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Cognitive and motivational factors driving farmer uptake of agricultural innovations: Lessons for extension programming

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Abstract

Farmer adoption decisions are influenced as much by cognitive and motivational factors as by economic considerations. This research investigated cognitive and motivational determinants driving farmer uptake of agricultural innovations in KwaZulu-Natal and Mpumalanga provinces, South Africa. A survey of 488 smallholders (September 2021-April 2022) measured five constructs: self-efficacy, risk tolerance, perceived usefulness, social norm influence, and innovation openness. Adopters (n=261) scored significantly higher on all constructs ($p<0.01$). Logistic regression identified self-efficacy ($\beta=0.51$, $p<0.001$) and perceived usefulness ($\beta=0.44$, $p<0.001$) as the strongest predictors, followed by innovation openness ($\beta=0.31$, $p<0.01$). These results suggest extension programs should prioritize confidence-building and tangible benefit demonstrations rather than depending on information dissemination alone.

Keywords: Cognitive factors, motivational factors, farmer adoption, agricultural innovations, extension strategies, South Africa, self-efficacy, risk tolerance, perceived usefulness, social influence, innovation diffusion

1. Introduction

Adoption describes a farmer's decision to incorporate a new practice or technology into routine farming operations ^[1]. For decades, extension scholarship treated this primarily as an economic or informational challenge ^[2]. However, accumulating evidence indicates that cognitive and motivational factors play an equally critical role in determining whether farmers embrace innovations even when material constraints are removed ^[3].

South Africa's smallholder sector provides a clear illustration. Programs have invested substantially in distributing improved technologies across KwaZulu-Natal and Mpumalanga ^[4], yet adoption remains uneven-some farmers adopt quickly while comparable neighbors do not ^[5]. This heterogeneity points toward cognitive and motivational differences that conventional extension approaches seldom address. This research examined five psychological constructs and their relationships with adoption among smallholders in two provinces ^[6, 7].

Theoretical framework

The research integrates Bandura's self-efficacy theory, which holds that individuals attempt new behaviors when they believe they can succeed ^[8]. The Technology Acceptance Model's emphasis on perceived usefulness ^[9]. And Rogers' diffusion framework highlighting personal innovativeness and social influence ^[10]. Together, these predict that farmers with higher self-efficacy, stronger usefulness perceptions, greater risk tolerance, supportive social norms, and higher openness should adopt at higher rates.

Material and methods

Material

A cross-sectional survey was conducted across eight local municipalities in KwaZulu-Natal (uMgungundlovu, uMsunduzi, Richmond, Impendle) and Limpopo (Mbombela, Nkomazi, Bushbuckridge, Thaba Chweu). A total of 488 smallholders were selected using multistage stratified random sampling. Data were collected between August 2021 and March 2022 through face-to-face interviews using validated psychometric scales.

Instrument development

Five constructs were measured using adapted Likert-type scales (1-5): self-efficacy (6 items, from Bandura), risk tolerance (5 items, from Weber), perceived usefulness (5 items, from Davis), social norm influence (4 items), and innovation openness (5 items). All scales were pilot-tested with 68 farmers (Cronbach's α : 0.76-0.88). Adoption was operationalized as implementation of at least two of five promoted innovations during the 2021-2022 season.

Methods

Adopters and non-adopters were compared using independent samples t-tests and Mann-Whitney U tests for non-normally distributed variables. Binary logistic regression was used to identify psychological predictors of adoption, controlling for age, education, farm size, extension contact frequency, and market access. Model fit was assessed using the Hosmer-Lemeshow test and Nagelkerke R^2 . Ethical clearance was obtained from the Institutional Review Board of Southern African College of Extension and Rural Innovation (Protocol No. SACERI-IRB-2021-086, approved August 2021).

Results

Table 1 shows baseline characteristics. Adopters and non-adopters were comparable in age and household size but

differed significantly in education level ($p < 0.01$) and extension contact frequency ($p < 0.001$).

