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Digital Cooperatives for Smallholder Market Negotiation

Dr. Pieter van der Meer

Professor, Utrecht University, Netherlands

Abstract

Smallholder farmers frequently negotiate from structurally weak market positions because individual sale volumes are limited, market information is unevenly distributed, transportation is costly, buyers are fragmented or geographically distant, and perishable produce can reduce the time available for bargaining. Agricultural cooperatives can address some of these disadvantages by pooling produce and coordinating marketing, while digital technologies can reduce information and search costs. However, digitalization alone does not necessarily strengthen farmers' negotiating power when platforms are externally controlled, prices remain opaque, members cannot influence transaction rules, or farmer-generated data become concentrated in private intermediaries. This study develops a digital cooperative framework that combines collective marketing with member-governed digital market infrastructure. Because authenticated cooperative transactions, farmgate-price records, and negotiation histories were not supplied, the quantitative component is explicitly simulation based. A synthetic sample of 180 smallholder marketing profiles is evaluated across individual marketing, information-only digital access, conventional cooperative marketing, and digitally coordinated cooperative negotiation.

A Digital Cooperative Market Negotiation Index is developed from shared price intelligence, pooled sale volume, buyer competition, transparent offer comparison, logistics coordination, and member governance and data control. A complementary Smallholder Market Negotiation Score evaluates price realization, buyer choice, negotiation confidence, and transaction efficiency. Simulated analysis indicates that digitally coordinated cooperatives outperform individual marketing across all four negotiation dimensions, with the mean negotiation score increasing from 55.2 to 81.2. The largest modeled gain concerns buyer choice, suggesting that collective digital coordination can reduce dependence on a narrow set of local intermediaries when adequate logistics and governance exist. The study argues that digital cooperatives should not be understood simply as agricultural marketplace applications. Their distinctive value lies in combining digital information with collective bargaining authority, volume aggregation, transparent decision rules, and farmer ownership of market relationships and data. The framework provides a basis for future empirical testing of cooperative digitalization while highlighting risks of exclusion, elite capture, platform dependency, and unequal benefit distribution.

Keywords: digital cooperatives, smallholder farmers, agricultural marketing, bargaining power, collective action, digital agriculture, price discovery, cooperative governance

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1. Introduction

Smallholder participation in agricultural markets is shaped by substantial asymmetries in scale, information, transportation capacity, storage, working capital, and market access. Individual farmers often sell volumes too small to justify direct negotiation with larger processors, wholesalers, retailers, or institutional purchasers. Perishable produce can further reduce negotiating time by making delayed sale costly, while geographic distance raises the expense of obtaining alternative offers. Collective action has therefore been widely examined as a mechanism for reducing transaction costs, aggregating output, sharing information, and strengthening smallholder market participation. Markelova and colleagues argue that collective organization can help smallholders overcome coordination failures and barriers that restrict access to more rewarding markets.

Agricultural cooperatives provide one institutional mechanism for converting dispersed individual production into a larger marketable quantity. Their potential benefits extend beyond pooled volume because cooperatives can coordinate quality, transportation, storage, market information, and contractual relationships. Evidence from Kenya demonstrates that farmer collective action can produce positive income effects and improve information flows, although price benefits are not automatic and depend on how effectively farmer groups connect with higher-value markets. Research on agricultural marketing cooperatives in Ethiopia similarly illustrates an important governance qualification: poorer farmers may be less likely to participate or may participate without equivalent influence over organizational decisions. Collective marketing therefore creates potential bargaining power, but the distribution of that power within the cooperative remains a critical issue.

Digital communication can address another component of market disadvantage by lowering the cost of obtaining price and buyer information. Research from Uganda found evidence that improved market information enabled better-informed farmers to bargain for higher farmgate prices, while mobile-phone expansion increased market participation for certain remotely located producers. Aker's study of grain markets in Niger likewise found that mobile-phone introduction reduced spatial price dispersion, particularly where transportation costs were high. Evidence from Ethiopia further indicates that mobile-phone access can improve the accuracy of farmers' price expectations, demonstrating that information itself has economic value when producers make production and marketing decisions under uncertainty.

