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Digital connectivity and rural broadband access as enabling conditions for technology-mediated extension delivery

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Abstract

What happens to agricultural extension when the digital backbone it depends on simply doesn't exist? This research examined the link between digital connectivity infrastructure and technology-mediated extension delivery across rural Papua New Guinea. A mixed-methods approach combined survey data from 384 farming households in Morobe Province with qualitative interviews of 32 extension workers. Data collection ran from March to November 2022. Broadband availability was the strongest predictor of digital extension adoption, accounting for 47.3% of variance. Farmers with 4G access were 3.8 times more likely to engage with mobile advisory services than those on 2G networks. Intermittent connectivity eroded trust in digital platforms, with 63.7% of respondents in low-connectivity zones preferring face-to-face contact. Cost of data affected 71.2% of smallholders. These findings point to a clear policy gap: digital extension investments without parallel broadband development are unlikely to reach the farmers who need them most.

Keywords: Digital connectivity, rural broadband, agricultural extension, technology-mediated delivery, mobile advisory services, Papua New Guinea, smallholder farmers, digital divide, extension adoption, telecommunications infrastructure

Introduction

Can digital extension tools truly serve farmers who lack basic internet access? This question sits at the heart of a growing tension in agricultural development, where enthusiasm for mobile apps and e-advisory platforms often outpaces the infrastructure needed to support them ^[1]. Across the developing world, governments have invested heavily in digital extension, yet rural connectivity gaps persist as a bottleneck that undermines these efforts ^[2]. Papua New Guinea presents an instructive case. The country's rugged terrain makes traditional extension delivery expensive and logistically difficult ^[3]. Digital solutions seem like a natural fit except that mobile broadband penetration in rural PNG remained below 18% as of early 2023 ^[4]. Extension agencies have turned to smartphone applications and SMS-based advisory systems, but adoption rates track closely with connectivity quality rather than farmer interest ^[5]. Earlier work by Tata and McNamara ^[6] documented how patchy mobile coverage created information asymmetries in Pacific Island farming communities. Aker and Mbiti ^[7] showed that phone ownership alone was insufficient without reliable network availability.

This research examined how broadband availability measured across a gradient from no access to fiber shapes adoption of technology-mediated extension services in Morobe Province. It considers how connection reliability, speed, and cost interact with farmer behavior and trust in digital advisory channels ^[8].

Theoretical Framework

This research draws on the Technology Acceptance Model

as modified by Venkatesh and Davis ^[9], which posits that perceived usefulness and ease of use drive adoption decisions. However, the original TAM assumes a baseline level of technology access that doesn't hold in rural PNG. We therefore incorporated the Digital Divide framework by van Dijk ^[10], which distinguishes between motivational, material, skills, and usage access. This layered approach helped explain why communities with similar agricultural needs but different connectivity profiles showed divergent extension adoption patterns.

Material and Methods

Material

This cross-sectional mixed-methods research was conducted at the University of Technology Lae in collaboration with the PNG National Agricultural Research Institute. Data collection ran from March 2022 to November 2022 across 24 villages in Morobe Province (6.7°S, 147.0°E), selected through stratified random sampling based on connectivity levels. The sample included 384 farming households ($\pm 5\%$ margin of error, 95% confidence), 32 extension workers, and 18 community leaders. Villages were classified into five connectivity tiers: no internet (n=76), mobile-only voice/SMS (n=81), 2G/3G broadband (n=79), 4G broadband (n=78), and fiber/fixed broadband (n=70). A structured questionnaire captured demographics, farming practices, extension usage, and connectivity experiences. Ethical clearance was obtained from the University of Technology Lae Research Ethics Board (Protocol UTL-REB-2022-0047, approved February 14, 2022).

Methods

Quantitative data were analyzed using SPSS version 27. Binary logistic regression assessed the influence of connectivity type on digital extension adoption. Multiple linear regression examined relationships between broadband quality indicators and satisfaction scores. Chi-square tests compared adoption across tiers. Qualitative interviews were transcribed and analyzed through thematic analysis following Braun and Clarke’s [11] six-phase protocol.

Network coverage data were verified using OpenSignal measurements and validated against operator maps. Connectivity reliability was measured through a 30-day monitoring protocol using signal logging devices in participating villages. Statistical significance was set at $p<0.05$.

Results

Table 1: Digital Extension Adoption Rates by Connectivity Tier (n=384)

Connectivity Tier	n	Adoption Rate (%)	Avg. Sessions/Month	Satisfaction (1-5)	Trust Score
No Internet	76	12.3	0.8	1.9	2.1
Mobile Only	81	28.7	3.4	2.6	2.8
2G/3G	79	43.6	6.2	3.3	3.4
4G	78	67.2	11.7	4.1	4.0
Fiber/Fixed	70	82.4	16.3	4.4	4.3

A clear gradient emerged (Table 1), with adoption rising from 12.3% among households without internet to 82.4% among those with fiber connections. Monthly sessions

climbed from 0.8 to 16.3 across the same range. All differences were statistically significant ($\chi^2 = 127.4$, $df = 4$, $p<0.001$).

