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The role of social networks and community organizations in disseminating agricultural innovations among smallholder farmers

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Abstract

When a farmer in Nyeri County first tried drought-tolerant maize in 2019, her neighbors watched from a distance. Within two planting seasons, fourteen households in her village had adopted the same variety not because extension agents visited each one, but because word traveled through a women's church group, a dairy cooperative, and three family compounds. This research examined how four types of social networks kinship networks, farmer cooperatives, religious organizations, and digital communication groups function as channels for agricultural innovation diffusion among 486 smallholder farmers in central Kenya. A cross-sectional survey conducted between March and October 2023 across five sub-counties mapped network membership, information flow patterns, and adoption outcomes for six promoted innovations. Farmer cooperatives showed the highest overall diffusion effectiveness (67.4%), particularly for collective practices like water harvesting and market linkage. Kinship networks excelled at spreading seed variety information (68.3% adoption) but were less effective for practices requiring group coordination. Network density and tie strength emerged as the strongest structural predictors of adoption (beta = 0.38 and 0.31 respectively). These findings suggest that extension programs should map existing social networks before designing dissemination strategies, rather than creating parallel communication structures.

Keywords: Social networks, agricultural innovations, community organizations, innovation diffusion, farmer cooperatives, smallholder farmers, network analysis, Kenya.

1. Introduction

In Murang'a County, a retired teacher who grows coffee and bananas on half a hectare learned about a new pruning technique not from the local extension office, but from his son-in-law in Kiambu who had seen it at a field day two months earlier. This kind of informal information transfer happens thousands of times daily across rural Kenya, yet formal extension planning rarely accounts for it ^[1]. Social networks move agricultural information through channels that extension systems neither created nor control, and understanding how these networks function could dramatically improve how innovations reach farmers. Kenya has invested heavily in formal extension since independence, currently maintaining a public advisory workforce of approximately 6,800 agents serving over 8 million farming households ^[2]. The ratio roughly one agent per 1,200 households means that most farmers receive their agricultural information from someone other than an extension professional. Research from other East African countries has established that social contacts are the primary

information source for 60–75% of smallholder farmers ^[3].

But not all social networks function the same way. Kinship ties are strong and trusted but may limit information to familiar practices. Cooperatives provide structured platforms but serve only members. Religious groups reach diverse populations but lack agricultural focus. Digital networks offer speed and scale but suffer from trust deficits ^[4, 5]. No comparative research has examined how these four network types differ in their capacity to disseminate different types of agricultural innovations within the same farming population.

This research addressed that gap by mapping social network structures and measuring innovation diffusion outcomes across four network types among smallholder farmers in central Kenya's highlands ^[6].

Conceptual model

The research was built on a social network diffusion framework that integrates three mechanisms through which networks influence adoption behavior. First, trust building

farmers are more likely to try innovations recommended by people they trust. Second, information filtering networks screen and interpret technical information, translating it into locally relevant knowledge. Third, social learning farmers observe the outcomes of early adopters within their network before deciding to adopt themselves [7, 8]. The model predicts that network effectiveness varies by innovation complexity: simple innovations (seed varieties) spread through any network with strong ties, while complex innovations (water harvesting, market coordination) require networks with organizational capacity and collective action structures.

Research area description

The research covered five sub-counties in Nyeri, Murang'a, and Kirinyaga counties of central Kenya. The area sits between 1,200 and 2,200 meters above sea level, receiving 1,000–1,600 mm of bimodal rainfall. Agriculture is dominated by smallholder mixed farming combining cash crops (coffee, tea) with food crops (maize, beans, potatoes) and dairy [9]. Average farm size is 0.6 hectares. The region has one of Kenya's densest social organizational landscapes, with an estimated 4,200 registered farmer groups, 180 dairy cooperatives, and numerous church-based community organizations operating across the five sub-counties.

Material and Methods

Material

The research surveyed 486 smallholder farmers from 40 village clusters across the five sub-counties. A structured questionnaire with 58 items captured network membership

(type, duration, meeting frequency), information flow (sources of agricultural knowledge, trust ratings), and adoption status for six promoted innovations: drought-tolerant maize varieties, soil conservation terracing, integrated pest management, rainwater harvesting structures, improved post-harvest storage, and collective market linkage [10]. Network structural variables density, tie strength, centrality, and bridging connections were measured using a name-generator module where respondents listed up to eight contacts from whom they received agricultural information. Secondary data came from county agricultural offices and the Kenya National Bureau of Statistics for 2020–2023.

