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Food Processing Innovation, Productive Employment, and Poverty Reduction in Afghanistan: An Integrative Narrative Review

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Abstract

Agrarian economies like Afghanistan face a persistent paradox: abundant agricultural endowments coexist with entrenched poverty and underemployment due to raw exports and severe post-harvest losses, yet scholarship rarely integrates food processing innovation with labor quality and fragile-state constraints. Anchored in Global Value Chain (GVC) governance theory and dynamic capabilities, this review examines how food processing innovation drives productive employment and poverty reduction in Afghanistan. We conducted an integrative narrative review across Scopus, Web of Science, ScienceDirect, Google Scholar, Persian repositories, and multilateral libraries, prioritizing 2021–2026 literature, and thematically synthesized 51 core publications using qualitative credibility appraisal. Findings indicate that although agriculture generates 33.7% of Afghanistan's gross domestic product versus 16.1% for industry, only 23.5% of reviewed studies examine Afghanistan directly. Comparative evidence demonstrates that agro-industrial jobs alleviate poverty durably only when formal, stable, and productivity-enhancing rather than precarious. In Afghanistan, interlocking deficits in credit, energy, cold chains, skills, and export certification exclude small and medium-sized enterprises (SMEs) from higher-value markets, rendering capital-intensive frontier processing technologies unviable in isolation. Instead, staged upgrading—prioritizing shared cold chains, hygienic packaging, and electronic marketing before moderate non-thermal processing—yields the highest inclusive-growth returns under binding transit and energy constraints. Theoretically, this review extends GVC governance and dynamic capabilities through a four-layer ecosystem framework tailored to fragile agrarian states. Practically, it guides SME managers toward capability-sequenced innovation and urges policymakers to bundle rural infrastructure with SME finance, accredited laboratories, and workforce training.

Keywords: Agro-Processing Innovation, Global Value Chain Governance, Productive Employment, Cold-Chain Logistics, Inclusive Growth.

JEL Classification: L66, O13, O14, O33, Q13.

Introduction

Developing agrarian economies frequently confront a persistent structural paradox: despite possessing abundant agricultural resources and a comparative advantage in raw commodity production, rural populations remain trapped in widespread poverty, underemployment, and food insecurity. In Afghanistan, where agriculture serves as a primary pillar of livelihoods and domestic output, this paradox is particularly acute. According to the World Bank (2025), modest economic stabilization has failed to translate into broad-based welfare gains; weak capital investment continues to constrain productivity, and per capita gross domestic product (GDP) is projected to decline by 4% in fiscal year 2025, leaving poverty entrenched across both rural and urban households. Trade data further underscore this structural vulnerability: while food products dominate Afghanistan's export basket, prolonged border disruptions, logistical bottlenecks, and weak domestic processing capacity have widened the trade deficit and limited export competitiveness (World Bank, 2026). Across comparable developing economies, post-harvest losses in perishable agricultural commodities routinely reach 15% to 45% due to inadequate storage, fragmented cold chains, and rudimentary processing (Urugo et al., 2024). When farm output is sold unprocessed or lost after harvest, rural economies forfeit the value-added margins, formal employment opportunities, and household income growth necessary to break the cycle of economic vulnerability.

Recent scholarship has increasingly examined the linkages between employment, agri-food value chains, and poverty alleviation, yet two distinct analytical streams remain largely disconnected. The first stream emphasizes the income-mediated pathways linking employment to household welfare and food security. Empirical evidence across 150 countries demonstrates that short-term economic and climatic shocks rapidly escalate household food insecurity, with income loss acting as the primary mediating mechanism—particularly in low-income nations characterized by high shares of agricultural and precarious labor (Kroeger, 2023). In Afghanistan specifically, household-level evidence reveals that food-insecure families—both rural and urban—suffer from high food expenditure shares, minimal savings, and severe income volatility, underscoring the urgent need for stable, non-farm income-generating opportunities (Hassanzoy et al., 2025). Expanding the rural nonfarm economy, particularly through downstream segments of agricultural value chains, has emerged as the predominant driver of rural household income and structural transformation across developing regions (Barrett et al., 2022; Hazell et al., 2024). However, scholars caution that job creation alone is

insufficient; durable poverty reduction depends on productive, formal, and resilient employment rather than subsistence-level informal work (Christiaensen et al., 2021).

A second stream of literature focuses on technological and organizational innovation within food processing and agri-food supply chains. Digitalization, smart manufacturing, and emerging thermal and non-thermal processing technologies offer substantial potential to reduce waste, extend shelf life, enhance food safety, and integrate fragmented food systems (Krupitzer & Stein, 2024). Yet, a sharp theoretical and empirical tension exists between technology-optimistic perspectives and institutional realities in fragile economies. While advanced processing technologies can elevate firm competitiveness, empirical evidence from developing-country agricultural value chains shows that policy interventions remain heavily skewed toward upstream input subsidies, leaving downstream processing, value-chain governance, and poverty-oriented outcomes severely underexplored (Reardon et al., 2021; Yeritsyan et al., 2024). In Afghanistan, pervasive market failures, weak contract enforcement, and high transaction costs severely restrict smallholder market participation and firm expansion (Ahmadzai, 2024). Although collaborative agribusiness and alternative food networks have demonstrated remarkable local resilience in sustaining agricultural production under resource scarcity (Amirzai & Chau, 2024), these informal mechanisms alone cannot achieve industrial-scale value addition, international quality standardization, or sustained export growth (Meemken et al., 2021).

Despite the clear economic stakes, a significant research gap persists. Most existing studies on Afghanistan concentrate on primary agricultural production, emergency humanitarian relief, or macroeconomic instability, paying limited attention to the food processing industry as a strategic engine of value creation and decent employment. Conversely, global literature on food processing innovation predominantly examines capital-intensive, digitally mature markets, offering limited applicability to small and medium-sized enterprises (SMEs) operating under severe infrastructure, energy, and financing constraints. Crucially, the literature lacks an integrative synthesis that connects technological innovation in food processing, value-chain constraints, employment quality, and poverty reduction within the specific institutional realities of Afghanistan—a context that holds broader global relevance for other fragile and post-conflict agrarian economies.

To address this gap, this review anchors its analytical framework in two complementary theoretical perspectives: Global Value Chain (GVC) governance theory (Gereffi et al., 2005**,**

2021) and the dynamic capabilities framework (Teece et al., 1997). GVC governance theory explains how institutional coordination, technical standards, and supplier capabilities determine whether developing-country producers remain locked in low-margin raw commodity exports or upgrade into higher-value processed segments. Complementing this macro-meso lens, the dynamic capabilities framework explains how food processing firms and SMEs sense market opportunities, seize technological and organizational innovations, and reconfigure scarce internal and external resources to sustain competitive advantage in volatile environments. Together, these theories provide the causal logic linking firm-level strategic innovation to sector-wide industrial upgrading, productive employment generation, and household poverty reduction.

Situated at the intersection of sustainable and inclusive growth, strategic innovation economics, and technology management and digital transformation, this study integrates economic analysis of labor markets, value-chain upgrading, and poverty dynamics with managerial perspectives on SME competitiveness, supply chain agility, and appropriate technology adoption. By integrating economic analysis of labor markets, value-chain upgrading, and poverty dynamics with managerial perspectives on SME competitiveness, supply chain agility, and appropriate technology adoption, the review bridges academic scholarship and actionable managerial and policy practice. Specifically, this narrative review is guided by three research questions: (1) Through what economic and managerial mechanisms does food processing innovation generate productive employment and reduce poverty in developing agrarian economies? (2) What structural, technological, and market-failure barriers constrain value-added food processing in Afghanistan? (3) How can appropriate processing technologies, value-chain coordination, and targeted institutional policies be aligned to foster inclusive industrial growth in Afghanistan?

