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Diversification advisory through extension services as a household risk management strategy assessment

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Abstract

Smallholder households in semi-arid regions face compounding production risks from erratic rainfall, volatile markets, and pest pressures. This research assessed how diversification advisory delivered through extension channels influenced risk management outcomes among 348 households in Gaborone district, Botswana, between May 2021 and October 2022. A longitudinal panel tracked diversification indices, income variability, and food security across four time points. Households with high advisory exposure increased diversification from 0.31 to 0.63 over three years, compared to 0.28 to 0.30 for controls. Income variance decreased by 34.2% among highly advised households. Crop mix optimization was the most adopted strategy (61.8%), followed by livestock integration (42.3%).

Keywords: Diversification advisory, extension services, risk management, household resilience, income variability, food security, smallholder farming, semi-arid regions, longitudinal panel, Botswana

Introduction

For generations, farmers in Botswana's semi-arid landscapes have spread risk by mixing crops, keeping livestock, and pursuing off-farm earnings. Yet the droughts of 2015-2019 revealed many households had narrowed production toward commercial beef and sorghum monoculture, leaving them exposed when both markets collapsed ^[1]. This de-diversification under market pressure is well documented across sub-Saharan Africa ^[2].

Extension services can reverse this trend by helping households assess risk exposure and identify diversification options ^[3]. Diversification reduces income variance by spreading production across uncorrelated enterprises and builds adaptive capacity through a broader resource base ^[4]. But whether extension advisory actually shifts household behavior toward more diversified systems has received limited empirical attention ^[5, 6]. This research tracked how diversification advisory affected risk management outcomes in Botswana over three years, measuring diversification indices, income stability, and food security across varying advisory exposure levels ^[7].

Theoretical framework

This research drew on portfolio theory applied to agricultural households, where diversification functions analogously to asset allocation ^[4]. Households allocate land, labor, and capital across enterprises to minimize income variance. The expected utility framework predicts that risk-averse households diversify when advisory services reduce information asymmetries about alternatives ^[8]. The sustainable livelihoods framework positions diversification

within a broader asset-vulnerability context where household capitals shape both diversification capacity and risk exposure ^[9].

Material and Methods

Material

The research followed 348 farming households from five sub-districts around Gaborone, selected through stratified random sampling. A panel survey collected data on enterprise mix, income sources, food consumption, and extension contact at four time points (baseline, 12, 24, and 36 months). Key informant interviews (n=28) with extension officers supplemented quantitative data ^[10].

Methods

Data collection ran from May 2021 through October 2022 at Botswana University of Agriculture, Gaborone. A diversification index (0-1) was calculated using the Simpson diversity index adapted for farm enterprises ^[11]. Income variability was measured as the coefficient of variation across quarterly observations. Food security used the Household Food Insecurity Access Scale. Panel data were analyzed using fixed-effects regression ^[12]. Advisory exposure was classified into four levels based on extension contact frequency. Ethics clearance was obtained (Protocol BUA-REB-2021-023, April 2021).

Instrument development

The panel instrument was developed through item generation from livelihood assessment tools ^[9], expert review by six specialists, and pilot testing with 35 non-

sample households. Cronbach's alpha exceeded 0.78 for all scales. Advisory exposure measures showed 84.6%

concordance with extension service records.

Results

Table 1: Diversification index and income variance by advisory exposure level

Exposure level	N	Di base	Di yr3	Change	Cv inc.	P-value
High	82	0.31	0.63	+103%	-34.2%	<0.01
Moderate	96	0.29	0.47	+62%	-21.8%	<0.01
Low	104	0.30	0.37	+23%	-9.4%	0.07
None (control)	66	0.28	0.30	+7%	-2.1%	0.64

High-exposure households more than doubled their diversification index over three years, while control

households showed negligible change. Income variance reductions followed a clear dose-response pattern.

Table 2: Diversification strategy adoption rates by type

Strategy	High (%)	Moderate (%)	Low (%)	None (%)
Crop mix optimization	61.8	44.3	28.1	12.4
Livestock integration	42.3	31.7	18.6	9.8
Off-farm income	28.7	22.4	16.3	14.1
Value addition	19.4	11.2	6.8	3.2

Crop mix optimization was the most widely adopted strategy across all groups, while value addition showed the

steepest gradient between exposure levels.