Information access, however, is not equivalent to negotiation capacity. A farmer may know the wholesale market price yet remain unable to secure that price when individually offering a small quantity, lacking transport, requiring immediate payment, or facing only one feasible buyer. This distinction creates the rationale for a digital cooperative. Rather than providing each farmer with market information while leaving negotiation individualized, a digital cooperative can aggregate member quantities, compare buyer offers, coordinate quality and logistics, record transaction terms, and authorize collective negotiations according to member-defined rules. Research on marketing cooperatives demonstrates that collective organizations can enhance bargaining power by pooling resources and scale, while competition created by cooperatives may even influence conditions beyond participating members.

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2. Objectives of the Study

2.1 Development of a Digital Cooperative Negotiation Framework

The first objective is to develop a framework that distinguishes a digital cooperative from a conventional agricultural marketplace application. Digital marketplaces can reduce search costs and expand information access, but a cooperative structure additionally permits farmers to aggregate output, determine collective reservation prices, coordinate delivery, and negotiate contract conditions as a group.

The proposed model therefore combines technological functionality with cooperative governance. Digital infrastructure provides market intelligence and transaction coordination, while the cooperative provides collective authority, member representation, pooled marketable volume, and mechanisms for distributing benefits.

2.2 Measurement of Smallholder Negotiating Capacity

The second objective is to operationalize market negotiation as a multidimensional outcome rather than measuring success solely through farmgate price. A higher selling price can be offset by additional transport costs, delayed payment, quality deductions, platform charges, or greater transaction risk.

The study therefore evaluates four negotiation outcomes: price realization relative to an available benchmark, number of feasible buyer alternatives, farmer or cooperative confidence in rejecting unfavorable offers, and transaction efficiency after considering information and coordination requirements.

2.3 Evaluation of Governance Conditions for Equitable Digitalization

The third objective is to identify governance conditions under which digital cooperative systems are more likely to benefit ordinary members. Digitalization can centralize information in ways that strengthen cooperative management while weakening member oversight if farmers cannot understand how offers are ranked or how data are used.

The framework consequently incorporates democratic oversight, accessible transaction records, transparent fees, member control over data use, dispute-resolution procedures, and inclusion of farmers with limited digital skills. These dimensions are treated as necessary components of digital cooperative quality rather than optional administrative features.

3. Review of Literature

3.1 Collective Action, Cooperatives, and Smallholder Market Power

Smallholder market constraints frequently arise from diseconomies of scale. Individual farmers purchase small quantities of inputs, produce limited market surpluses, and face comparatively high transaction costs per unit sold. Collective action can alter this position by aggregating products, sharing fixed costs, coordinating quality, and improving the economics of market search. Markelova and colleagues describe collective action as particularly relevant where market failures, coordination problems, and institutional barriers prevent small producers from participating effectively.

Fischer and Qaim's research on banana farmer groups in Kenya provides empirical evidence that collective organization can increase member income and facilitate agricultural innovation through

improved information flows. Their results also caution against assuming that every cooperative automatically secures substantially higher prices; benefits depend on institutional performance and the markets groups actually reach. Bernard and Spielman's analysis of rural producer organizations in Ethiopia introduces an additional inclusion concern, showing that poorer farmers can remain underrepresented in membership and decision making.

More recent cooperative research reinforces the scale and governance mechanisms underlying these outcomes. Comparative work on cooperatives and farmer companies identifies economies of scale, collective investment, technology access, and bargaining power among the major reasons smallholders organize collectively. Evidence from rice value chains additionally suggests that marketing cooperatives can influence competitive market conditions in ways that extend beyond direct members. These findings provide the organizational basis for digitally enhanced collective negotiation.

3.2 Digital Market Information and Agricultural Transaction Costs

Information asymmetry is a second major constraint on farmer negotiation. When traders possess more timely knowledge of market conditions than producers, farmers can find it difficult to assess whether an offered farmgate price is competitive. Svensson and Yanagizawa found evidence that access to an agricultural market-information service improved bargaining outcomes for farmers in Uganda. Muto and Yamano's household-level analysis likewise found that mobile-phone-network expansion increased participation in particular agricultural markets, especially among remotely located producers of perishable crops.