This review makes three distinct contributions to the literature. First, it provides the first integrative synthesis bridging international evidence on food processing innovation and rural industrialization with the empirical realities of Afghanistan's agri-food sector. Second, it extends GVC upgrading and dynamic capabilities logic to fragile-state contexts by demonstrating why isolated interventions—such as physical infrastructure or advanced processing technologies alone—fail without concurrent institutional, financial, and human-capital alignment. Third, it translates theoretical insights into an actionable strategic roadmap for agribusiness managers, SME entrepreneurs, investors, and policymakers seeking to convert raw agricultural endowments into resilient economic opportunities. The central argument of

this review is that while food processing innovation holds transformative potential for employment generation and poverty reduction in Afghanistan, realizing this potential requires a coordinated ecosystem approach—combining appropriate technology transfer, cold-chain and market infrastructure, SME financing, and workforce skill development—rather than piecemeal technological adoption. The remainder of this article outlines the review methodology, synthesizes thematic evidence on employment, rural industrialization, Afghan sector constraints, and emerging processing technologies, discusses theoretical and policy implications, and concludes with strategic recommendations.

Research Method

Review Design and Protocol

This study employed a structured integrative narrative review design to examine how food processing innovation contributes to productive employment generation and poverty reduction in Afghanistan. Because the relevant evidence spans heterogeneous disciplinary domains—namely food engineering, agricultural and labor economics, strategic management, and rural development—and combines empirical studies with institutional policy analyses, statistical meta-analysis was neither feasible nor methodologically appropriate. Instead, an integrative narrative synthesis was selected to bridge fragmented streams of scholarship, reconcile competing perspectives on technological innovation versus institutional constraints, and develop an actionable conceptual framework tailored to fragile agrarian economies (Snyder, 2019; Torraco, 2016). To ensure methodological rigor, transparency, and balanced reporting, the review protocol was structured in accordance with the six quality domains of the Scale for the Assessment of Narrative Review Articles (SANRA): justification of the review's importance, formulation of concrete research questions, transparent description of literature identification, appropriate referencing, scientific reasoning, and balanced presentation of evidence levels (Baethge et al., 2019).

Information Sources, Search Strings, and Search Period

Literature identification combined structured searches across major multidisciplinary academic databases (Scopus, Web of Science, ScienceDirect, and Google Scholar) with targeted retrieval from regional Persian-language academic repositories and institutional digital libraries—specifically the World Bank, the International Labour Organization (ILO), and the Overseas Development Institute (ODI). Including regional Persian-language peer-reviewed studies and multilateral policy reports was essential to prevent publication bias against

Afghanistan-specific empirical evidence that remains underrepresented in mainstream English-language indexing services.

Structured keyword combinations and Boolean operators were applied across four thematic search strings aligned with the review's three research questions:

1. Employment and Poverty Pathways: ("food processing" OR "agro-processing" OR "food industry") AND ("employment generation" OR "productive employment" OR "decent work" OR "poverty reduction" OR "household income")
2. Rural Industrialization and Value Chains: ("rural industries" OR "rural nonfarm economy" OR "agricultural value chain" OR "alternative food networks") AND ("developing countries" OR "structural transformation" OR "inclusive growth")
3. Afghanistan Sector Context and Constraints: ("Afghanistan") AND ("food industry" OR "agro-processing" OR "post-harvest losses" OR "cold chain" OR "agricultural exports" OR "market failure")
4. Processing Innovation and Firm Competitiveness: ("emerging food processing technologies" OR "non-thermal processing" OR "cold chain logistics" OR "green marketing" OR "supply chain agility") AND ("food industry" OR "small and medium-sized enterprises")

Backward citation tracking (reference-list snowballing) was conducted on key review articles and recent empirical studies to identify additional relevant contributions. The primary search window prioritized recent empirical, technological, and policy literature published between 2021 and 2026 (including early-access 2027 food engineering publications) to capture post-2021 economic dynamics in Afghanistan alongside contemporary advances in food processing technology. Earlier regional empirical works (2017–2020) and foundational institutional or theoretical benchmarks (1997–2018)—specifically ILO employment definitions, World Bank structural reports, Global Value Chain (GVC) governance theory, and the dynamic capabilities framework—were selectively retained to anchor analytical constructs.

Eligibility Criteria, Screening Process, and Quality Appraisal

Sources retrieved from academic databases and institutional repositories underwent a purposive, three-stage screening process: (1) title and abstract screening to remove out-of-

scope records and duplicates; (2) full-text evaluation against explicit inclusion and exclusion criteria (Table 1); and (3) thematic mapping and qualitative credibility appraisal.

Table 1. Inclusion and Exclusion Criteria for Literature Selection

Criterion	Inclusion Criteria	Exclusion Criteria
Topic Relevance	Studies examining food processing, agro-processing, rural industrialization, cold chains, emerging processing technologies, labor quality, or poverty reduction with clear economic, managerial, or policy relevance.	Purely clinical nutrition, biomedical, or laboratory food-chemistry studies lacking linkage to value addition, firm competitiveness, employment, or economic welfare.
Geographic Scope	Direct empirical or policy studies on Afghanistan, plus comparative studies from developing or transition economies offering transferable mechanisms (e.g., China, Ethiopia, Indonesia, Bolivia, Turkey, Bangladesh, Poland).	Studies restricted exclusively to high-income industrial markets without analytical transferability to resource-constrained or developing-country contexts.
Publication Type	Peer-reviewed journal articles (original research, systematic reviews, and conceptual studies) and authoritative multilateral or policy reports (e.g., World Bank, ILO, ODI).	Non-scholarly blogs, news articles, opinion editorials, unverified gray literature, and publications from journals with questionable peer-review practices.
Language	English and Persian (Farsi/Dari) publications with verifiable bibliographic records.	Publications in other languages without reliable full-text translation.
Time Horizon	Core empirical and technological evidence from 2021–2026 (including early-access 2027 studies), supplemented by foundational theoretical and institutional benchmarks (1997–2020).	Outdated descriptive or statistical reports superseded by more recent institutional datasets.

Note. Eligibility criteria established by the authors in accordance with SANRA quality criteria (Baethge et al., 2019) and integrative literature review guidelines (Snyder, 2019).

Following full-text screening, a final core corpus of **[N]** publications—comprising international peer-reviewed journal articles, regional peer-reviewed studies, and authoritative institutional reports (excluding foundational theoretical and methodological citations)—was retained for synthesis. Because the review integrates heterogeneous research designs under an integrative narrative protocol rather than a statistical meta-analysis, formal risk-of-bias scoring instruments (such as clinical trial checklists) were not applied. Instead, each retained source underwent structured qualitative quality appraisal guided by SANRA (Baethge et al., 2019) and Snyder (2019) across four dimensions: (1) peer-review standing or institutional authority of the issuing body; (2) methodological transparency and analytical coherence; (3) contextual

transferability to small and medium-sized enterprises (SMEs) in fragile agrarian economies; and (4) explicit differentiation between direct empirical evidence from Afghanistan and comparative evidence applied by analogy from other developing economies.

Data Extraction and Thematic Synthesis

Data extraction and synthesis followed the three-stage thematic synthesis procedure outlined by Thomas and Harden (2008), adapted for cross-disciplinary economic and management integration (Torraco, 2016). First, key attributes from each retained source—including geographic context, analytical method, core variables or technologies, employment and poverty mechanisms, and identified constraints—were extracted into a structured synthesis matrix. Second, extracted findings were coded iteratively using a hybrid deductive–inductive approach anchored in the review's dual theoretical lens: GVC governance theory (focusing on market coordination, technical standards, and industrial upgrading barriers) and the dynamic capabilities framework (focusing on firms' capacity to sense market demand, adopt appropriate technologies, and reconfigure scarce resources). Third, descriptive codes were consolidated into six overarching analytical themes that structure the Findings section: (1) concepts of employment and decent work quality; (2) economic pathways linking employment generation to poverty reduction; (3) rural industries and nonfarm structural transformation; (4) the economic role of the food industry in Afghanistan; (5) structural, financial, technological, cold-chain, marketing, and export constraints in Afghanistan; and (6) emerging food processing technologies and appropriate innovation adoption. Figure 1 summarizes the end-to-end review protocol and thematic synthesis workflow.

