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Market price risk management advisory through extension services: Tools and farmer adoption patterns

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Abstract

Price volatility remains one of the biggest threats to smallholder farm income across Central America. This research examined how extension services delivered market price risk management advisory and which tools farmers adopted most readily. A cross-sectional survey of 218 smallholder farmers across four agricultural regions of Costa Rica was conducted from October 2021 to April 2022. Five price risk tools were assessed: SMS price alerts, futures contracts, warehouse receipts, group marketing, and price insurance. Results showed that group marketing had the highest overall adoption (59.9%), while price insurance had the lowest (6.5%). Extension contact frequency was positively associated with adoption of any tool ($r = 0.62$, $p < 0.01$). Farmers with five or more annual extension contacts adopted tools at 71.3% compared to 12.8% among those with no contact. Regional variation was substantial, with informal tools dominating in less commercially connected areas. The findings point to a need for extension programs that match tool complexity to farmer capacity and market context.

Keywords: Market price risk, extension services, farmer adoption, price tools, group marketing, smallholder farmers, Costa Rica, agricultural advisory, risk management, price volatility

1. Introduction

Falling coffee prices in 2019 wiped out nearly a third of net income for smallholder producers in Costa Rica's highland regions, exposing a gap that production-focused extension alone cannot fill ^[1]. Price risk-the chance that market prices drop below production costs-is consistently ranked among the top three concerns by Central American farm households ^[2]. A range of tools exists to manage this risk, from simple SMS alerts to formal futures contracts, yet adoption among smallholders remains low ^[3].

Extension services are well positioned to introduce these tools because they already maintain trust-based relationships with farming communities ^[4]. But most extension curricula in the region still center on agronomy and pest management, leaving price risk advisory as an afterthought ^[5]. Where pilot programs have tested market-oriented extension, results have been mixed-adoption tends to cluster around simpler, informal mechanisms while formal financial instruments see little uptake ^[6, 7].

This research assessed which price risk management tools farmers adopted when introduced through extension services and how adoption patterns varied by extension contact frequency and region. The objectives were:

- To measure adoption rates for five price risk tools across four Costa Rican agricultural regions,
- To test the association between extension contact and tool adoption, and

- To identify regional and farmer-level factors shaping adoption choices ^[8].

Field research design

A multi-site cross-sectional design was used, sampling from four distinct agricultural regions: Central Valley, Caribbean Coast, Northern Plains, and Southern Highlands. These regions were chosen to capture variation in crop type, market connectivity, and extension infrastructure. Within each region, three cantons with active extension programs were selected. Households were sampled proportionally from canton-level farmer association registries, yielding 218 respondents distributed across the four regions ^[9].

Seasonal variations

Data collection ran from October 2021 to April 2022, spanning both the main harvest season for coffee and staple grains (October-January) and the dry-season marketing window (February-April). Price risk awareness peaks during harvest when farmers negotiate sales, making this period relevant for assessing tool awareness and recent adoption behavior. Extension contacts were also more frequent during harvest months ^[10].

Material and methods

Material

A structured questionnaire was administered face-to-face to

218 smallholder farmers. The instrument captured household demographics, crop portfolio, extension contact history, awareness and use of five price risk tools, and perceived barriers to adoption. Secondary data on regional price indices were obtained from the Costa Rican National Production Council. Ethical clearance was granted by the University of Costa Rica Research Ethics Committee (Protocol UCR-VI/2021-058, dated September 20, 2021) [11].

Results

Methods

Descriptive statistics summarized adoption rates by tool and region. Chi-square tests compared adoption across extension contact categories. Pearson correlation measured the relationship between annual extension contacts and tool adoption. Binary logistic regression modeled the probability of adopting any tool as a function of extension contacts, farm size, education, market distance, and region. Data were analyzed using Stata version 17 [12].

Table 1: Adoption rates of price risk tools by agricultural region (n = 218)

Region	SMS alerts	Futures	Warehouse	Group mkt	Insurance	Any tool
Central Valley	62.3%	14.8%	28.7%	51.4%	9.3%	78.6%
Caribbean Coast	43.1%	7.2%	18.4%	67.8%	5.1%	72.4%
Northern Plains	54.6%	11.3%	22.9%	48.2%	7.8%	68.1%
Southern Highlands	38.7%	5.4%	15.1%	72.3%	3.6%	74.8%

Group marketing dominated in less commercially connected regions (Caribbean Coast, Southern Highlands), while SMS alerts and formal tools were higher in the Central Valley.