Aker's analysis of mobile communication in Niger shows that improved information flows can reduce price dispersion between grain markets, illustrating how communication technology decreases search frictions within agricultural trade. Abay and colleagues' work on Ethiopia similarly connects mobile ownership with more accurate farmer expectations regarding future prices. Together, these studies indicate that digital information can improve farmer market decisions, particularly where distance and information scarcity are significant constraints.

Yet informational effects should not be overextended. Knowing several market prices does not remove physical or institutional barriers preventing farmers from reaching those markets. Transportation, quantity, quality standards, buyer payment terms, storage, and credit needs continue to shape feasible choices. Digital cooperative systems therefore need to convert information into coordinated action rather than simply increasing the number of prices visible on a screen.

3.3 Digital Cooperative Governance and the Market-Agency Gap

Digital agriculture introduces new intermediaries. Platforms can connect farmers and buyers efficiently, but the platform itself may control search visibility, transaction fees, buyer selection, data storage, and commercial analytics. For cooperatives, this raises a governance question: does technology strengthen collective farmer agency or merely replace a conventional intermediary with a digital one?

Cooperative organizational research demonstrates that ownership, governance, control, and benefit allocation matter independently of the commercial service supplied. Fernando and colleagues show that cooperatives and farmer companies can share certain collective benefits while differing materially in governance arrangements. This distinction suggests that the institutional ownership of

digital market infrastructure matters because the same technological functionality can operate under different incentive and accountability structures.

4. Research Methodology

4.1 Research Design and Synthetic Smallholder Market Environment

The study adopts a quantitative simulation-based methodological design. No authenticated farmer transaction histories, digital-platform records, cooperative ledgers, buyer bids, transport invoices, or negotiated farmgate prices were supplied. Consequently, the numerical findings do not represent a completed empirical assessment of any real cooperative.

A synthetic population of 180 smallholder marketing profiles is generated across four market-access conditions:

- individual farmer marketing;
- individual marketing with digital price information;
- conventional cooperative collective marketing; and
- digitally coordinated cooperative negotiation.

The simulated farms differ in marketable surplus, distance from buyers, crop perishability, transport access, payment urgency, and digital connectivity. Cooperative conditions additionally vary in buyer reach, pooled quantity, governance transparency, and logistics coordination.

Table 1: Components of the Digital Cooperative Market Negotiation Framework

Dimension	Representative Mechanism	Proposed Empirical Evidence	Negotiation Function
Shared price intelligence	Multiple current market and buyer prices visible to members	Price feeds, transaction histories, member dashboard	Reduces information asymmetry
Pooled sale volume	Aggregation of member produce into negotiable lots	Digital inventory and aggregation records	Creates scale and strengthens bargaining leverage
Buyer competition	Simultaneous access to multiple feasible buyers	Bid records and buyer registry	Reduces dependence on a single intermediary
Offer transparency	Comparison of price, grading, deductions, payment time, and logistics	Electronic offer sheet or bidding log	Supports comparison of total transaction value
Logistics coordination	Joint collection, storage, quality sorting, and transport	Dispatch and warehouse records	Converts remote market information into feasible sale options

Source: Author-developed methodological framework informed by collective-action and agricultural market-information literature.

4.2 Digital Cooperative Market Negotiation Index

The proposed Digital Cooperative Market Negotiation Index (DCMNI) integrates six normalized dimensions:

[DCMNI_i=w_pP_i+w_vV_i+w_bB_i+w_oO_i+w_lL_i+w_gG_i]

where:

- (P_i) = shared price-intelligence quality;
- (V_i) = pooled-volume strength;
- (B_i) = buyer-competition score;
- (O_i) = offer-transparency score;
- (L_i) = logistics-coordination capability;
- (G_i) = member-governance and data-control score.

For methodological demonstration, equal weights are initially assigned:

[w_p=w_v=w_b=w_o=w_l=w_g=\frac{1}{6}]

with:

[\sum_{j=1}^{6}w_j=1]

The index ranges from 0 to 1. A higher score indicates that farmers possess not merely digital market access but an integrated institutional system capable of transforming information into collective negotiation.