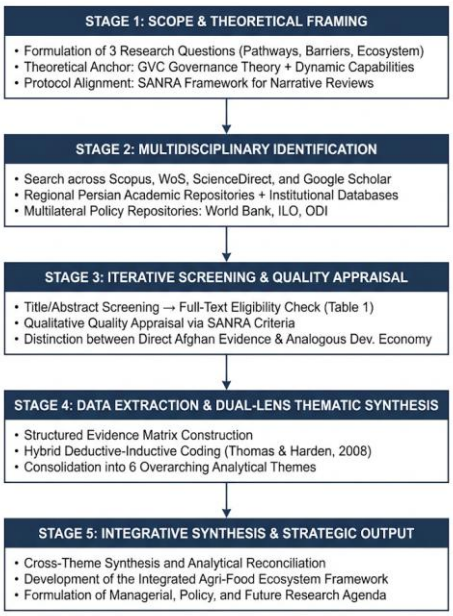


Figure 1. Methodological Workflow of the Structured Integrative Narrative Review and Thematic Synthesis

Note. Authors' methodological workflow structured in accordance with the SANRA guidelines (Baethge et al., 2019), integrative review principles (Snyder, 2019; Torraco, 2016), and thematic synthesis procedures (Thomas & Harden, 2008).

Ethics, Transparency, and Replicability

As a secondary literature synthesis drawing exclusively on published academic studies and publicly available institutional reports, this review involved no human participants or confidential primary data; consequently, institutional ethical approval and informed consent were not required (see Ethics Statement). To maintain transparency and replicability, all search strings, eligibility rules, and thematic coding procedures are documented above, and every synthesized source is listed in the References section (see Data Availability Statement).

Findings

Descriptive Trends of the Reviewed Literature

Before synthesizing thematic mechanisms, Table 2 summarizes the descriptive distribution of the 51 core publications retained for thematic synthesis (excluding 11 theoretical, contextual framing, and methodological works cited in the Introduction, Review Method, and Discussion). Three clear structural patterns emerge from the corpus. First, scholarly attention to agri-food value chains, employment quality, and sustainable processing has accelerated sharply in recent years: 45 of the 51 reviewed works (88.2%) were published between 2021 and 2027, with 40 publications (78.4%) appearing from 2023 onward. This concentration reflects heightened global research interest in food system resilience, rural nonfarm transformation, and Afghanistan's post-2021 economic restructuring.

Second, peer-reviewed academic scholarship accounts for 80.4% of the corpus—comprising 35 international English-language journal articles (68.6%) and 6 regional Persian-language journal articles (11.8%)—complemented by 10 multilateral institutional and field policy reports (19.6%) from the World Bank, the International Labour Organization (ILO), and the Overseas Development Institute (ODI). Third, the geographic distribution reveals a pronounced empirical asymmetry. Only 12 publications (23.5%) examine Afghanistan directly, and these focus predominantly on primary agriculture, household food insecurity, rural governance, or raw commodity exports rather than firm-level food processing economics. By contrast, comparative evidence from other developing and transition economies (such as China, Iran, Ethiopia, Indonesia, Bolivia, Turkey, Bangladesh, and Poland) constitutes 35.3% of the

corpus, while global cross-country studies and technological reviews represent 41.2%. Consequently, evaluating the employment and poverty-alleviation potential of food processing in Afghanistan requires systematically bridging direct domestic diagnostics with transferable economic and managerial mechanisms from comparable economies.

Table 2. Descriptive Profile of the Reviewed Literature Corpus ($N = 51$)

Dimension	Category	Count (n)	Share (%)	Analytical Implication
Publication Period	2012–2020	6	11.8	Foundational labor definitions (ILO), baseline Afghan agricultural diagnostics, and early supply-chain studies.
	2021–2022	4	7.8%	Post-pandemic rural industrialization, digital integration, and sectoral job-creation analyses.
	2023–2024	25	49.0	Surge in value-chain governance, rural nonfarm transformation, and Afghanistan market-failure studies.
	2025–2027*	16	31.4%	Latest evidence on post-2021 Afghan food insecurity, firm productivity, cold chains, and non-thermal processing.
Source Category	International peer-reviewed journals (English)	35	68.6	Core empirical, economic, managerial, and food-engineering evidence base.
	Regional peer-reviewed journals (Persian)	6	11.8	Regionally grounded firm-level evidence on food-industry agility, e-marketing, and rural livelihoods.
	Multilateral & field policy reports	10	19.6	Macroeconomic indicators, labor standards, and post-harvest field diagnostics (World Bank, ILO, ODI).
Geographic Focus	Direct Afghanistan focus	12	23.5	Mostly descriptive macroeconomic, agricultural, or export analyses; scarce firm-level processing metrics.
	Comparative developing & transition economies	18	35.3	Transferable mechanisms from China, Iran, Ethiopia, Indonesia, Bolivia, Turkey, Bangladesh, and Poland.
	Global, cross-country & technological benchmarks	21	41.2	Multi-country labor/food-security panels, value-chain gap maps, and emerging processing reviews.
Total		**51**	**100.0**	-

Note. Authors' descriptive compilation of the core reviewed corpus ($N = 51$). Counts exclude 11 theoretical, contextual framing, and methodological works cited outside the core synthesis (Baethge et al., 2019; Barrett et al., 2022; Christiaensen et al., 2021; Gereffi et al., 2005, 2021; Meemken et al., 2021; Reardon et al., 2021; Snyder, 2019; Teece et al., 1997; Thomas & Harden, 2008; Torraco, 2016). *Includes one early-access 2027 food-engineering review (Wang et al., 2027).

Employment Quantity Versus Productive and Decent Work Quality

A central conceptual distinction across labor economics literature separates raw employment headcounts from productive and sustainable work. Standard statistical conventions define employment broadly as engaging in economic activity to produce goods or services for pay or profit for at least one hour during a reference period (ILO, 2013), where an individual may hold one or multiple jobs within distinct economic units (Kolev & Manfredi, 2024). While expanding aggregate employment generally raises household purchasing power, expands gross domestic product (GDP), and dampens social vulnerability (World Bank, 2013), labor market scholars increasingly caution that headcount job growth alone is an inadequate barometer of development.

In developing agrarian economies, poverty persists despite high labor participation when workers remain concentrated in low-productivity, informal, and seasonal farm activities. To resolve this limitation, institutional and empirical scholarship emphasizes productive employment—work generating sufficient returns to lift households above basic poverty thresholds while producing higher-value goods and services (ILO, 2012, 2015)—and sustainable, decent work anchored in Sustainable Development Goal 8 (SDG 8). Recent multidimensional frameworks demonstrate that job quality encompasses earnings adequacy, contract formalization, employment stability, occupational safety, social protection, and skill-development pathways (Chigbu & Nekhwevha, 2023; ILO, 2024; Sehnbruch et al., 2024). Meta-analytic evidence confirms that decent work significantly strengthens worker well-being and long-term career capabilities (Su & Chan, 2023). Viewed through a strategic economics lens, this body of evidence establishes a critical benchmark for agro-processing: expanding food manufacturing contributes durably to inclusive growth only when value addition translates into higher labor productivity and formal, stable employment rather than reproducing precarious informal labor.