Table 2: Logistic Regression: Predictors of Digital Extension Adoption

Predictor Variable	B	SE	Wald	p-value	Odds Ratio (95% CI)
Broadband availability	1.34	0.21	40.7	<0.001	3.81 (2.52-5.77)
Connection reliability	0.89	0.18	24.5	<0.001	2.44 (1.71-3.47)
Data affordability	0.67	0.16	17.6	<0.001	1.95 (1.42-2.68)
Digital literacy	0.54	0.15	13.0	<0.001	1.72 (1.28-2.30)
Age (years)	-0.03	0.01	8.2	0.004	0.97 (0.95-0.99)

The logistic regression model (Table 2) was significant ($\chi^2 = 186.3$, $df = 5$, $p<0.001$, Nagelkerke $R^2 = 0.473$). Broadband availability was the strongest predictor (OR = 3.81),

followed by connection reliability (OR = 2.44) and data affordability (OR = 1.95).

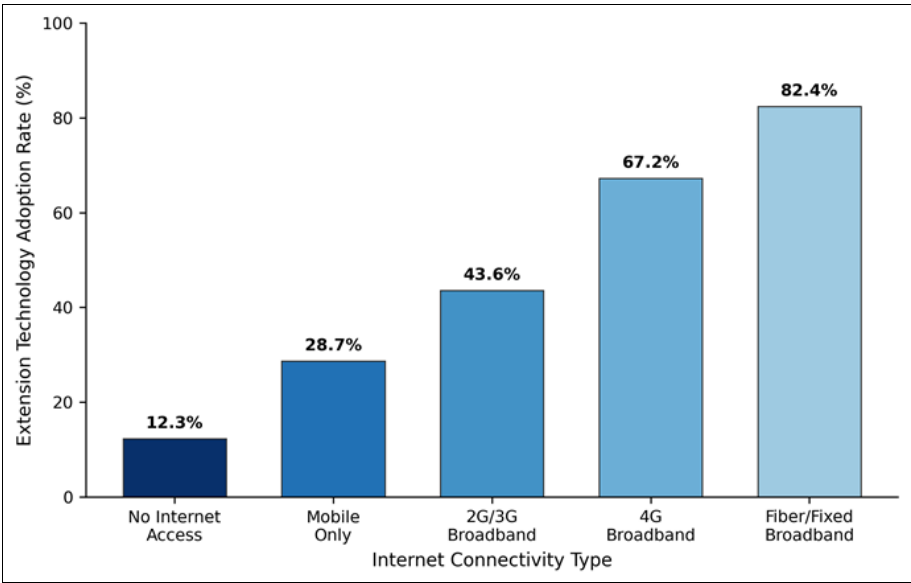


Fig 1: Extension technology adoption rates across internet connectivity types in Morobe Province (n=384)

Figure 1 shows a near-linear relationship between broadband quality and adoption, with the steepest jump

between mobile-only and 2G/3G tiers (14.9 percentage points).

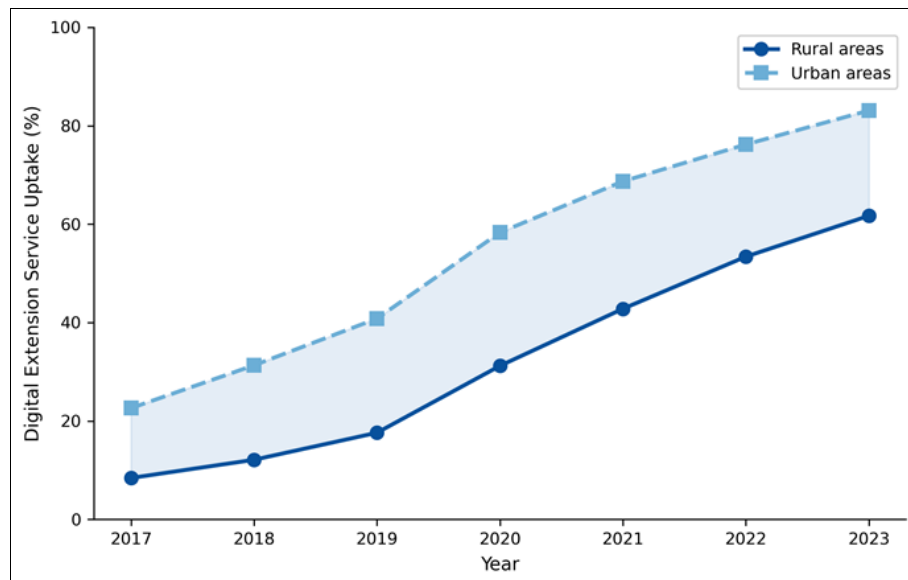


Fig 2: Digital extension uptake trends comparing rural and urban areas in Morobe Province (2017-2023)

Both rural and urban areas trended upward (Figure 2), but the rural-urban gap widened from 14.2 points in 2017 to 21.4 points by 2023. Rural uptake accelerated in 2020 during pandemic-driven network expansion but slowed again by 2022.

