Research proposal

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A Bounded Feasibility Study of an Open-Source Coordination Framework for Local Perishable Produce Supply in Summit County, Ohio

USDA SBIR Phase I · Topic 8.6, Rural and Community Development

Fruitful Network Development LLC

Abstract

Fruitful Network Development LLC proposes an eight-month Phase I feasibility study evaluating whether a coordination-first software framework can improve local perishable produce sourcing outcomes for small and independent farms in Summit County, Ohio.

The problem is structural rather than attitudinal. Consumer and institutional interest in local food does not reliably convert into durable local procurement, because farm-side data, buyer requirements, and logistics constraints remain fragmented across incompatible systems and manual workflows. National evidence establishes that local food sales are meaningful but remain a small share of total agricultural sales, and that growth depends disproportionately on intermediated and institutional channels, which demand a level of reliability and coordination that direct-to-consumer channels never test.

The Phase I innovation is a local-first, network-later architecture built on an open, schema-first coordination layer. Rather than assuming marketplace scale, the study tests one bounded transitional question: whether observed farm capacity bands, buyer constraints, and routing assumptions can produce at least one two-sided feasible window in which producer outcomes improve while buyers remain non-worse-off on delivered cost and service.

Work comprises minimum schema definition, prototype coordination engine development, bounded data collection, scenario simulation, and feasibility decision reporting. Success is defined as a replicable feasibility finding with explicit boundary conditions for Phase II. The expected outcome is a decision-grade technical and economic basis for whether implementation should proceed, be revised, or be suspended under current assumptions.

I. Responsiveness to USDA NIFA SBIR Priorities

This proposal is responsive to Topic 8.6, Rural and Community Development, because it addresses a rural economic coordination problem that directly constrains the viability of small and independent agricultural producers.

The project is designed as a bounded feasibility study rather than a deployment claim, which aligns with Phase I expectations for a focused, testable technical investigation over an approximately eight-month horizon. It intersects substantively with small and mid-size farm priorities by targeting the interoperability, planning reliability, and procurement coordination barriers that limit market participation even where local demand is demonstrably present.

USDA evidence shows direct farm sales to local food channels are significant but structurally dependent on intermediated buyers and institutions, which require consistent data and service reliability that many small farms cannot supply without shared coordination infrastructure. That dependency is the specific gap this study investigates.

II. Identification and Significance of the Problem

Core problem statement

Local agriculture is constrained more by structure than by consumer indifference. Local preference exists. Farms nonetheless face procurement, scheduling, handling, compliance, and pricing systems that reward low-friction standardized supply. As a result, local demand signals frequently fail to become local producer advantage.

National evidence supports this framing. USDA reporting places local edible farm product sales at approximately 11.8 billion dollars in 2017, roughly three percent of all agricultural sales that year. The 2020 Local Food Marketing Practices Survey places direct farm sales of local edible food commodities near nine billion dollars, with institutions and intermediaries accounting for approximately 46 percent of direct sales against approximately 33 percent for direct-to-consumer. Growth therefore lives in exactly the channels with the highest reliability and documentation requirements.

The broader food cost structure compounds the disadvantage. ERS Food Dollar data show the farm share at roughly 16 cents of each food dollar in 2023 under the marketing bill methodology, with the remainder absorbed by processing, transportation, wholesaling, retailing, and foodservice. The centralized system's advantage is concentrated in the marketing and logistics stack, which is precisely the function that coordination quality governs. Local supply competes against a system optimized for the thing local supply performs worst.

Where the recoverable margin actually is

The competitive question resolves into a decomposition: delivered cost equals production cost plus delivered overhead, where delivered overhead is everything required to sell a unit that is not growing it.