Economic Pathways Linking Employment Generation to Poverty Reduction

Synthesizing comparative evidence across developing economies reveals four interlocking economic mechanisms through which sectoral job creation translates into sustained poverty reduction.

First, sectoral capital allocation and human-capital transfer determine the magnitude of employment multipliers. Macroeconomic evidence indicates that external financial inflows and public investments generate far stronger, more durable employment and growth effects when channeled into human-capital formation and productive sectors rather than untargeted consumption support (Asaleye et al., 2023). Similarly, macro-micro simulations demonstrate that targeted public investment in labor-intensive service and human-capital sectors—such as expanding care and educational infrastructure in Turkey by 1.8% of GDP—can generate over one million jobs, disproportionately expand female labor force participation, and lift vulnerable households above official income poverty lines (Ilkkaracan et al., 2021). Complementing domestic capital formation, qualitative cross-country research highlights that international educational mobility fosters systemic poverty reduction through knowledge transfer, innovation diffusion, and professional networks, provided domestic institutions actively reintegrate returning specialists (Chankseliani et al., 2025). For Afghanistan's food industry, this suggests that pairing sector-specific capital allocation with returning food-engineering and supply-chain specialists can directly expand domestic productive capacity.

Second, employment formalization and firm-level productivity upgrading mediate whether income gains endure. Regional efficiency analyses in Bolivia demonstrate that national-level poverty reductions frequently mask entrenched subnational inequalities, and that structural policies promoting industrial expansion, public-investment efficiency, and labor formalization reduce poverty more durably than short-term transfers (Canavire-Bacarreza et al., 2025). At the microeconomic level, empirical evidence from China's precision poverty alleviation initiatives shows that targeted enterprise support enhances firm total factor productivity (TFP) by relaxing credit constraints, strengthening corporate governance oversight, and embedding social responsibility into business operations (Lu, 2025). Comparable sector-level findings from nature-based local enterprises in Bangladesh confirm that permanent, stable jobs—as opposed to episodic casual wages—enable households to smooth consumption across food, health, and education (Sarker et al., 2021).

Third, physical infrastructure requires complementary market and capability investments to close regional poverty gaps. Quasi-experimental evidence evaluating Indonesia's Suramadu

Bridge reveals that major connectivity infrastructure improves physical mobility and generates localized migration and remittance effects, yet fails on its own to eliminate entrenched regional poverty disparities when divorced from local enterprise development, workforce training, and producer market support (Heriqbaldi et al., 2025).

Fourth, food-system value addition generates dual nutritional and sustainability trade-offs that demand coordinated policy design. Systematic review evidence across low- and middle-income countries demonstrates that food-industry upgrading—via nutrient-preserving processing, food fortification, resilient value chains, and cross-sector governance—simultaneously mitigates undernutrition, improves dietary access, and reinforces local economic resilience (Klinger et al., 2026). At the same time, spatial-econometric evidence from Hubei Province, China, illustrates a critical environmental boundary condition: while per capita GDP growth reduces poverty, carbon-intensive industrial expansion elevates emissions unless paired with green-economy strategies, carbon-sink preservation, and region-specific environmental governance (Liu & Ge, 2025). Collectively, these four pathways underscore that agro-industrial employment reduces poverty most effectively when formalization, firm productivity, complementary infrastructure, and environmental sustainability advance in tandem.

Rural Industrialization and Nonfarm Structural Transformation

Across developing regions, rapid urbanization and evolving agri-food value chains have elevated the rural nonfarm economy into a primary engine of household income diversification, climate-shock resilience, and economic empowerment for women and youth (Hazell et al., 2024). Rural industries anchored in agricultural processing curb rural-to-urban distress migration by absorbing underemployed farm labor and creating localized backward and forward linkages across villages (Li et al., 2022; Yar & Noori, 2024).

Comparative synthesis of rural industrialization experiences—most notably lessons drawn from China's Township and Village Enterprises (TVEs) for agrarian economies such as Ethiopia—demonstrates that industrial takeoff is not driven by factor endowments alone. Rather, it rests on the interaction of three institutional pillars: adaptive industrial policymaking, localized entrepreneurship, and supportive socio-cultural norms coordinated through effective formal and informal institutions (Tadesse Wazza & Belay Bedeke, 2022). Spatial studies further confirm that transport infrastructure acts as a vital catalyst for integrating rural agriculture, processing industries, and downstream services, particularly when reinforced by urban market linkages and external capital inflows (He et al., 2024). However, evidence from

Western China cautions against uniform, one-size-fits-all industrial blueprints: because rural districts differ sharply in resource endowments, labor skills, and geographic accessibility, sustainable revitalization requires differentiated, place-based development pathways aligned with local comparative advantages (Geng et al., 2024).

The Economic Role and Untapped Potential of the Afghan Food Industry

Within Afghanistan's macroeconomic structure, agriculture remains a foundational pillar of livelihoods and domestic production, yet downstream industrial capture remains severely underdeveloped. As illustrated in Figure 2, agriculture accounted for 33.7% of Afghanistan's GDP in 2023, trailing services (45.0%) while more than doubling the entire industrial sector's contribution (16.1%) (Sarfarazi & Mohammadi, 2024). This structural imbalance highlights a classic Global Value Chain (GVC) upgrading bottleneck: despite possessing rich agro-ecological diversity and established comparative advantages in high-value crops—including fresh and dried fruits, nuts, cereals, dairy, livestock, and medicinal plants—Afghanistan exports a disproportionate share of its agricultural output in raw or minimally graded form, forfeiting processing margins and domestic job creation (Fariady & Aman, 2024; Sarfarazi & Mohammadi, 2024).

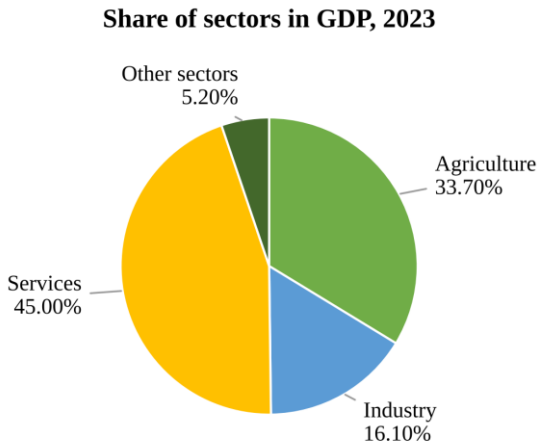


Figure 2. Sectoral Composition of Afghanistan's Gross Domestic Product (GDP), 2023 (%). Adapted from Sarfarazi and Mohammadi (2024).

Strengthening domestic food processing addresses two interconnected macroeconomic vulnerabilities simultaneously. First, expanding local preservation, storage, and value-added manufacturing smooths seasonal supply volatility under recurrent droughts and climatic shocks, directly mitigating severe rural and urban household food insecurity (Hassanzoy et al., 2025). Second, domestic processing substitutes for costly processed food imports while

converting raw agricultural surpluses into export-ready commodities capable of earning foreign exchange (Amirzai & Chau, 2024; Fariady & Aman, 2024; Sarfarazi & Mohammadi, 2024).

Despite decades of conflict, water scarcity, and weak formal institutions, empirical evidence reveals notable grassroots adaptive capacity within Afghanistan's agri-food system. Amirzai and Chau (2024) conceptualize this collaborative agribusiness dynamic through the 3Rs framework—*resilience*, *resourcing*, and *revealing* (Figure 3)—showing how alternative food networks (AFNs) mobilize social cohesion, informal local cooperation, and community-based resource sharing to keep smallholder production viable in remote areas. Through the lens of GVC governance theory (Gereffi et al., 2005), however, AFNs represent a crucial survival and aggregation base rather than a complete upgrading solution: transitioning from informal survival networks to internationally competitive agro-industrial value chains requires formal quality standards, cold-chain infrastructure, and structured firm-level managerial capabilities.