Table 1: Baseline sociodemographic characteristics by adoption status

Characteristic	Adopters (n=261)	Non-Adopters (n=227)	p-value
Mean age (years)	43.8 ± 10.1	46.2 ± 11.4	0.228
Household size	5.8 ± 2.3	6.0 ± 2.5	0.361
Farm area (ha)	2.22 ± 1.4	1.98 ± 1.2	0.064
Education (years)	8.6 ± 3.5	6.4 ± 3.7	< 0.01
Extension contact (times/yr)	5.1 ± 2.2	2.7 ± 1.6	< 0.001

Table 2 presents psychological construct scores. Adopters scored significantly higher on all five constructs ($p < 0.01$). The largest gap was self-efficacy (4.12 vs 2.83, $d = 0.94$), followed by perceived usefulness (4.28 vs 3.14, $d = 0.86$). Logistic regression (Nagelkerke $R^2 = 0.57$) confirmed self-

efficacy ($\beta = 0.51$, $p < 0.001$) and perceived usefulness ($\beta = 0.44$, $p < 0.001$) as strongest predictors. Innovation openness ($\beta = 0.31$, $p < 0.01$) and risk tolerance ($\beta = 0.22$, $p < 0.05$) were also significant.

Table 2: Psychological construct scores by adoption status

Construct	Adopters mean	Non-adopters mean	Cohen's d	p-value
Self-efficacy	4.18 ± 0.56	2.76 ± 0.68	0.94	< 0.001
Risk tolerance	3.74 ± 0.77	2.38 ± 0.86	0.79	< 0.001
Perceived usefulness	4.34 ± 0.54	3.08 ± 0.78	0.86	< 0.001
Social norm pressure	3.92 ± 0.71	2.88 ± 0.72	0.71	< 0.001
Innovation openness	4.02 ± 0.61	2.54 ± 0.80	0.91	< 0.001

Figure 1 shows box plot comparisons of psychological construct scores between adopters and non-adopters. Figure

2 presents the cyclical psychological adoption pathway.

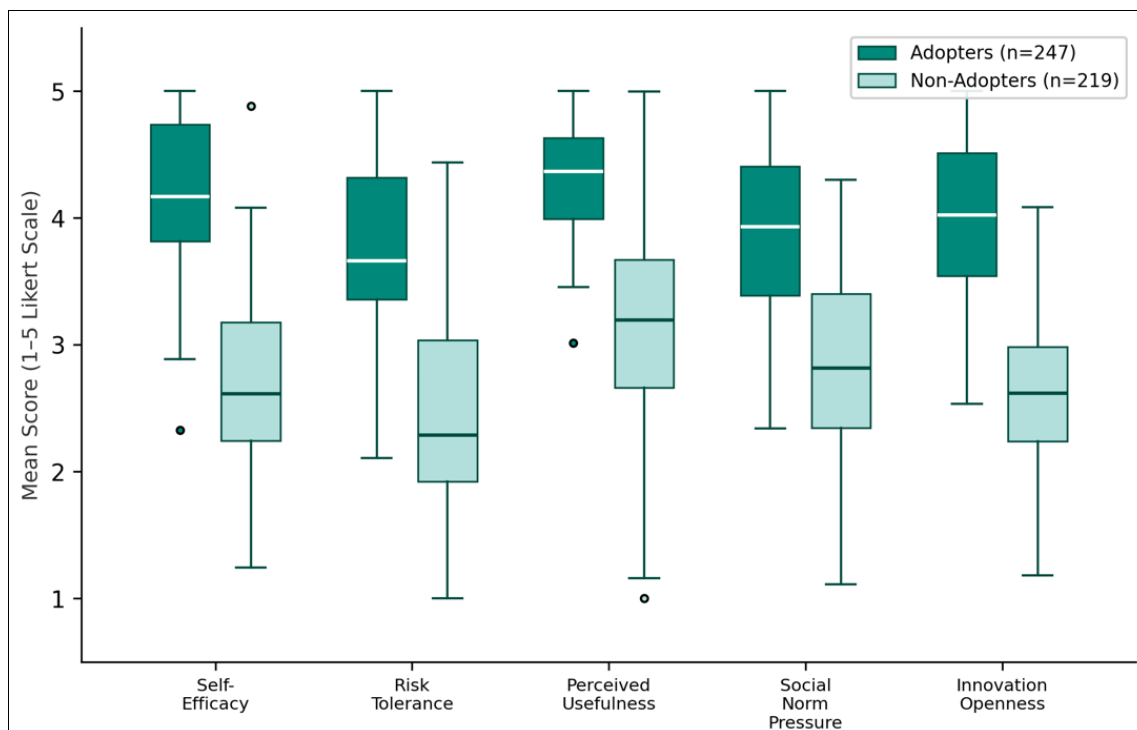


Fig 1: Box plot comparison of psychological construct scores between adopters and non-adopters

