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Social capital and community-based institutions as channels for agricultural technology transfer

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Abstract

While formal extension systems reach only a fraction of farming communities, informal social capital structures move knowledge across entire regions. This research examined how social capital structures and community-based institutions disseminate agricultural innovations among 420 farmers in the Negev and Galilee, Israel (June 2021 to August 2022). Farmer organizations were the primary channel (28.6%), followed by informal networks (24.3%). Network density ($\text{Beta} = 0.29$) and tie strength ($\text{Beta} = 0.26$) were the strongest predictors of adoption speed. Farmers in denser networks adopted innovations 2.3 times faster. Extension programs should invest in strengthening existing community networks.

Keywords: Social capital structures, community-based institutions, agricultural innovations, dissemination, network analysis, farmer organizations, innovation adoption, tie strength, cooperative groups, extension services

Introduction

Formal extension services and informal social capital structures operate as parallel channels for agricultural knowledge. Extension agencies invest in trained advisors, yet farmers learn most from other farmers ^[1, 2]. Should extension systems reach farmers directly, or work through existing social capital structures and community-based institutions?

Social network theory suggests that relationship structure who knows whom, interaction frequency, trust levels shapes information flow speed and direction ^[3]. Community organizations add institutional structure, creating meeting points and shared decision spaces that accelerate innovation spread ^[4, 5].

Israel's mix of kibbutz cooperatives, moshav communities, and independent farms offered a natural laboratory for examining how network structures affect technology transfer ^[6, 7].

Material and Methods

Research Area

The research was conducted in the Negev (southern Israel) and Galilee (northern Israel) regions. The Negev is semi-arid with 200-300 mm annual rainfall and irrigated agriculture focused on vegetables, flowers, and dairy. The Galilee receives 500-900 mm and supports fruit orchards, field crops, and mixed farming. The research period was June 2021 to August 2022.

Material

A cross-sectional survey sampled 420 farmers through

stratified random sampling across three community types: kibbutz cooperatives ($n = 140$), moshav communities ($n = 148$), and independent farms ($n = 132$). A structured questionnaire assessed innovation adoption (12 innovations from the previous 3 years), social network characteristics, community organization participation, and information preferences. Full sociometric network data were collected from 6 purposively selected communities (2 per type) involving 187 farmers. Ethics approval: Levant Institute of Agricultural Innovation, Israel (Ref: LIAI/IL/2021-024, May 2021).

Methods

Social network analysis used UCINET 6.0 to calculate network density, centrality, and betweenness measures for the six sociometric communities. Survey data were analyzed in SPSS 26.0 using ANOVA to compare community types, and multiple regression to identify predictors of adoption speed. Adoption speed was measured as months from first awareness to implementation for each innovation ^[8].

Ethical Considerations

All participants provided written informed consent. Network data collection required special ethical attention — participants were informed that connections would be mapped anonymously with no individual positions disclosed. Data were stored on encrypted servers with restricted access. Participants could withdraw without affecting their community standing.

Results

Table 1: Innovation dissemination indicators across three community types (n = 420)

Dissemination Indicator	Kibbutz (n=140)	Moshav (n=148)	Independent (n=132)	F-value	p	Post-hoc
Innovations Adopted (of 12)	8.4 ± 2.1	6.7 ± 2.8	4.9 ± 3.1	52.18	<0.001	K>M>I
Adoption Speed (months)	4.2 ± 1.8	7.1 ± 3.2	11.6 ± 4.7	41.73	<0.001	K<M<I
Network Density Index	0.74 ± 0.11	0.53 ± 0.16	0.31 ± 0.19	67.42	<0.001	K>M>I
Org. Participation Score	4.3 ± 0.6	3.4 ± 0.9	2.1 ± 1.1	38.91	<0.001	K>M>I
Trust in Peer Information	4.1 ± 0.7	3.8 ± 0.8	3.2 ± 1.0	18.64	<0.001	K>M>I

Table 1 shows significant differences across community types on all indicators ($p < 0.001$). Kibbutz farmers adopted the most innovations (8.4 of 12) fastest (4.2 months), while

independent farmers adopted fewest (4.9) and slowest (11.6 months). Network density followed the same gradient.