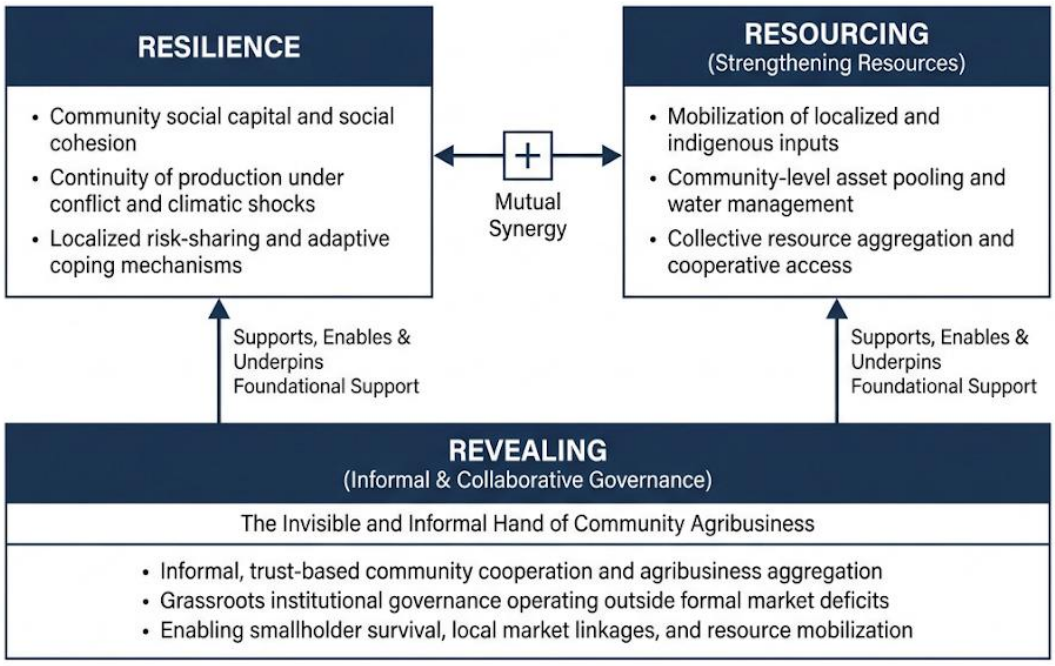


Figure 3. Conceptual Components of Alternative Food Networks in Afghanistan (3Rs Model). Adapted from Amirzai and Chau (2024).

Interlocking Structural, Managerial, and Export Constraints in Afghanistan

The literature consistently indicates that underperformance in Afghanistan's food processing sector stems not from isolated operational deficiencies, but from five mutually reinforcing structural and managerial bottlenecks (summarized in Table 3).

Table 3. Interlocking Structural, Technological, and Market Constraints in Afghanistan's Food Processing Sector

Constraint Domain	Primary Bottlenecks Identified in Literature	Economic & Managerial Impact	Key Supporting Sources
Capital & Financial Exclusion	Low public/private investment, weak banking and credit intermediation, high borrowing costs, and elevated macroeconomic risk.	Small and medium-sized enterprises (SMEs) operate below capacity, cannot invest in modern machinery, and remain locked in raw commodity trading.	Ahmadzai (2024); Urugo et al. (2024); World Bank (2018, 2026); Yeritsyan et al. (2024)
Technological & Skill Deficits	Reliance on rudimentary processing methods, outdated packaging, and acute shortages of food technologists and quality-control specialists.	High processing waste, inconsistent product safety, and inability to meet formal domestic or international quality benchmarks.	Ghafoori et al. (2023); Pain & Levine (2024); Sarfarazi & Mohammadi (2024)
Cold-Chain & Post-Harvest Gaps	Fragmented refrigerated storage, scarce temperature-controlled transport, and unreliable energy supply.	Severe post-harvest spoilage of perishable fruits, vegetables, and dairy; forced distress selling at farm-gate prices.	Edo et al. (2026); Ghafoori et al. (2023); Urugo et al. (2024)
Supply-Chain & Marketing Weakness	Low supply-chain agility, weak branding, underutilization of information technology (IT) and e-marketing, and scarce innovation intermediaries.	Weak customer reach, slow responsiveness to demand shifts, and compressed firm profit margins compared with regional competitors.	Akhavan et al. (2026); Babaei Meybodi & Rostapisheh (2017); Jamali et al. (2023); Mirghafoori et al. (2025); Sahraei & Mafi Balani (2023)
Export & Governance Barriers	Lack of international certification, inadequate accredited testing laboratories, transit restrictions, bureaucratic friction, and weak contract enforcement.	Eroded regional and global competitiveness; failure to capture value-chain upgrading rents in dried fruits, nuts, and medicinal plants.	Ahmadzai (2024); Fariady & Aman (2024); Rahimi & Artukoğlu (2023); World Bank (2026)

At the financial foundation, capital scarcity and transaction-cost barriers prevent agriculture–industry linkages from materializing. Empirical tests in Afghanistan confirm that pervasive market failures, credit constraints, and elevated transaction costs lock smallholders

and small processors out of formal commercial markets (Ahmadzai, 2024; World Bank, 2018, 2026). Consistent with broader evidence gap maps across developing countries (Urugo et al., 2024; Yeritsyan et al., 2024), insufficient private capital keeps SMEs trapped at suboptimal scale, unable to finance modern processing lines, standardized packaging, or food-safety compliance.

Directly compounded by underinvestment are technological obsolescence and cold-chain deficits. Field studies in Afghanistan document that traditional drying, handling, and storage practices generate substantial post-harvest losses and degrade product quality, while shortages of trained food scientists hinder international standard compliance (Ghafoori et al., 2023; Pain & Levine, 2024). As synthesized in Table 4 and Figure 4, cold-chain logistics reduce post-harvest losses across three progressively complex tiers—from basic manual local cooling to intermediate refrigerated transport and advanced automated tracking (Edo et al., 2026). Crucially, however, cold-chain effectiveness is highly context-dependent: in infrastructure-constrained environments like Afghanistan, high capital expenditure, erratic electricity grids, and limited technical maintenance restrict adoption primarily to basic and intermediate systems unless accompanied by off-grid energy and shared cold-storage investment.

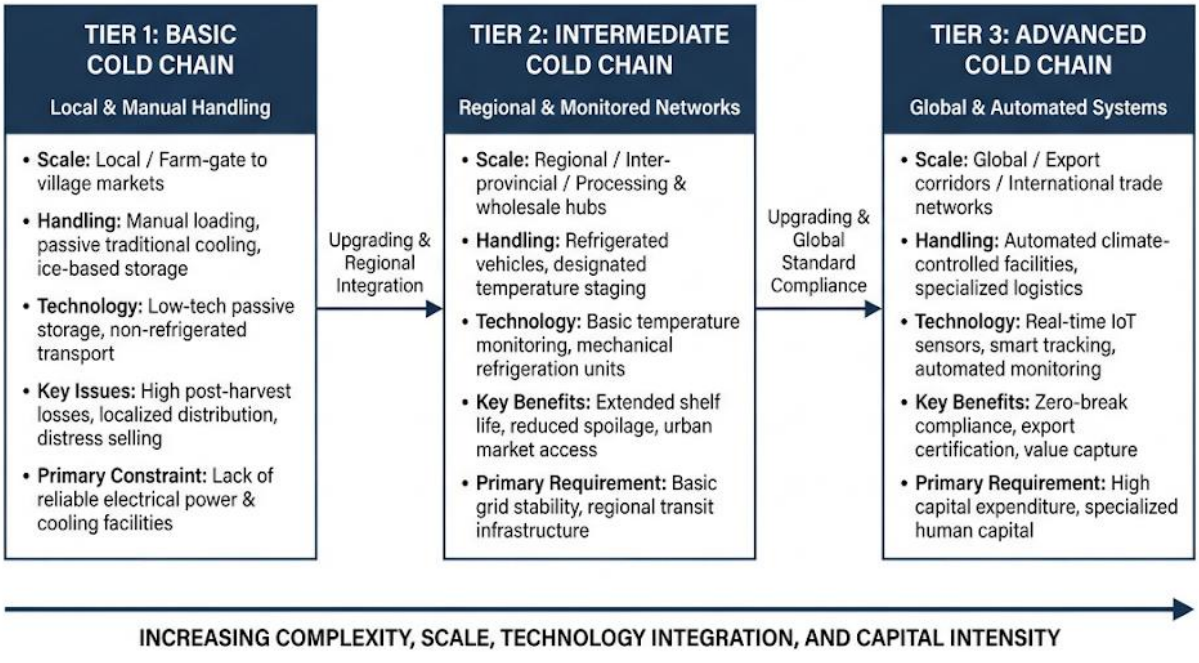


Figure 4. Analytical Framework of Cold-Chain Logistics Systems Across Local, Regional, and Global Tiers. Adapted from Edo et al. (2026).