Local production does not generally hold a production-cost advantage. USDA Census typology data show that very large family farms with gross cash farm income at or above five million dollars generated approximately 52 percent of national vegetable-group sales in 2022, while small family farms below 350,000 dollars in gross cash farm income accounted for roughly four percent. Regulatory cost is regressive by size: ERS estimates of Food Safety Modernization Act Produce Rule compliance show the smallest farms bearing substantially larger costs as a share of sales, and separate ERS work documents that produce buyers frequently require third-party audits beyond

regulatory minimums, adding cost that scales with the number of buyer relationships rather than with volume.

The local advantage lies entirely in delivered overhead, and specifically in components that scale with distance and time. USDA AMS refrigerated truck rate data for the second quarter of 2024 give a rate of 6.45 dollars per mile in the zero to 500 mile band and 2.81 dollars per mile in the 501 to 1,500 mile band. At a 40,000 pound payload, a 1,000 mile shipment carries roughly 7.0 cents per pound in transport cost while a 50 mile shipment carries roughly 0.8 cents per pound. The proximity advantage is real and quantifiable.

That advantage is routinely forfeited. Uncoordinated local supply substitutes one form of overhead for another: the fuel saved by proximity is spent again on manual availability updates, failed deliveries, unsold perishables, and owner attention diverted from production. The recoverable margin is in the coordination and shrink components of delivered overhead, not in production cost, and that is the premise this study tests rather than assumes.

Demand realism

This proposal does not rest on a local price premium. The evidence does not support one as a general condition. Meta-regression of the willingness-to-pay literature finds substantial heterogeneity across products and contexts along with evidence of publication selection bias. A large field experiment found that a generic locally produced label did not raise willingness to pay for some products under realistic purchasing conditions. Research on purchase barriers consistently identifies price and availability as dominant, including among consumers expressing strong local preference.

The correct reading is that stated preference is real and revealed premium is conditional. A feasibility study that assumed a general premium would be testing the wrong thing. This study tests delivered-cost competitiveness instead.

Significance

The problem is significant across three dimensions. Economically, fragmented coordination raises transaction and planning overhead, suppressing stable farm revenue potential and the reinvestment it would fund. Technically, format-level compatibility does not produce semantic interoperability under changing requirements, and integration costs escalate through adapter maintenance and schema drift. For communities, when local supply cannot be organized reliably, nearby institutions and retailers continue sourcing through longer centralized channels despite genuine local participation interest.

Beneficiaries

Primary beneficiaries are small and independent farms in the Summit County region. Secondary beneficiaries include local food hubs, grocers, and institutional buyers seeking more reliable local procurement under bounded cost and service conditions. Rural communities benefit indirectly through improved local economic circulation and stronger producer continuity.

III. Background and Rationale

Current software categories, including farm management tools, digital marketplaces, and compliance systems, each solve part of the problem. Few provide a portable coordination layer supporting decentralized interoperability across independent operators. Evidence from USDA-funded and adjacent projects indicates strong innovation activity in farm tooling and local food platforms, while the persistent challenge remains coordinated execution across heterogeneous systems and constraints.

The rationale is therefore not that tools are absent. It is that tools remain siloed by product boundary, participant type, or proprietary data model.

The technical reason this persists is worth stating precisely, because it determines the study's design. A fixed format solves transmission agreement, telling participants how bits should be segmented into fields. It does not solve operational interoperability, meaning the capacity of independent systems to query, validate, transform, compose, and evolve those structures without bespoke bilateral work. That gap widens over time because syntax and meaning decay at different rates: a field name persists while the rule attached to it changes, and a shared schema remains nominally standard while implementations drift apart.

Three failure modes follow and compound. Schema drift is divergence of field names, types, nesting, and invariants across local implementations. Semantic drift is divergence of meaning attached to symbols that continue to look identical. Adapter explosion is the scaling failure in which translators and integration patches grow faster than participants, approaching quadratic growth in the worst case.

A schema-first, open coordination layer may reduce repeated translation overhead and allow participant-specific systems to remain locally useful while becoming mutually legible for bounded procurement scenarios. Whether it does so at a magnitude that changes procurement outcomes is an empirical question, which is what Phase I exists to answer.