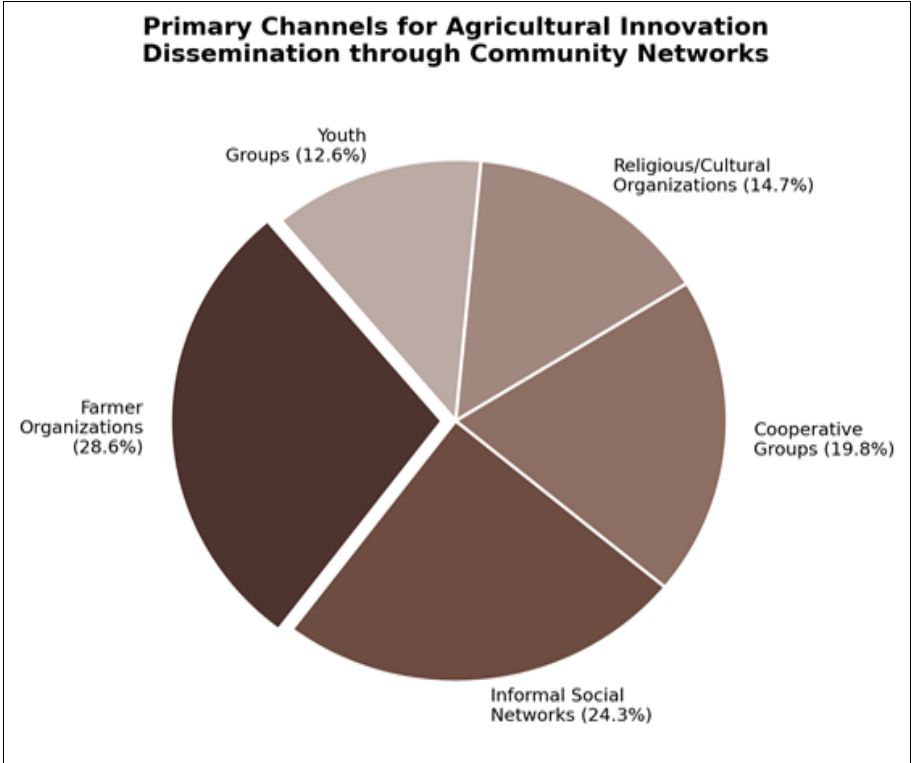


Fig 1: Primary channels for agricultural technology transfer through community networks

Figure 1 shows the primary channels through which farmers reported first learning about innovations. Farmer organizations (28.6%) and informal social capital structures

(24.3%) together accounted for over half of initial dissemination, exceeding formal extension services (not shown as a community-based channel).

Table 2: Regression analysis of network factors predicting adoption speed

Predictor	B	SE	Beta	t	p	VIF
Network Density	-2.87	0.72	0.29	3.99	<0.001	1.48
Tie Strength (avg.)	-2.41	0.68	0.26	3.54	<0.001	1.36
Org. Participation Level	-1.93	0.61	0.22	3.16	0.002	1.52
Betweenness Centrality	-1.68	0.57	0.19	2.95	0.003	1.29
Trust in Peer Info	-1.24	0.49	0.16	2.53	0.012	1.18

Regression (Table 2) identified predictors of adoption speed negative B values indicate faster adoption ($R^2 = 0.538$, $F(5,414) = 96.38$, $p < 0.001$). Network density was strongest

(Beta = 0.29), followed by tie strength (Beta = 0.26). VIF values below 1.6 confirmed no multicollinearity.

