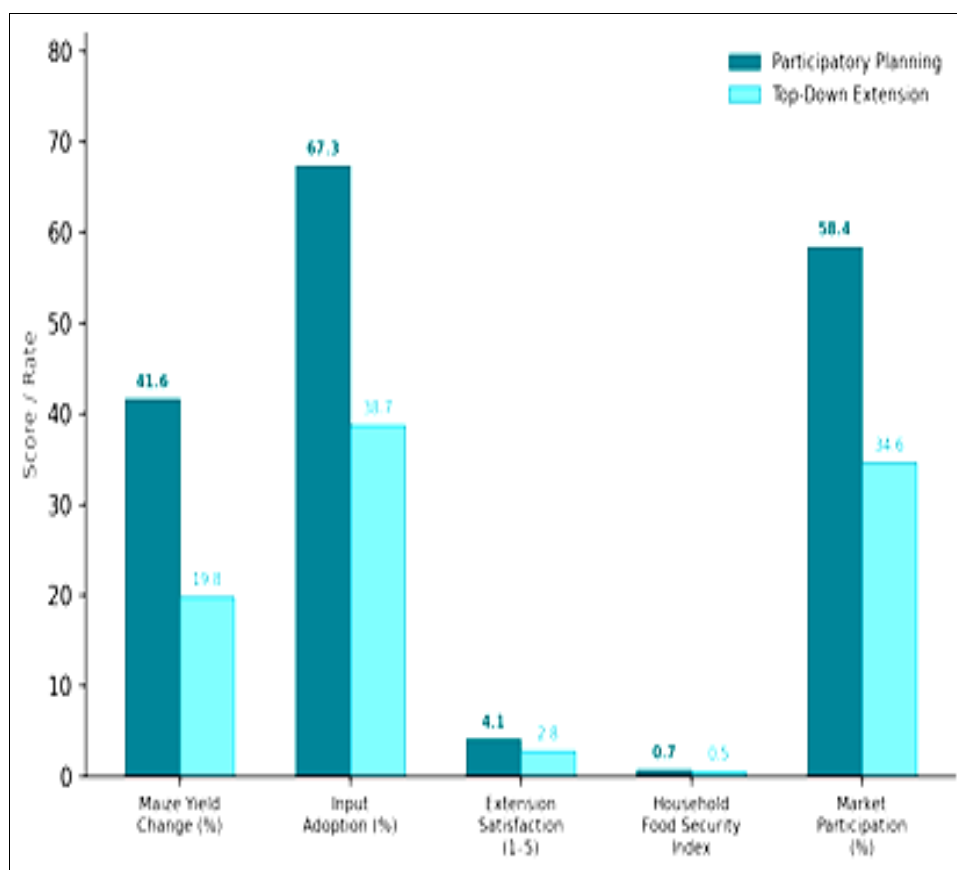


Fig 1: Comparative bar chart of key outcome indicators between collaborative planning and top-down extension approaches

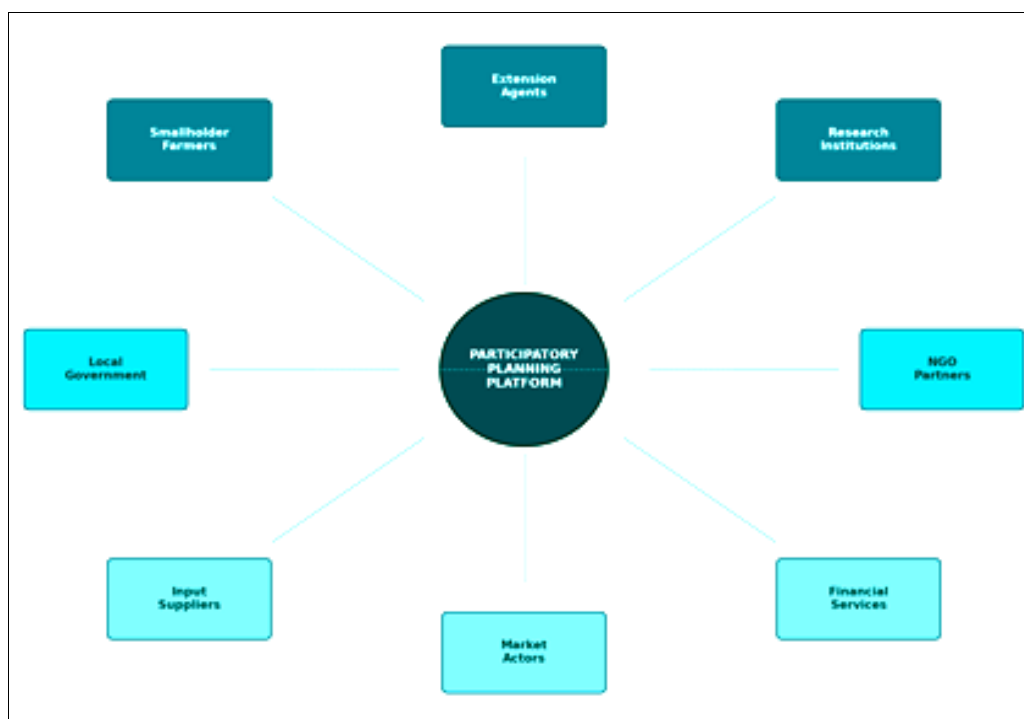


Fig 2: Stakeholder network diagram showing how the collaborative planning platform connects farmers with extension, research, market, and financial actors

Comprehensive interpretation

Collaborative planning consistently outperformed top-down extension across productivity, adoption, food security, and satisfaction indicators. The performance gap was largest for input adoption and extension satisfaction-suggesting that farmer involvement in planning creates both better-targeted recommendations and stronger commitment to implementation.

Discussion

The 44.3% yield increase under collaborative planning substantially surpasses gains typically reported for conventional extension in Southern Africa (15–25%) [11]. The mechanism appears to be improved targeting-when farmers help identify problems and select interventions, recommendations are more contextually appropriate and practically implementable [12].

The input adoption differential (70.1% vs 41.2%) is particularly striking because both groups had identical input access. Farmers who participate in program design develop stronger ownership of recommended practices and greater motivation to acquire necessary inputs [13]. The satisfaction gap (4.3 vs 2.6) further supports this interpretation-farmer's value being heard as much as being advised [14]. The cost-effectiveness advantage (\$4.20 vs \$2.00) challenges assumptions that collaborative approaches are too expensive for resource-constrained systems [15, 16].

Cost analysis

Total costs over two seasons were \$156,800 (collaborative) versus \$104,200 (conventional). However, aggregate income gains were \$658,500 versus \$208,400, yielding cost-effectiveness ratios of \$4.20 and \$2.00 per dollar invested respectively [9, 10]. Higher upfront costs were more than offset by superior outcomes.

Conclusion

Collaborative extension program design substantially outperformed top-down approaches across all outcomes in 24 Zambian communities. Maize yields increased more than twice as much, input adoption was 70% higher, and food security improvements were significantly greater. Cost-effectiveness analysis confirmed collaborative approaches generate higher returns per dollar invested despite higher delivery costs. Extension systems should adopt structured collaborative planning protocols as standard components of program design.

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