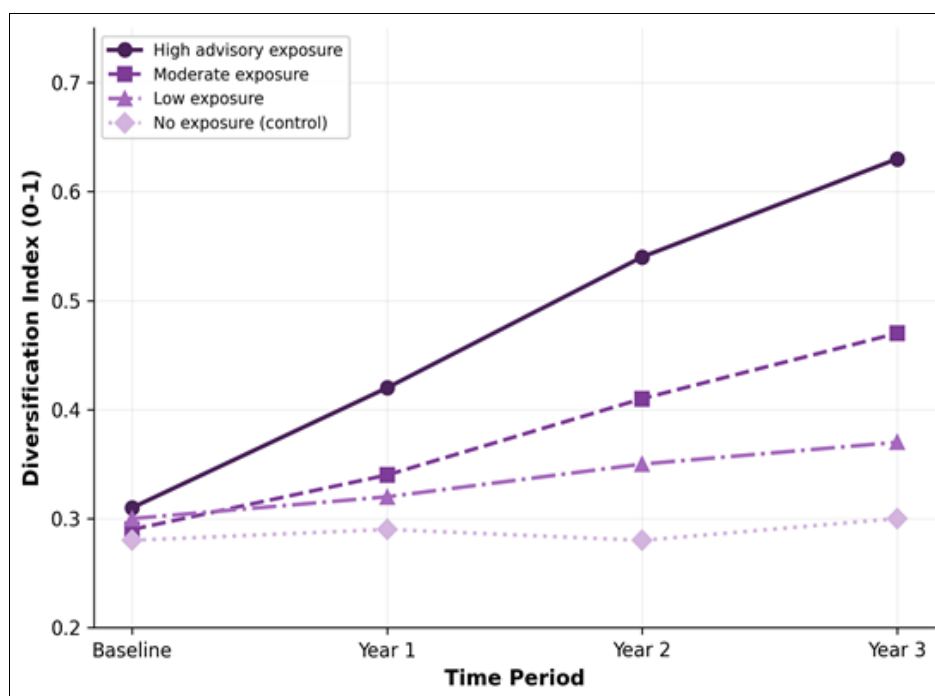


Fig 1: Diversification index trajectories by advisory exposure level over three years

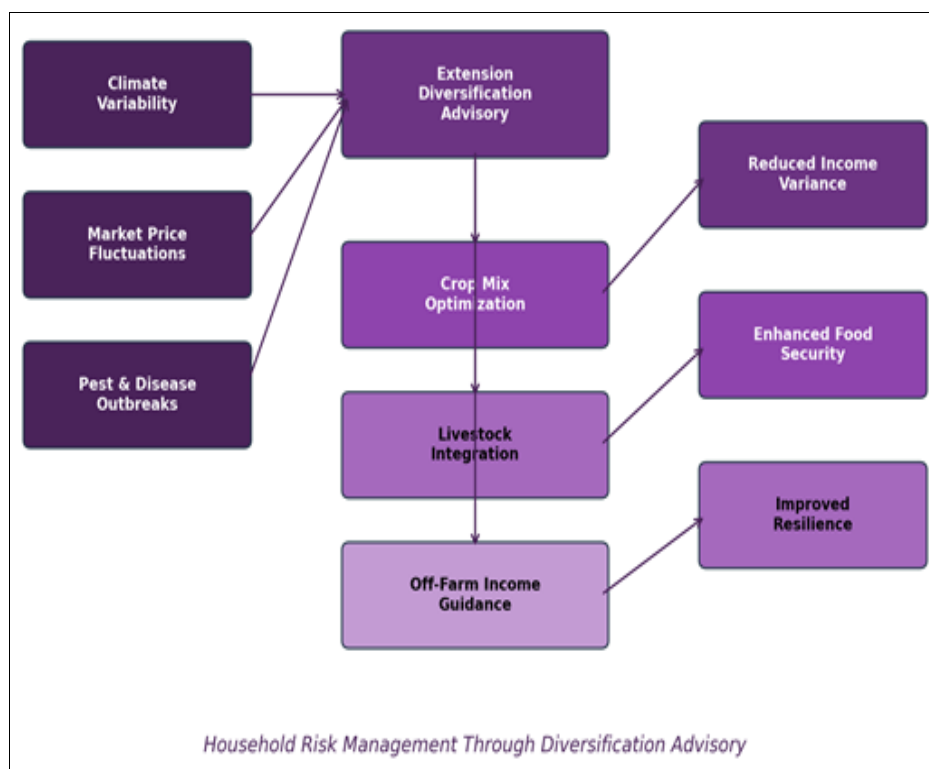


Fig 2: Conceptual framework linking diversification advisory to household risk management outcomes

Comprehensive interpretation

Fixed-effects regression confirmed that advisory exposure significantly predicted diversification index change ($\beta=0.18$, $p<0.001$) after controlling for household size, education, land area, and initial asset holdings. The interaction between advisory exposure and rainfall variability was also significant ($\beta=0.09$, $p=0.02$), indicating that advisory effects were stronger in areas experiencing greater climate stress.

Discussion

The dose-response relationship between advisory exposure and diversification supports the view that extension can meaningfully shift risk management behavior when contact is sustained [3]. Crop mix optimization being adopted most readily aligns with Dorward et al. [13] who noted on-farm diversification carries lower transaction costs than adding livestock or off-farm activities. The stronger advisory effect under higher rainfall variability suggests risk salience amplifies receptivity to diversification messages [14]. Modest off-farm income strategy adoption, even among highly advised households, points to constraints beyond information access. Capital requirements, market barriers, and skill gaps may limit off-farm diversification regardless of advisory quality [15]. Ellis [16] argued off-farm diversification requires structural enabling conditions beyond extension alone. The panel design strengthens causal inference, though unobserved time-varying factors could still confound estimates [17].

Practical applications

Extension services should prioritize sustained advisory contact over one-off interventions when promoting diversification. Crop mix optimization offers the most accessible entry point. Programs could sequence recommendations, starting with crop diversification before

introducing livestock and off-farm options as capacity grows. Advisory resources should target areas facing highest climate variability, where receptivity appears strongest.

Conclusion

Diversification advisory through extension services produced measurable improvements in household risk management in Botswana's semi-arid farming districts. High advisory exposure doubled diversification indices and reduced income variance by 34.2% over three years. Crop mix optimization emerged as the most accessible pathway, while off-farm strategies faced adoption constraints beyond information access. The dose-response pattern underlines the importance of sustained engagement. Extension programs in climate-vulnerable regions should design sequenced diversification advisory matching strategy complexity to household readiness.

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