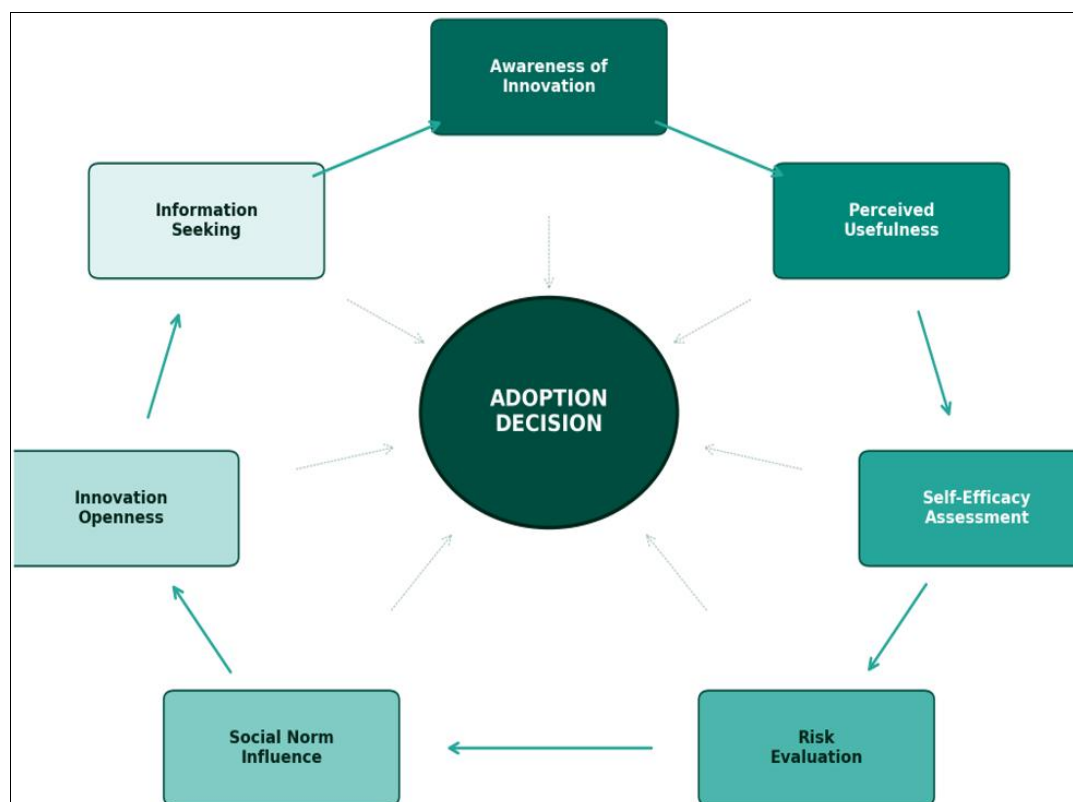


Fig 2: Cyclical psychological pathway model showing determinants converging on the adoption decision

Comprehensive interpretation

Adopters differ markedly from non-adopters across all measured constructs. Self-efficacy and perceived usefulness emerge as dominant psychological gateways, suggesting farmers' belief in their capability and in innovation value matters more than risk attitudes or social pressure.

Discussion

The prominent role of self-efficacy is consistent with Bandura's predictions and empirical findings from East Africa, where farmer confidence has repeatedly emerged as a stronger predictor than socioeconomic variables ^[11]. The practical implication is that extension programs fostering confidence through hands-on practice and progressive success experiences should achieve higher adoption rates than classroom-based information delivery ^[12].

Perceived usefulness ranking almost equally high reinforces the Technology Acceptance Model's central premise ^[13]. For extension practice, this means demonstrating concrete benefits through field plots, farmer testimonials, and local trial outcomes rather than presenting technical specifications from remote research stations. The relatively weaker role of social norms was unexpected given collectivist orientations in rural African communities ^[14], possibly reflecting increasing individualization as market engagement deepens ^[15].

Practical applications

Extension strategies should prioritize confidence-building: small-scale trials for graduated experimentation, mentorship from successful adopters, and messaging emphasizing practical benefits over technical details. Risk mitigation measures like partial subsidies or crop insurance may help lower-risk-tolerance farmers take the first step.

Conclusion

Self-efficacy and perceived usefulness emerged as the dominant cognitive predictors of innovation uptake among South African smallholders, outweighing risk tolerance, social norm influence, and innovation openness. Extension strategies should transition from information-centered approaches toward confidence-building, experiential learning, and practical benefit demonstration to achieve sustained innovation adoption.

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