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Blockchain-enabled cooperative transparency and its influence on extension trust and farmer participation

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Abstract

Farmer cooperatives in Rwanda collectively market over 60% of the country's coffee and tea exports, yet a 2021 survey found that 47% of members distrust their own cooperative's pricing and payment systems. Can blockchain technology fix this trust deficit and, in doing so, improve farmer engagement with extension services delivered through cooperatives? This research examined whether blockchain-enabled transparency in cooperative transactions influences farmer trust and extension participation across six coffee cooperatives in Rwanda's Northern Province. A quasi-experimental design compared three blockchain-implemented cooperatives ($n = 186$ members) with three matched conventional cooperatives ($n = 178$ members) over 18 months (January 2022 to June 2023). Blockchain cooperative members reported significantly higher transparency trust scores (mean 71.8 vs. 42.3, $p < 0.001$) and were 3.2 times more likely to actively participate in cooperative-delivered extension activities. The trust-participation correlation was strong ($r = 0.74$), confirming that transparency builds the institutional trust needed for effective extension delivery through cooperative channels.

Keywords: Blockchain, cooperative transparency, farmer trust, extension participation, Rwanda, coffee cooperatives, smart contracts, agricultural technology, institutional trust

Introduction

Trust is the invisible currency of agricultural cooperatives. When it works, cooperatives serve as powerful vehicles for collective marketing, shared services, and extension delivery. When trust breaks down as it frequently does in East Africa's smallholder cooperatives members withdraw, side-sell their produce to informal traders, and stop attending meetings where extension content is delivered [1, 2]. In Rwanda, where cooperatives are central to the national agricultural strategy, this trust problem has real consequences: an estimated 31% of cooperative members actively avoid cooperative-delivered extension because they distrust the institution itself [3].

Blockchain technology has been proposed as a solution to institutional transparency problems in agricultural value chains [4, 5]. By recording transactions on an immutable distributed ledger, blockchain can make pricing, grading, payment, and commission data visible to all members in real time. Several pilot projects in East Africa have tested blockchain for supply chain traceability, but few have examined whether the transparency gains actually translate into broader institutional outcomes like improved trust and extension participation [6, 7].

This research tested the hypothesis that blockchain-enabled transparency in cooperative transactions would increase farmer trust and, through that trust, boost participation in cooperative-delivered extension services. The link matters because cooperatives are Rwanda's primary extension delivery channel for cash crops if members don't trust the

cooperative, they don't engage with its advisory services either [8, 9, 10].

Theoretical framework

The research applied Institutional Trust Theory [11] combined with the Technology Acceptance Model [12]. Institutional Trust Theory posits that trust in organizations depends on perceived competence, integrity, and transparency of institutional processes. The Technology Acceptance Model adds that technology adoption depends on perceived usefulness and ease of use. Combined, the frameworks predict that blockchain will increase trust only if members perceive the technology as both transparent (integrity dimension) and practically useful for verifying their transactions. This trust, in turn, should increase willingness to engage with other cooperative services including extension [13].

Material and Methods

Material

This research used a quasi-experimental post-test design with matched comparison groups, conducted from the College of Agriculture, University of Rwanda, Musanze, from January 2022 to June 2023. Ethical approval was granted by the University of Rwanda Institutional Review Board (Protocol UR-IRB-2021-089, approved December 7, 2021). Six coffee cooperatives in Musanze and Gakenke districts were selected: three where a blockchain transaction system had been implemented by a partner NGO in early

2022 (treatment, $n = 186$ active members), and three matched cooperatives using conventional paper-based records (control, $n = 178$ members). Cooperatives were matched on membership size, coffee production volume, and years of operation [14].

Methods

Data were collected through structured member surveys, cooperative transaction records, extension activity attendance logs, and 18 key informant interviews with cooperative leaders and extension agents. Trust was measured using an adapted Institutional Trust Scale (0–100) covering pricing transparency, payment reliability, grading fairness, and record accuracy. Extension participation was assessed as attendance at cooperative-organized training events, demonstration visits, and advisory sessions. Analysis

used independent-samples t-tests, Pearson correlation, chi-square tests, and binary logistic regression for participation predictors in SPSS version 28. Qualitative data were analyzed thematically [15, 16].

