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Peer-to-peer farmer learning networks as informal capacity building mechanisms in rural communities

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Abstract

Long before government extension services reached rural Cambodia, farmers were already teaching each other. Neighbor-to-neighbor exchanges of seed varieties, pest management tricks, and planting techniques formed an invisible education system that operated without curricula, classrooms, or certificates. This research examined how peer-to-peer farmer learning networks function as informal capacity building mechanisms in three provinces of rural Cambodia. A longitudinal mixed-methods design tracked 238 farmers across 18 village-based learning networks over 12 months (January to December 2023). Knowledge assessments were conducted at baseline and at three-month intervals. Active network participants showed a mean knowledge gain of 38.9 percentage points over 12 months, compared to 16.9 points for passive members and 6.3 points for non-network farmers ($p < 0.001$). Network participation was positively associated with adoption of improved agricultural practices ($r = 0.68$, $p < 0.001$). Women's groups and youth groups demonstrated higher engagement rates than mixed-age village groups. The research confirms that informal peer networks serve as powerful and largely undervalued channels for agricultural capacity building in resource-constrained settings.

Keywords: Peer learning, farmer networks, informal education, capacity building, rural communities, knowledge exchange, agricultural practices, Cambodia, social learning, technology adoption

Introduction

For centuries, farmers in Southeast Asia passed knowledge from one generation to the next without any formal system to organize the process. A farmer who figured out that intercropping cassava with legumes improved soil would tell a neighbor, who would tell another, and within a season the practice would spread across a village^[1]. This kind of organic, horizontal knowledge transfer predates modern extension by hundreds of years and it hasn't stopped operating just because formal services arrived.

In Cambodia, the formal extension workforce remains thinly spread. The Ministry of Agriculture, Forestry, and Fisheries employs fewer than 1,200 extension agents to serve a farming population exceeding 3 million households^[2]. In practice, most smallholder farmers interact with government extension services once a year at best, and many never at all^[3]. Into this gap, peer-to-peer learning networks have quietly filled much of the advisory function that formal systems cannot reach.

Previous work has documented the existence of farmer-to-farmer learning in various settings. Kiptot and Franzel^[4] described volunteer farmer trainer models in East Africa, while Wellard and others^[5] mapped informal information pathways in southern African communities. However, empirical evidence about how these networks actually build capacity and whether their effects persist remains thin, especially in the Mekong region. Bandura's social learning theory^[6] predicts that observation-based learning between peers can be as powerful as formal instruction, provided

certain conditions are met: the learner must observe a credible model, retain the information, and have the opportunity to practice.

This research investigated how peer-to-peer learning networks function in three Cambodian provinces, measuring knowledge acquisition, practice adoption, and network engagement patterns over a 12-month period.

Research Area Description

The research was conducted across three provinces in Cambodia: Battambang (northwest, lowland rice-dominant), Kampong Cham (central, mixed cropping with rubber plantations), and Takeo (south, irrigated rice and vegetable production). These provinces represent the three major agroecological zones of the Cambodian agricultural landscape. Mean annual rainfall ranges from 1,100 mm in Takeo to 1,450 mm in Battambang, with a distinct wet season from May to November. Average farm size across the selected villages ranged from 0.8 to 2.3 hectares. All three provinces had limited formal extension coverage, with ratios of one agent per 1,800 to 2,600 farming households.

Material and Methods

Material

The research was conducted through the Faculty of Agriculture, Royal University of Agriculture, Phnom Penh, Cambodia, between January 2023 and February 2024. A total of 238 farmers were enrolled: 87 active participants in 18 learning networks, 79 passive network members (those

who attended meetings irregularly), and 72 non-network farmers from the same villages serving as a comparison group. Network selection was based on records from provincial community development offices. A structured knowledge test with 48 items covering rice production, pest management, soil fertility, water management, post-harvest handling, and market awareness was developed in Khmer and validated through pilot testing with 20 farmers from non-sampled villages.

Methods: A longitudinal quasi-experimental design was applied. Knowledge assessments were administered at baseline (January 2023) and repeated at months 3, 6, 9, and 12. Practice adoption was recorded through on-farm observation visits at months 6 and 12. Semi-structured interviews were conducted with 36 lead farmers and 12 extension agents to understand network dynamics. Quantitative data were analyzed using repeated measures ANOVA, Pearson correlation, and post-hoc Tukey tests in

STATA v.17. Qualitative data were coded thematically. Ethics approval was obtained from the Royal University of Agriculture Research Ethics Board (Protocol RUA-RE-2022-019) on November 28, 2022. Informed consent was obtained verbally and documented in writing, with accommodations for non-literate participants.