This proposal intentionally limits its claims. It does not assert universal competitiveness of local supply, nor that software alone resolves structural inequality in food systems. It asks whether a bounded coordination

intervention can identify technically and economically credible transition scenarios under realistic assumptions.

IV. Relationship to Research and Phase II

Governing Phase I research question

Phase I tests one decisive feasibility claim:

Can an open-source coordination framework identify at least one credible local sourcing scenario in Summit County where participating farms improve expected position while buyers remain non-worse-off under defined delivered-cost and service thresholds?

This is a transitional pathway question, not a finished-state adoption claim.

Phase I outputs

1. A minimum coordination schema for farm-side, buyer-side, and scenario variables.
2. A prototype coordination engine sufficient for bounded scenario execution.
3. A parameterized local feasibility simulation using capacity-banded assumptions.
4. A decision-oriented feasibility report specifying pass and fail conditions and limiting constraints.

Phase II relationship

A positive Phase I result justifies Phase II operationalization: onboarding expansion, recurring workflows, integration hardening, and validation under live transaction conditions. A negative result still yields value by identifying binding constraints and explicit redesign requirements before additional public investment. Both outcomes are decision-grade, which is the point of structuring Phase I as a test rather than a build.

V. Technical Objectives

Objective 1: Define minimum representational requirements. Specify the smallest viable shared schema needed to represent producer capacity bands, timing windows, handling constraints, location attributes, buyer demand profiles, and service thresholds. Success condition: the

representation supports bounded scenario testing without forcing full participant standardization.

Objective 2: Build a minimum prototype coordination engine. Develop a prototype that ingests structured inputs, normalizes key fields, applies bounded constraints, and produces interpretable scenario outputs. Success condition: end-to-end scenario runs execute without ad hoc workflow rewrites.

Objective 3: Parameterize a Summit County feasibility model. Collect and encode sufficient bounded partner input to run scenario sweeps across plausible local sourcing combinations. Success condition: input quality and quantity are sufficient to test baseline against coordinated scenarios.

Objective 4: Evaluate two-sided feasibility window existence. Determine whether producer-side improvement and buyer-side non-worse-off conditions overlap in at least one credible scenario. Success condition: either a feasible window is identified, or decision-grade evidence establishes that none exists under tested assumptions.

VI. Phase I Research Design and Work Plan

A. Study design

The study uses a bounded, capacity-banded feasibility model rather than a full agronomic optimization system. The model treats uncertainty explicitly and evaluates whether coordination improves practical outcomes under realistic constraints. Methodologically, Phase I combines structured requirement capture, prototype-based systems testing, and scenario-based comparative analysis against predeclared baselines.

B. Decision rule

Phase I is feasible for Phase II advancement if at least one credible scenario satisfies both conditions. The producer-side condition is that expected farm position improves, or at minimum does not worsen, relative to baseline. The buyer-side condition is that delivered cost and service thresholds remain non-worse-off relative to comparator sourcing.

Primary outputs are reported as bounded ranges rather than single-point forecasts. Scenario outcomes include sensitivity checks for key assumptions, specifically participation level, route constraints, and shrink rates, to establish the robustness of any positive result.

C. Fixed boundaries and variable parameters

Fixed in Phase I: Summit County-centered geographic scope and adjacency assumptions; study timeframe and seasonal framing; bounded buyer classes and baseline comparator definitions; and minimum basket assumptions for time-sensitive produce.

Variable in scenario analysis: participation intensity; capacity overlap and timing alignment; route and handling assumptions; shrink and waste assumptions; and buyer tolerance thresholds.

Scope is restricted to perishable, time-sensitive produce, meaning fresh vegetables, berries, and fruit. Storable commodity grains and oilseeds are excluded because their yield, logistics, shrink, and pricing dynamics differ materially.

D. Evidence-informed baseline assumptions

Phase I assumptions are grounded in established national evidence and then localized through bounded partner inputs. National anchors include local and intermediated channel structure, marketing-cost and coordination burden context, food hub and institutional barrier patterns, food loss and perishability rates, and produce transport rate bands used for scenario conversion.