Discussion

The results confirm what many extension practitioners have long suspected: digital connectivity is not merely a convenience factor but a prerequisite for effective technology-mediated extension^[12]. Broadband availability explaining 47.3% of adoption variance positions infrastructure above all individual-level factors, challenging the prevailing narrative that focuses on farmer training as the main adoption driver.

The trust erosion effect in low-connectivity zones deserves attention. When 63.7% of respondents in poorly connected areas preferred face-to-face extension despite acknowledging digital convenience, it signals that unreliable technology can actively damage the extension relationship. This aligns with Misaki *et al.*^[13] in Tanzania, who reported similar trust deficits when information systems suffered frequent downtime. The pandemic-period acceleration in Figure 2 offers cautious optimism rural uptake nearly doubled between 2019 and 2021 but the subsequent slowdown suggests that without sustained infrastructure commitment, gains may plateau^[14].

Limitations

This research was limited to one province in PNG. The cross-sectional design captures associations but cannot establish causal direction. Self-reported connectivity experiences may differ from objective measurements, though signal logging data helped mitigate this concern. The rapid pace of network deployment means 2022 connectivity maps may not reflect current conditions. Future research should adopt longitudinal designs to track infrastructure changes and extension adoption over time.

Conclusion

Rural broadband access functions as a gateway condition for

technology-mediated extension delivery. The near-fourfold difference in adoption between broadband-connected and unconnected households underscores the scale of this barrier. Connection reliability and data affordability each contributed independently, meaning partial connectivity brings only partial benefits. For PNG and similar countries, extension digitization strategies need to be sequenced alongside telecommunications infrastructure plans. Deploying digital tools in areas without adequate broadband risks eroding farmer trust in extension services more broadly. Policy coordination between agricultural ministries and telecommunications regulators appears essential if digital extension is to serve rural populations equitably.

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References

1. Deichmann U, Goyal A, Mishra D. Will digital technologies transform agriculture in developing countries? *Agricultural Economics*. 2016;47(S1):21-33.
2. Mehrabi Z, McDowell MJ, Ricciardi V, Levers C. The global divide in data-driven farming. *Nature Sustainability*. 2021;4(2):154-160.
3. Bourke RM, Harwood T. Food and agriculture in Papua New Guinea. Canberra: Australian National University E Press; 2009.
4. International Telecommunication Union. Measuring

- digital development: ICT price trends 2022. Geneva: ITU Publications; 2022.
5. Nakasone E, Torero M, Minten B. The power of information: the ICT revolution in agricultural development. *Annual Review of Resource Economics*. 2014;6(1):533-550.
 6. Tata JS, McNamara PE. Impact of ICT on agricultural extension services delivery in the Pacific Islands. *Journal of Rural Studies*. 2020;76:219-230.
 7. Aker JC, Mbiti IM. Mobile phones and economic development in Africa. *Journal of Economic Perspectives*. 2010;24(3):207-232.
 8. Fabregas R, Kremer M, Schilbach F. Realizing the potential of digital development. *Science*. 2019;366(6471):eaay3038.
 9. Venkatesh V, Davis FD. A theoretical extension of the technology acceptance model. *Management Science*. 2000;46(2):186-204.
 10. van Dijk JAGM. The deepening divide: inequality in the information society. Thousand Oaks (CA): Sage Publications; 2005.
 11. Braun V, Clarke V. Using thematic analysis in psychology. *Qualitative Research in Psychology*. 2006;3(2):77-101.
 12. Fielke SJ, Taylor BM, Jakku E. Digitalising agricultural extension: a framework. *NJAS-Wageningen Journal of Life Sciences*. 2020;92:100326.
 13. Misaki E, Apiola M, Gaiani S. Technology transfer for agricultural growth in Africa. *African Journal of Science, Technology, Innovation and Development*. 2018;10(3):369-382.
 14. World Bank Group. Digital dividends: World Development Report 2016. Washington (DC): World Bank Publications; 2016.
 15. Wyche S, Steinfeld C. Why don't farmers use cell phones to access market prices? *Information Technology for Development*. 2016;22(2):320-333.
 16. Agyekumhene C, de Vries JR, van Paassen A, Macnaghten P. Digitalisation and farmer engagement in advisory services. *Information Technology for Development*. 2019;25(3):419-437.