Table 4. Economic and Operational Mechanisms of Post-Harvest Loss Reduction Through Cold-Chain Logistics

Mechanism	Operational Approach	Economic & Post-Harvest Impact
Temperature Control & Shelf-Life Extension	Maintaining commodity-specific temperature bands via cold storage and refrigerated transport to suppress respiration and microbial spoilage.	Extends marketable shelf life, preserves grade quality, lowers physical spoilage, and reduces buyer rejection rates.
Monitoring & Process Integration	Deploying temperature/humidity sensors, controlled-atmosphere storage, and Internet of Things (IoT) alert systems.	Enables early anomaly detection, stabilizes product quality, and lowers compliance losses across multi-stage distribution.
Market Access & Value Capture	Linking dispersed rural producers to urban wholesale hubs and cross-border export corridors.	Mitigates distress selling during harvest peaks, expands geographic market reach, and increases producer net margins.

Source: Adapted from Edo et al. (2026).

Finally, firm-level managerial weaknesses and export governance barriers severely limit market scaling. Regional empirical evidence from neighboring food-processing markets demonstrates that firms achieve superior competitiveness, revenue growth, and job creation when they invest in agile supply-chain management (Babaei Meybodi & Rostapisheh, 2017), convergent digital technologies (Mirghafoori et al., 2025), electronic marketing and specialist staff (Sahraei & Mafi Balani, 2023), and technology intermediaries that coordinate innovation networks (Akhavan et al., 2026). Case evidence from rural agro-industries further confirms that localized processing expansion strengthens village living standards and employment when paired with structured marketing (Jamali et al., 2023). In Afghanistan, however, exporters confront compounding institutional frictions: absence of internationally accredited testing laboratories and certifications, weak packaging centers, energy deficits, trade and transit restrictions, scarce trade finance and insurance, and administrative bureaucracy (Fariady & Aman, 2024; Rahimi & Artukoğlu, 2023; World Bank, 2026). Together, these constraints prevent domestic processors from translating raw agricultural abundance into sustained competitive advantage.

Emerging Food Processing Technologies and Appropriate Innovation for SMEs

Global food-engineering scholarship identifies a rapidly expanding suite of thermal and non-thermal innovations capable of transforming firm productivity, product quality, and

sustainability. Four emerging thermal technologies—microwave (MW), radiofrequency, infrared, and ohmic heating—and six non-thermal methods—ultraviolet-C (UVC) radiation, pulsed electric field (PEF), pulsed light (PL), ozone, cold plasma, high-pressure processing (HPP), and ultrasound—consistently outperform conventional heat processing by shortening production cycles, lowering energy intensity, extending shelf life, improving microbial inactivation, and preserving heat-sensitive nutrients and sensory attributes (Ramírez-Corona, 2024; Yuan et al., 2025). Complementary advances in intensified extraction (such as microwave-assisted, supercritical, and ultrasound extraction), microbial bioprocessing using *Kluyveromyces marxianus* to valorize food waste into high-value enzymes or proteins (Wang et al., 2025), and non-thermal oil structuring to produce healthier, low-saturated-fat oleogel substitutes from plant by-products (Wang et al., 2027) open new frontiers for circular-economy value creation and functional food differentiation.

From a strategic management and innovation economics perspective, however, a stark feasibility gap separates technological potential from commercial adoption in developing economies. Across the reviewed engineering literature, two persistent economic barriers impede industrial uptake: high upfront capital expenditure and unresolved scale-up, process-standardization, and technical-awareness hurdles (Ramírez-Corona, 2024; Wang et al., 2025, 2027; Yuan et al., 2025). Furthermore, digital agri-food transformation requires reliable power, broadband connectivity, and interoperable data systems that remain scarce in low-income rural regions (Krupitzer & Stein, 2024).

Historical sectoral evidence from transition economies resolves this tension by shifting focus from frontier equipment acquisition to absorptive capacity and organizational learning. Research on the Polish food-processing industry demonstrates that long-term industrial resilience during macroeconomic shocks depends less on legacy industrial endowments than on inter-organizational learning networks, sustained collaboration with scientific research centers, targeted research and development (R&D), and workforce training (Yoruk et al., 2023). Similarly, innovation-network studies confirm that technology intermediaries play a pivotal governance role in connecting fragmented food firms with external technical knowledge and reducing innovation risk (Akhavan et al., 2026).

Synthesizing these technological and managerial insights through the dynamic capabilities framework (Teece et al., 1997), Table 5 classifies processing innovations by their economic value-capture mechanisms, capital intensity, and staged adoption feasibility for resource-constrained Afghan SMEs. Rather than leapfrogging immediately into capital-

intensive frontier systems (such as HPP, supercritical extraction, or industrial oleogel structuring), the evidence favors a phased, capability-building trajectory: prioritizing accessible, moderate-cost interventions—such as basic-to-intermediate cold chains, improved solar/hygienic drying, standardized packaging, and selected non-thermal sanitation (e.g., UVC or ultrasound)—before scaling toward advanced bioprocessing and digitalized supply-chain integration as energy, financing, and technical human capital mature.

Table 5. Strategic Assessment of Food Processing Innovations for Resource-Constrained SMEs

Innovation Tier & Technologies	Core Economic & Value-Added Mechanism	Capital & Infrastructure Intensity	Staged Adoption Feasibility for Afghan SMEs	Supporting Sources
Tier 1: Foundational Upgrading Basic/intermediate cold chains, hygienic grading, standardized packaging, basic IT & e-marketing	Cuts 15%–45% post-harvest losses, stabilizes quality, reduces distress sales, and opens domestic urban & regional export markets.	Low to Moderate (adaptable to shared facilities & off-grid/solar cooling)	**Immediate / Short-Term Priority:** Highest employment-to-capital ratio and immediate fit for smallholder cooperatives and SMEs.	Edo et al. (2026); Fariady & Aman (2024); Sahraei & Mafi Balani (2023); Urugo et al. (2024)
Tier 2: Intermediate Process Intensification UVC sanitation, ultrasound-assisted processing, microwave drying, agile supply-chain & digital traceability tools	Shortens processing time, lowers energy per unit output, extends shelf life, and improves compliance with export safety standards.	Moderate (requires stable power, technical training, and intermediary R&D support)	**Medium-Term Target:** Viable for growth-oriented medium enterprises supported by university–industry extension and trade finance.	Akhavan et al. (2026); Babaei Meybodi & Rostapisheh (2017); Krupitzer & Stein (2024); Ramírez-Corona (2024); Yoruk et al. (2023)
Tier 3: Frontier Bio- & Non-Thermal Processing Pulsed electric field (PEF), HPP, cold plasma, *K. marxianus* waste bioprocessing, non-thermal oleogel structuring	Maximizes nutrient retention, creates premium functional foods, and valorizes agricultural by-products in circular bioeconomies.	High (heavy CapEx, specialized biotechnology/engineering staff, unresolved industrial scale-up)	**Long-Term Horizon:** Unsuitable for immediate standalone SME adoption; requires mature industrial hubs, foreign investment, and institutional R&D.	Ramírez-Corona (2024); Wang et al. (2025, 2027); Yuan et al. (2025)