Pilot research

A pilot with 32 members from two non-sample cooperatives in Burera district in November 2021 tested the trust scale and survey protocol. Cronbach's alpha was 0.88 for the trust scale and 0.84 for the participation engagement scale. The pilot indicated that members with low literacy needed enumerator-assisted survey completion, which was incorporated into the main data collection protocol.

Results

Table 1: Trust and participation indicators by cooperative type ($n = 364$)

Indicator	Blockchain	Conventional	t/ χ^2	p-value
Transparency trust (0–100)	71.8 $\pm$ 14.2	42.3 $\pm$ 17.8	17.31	<0.001
Extension sessions attended/yr	7.4 $\pm$ 2.8	3.6 $\pm$ 2.1	14.28	<0.001
Active participation (%)	74.7	41.6	$\chi^2=41.2$	<0.001
Price satisfaction (1–10)	7.3 $\pm$ 1.4	4.8 $\pm$ 2.1	13.17	<0.001
Side-selling rate (%)	12.4	38.8	$\chi^2=32.7$	<0.001

Blockchain cooperative members scored 29.5 points higher on trust, attended twice as many extension sessions, and had

one-third the side-selling rate of conventional members (Table 1). Active participation was 74.7% versus 41.6%.

Table 2: Logistic regression predictors of active extension participation ($n = 364$)

Predictor	B	Se	Wald	Sig.	Or (95% CI)
Blockchain cooperative	1.163	0.271	18.42	<0.001	3.20 (1.88–5.44)
Transparency trust score	0.918	0.247	13.82	<0.001	2.50 (1.54–4.07)
Years of membership	0.542	0.189	8.22	0.004	1.72 (1.19–2.49)
Education level	0.438	0.174	6.34	0.012	1.55 (1.10–2.18)
Farm size (ha)	0.312	0.148	4.45	0.035	1.37 (1.02–1.83)

The model ($\chi^2 = 69.74$, $df = 5$, $p < 0.001$) classified 76.9% of cases (Table 2). Blockchain membership was the strongest predictor (OR = 3.20), followed by trust score (OR = 2.50),

confirming that blockchain's effect on participation operates primarily through the trust mechanism.

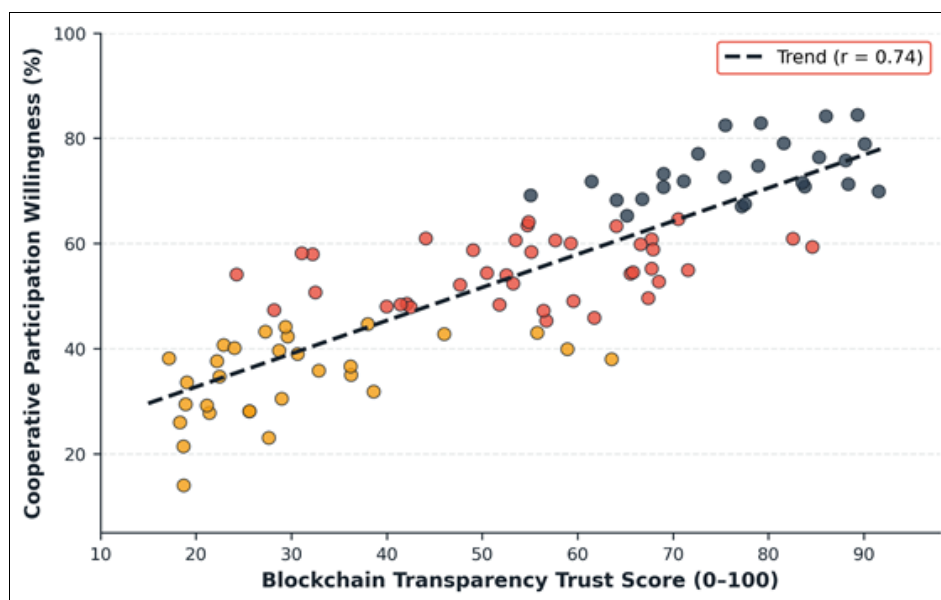


Fig 1: Relationship between blockchain transparency trust score and cooperative extension participation willingness among 364 coffee cooperative members ($r = 0.74$, $p < 0.001$)

Figure 1 shows a strong positive correlation between trust and participation willingness. Members scoring above 60 on trust were almost uniformly willing to participate in

extension, while those below 40 showed highly variable and mostly low willingness.