One methodological limitation is disclosed in advance. The Census vegetables sales category used for national comparison is vegetables, melons, potatoes, and sweet potatoes. Potatoes and sweet potatoes are included by Census taxonomy and are not time-sensitive in the same way as leafy greens and berries. This category is used as a best-available national proxy for perishable produce at scale, and the limitation is flagged wherever it bears on a result.

A second definitional boundary is stated explicitly. USDA program definitions commonly treat local as marketed within 400 miles of origin or within the same state, while consumer perception research places the boundary substantially closer. For logistics calculation this study treats local as a 50 to 100 mile scenario and conventional as a 1,000 to 1,500 mile scenario, presented as scenarios rather than as asserted national averages.

E. Data trust and limitations protocol

Inputs are treated as decision-grade for feasibility, not as predictive certainty, when they are sourced from structured partner interviews and operational records where available, internally consistent with model constraints, and documented with explicit provenance and uncertainty bounds.

The study reports limitations directly, including local sample bounds, proxy use for national comparisons, and sensitivity of outcomes to core assumptions.

F. Analysis and validation approach

For each scenario set, the project computes comparative outcome deltas relative to baseline against producer-side and buyer-side criteria. Results are summarized at minimum, median, and upper-bound parameter combinations, with explicit annotation of the assumptions driving each result class.

Prototype validation is performed through reproducible input-output test cases verifying schema conformance, constraint handling, and consistency of scenario results under repeated runs. Determinism is a validation requirement rather than an implementation convenience, because a coordination layer whose outputs vary across identical inputs cannot support the comparative analysis the study depends on.

G. Eight-month task sequence

Task 1, Months 1 to 2: Scope and schema definition. Finalize research question expression, minimum variables, trust protocol, and baseline comparator setup.

Task 2, Months 2 to 4: Prototype coordination engine development. Implement the minimum ingest, normalize, and evaluate pipeline with scenario output support.

Task 3, Months 4 to 6: Input collection and model parameterization. Collect bounded farm and buyer inputs and instantiate the scenario dataset.

Task 4, Months 6 to 7: Scenario analysis. Run parameter sweeps, identify feasible and non-feasible regions, and isolate dominant constraints.

Task 5, Months 7 to 8: Feasibility synthesis and transition logic. Produce the final feasibility report, boundary conditions, and Phase II go or no-go rationale.

VII. Related Research and Competitive Context

The proposal is differentiated from two established categories.

Single-application tools improve local internal workflows but do not provide transferable interoperability across independent actors. They make one operator better at its own work without making two operators legible to each other.

Centralized marketplace models coordinate effectively but generally require platform-level control over network rules and participant representation. This is a working answer with a structural consequence: the coordinating entity becomes the point at which network rules are set, and the value created by improved coordination accrues to whoever holds that position.

Recent USDA SBIR awards demonstrate durable demand for farm software, market-linkage systems, and data-driven tooling. This project is complementary rather than dismissive. It tests whether an open coordination substrate can function as a shared interoperability primitive supporting multiple local workflows without requiring a single network owner.

The open-source strategy follows established platform logic. Openness at the schema and tooling level is paired with quality and trust in the reference implementation, governance clarity about what is official and what is merely compatible, and demonstrated operational reliability. In this model the developing organization does not need to own the network. It needs to maintain the most trusted implementation of an open substrate, which is a position earned continuously rather than held by exclusion.

VIII. Market Opportunity and Commercialization Path

Market rationale

National and regional evidence indicates durable produce demand and continuing local-food participation alongside strong structural constraints on scaling local procurement through reliable intermediated channels. The commercial opportunity is therefore not local preference. It is the reduction of coordination friction that currently prevents local supply from meeting buyer reliability standards.