Table 2: Logistic regression predictors of any price risk tool adoption

Predictor	B	S.E.	Wald	Sig.	Exp(B)	95% CI
Extension contacts/yr	0.714	0.183	15.21	<0.001**	2.04	1.42-2.93
Farm size (ha)	0.231	0.108	4.58	0.032*	1.26	1.02-1.56
Education (years)	0.187	0.076	6.06	0.014*	1.21	1.04-1.40
Market distance (km)	-0.084	0.047	3.19	0.074	0.92	0.84-1.01

* $p < 0.05$; ** $p < 0.01$. Nagelkerke $R^2 = 0.298$. Extension contact was the strongest predictor of tool adoption

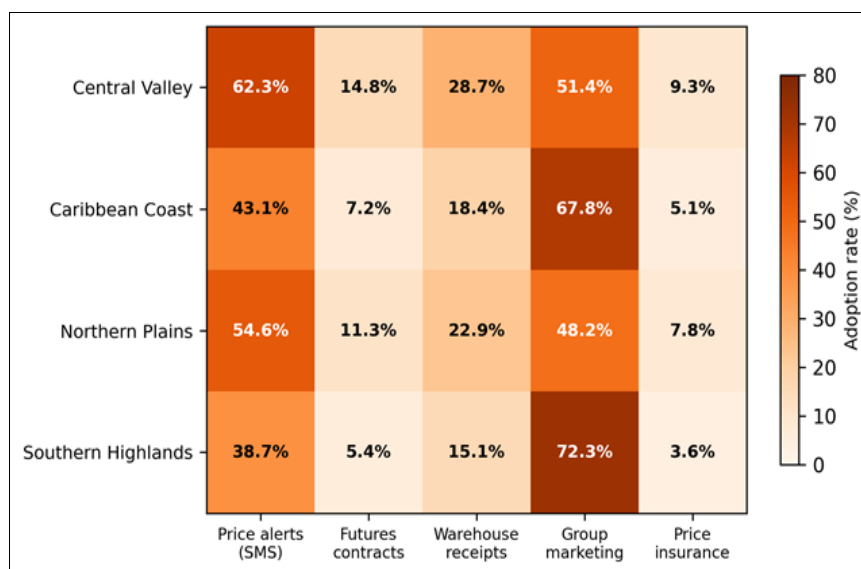


Fig 1: Heatmap of price risk tool adoption rates across four agricultural regions (%)

The heatmap highlights that informal tools (group marketing) showed the highest adoption uniformly, while

formal tools (futures, insurance) remained low across all regions.

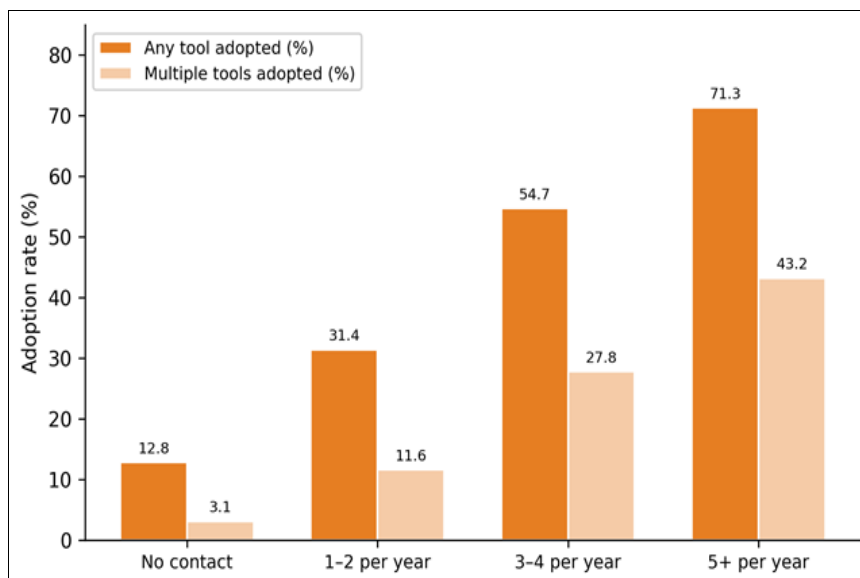


Fig 2: Adoption of any price risk tool and multiple tools by extension contact frequency

A steep gradient was evident: farmers with 5+ annual contacts adopted at 71.3%, nearly six times the rate of those with no extension contact (12.8%).