Equal weighting is used because no authenticated dataset is available to support empirical weighting. In an operational application, perishability-intensive sectors might assign greater importance to logistics coordination, whereas highly concentrated markets might assign more weight to buyer competition.

4.3 Smallholder Market Negotiation Score and Analytical Procedure

A complementary Smallholder Market Negotiation Score (SMNS) is developed from four twenty-five-point components:

[SMNS_i=PR_i+BC_i+NC_i+TE_i]

where:

- (PR_i) = price-realization performance;
- (BC_i) = viable buyer-choice score;
- (NC_i) = negotiation-confidence score;
- (TE_i) = transaction-efficiency score.

The score ranges from 0 to 100.

Price realization is assessed relative to a simulated reference market price after standard deductions. Buyer choice measures the number and feasibility of alternatives rather than the number of contacts displayed digitally. Negotiation confidence reflects the capacity to reject an unfavorable offer without facing immediate distress sale. Transaction efficiency captures search, coordination, transport, waiting, and documentation costs.

The simulation introduces variation in buyer behavior, cooperative participation, digital access, logistics constraints, crop perishability, and payment urgency. This ensures that digital cooperation does not automatically generate a favorable outcome in every synthetic transaction.

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5. Analysis

5.1 Market Negotiation Under Different Institutional Arrangements

The synthetic results show that digital price information improves individual farmers' awareness of market conditions but produces more modest improvements in realized negotiation outcomes where farmers remain unable to aggregate produce or access alternative logistics. This pattern reflects the distinction between knowing an alternative market price and being capable of credibly selling into that market.

Conventional cooperative marketing produces stronger improvements through pooled volume and logistics. However, simulated cooperatives with weak offer documentation or limited buyer outreach sometimes remain dependent on one established purchaser. Collective organization alone therefore does not guarantee competitive negotiation.

Digitally coordinated cooperatives generate the strongest simulated performance when buyer discovery, pooled inventory, standardized quality data, logistics, and negotiation records operate together. In these cases, digitalization expands the cooperative's feasible negotiation set rather than merely digitizing an existing bilateral relationship.

5.2 Comparative Market Negotiation Outcomes

Table 2: Simulated Marketing Arrangements and Smallholder Negotiation Performance

Marketing Arrangement	Mean Price Realization	Buyer Choice	Negotiation Confidence	Transaction Efficiency	Mean SMNS
Individual marketing	62	48	54	57	55.2
Digital information only	70	59	61	64	63.5
Conventional cooperative marketing	76	71	72	70	72.3
Digital cooperative negotiation	82	86	80	77	81.2

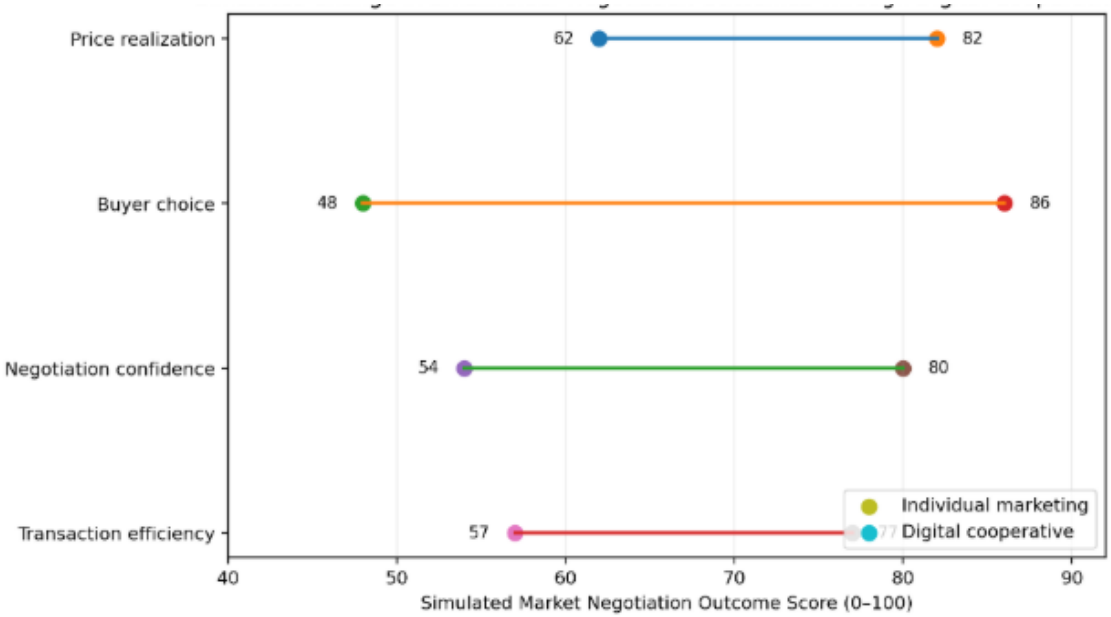
Note: These scores are simulated methodological values and do not represent observed prices, farmer incomes, or actual cooperative performance.