Discussion and Research Agenda

Synthesis of Principal Findings and Theoretical Interpretation

Synthesizing 51 core studies across labor economics, rural industrialization, agri-food value chains, and food engineering yields a coherent central answer to this review's three research questions: food processing innovation can function as a powerful engine for productive employment and poverty reduction in Afghanistan, but only when technological upgrading is embedded within coordinated institutional, financial, and managerial ecosystems. Across comparative developing economies, employment raises household purchasing power and mitigates vulnerability to income-mediated food insecurity (Kroeger, 2023; World Bank, 2025). Yet, the evidence consistently indicates that raw job counts do not guarantee durable poverty exit; lasting welfare improvements depend on productive, formal, and stable employment backed by rising firm productivity (Canavire-Bacarreza et al., 2025; ILO, 2015, 2024; Lu, 2025). In Afghanistan, although agriculture accounts for 33.7% of gross domestic product (GDP) and offers strong comparative advantages in high-value crops (Fariady & Aman, 2024; Sarfarazi & Mohammadi, 2024), mutually reinforcing deficits in capital, energy, cold-chain infrastructure, technical skills, and export certification trap domestic producers in raw commodity sales and severe post-harvest losses (Ahmadzai, 2024; Ghafoori et al., 2023; Rahimi & Artukoğlu, 2023).

Interpreting these findings through our dual theoretical lens clarifies *why* Afghanistan's agro-industrial potential remains unrealized and *why* isolated interventions repeatedly underperform. Under Global Value Chain (GVC) governance theory (Barrett et al., 2022; Gereffi et al., 2005), transitioning from raw commodity exports to processed, export-ready food products requires meeting stringent codification and compliance standards—such as food safety certification, cold-chain traceability, and uniform packaging. Because Afghanistan lacks accredited testing laboratories, reliable trade finance, and contract enforcement mechanisms (Ahmadzai, 2024; Rahimi & Artukoğlu, 2023), local processors cannot satisfy the governance requirements of regional or global lead buyers. Consequently, the sector remains locked in low-margin, spot-market transactions where value-added rents accrue abroad rather than to domestic workers and smallholders.

Complementing this macro–meso governance bottleneck, the dynamic capabilities framework (Teece et al., 1997) explains performance divergence at the enterprise level. In volatile, resource-scarce markets, small and medium-sized enterprises (SMEs) must continuously *sense* shifting consumer and export demands, *seize* feasible process and

marketing innovations, and *reconfigure* scarce financial and human resources. However, when credit exclusion restricts capital investment (World Bank, 2018, 2026) and shortages of food-engineering specialists weaken organizational absorptive capacity (Pain & Levine, 2024; Yoruk et al., 2023), firms lack the micro-foundations required to adopt even moderate processing upgrades. This interaction between GVC governance lock-in and constrained firm-level dynamic capabilities explains why standalone investments—whether in physical connectivity infrastructure (Heriqbaldi et al., 2025) or advanced processing machinery (Ramírez-Corona, 2024)—fail to generate systemic poverty reduction unless accompanied by complementary capability building and market coordination.

An Integrative Ecosystem Framework for Agro-Industrial Upgrading

To bridge these macro-institutional, meso-value-chain, and micro-managerial dimensions, Figure 5 proposes an Integrative Ecosystem Framework for Food Processing Innovation, Productive Employment, and Poverty Reduction tailored to Afghanistan and comparable fragile agrarian economies. Rather than treating technological adoption as a linear, firm-isolated event, the framework conceptualizes agro-industrial upgrading as a four-layer interdependent system.



Figure 5. Integrative Ecosystem Framework for Food Processing Innovation, Productive Employment, and Poverty Reduction in Fragile Agrarian Economies

Note. Authors' conceptual synthesis integrating Global Value Chain governance theory (Gereffi et al., 2005), dynamic capabilities (Teece et al., 1997), the 3Rs alternative food network framework (Amirzai & Chau, 2024), tiered cold-chain logistics (Edo et al., 2026), and empirical evidence reviewed in this study.

As illustrated in Figure 5, Layer 1 establishes the foundational enabling conditions—targeted credit, decentralized or reliable energy, rural transport integration, and accredited quality infrastructure—that lower transaction costs and de-risk private capital (Ahmadzai, 2024; He et al., 2024; Lu, 2025). Layer 2 acts as the critical meso-level transmission belt: it links Afghanistan's resilient informal alternative food networks (AFNs) and 3Rs community structures (Amirzai & Chau, 2024) with formal cooperatives, shared cold-storage hubs, and technology intermediaries (Akhavan et al., 2026; Edo et al., 2026). Layer 3 operationalizes firm-level dynamic capabilities through staged technology adoption—progressing deliberately from Tier 1 foundational upgrading (hygienic drying, grading, basic-to-intermediate cold chains, e-marketing) to Tier 2 process intensification (ultraviolet-C sanitation, ultrasound processing, agile supply-chain integration) as human capital and returning specialist networks expand (Chankseliani et al., 2025; Sahraei & Mafi Balani, 2023; Yoruk et al., 2023). Finally, when Layers 1 through 3 operate in alignment, Layer 4 generates multidimensional welfare gains: reduced post-harvest spoilage, higher export value capture, formalized decent employment, improved dietary resilience, and environmentally sustainable poverty alleviation.

Scholarly Dialogue: Resolving Tensions and Conceptual Gaps

Confronting the reviewed evidence across disciplines exposes three central scholarly tensions that require explicit reconciliation.

First, a substantive tension exists between employment-volume narratives and employment-quality scholarship. Conventional rural development arguments often equate expanding agro-processing volume directly with poverty alleviation (Jamali et al., 2023; Yar & Noori, 2024). While our synthesis confirms the positive income-generating potential of rural nonfarm expansion (Christiaensen et al., 2021; Hazell et al., 2024), it aligns more closely with multidimensional labor-quality scholarship (Chigbu & Nekhwevha, 2023; Sehnbruch et al., 2024; Su & Chan, 2023) and empirical policy evaluations from Bolivia and Bangladesh (Canavire-Bacarreza et al., 2025; Sarker et al., 2021). These studies show that precarious, seasonal, or informal processing jobs fail to insulate households from recurring economic shocks. Divergences across prior studies largely reflect measurement scope: macro-level or village case studies focusing solely on headcount participation overlook wage adequacy, contract stability, and labor productivity—factors essential for permanent poverty exit.

Second, this review uncovers a sharp feasibility gap between frontier food-engineering optimism and fragile-state institutional realities. Contemporary food-engineering reviews emphasize the transformative benefits of high-pressure processing, pulsed electric fields,

microbial bioprocessing via *Kluyveromyces marxianus*, non-thermal oleogel structuring, and end-to-end agri-food digitalization (Krupitzer & Stein, 2024; Ramírez-Corona, 2024; Wang et al., 2025, 2027; Yuan et al., 2025). Our synthesis does not refute the technical superiority of these methods in extending shelf life or reducing nutrient degradation; rather, it refutes the implicit assumption that frontier technologies are directly transferable to resource-constrained SMEs. The divergence stems from context and scale: frontier processing research is anchored in capital-abundant industrial hubs with stable power grids and specialized R&D ecosystems, whereas Afghan food processors face severe credit rationing, energy disruptions, and acute technical skill gaps (Ghafoori et al., 2023; World Bank, 2026). Extending insights from Poland's food-processing resilience (Yoruk et al., 2023) and Ethiopia's agro-processing constraints (Urugo et al., 2024), our analysis suggests that absorptive capacity and appropriate, tiered innovation—not technological sophistication per se—govern commercial viability in developing economies.