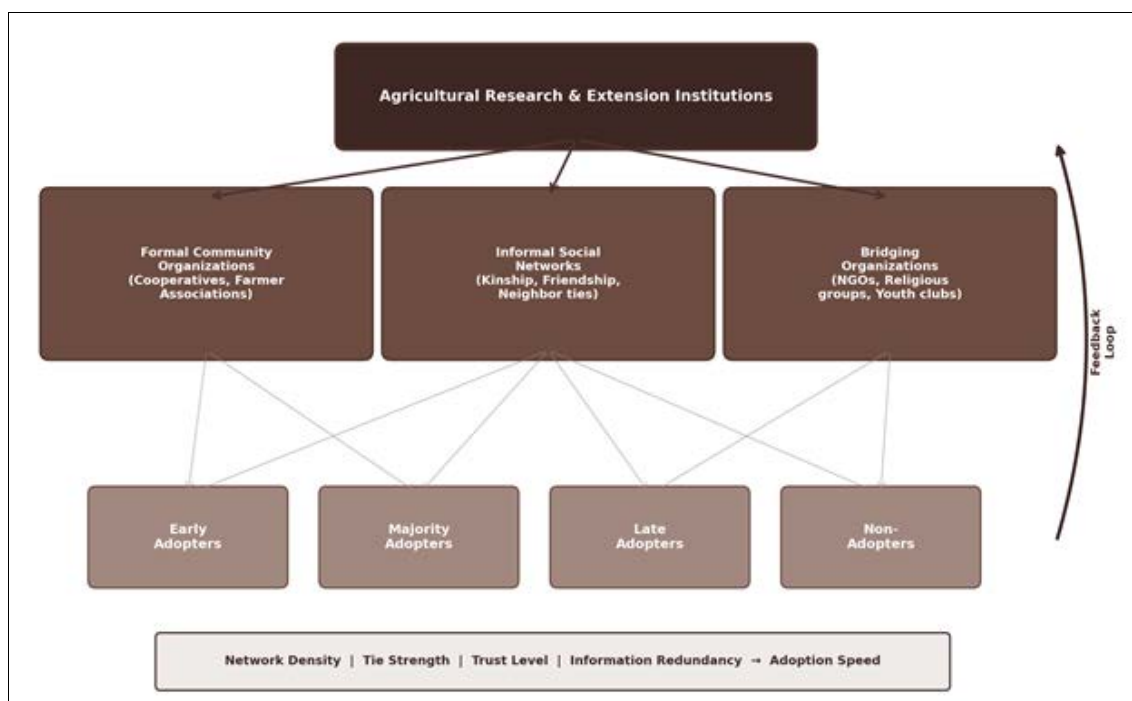


Fig 2: Flowchart of technology transfer pathways through social capital structures and community-based institutions

Figure 2 maps the dissemination pathways from research institutions through three types of community networks to farmer adoption categories, showing how network properties (density, tie strength, trust) mediate adoption speed.

Discussion

The finding that network density was the strongest predictor of adoption speed supports Granovetter's network theory^[9] and aligns with agricultural network research by Isaac *et al.*^[10] in Ghana. Kibbutz communities, with their cooperative structure and shared decision-making, naturally create the dense, high-trust networks that accelerate information flow. But this doesn't mean independent farmers are unreachable it means extension must invest differently to reach them^[11, 12].

The 2.3-fold difference in adoption speed between dense and sparse networks has practical significance. Innovations spread through well-connected organizations in months, while the same innovations took years to reach isolated farmers^[13, 14]. This gap widens productivity disparities over time^[15, 16].

Limitations

The cross-sectional design cannot determine whether dense networks cause faster adoption or whether innovation-oriented communities develop denser networks over time. Israel's unique community structures (kibbutz, moshav) limit direct generalization. Self-reported network data may undercount weak ties^[17, 18].

Practical Applications

Extension agencies should map community networks before designing programs and identify well-connected farmers as innovation brokers. For sparse-network communities, building farmer groups should precede technology introduction. Digital platforms can supplement but not

replace trust-based face-to-face networks^[19, 20].

Conclusion

Social capital structures and community-based institutions serve as the primary channels through which agricultural innovations reach farming communities. Network density and tie strength are the strongest determinants of adoption speed, explaining why cooperative communities adopt innovations 2.3 times faster than isolated farms. Extension programs that work through existing social structures rather than around them are more likely to achieve widespread adoption. Investing in community network development may yield greater returns than investing in more extension workers or information materials alone.

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