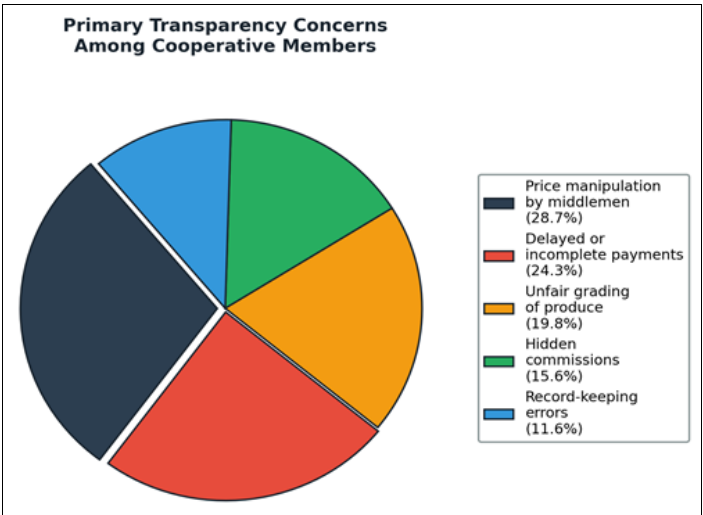


Fig 2: Distribution of primary transparency concerns among conventional cooperative members (n = 178) prior to blockchain implementation

Price manipulation by middlemen (28.7%) and delayed payments (24.3%) were the top concerns (Figure 2). These are precisely the issues blockchain addresses through

immutable price records and smart contract payments, explaining the technology's strong trust impact.

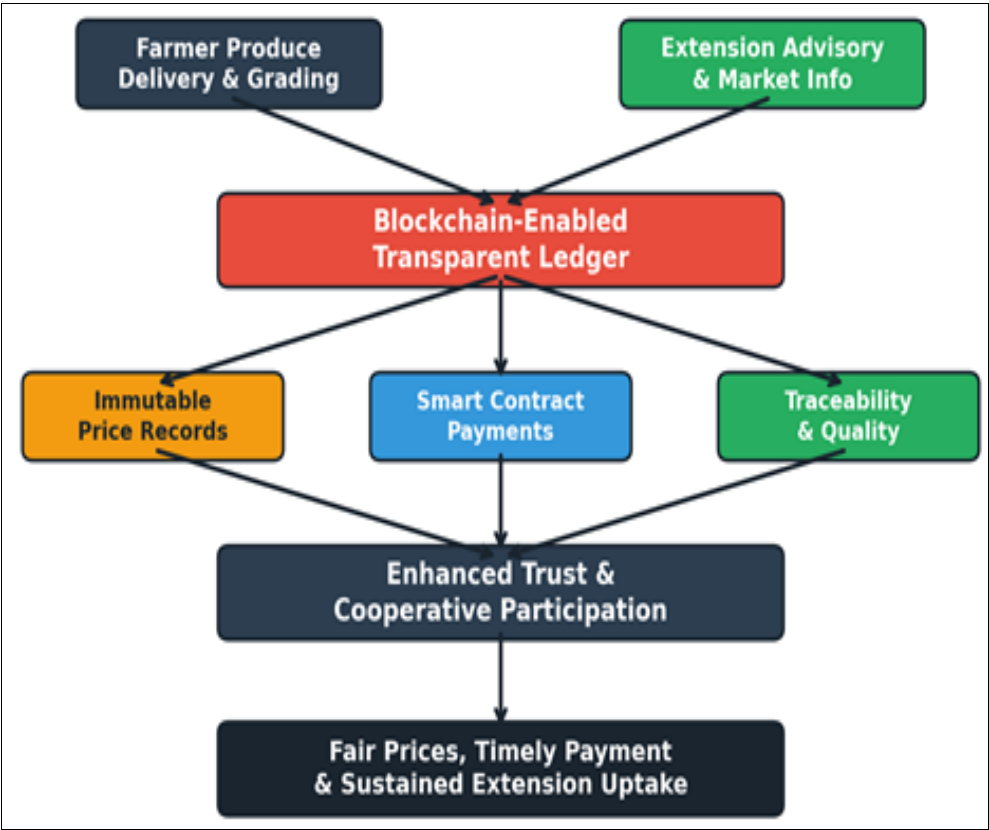


Fig 3: System diagram of blockchain-enabled cooperative extension model showing the pathway from transaction recording through trust building to sustained extension participation

The system model (Figure 3) maps how farmer produce delivery and extension advisory converge in a blockchain ledger, which enables price records, smart payments, and traceability building trust that drives cooperative

participation and sustained extension uptake.