Regional sizing

A bounded proxy establishes the order of magnitude. Congressional Research Service estimates place U.S. consumer sales of fruit and vegetable products between 160 and 190 billion dollars annually. Against a July 2024 national population of 340.1 million, this yields per-capita produce spending of roughly 470 to 559 dollars per year. Applied to a Summit County population of 538,370, the county-level produce consumer market proxy is approximately 253 to 301 million dollars annually. Applied to Ohio's population of 11.88 million, the state proxy is approximately 5.6 to 6.6 billion dollars annually.

These figures are consumer-sales proxies derived by population scaling, not measured local procurement. They are presented to establish that the addressable spend in a single county is substantial relative to the intervention's cost, not to assert a capturable share.

Conditional commercialization path

Phase I is a technical and commercial gateway, not end-state commercialization. A positive Phase I supports Phase II deployment-oriented development with expanded onboarding, recurring workflows, and implementation partnerships. A negative Phase I directs revision of assumptions, adjustment of boundary conditions, or deferral pending additional evidence.

Early customer classes

Small and independent produce farms; local and regional food hubs and aggregators; and retail and institutional buyers with local procurement targets.

The highest-value early adopters share a profile that follows from the economics rather than from category. They sell finite inventory across two or more channels, which creates a reconciliation burden that grows with success. They carry an existing software bill that new tooling can displace rather than add to. They generate sufficient volume for recurring cost to be favorable. And they are owner-operated with a single decision maker. By that filter, year-round local food operations and producers selling both wholesale and direct are materially stronger targets than seasonal market vendors, whose coordination load is low and whose revenue is too seasonally concentrated to support recurring cost.

Revenue direction

Commercialization follows an open-core implementation model: an open coordination layer with paid implementation, integration, operational tooling, and support services. Revenue is deliberately not drawn as a percentage of coordinated transaction value, because a percentage claim on coordination converts the substrate into a toll and reintroduces the margin extraction that constrains existing intermediary models. Charging for work performed rather than for value intercepted preserves interoperability and keeps the substrate adoptable by parties who have no reason to trust a vendor with their supplier relationships.

IX. Resources, Facilities, and Team

Fruitful Network Development LLC is a small technical organization with domain continuity in agricultural software and data organization for local producers. The company operates a live services business supporting regional farm and local food clients, which provides direct and ongoing access to the operational conditions this study investigates.

The Principal Investigator combines software engineering execution with sustained concept development and customer discovery in agricultural contexts, including university-connected entrepreneurial research activity through the University of Akron Research Foundation I-Corps program. The company maintains active federal registrations on SAM.gov and Grants.gov.

Phase I resource requirements are modest and aligned to feasibility scope: a secure development workspace; workstation and cloud infrastructure for prototype and simulation tasks; project management and records systems suitable for federal reporting; and bounded stakeholder engagement capacity for structured input collection.

The company is positioned to execute a tightly scoped Phase I investigation with disciplined deliverables and explicit decision criteria.

X. Anticipated Significance

This project treats a widely discussed local-food challenge as a testable coordination hypothesis rather than a normative claim. The contribution of Phase I is methodological and decision-oriented: it establishes whether a bounded interoperability intervention can generate practical two-sided feasibility, and under what conditions.

Positive findings would provide evidence that some portion of local underutilization is reducible through better information coordination and scenario-based planning rather than fixed by immutable market preference constraints. That distinction matters for public investment, because the two diagnoses imply entirely different interventions.

Negative findings are equally valuable. They prevent scale-up on weak assumptions and identify precisely what must change before credible deployment. A study designed so that both outcomes produce usable knowledge is a more defensible use of public funds than one that can only succeed.

XI. Conclusion

This proposal describes a bounded Phase I feasibility study for USDA SBIR Topic 8.6, designed to answer one decisive transitional question under explicit assumptions, produce minimum technical artifacts, and generate a decision-grade outcome for Phase II.

By anchoring claims in documented evidence, constraining scope to a realistic local context, declining to rely on an unsupported local price premium, and

defining explicit success and failure conditions in advance, the study supports rational public investment in a technically credible rural coordination innovation.

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