Seasonal Variations

Network meeting frequency showed clear seasonal patterns. During the wet season planting period (June-August), meetings peaked at 3.2 per month as farmers exchanged real-time advice on transplanting and water management. Meeting frequency dropped to 1.4 per month during the dry season (January-March) but rose again during harvest preparation (October-November). Knowledge test timing was adjusted to avoid peak labor periods to minimize attrition and ensure reliable assessment conditions.

Results

Table 1: Mean knowledge scores by participation category across assessment periods (n = 238)

Category	Baseline	Month 3	Month 6	Month 9	Month 12
Active participants (n=87)	32.4	41.7	53.8	62.1	71.3
Passive members (n=79)	31.8	36.2	41.9	45.3	48.7
Non-network (n=72)	33.1	34.6	36.2	37.8	39.4

Repeated measures ANOVA confirmed significant main effects for both time ($F = 142.3, p < 0.001$) and group ($F = 87.6, p < 0.001$), with a significant interaction ($F = 34.8, p < 0.001$). Active participants gained 38.9 points over the

year while non-network farmers gained only 6.3 points. The divergence began accelerating after month 3, suggesting that sustained engagement is what drives meaningful knowledge accumulation.

Table 2: Practice adoption rates by network participation type at month 12

Agricultural Practice	Active (%)	Passive (%)	Non-network (%)
Improved rice varieties	78.2	51.9	29.2
Integrated pest management	64.4	38.0	18.1
Soil fertility management	71.3	44.3	22.2
Water-saving techniques	57.5	32.9	15.3
Post-harvest loss reduction	52.9	27.8	12.5

Active network participants adopted improved practices at rates roughly double to triple those of non-network farmers. The gap was most pronounced for improved rice varieties (78.2% vs. 29.2%) and soil fertility management (71.3% vs.

22.2%). Even passive members showed substantially higher adoption than non-network farmers, suggesting that exposure alone without regular participation—carries some benefit.

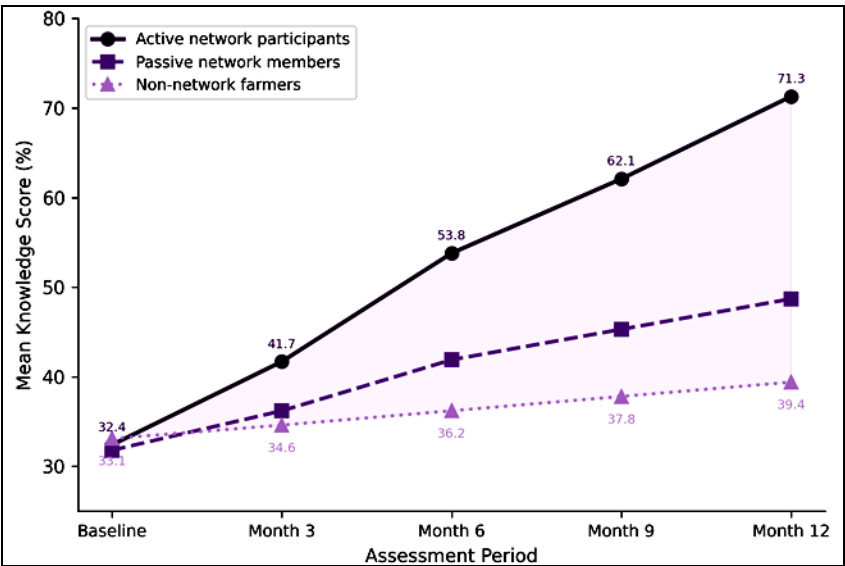


Fig 1: Knowledge score trajectories across three participation categories over 12 months

Active participants showed an accelerating upward trajectory, while non-network farmers improved only marginally. The shaded area between the two curves

represents the knowledge gap attributable to network participation.