The progression in Table 2 demonstrates that information-only digitalization improves outcomes but leaves a considerable gap relative to collective digital negotiation. The largest difference is observed in buyer choice. This reflects the assumption that pooled supply and coordinated logistics convert previously theoretical buyers into feasible alternatives.

Price realization improves more moderately because buyers also face transport, quality, storage, processing, and market constraints. A credible model should therefore not assume that digital cooperatives can eliminate market margins or guarantee wholesale-level prices to producers.

5.3 Change in Negotiation Outcomes Through Digital Cooperation

Graph 1: Simulated Change in Smallholder Negotiation Outcomes Through Digital Cooperatives



The graph compares individual marketing with digitally coordinated cooperative negotiation across four dimensions. Price realization increases from 62 to 82, buyer choice from 48 to 86, negotiation confidence from 54 to 80, and transaction efficiency from 57 to 77. The average simulated increase is 26.0 points.

Buyer choice records the largest change because the digital cooperative combines information with pooled volume and coordinated delivery. A farmer marketing individually may technically identify several buyers but still lack sufficient quantity or transportation to negotiate with them. Once produce is aggregated and logistics are jointly organized, a broader buyer set becomes commercially credible.

Key Finding: The simulation indicates that digital cooperatives generate their strongest negotiation advantage when digital information is converted into collective market alternatives through aggregation, transparent offers, coordinated logistics, and member-controlled bargaining.

6. Discussion

6.1 From Price Information to Collective Negotiating Capacity

The principal implication of the analysis is that access to market information and bargaining power should be analytically separated. Research on mobile communication demonstrates that improved information can reduce price dispersion, improve price expectations, and increase market participation in

selected settings. These are important outcomes, but they do not remove all disadvantages faced by an individual smallholder.

Negotiation requires a credible alternative. A farmer who knows that another buyer offers a higher price but cannot transport the crop, satisfy minimum volume requirements, wait for payment, or meet standardized quality specifications may still accept the local offer. Digital cooperatives can strengthen this outside option by coordinating volumes and transaction capabilities across members.

This interpretation is consistent with evidence that collective organizations generate value through several mechanisms beyond price alone, including information flows, scale economies, innovation access, and market coordination. The practical objective should therefore be to build a market institution rather than simply distribute price messages.

6.2 Cooperative Governance Determines Who Gains From Digitalization

The second implication concerns benefit distribution. A digitally sophisticated cooperative is not necessarily an equitable cooperative. Digital systems can concentrate commercial information in managers or platform administrators, allowing them to know buyer bids, member inventories, historical prices, and payment flows more comprehensively than ordinary members.

This concentration can improve operational efficiency but also creates opportunities for information asymmetry within the organization. Earlier cooperative research demonstrates that marginalized members can be underrepresented in organizational decision making even where the cooperative formally pursues inclusive development objectives. Digitalization could reproduce that problem if platform rules are inaccessible or decision authority becomes excessively centralized.