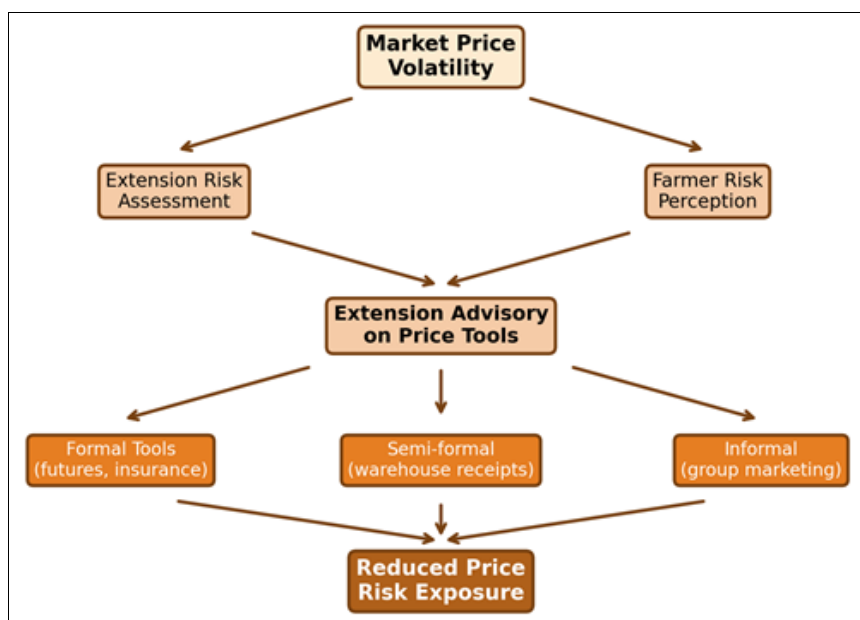


Fig 3: Extension advisory pathway from market price volatility to reduced farmer risk exposure

The pathway classifies tools into formal, semi-formal, and informal categories, showing how extension advisory channels farmer risk perception toward appropriate tool selection.

Comprehensive interpretation

Extension contact frequency was consistently the strongest factor driving tool adoption. Regional context shaped which tools farmers preferred, with informal mechanisms dominating where market infrastructure was weaker.

Discussion

The dominance of group marketing among adopted tools echoes findings from similar Central American contexts ^[6, 7]. Group marketing requires no financial literacy or institutional access—farmers pool produce and negotiate

collectively, which reduces individual transaction costs. In contrast, futures contracts and price insurance demand understanding of abstract financial instruments, access to formal markets, and upfront costs that most smallholders can't absorb ^[13].

The strong dose-response relationship between extension contacts and adoption suggests that price risk advisory works best as a repeated, relationship-based process rather than a one-off information event ^[14]. The regional patterns indicate that extension agents should tailor their tool recommendations to local market conditions. In commercially connected areas like the Central Valley, promoting SMS alerts and warehouse receipts alongside group marketing seems feasible. In more remote regions, strengthening group marketing while gradually introducing simpler formal tools may be more realistic ^[15, 16].

Conclusion

This research shows that extension services can meaningfully increase farmer adoption of price risk management tools, but the type of tool adopted depends heavily on regional market context and farmer capacity. Group marketing was the most widely adopted tool across all regions, while formal instruments remained marginal. Extension contact frequency was the strongest predictor of adoption, reinforcing the value of regular, sustained advisory engagement.

Extension programs should adopt a tiered approach-building on the informal tools farmers already trust while gradually introducing more formal instruments where market infrastructure allows. Matching tool complexity to farmer readiness is likely to produce better outcomes than promoting a uniform toolkit across diverse agricultural regions ^[17].

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