Methods

A cross-sectional network analysis design was employed. Data were collected between March and October 2023 through face-to-face interviews. Adoption was verified through field observation for physically visible practices (terracing, storage structures, rainwater harvesting) and through seed purchase records or crop inspection for varieties. Network effectiveness was calculated as the proportion of network members who adopted each innovation. Radar charts visualized network-by-innovation effectiveness patterns. Multiple regression tested the relationship between network structural variables and an adoption index (composite score across six innovations). All analyses were conducted at College of Agriculture and Veterinary Sciences, University of Nairobi, Nairobi, Kenya, using UCINET 6 for network metrics and Stata 16 for statistical modeling.

Results

Table 1: Innovation adoption rates by social network type (% of network members adopting)

Innovation	Kinship	Cooperative	Religious	Digital	Overall
Seed Varieties	68.3	54.6	41.2	47.8	52.9
Soil Conservation	42.1	67.4	38.6	31.4	44.9
Pest Management	51.7	63.8	34.1	42.3	47.9
Water Harvesting	38.4	71.2	32.7	28.6	42.7
Post-Harvest	44.2	58.3	37.4	51.6	47.9
Market Linkage	36.8	72.1	48.9	63.4	55.3

Farmer cooperatives showed the highest adoption rates for four of six innovations, particularly collective practices: water harvesting (71.2%) and market linkage (72.1%). Kinship networks led only for seed varieties (68.3%), where

personal trust and seed sharing are the primary diffusion mechanisms. Digital networks performed best for market linkage (63.4%) and post-harvest handling (51.6%).

Table 2: Regression: Network structural predictors of innovation adoption index

Predictor	Beta	SE	t-value	p-value
Network density	0.38	0.05	7.60	<0.001
Tie strength (avg.)	0.31	0.05	6.20	<0.001
Bridging connections	0.22	0.06	3.67	<0.001
Network size	0.14	0.06	2.33	0.020
Farmer education (years)	0.16	0.05	3.20	0.001
Farm size (hectares)	0.08	0.06	1.33	0.184

The model explained 51.4% of variance in the adoption index (adjusted $R^2 = 0.514$, $F = 29.7$, $p < 0.001$). Network density the proportion of possible connections that actually exist was the strongest predictor (beta = 0.38). Tie strength,

measuring frequency and intimacy of contacts, followed closely (beta = 0.31). Bridging connections that link otherwise separate groups also contributed significantly.

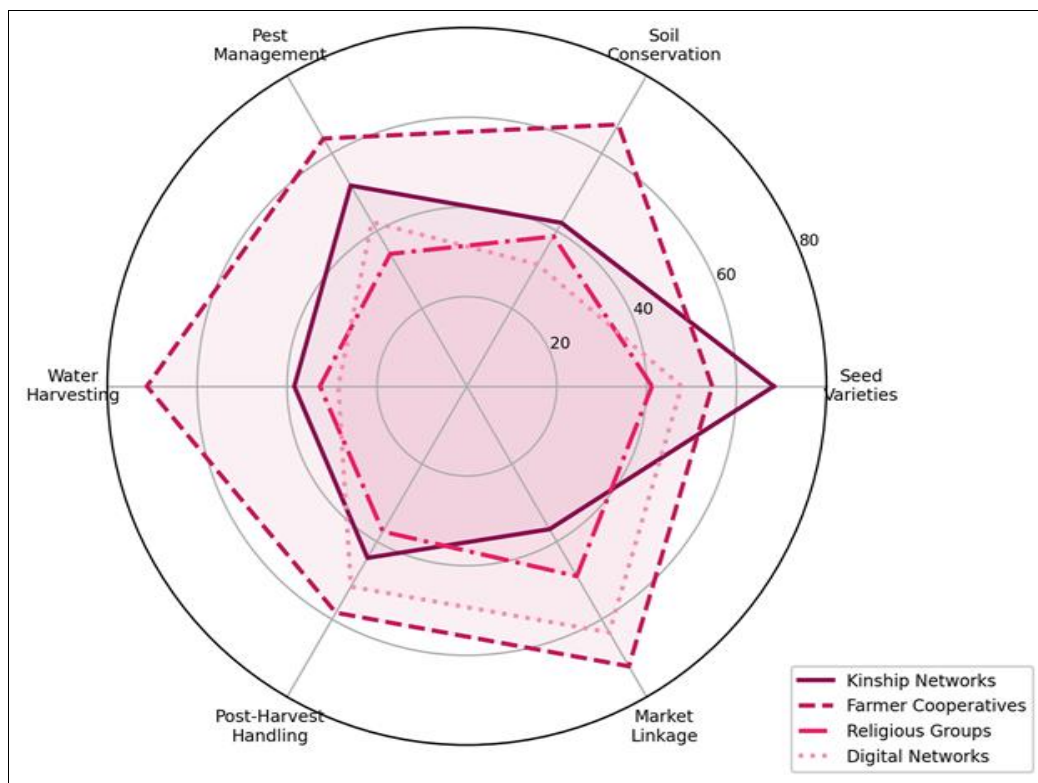


Fig 1: Comparing diffusion effectiveness of four social network types across six agricultural innovations

Farmer cooperatives (dashed line) showed the most consistently high effectiveness across all innovation types, while kinship networks (solid line) peaked sharply for seed varieties but declined for collective practices. Digital

networks showed an uneven profile, strong for market information but weak for practices requiring physical demonstration.