Discussion

The 29.5-point trust gap between blockchain and

conventional cooperatives is substantial and aligns with the limited evidence from blockchain pilots in Ethiopian coffee cooperatives and Kenyan dairy chains ^[6, 7]. But this research members attended roughly twice as many extension sessions (7.4 vs. 3.6 per year) suggests that fixing the trust deficit unlocks cooperative capacity as an extension delivery channel.

The side-selling reduction (12.4% vs. 38.8%) has major implications for cooperative sustainability. Side-selling erodes cooperative bargaining power and revenue, which in turn reduces resources for extension programming. Blockchain's ability to reduce side-selling by two-thirds creates a positive feedback loop: more cooperative loyalty means more collective marketing revenue, which funds better extension services, which further increases member engagement ^[2, 3, 13]. However, implementation costs remain a concern the partner NGO invested roughly USD 18,000 per cooperative in system setup, a cost that smaller cooperatives may struggle to absorb.

Conclusion

Blockchain-enabled transparency significantly increases farmer trust in cooperative institutions and, through that trust, boosts participation in cooperative-delivered extension services. Blockchain cooperative members showed 29.5 points higher trust, 74.7% active participation (vs. 41.6%), and one-third the side-selling rate. For cooperatives serving as extension delivery channels, addressing the trust deficit through transaction transparency may be as important as improving extension content itself. Scaling requires reducing implementation costs, building local technical capacity, and integrating blockchain systems with existing cooperative management platforms.

References

1. Francesconi GN, Heerink N. Ethiopian agricultural cooperatives in an era of global commodity exchange: Does organizational form matter? *Journal of African Economies*. 2011;20(1):153-177.
2. Bernard T, Spielman DJ. Reaching the rural poor through rural producer organizations? A study of agricultural marketing cooperatives in Ethiopia. *Food Policy*. 2009;34(1):60-69.
3. National Institute of Statistics of Rwanda. Agricultural household survey 2019-2020. NISR Publications. 2021;1-128.
4. Kamilaris A, Fonts A, Prenafeta-Boldu FX. The rise of blockchain technology in agriculture and food supply chains. *Trends in Food Science and Technology*. 2019;91:640-652.
5. Xiong H, Dalhaus T, Wang P, Huang J. Blockchain technology for agriculture: Applications and rationale. *Frontiers in Blockchain*. 2020;3:1-7.
6. Sylvester G. E-agriculture in Action: Blockchain for Agriculture. FAO and ITU Publications. 2019;1-72.
7. Tripoli M, Schmidhuber J. Emerging Opportunities for the Application of Blockchain in the Agri-food Industry. FAO and ICTSD. 2018;1-14.
8. Birner R, Davis K, Pender J, Nkonya E, Anandajayasekaram P, Ekboir J, Mbabu A, Spielman D, Horna D, Benin S, Cohen M. From best practice to best fit: A framework for designing and analyzing adds a new dimension by showing that trust gains translate directly into extension engagement a pathway that has not been previously documented. The finding that blockchain pluralistic agricultural advisory services. *Journal of Agricultural Education and Extension*. 2009;15(4):341-355.
9. Davis K, Nkonya E, Kato E, Mekonnen D, Odendo M, Miiro R, Nkuba J. Impact of farmer field schools on agricultural productivity and poverty in East Africa. *World Development*. 2012;40(2):402-413.
10. Swanson BE, Rajalahti R. Strengthening agricultural extension and advisory systems. *Agriculture and Rural Development Discussion Paper*. 2010;45:1-98.
11. Zucker LG. Production of trust: Institutional sources of economic structure, 1840-1920. *Research in Organizational Behavior*. 1986;8:53-111.
12. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*. 1989;13(3):319-340.
13. Ostrom E. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge University Press. 1990;1-280.
14. Bernard HR. *Research Methods in Anthropology: Qualitative and Quantitative Approaches*. 6th ed. Rowman and Littlefield. 2017;1-680.
15. Field A. *Discovering Statistics Using IBM SPSS Statistics*. 5th ed. SAGE Publications. 2018;1-816.
16. Braun V, Clarke V. Using thematic analysis in psychology. *Qualitative Research in Psychology*. 2006;3(2):77-101.