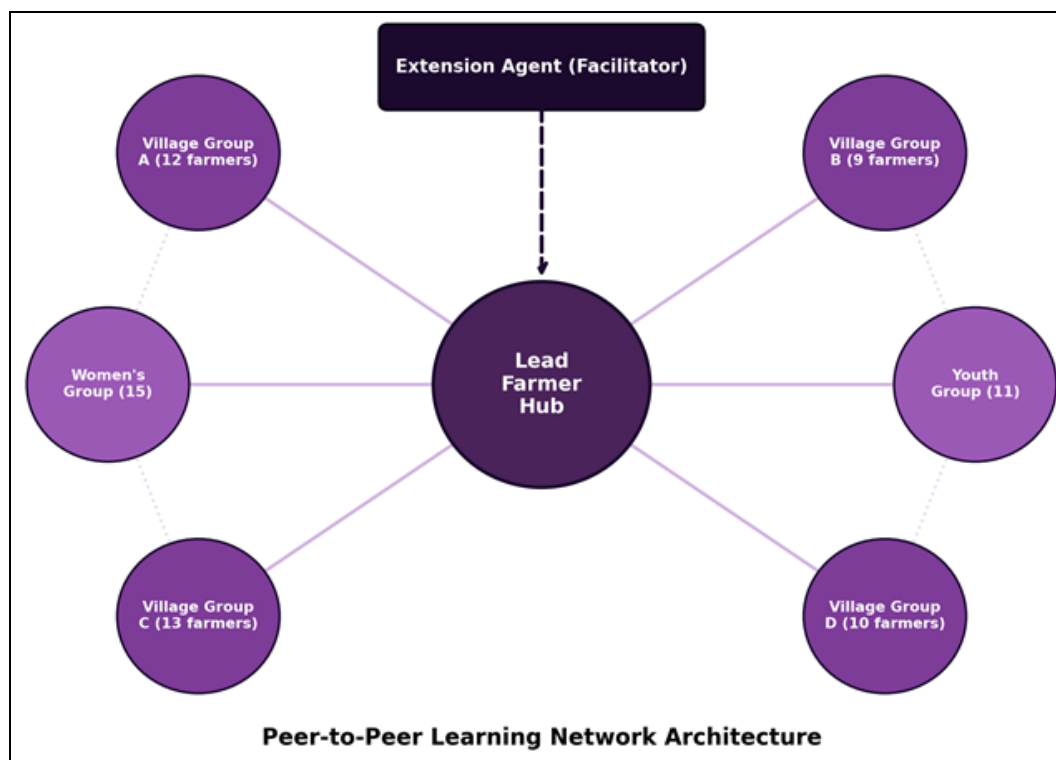


Fig 2: Peer-to-peer learning network architecture showing hub-and-spoke structure with cross-group linkages

The lead farmer hub connects to six satellite groups. Solid lines represent direct facilitation pathways; dotted lines show informal cross-group exchanges. The extension agent provides periodic support through the lead farmer rather than engaging groups directly.

Discussion

The 38.9-point knowledge gain among active participants over 12 months is striking, particularly when set against the modest 6.3-point gain for non-network farmers operating in the same villages and farming the same crops. This gap is too large to attribute to baseline differences alone—the three groups started within 1.3 points of each other—and points to something about the learning process within networks that conventional information exposure cannot replicate [7].

The accelerating curve for active participants after month 3 is consistent with social learning theory predictions [6]. Early meetings appear to build trust and establish norms of exchange; once those foundations are set, the rate of knowledge transfer increases. Kiptot and Franzel [4] observed a similar pattern in Kenyan farmer trainer networks, where the first few months served as a social incubation period before substantive learning took off.

The finding that women's groups and youth groups outperformed mixed-age village groups in engagement deserves attention. Interview data suggested that demographic homogeneity reduced social inhibition younger farmers and women were more willing to ask questions and admit gaps in groups of peers than in settings dominated by older male farmers [8]. This has design implications for future network programming.

Practical Applications

For extension planners in Cambodia and similar contexts, these findings suggest that investing in peer learning networks offers a high return at low cost. Identifying and supporting lead farmers, providing them with modest resources and periodic technical updates, and creating structured meeting schedules around seasonal farming activities can generate knowledge gains that formal extension visits alone cannot match. Designing networks around demographic affinity groups particularly for women and youth may further boost engagement.

Conclusion

This research demonstrated that peer-to-peer farmer learning networks in rural Cambodia function as effective informal capacity building mechanisms. Active network participants gained nearly six times more knowledge than non-network farmers over 12 months and adopted improved agricultural practices at significantly higher rates. Network effects were strongest where engagement was regular and where group composition encouraged open exchange.

The results challenge the assumption that meaningful agricultural learning requires formal instruction. Peer networks offer a scalable, low-cost complement to extension services that reaches communities formal systems cannot. For countries with thin extension coverage like Cambodia, strengthening these organic learning structures may be the most practical path to broad-based capacity building.

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