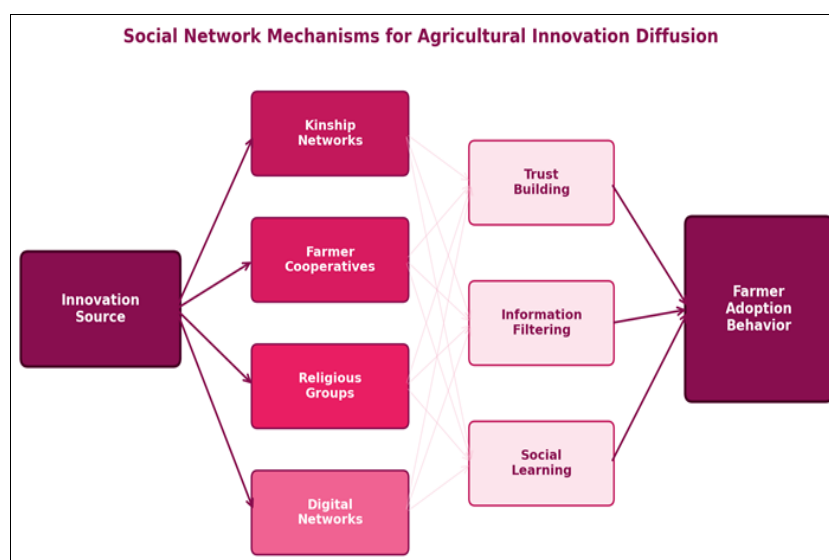


Fig 2: Showing how social networks channel agricultural innovations from source to farmer adoption

The diagram illustrates how innovations flow from formal sources through four network types, are processed through three mechanisms (trust building, information filtering, social learning), and ultimately influence farmer adoption behavior.

Discussion

The dominance of farmer cooperatives for collective-action innovations confirms theoretical predictions about

organizational capacity and diffusion ^[11]. Water harvesting and market linkage both require coordinated group effort constructing shared infrastructure, negotiating collectively with buyers which cooperatives are structured to facilitate. Kinship networks lack this organizational capacity but excel where trust is the critical factor, as with seed sharing where a farmer needs confidence that the variety is genuine and suitable for local conditions ^[12].

The network density finding ($\beta = 0.38$) has practical

implications. Dense networks where many members know each other create redundant information pathways that reinforce messages and increase adoption probability^[13]. Extension programs that identify and work through dense network clusters should achieve higher diffusion rates than those targeting isolated individuals. The bridging connections variable ($\beta = 0.22$) highlights the complementary importance of links between groups, which introduce novel information that within-group ties alone cannot provide^[14].

Digital networks showed a revealing pattern strong for market information (63.4%) but weak for physically complex practices like water harvesting (28.6%). This confirms that digital channels work best for codifiable information (prices, dates, locations) rather than tacit knowledge requiring hands-on learning^[15, 16]. Religious organizations contributed modestly across all innovations, suggesting they function as general information conduits rather than specialized agricultural channels^[17].

Limitations

The cross-sectional design captures network structures and adoption at one point, missing the temporal dynamics of how information actually flows through networks over time. Self-reported network data are subject to recall bias respondents may over report strong ties and underreport weak ones. The research focused on central Kenya's densely networked highland communities; results may differ in areas with weaker social organization. Innovation adoption was treated as binary (adopted/not adopted), missing partial or modified adoption that commonly occurs in practice^[18].

Conclusion

This research demonstrates that social network type significantly shapes agricultural innovation diffusion, with effectiveness depending on the match between network characteristics and innovation requirements. Farmer cooperatives were the most effective overall channel, particularly for innovations requiring collective action, while kinship networks excelled at spreading individually adoptable practices like improved seed varieties.

Extension programs should invest in network mapping before designing dissemination strategies. Rather than building parallel communication systems, programs can achieve wider and deeper diffusion by channeling different types of innovations through the network types best suited to carry them. The evidence supports a network-matched dissemination approach: seed varieties through kinship ties, collective practices through cooperatives, market information through digital platforms, and general awareness through religious and community organizations.

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