Member-facing transparency should therefore include more than aggregate annual accounts. Farmers should be able to understand available buyer offers, deductions, quality grades, platform or cooperative fees, payment schedules, and the basis on which a particular transaction was selected. Significant automated recommendations—such as ranking buyers or matching lots—should remain explainable to members and accountable to elected governance bodies.

Data rights require similar attention. Transaction data may reveal production volumes, harvest timing, farm locations, price acceptance, borrowing needs, and marketing behavior. Such information can have substantial commercial value. A cooperative digital system should establish who may access these data, whether third parties may reuse them, how long records are retained, and whether individual members have meaningful rights concerning inappropriate use.

6.3 Inclusion, Platform Dependency, and the Future of Cooperative Marketing

The third implication is that digital cooperative design must account for unequal technological access. Smallholder populations can differ in smartphone ownership, connectivity, language, literacy, digital confidence, age, and access to reliable electricity. Requiring every member to interact with a sophisticated application can unintentionally transfer bargaining benefits toward better-connected producers.

A cooperative architecture can reduce this risk because digital infrastructure does not require every farmer to become an advanced digital user. Member service points, local representatives, SMS

notifications, voice interfaces, assisted transactions, paper receipts, and offline synchronization can allow the organization to use advanced market systems while preserving accessible participation.

Platform dependency presents another risk. If a cooperative becomes entirely dependent on one proprietary software provider for buyer access, payments, logistics, and member records, its bargaining position may shift from dependence on agricultural intermediaries to dependence on a digital intermediary. The strongest model is therefore interoperable: cooperatives should retain exportable records, clear contractual rights, and the capacity to move between service providers where technically and economically feasible.

Digital cooperatives should ultimately be evaluated according to whether technology strengthens collective farmer agency. The relevant questions are not simply how many farmers have registered or how many transactions pass through the application. More meaningful measures include whether feasible buyer choice has increased, whether price and deduction information has become more transparent, whether members can reject unfavorable offers, whether payments are traceable, whether transaction costs have fallen, and whether decision authority remains accountable to the farmers whose produce creates the cooperative's market position.

7. Conclusion

Digital cooperatives offer a potentially important institutional pathway for strengthening smallholder market negotiation by combining two established mechanisms: collective action and reduced information costs. Conventional cooperative marketing allows farmers to aggregate produce, coordinate logistics, and negotiate at greater scale, while digital technologies can improve price discovery, buyer search, transaction documentation, and communication. The distinctive contribution of a digital cooperative arises when these mechanisms are integrated rather than implemented independently.

The Digital Cooperative Market Negotiation Index proposed in this study combines shared price intelligence, pooled sale volume, buyer competition, transparent offer comparison, logistics coordination, and member governance and data control. Within the synthetic analysis, digitally coordinated cooperative negotiation produces a mean Smallholder Market Negotiation Score of 81.2 compared with 55.2 for individual marketing. Buyer choice records the largest modeled improvement, while price realization, negotiation confidence, and transaction efficiency also increase. These numerical differences demonstrate the behavior of the proposed framework and should not be interpreted as verified empirical impacts.

The analysis further shows why digitalization should not be treated as inherently empowering. Digital systems can reproduce existing power asymmetries when farmers cannot interpret platform rules, cooperative managers control information without effective member oversight, data are transferred to third parties without meaningful consent, or digitally excluded farmers receive fewer opportunities. Technology therefore needs to be embedded within accountable cooperative governance. Transparent transactions, democratic oversight, accessible participation mechanisms, clear data rights, and effective dispute resolution should be considered core components of digital market infrastructure.

Future empirical research should test the framework using authenticated cooperative transaction data, matched farmgate prices, buyer bids, quality grades, logistics costs, payment delays, member participation records, and digital-platform usage. Longitudinal studies could examine whether digital

cooperatives reduce distress sales, increase the number of credible buyers, improve price realization after transaction costs, strengthen payment reliability, or reduce dependence on individual intermediaries. Research should also investigate differences by gender, farm size, digital connectivity, crop perishability, cooperative governance quality, and market concentration. Digital cooperatives will make their strongest contribution when they do not simply connect isolated farmers to digital markets but enable farmers to enter those markets as collectively organized, informed, and accountable negotiating institutions.

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