Third, the literature reveals a governance tension between grassroots community resilience and formal export competitiveness. Recent Afghanistan-specific scholarship persuasively documents how informal social capital, local cooperation, and village-level adaptive norms sustain farming under state fragility (Amirzai & Chau, 2024; Pain & Levine, 2024). Yet, trade and export studies demonstrate that informal practices cannot overcome international sanitary and phytosanitary barriers, customs friction, or standardized packaging requirements (Fariady & Aman, 2024; Meemken et al., 2021; Rahimi & Artukoğlu, 2023). Moreover, environmental-economic evidence from China introduces an additional sustainability tension: rapid agro-industrial growth that relies on carbon-intensive energy or unmitigated waste risks accelerating ecological degradation even as incomes rise (Liu & Ge, 2025). Resolving both tensions requires hybrid institutional models that formalize quality standards and green energy practices *on top of* existing community trust networks, rather than attempting to replace local institutions with disconnected top-down structures (Tadesse Wazza & Belay Bedeke, 2022).

Global Elevation, Boundary Conditions, and Theoretical Contributions

Although Afghanistan serves as the empirical anchor of this review, its structural predicament exemplifies a broader global challenge confronting fragile, landlocked, and post-conflict agrarian economies across Central Asia, South Asia, and Sub-Saharan Africa. Comparative parallels with Ethiopia's post-harvest agro-processing barriers (Urugo et al., 2024), Bolivia's subnational poverty inefficiencies (Canavire-Bacarreza et al., 2025),

Indonesia's infrastructure-only limitations (Heriqbaldi et al., 2025), and Western China's differentiated rural revitalization paths (Geng et al., 2024) confirm that the "raw-commodity poverty trap" is a systemic phenomenon rather than a purely localized anomaly. Elevating Afghanistan's food-processing challenge into global discourse directly informs international development agendas—specifically Sustainable Development Goal (SDG) 1 (No Poverty), SDG 2 (Zero Hunger and nutritional resilience; Klinger et al., 2026; Nguyen & Qaim, 2025), SDG 8 (Decent Work and Economic Growth), and the transition toward low-carbon, waste-minimizing agri-food value chains (Edo et al., 2026; Liu & Ge, 2025).

At the same time, external validity depends on four explicit boundary conditions that govern when food processing innovation successfully drives inclusive growth:

1. Minimum Macroeconomic and Transit Predictability: Export-led processing upgrading requires predictable cross-border transit corridors and stable trade governance; prolonged border closures rapidly erode cold-chain returns on perishable commodities (Gereffi et al., 2021; World Bank, 2026).
2. Threshold Energy Reliability: Even Tier 1 and Tier 2 cold storage and processing facilities cannot operate profitably without consistent electrical power or viable off-grid solar/renewable alternatives.
3. Inclusive Labor-Market Participation: Comparative evidence shows that maximizing household poverty reduction through sectoral expansion depends heavily on enabling broad labor participation across rural youth and women (Hazell et al., 2024; Ilkkaracan et al., 2021); legal or socio-institutional restrictions on workforce participation impose a binding ceiling on aggregate welfare multipliers.
4. Place-Based Ecological Fit: Consistent with differentiated rural revitalization findings (Geng et al., 2024), agro-processing clusters must align with regional water availability and crop specialization rather than pursuing uniform industrial templates across drought-prone districts.

Within these boundary conditions, this review delivers two explicit theoretical contributions bridging economics and strategic management. To innovation and development economics, it integrates GVC governance constraints (Gereffi et al., 2005**,** 2021) with transaction-cost market failures (Ahmadzai, 2024) and multidimensional decent-work criteria (ILO, 2024), demonstrating how value-chain upgrading mediates the causal pathway from agricultural endowments to durable poverty reduction in fragile states. To strategic

management and entrepreneurship, it extends the dynamic capabilities framework (Teece et al., 1997) and sectoral absorptive capacity theory (Yoruk et al., 2023) to extreme resource-scarcity contexts by replacing binary technology-adoption assumptions with a three-tier, capability-sequenced innovation model (Table 5 and Figure 5).

Prioritized Future Research Agenda

Because direct firm-level econometric evidence on Afghanistan's food processing industry remains strikingly scarce (representing a fraction of the 23.5% Afghanistan-focused literature in our corpus), advancing both scholarship and evidence-based policy requires moving beyond descriptive macroeconomic overviews and analogical reasoning. Table 6 outlines a prioritized, three-tier future research agenda specifying concrete research questions, recommended empirical designs, and expected contributions.

Table 6. Prioritized Future Research Agenda on Food Processing Innovation and Inclusive Growth in Fragile Economies

Priority Tier	Thematic Focus	Specific Research Questions (RQs)	Recommended Empirical & Methodological Approach	Expected Academic & Policy Contribution
Priority 1 (Immediate)	Firm-Level Employment & Income Multipliers in Afghan Value Chains	**RQ1:** What are the direct and indirect employment elasticities, wage premiums, and household poverty-exit effects of specific Afghan agro-processing chains (e.g., dried fruits, nuts, dairy, medicinal herbs)?	Multi-province enterprise and household panel surveys; propensity score matching or difference-in-differences comparing participating vs. non-participating producers.	Replaces analogical estimates with rigorous causal micro-evidence on job quality and household welfare in Afghanistan.
Priority 1 (Immediate)	Cost–Benefit & Institutional Viability of Shared Cold Chains	**RQ2:** Under what governance and off-grid energy models (e.g., solar-powered cooperative hubs) do Tier 1–2 cold-chain investments achieve financial breakeven and measurable post-	Techno-economic feasibility modeling combined with field quasi-experiments across perishable fruit and dairy corridors.	Guides donors and private investors toward commercially sustainable, low-carbon cold-storage deployments.

		harvest loss reduction?		
Priority 2 (Medium-Term)	Hybrid Governance Bridging AFNs and Formal GVC Upgrading	**RQ3:** How can informal 3Rs alternative food networks transition into formal producer cooperatives capable of meeting international sanitary and phytosanitary export standards without eroding local social trust?	Comparative multiple-case studies using the Gioia coding methodology and informant triangulation across exporting vs. non-exporting cooperatives.	Extends GVC governance and institutional theory to fragile, informal-economy settings.
Priority 2 (Medium-Term)	SME Dynamic Capabilities, Credit Access & Appropriate Tech Adoption	**RQ4:** How do credit constraints, technology intermediaries, and returning technical diaspora specialists moderate SMEs' adoption of Tier 2 processing, packaging, and e-marketing innovations?	Structural equation modeling (SEM) or discrete choice experiments among food-processing SME managers; network analysis of university–industry ties.	Identifies exact micro-level managerial and financial levers that accelerate absorptive capacity and TFP growth.
Priority 3 (Long-Term)	Circular Bioeconomy, Climate Resilience & Green Upgrading	**RQ5:** How can water-efficient and waste-valorizing processing technologies (e.g., fruit/nut by-product utilization) simultaneously reduce carbon intensity and bolster rural resilience against drought shocks?	Life-cycle assessment (LCA) integrated with regional spatial econometrics or computable general equilibrium (CGE) simulations.	Connects fragile-state agro-industrialization to global green-transition and climate-adaptation scholarship.

Note. Research priorities are derived directly from empirical, methodological, and geographic gaps identified in the thematic synthesis of the reviewed corpus ($N = 51$).

Managerial and Policy Implications

Translating the Integrative Ecosystem Framework (Figure 5) into practice requires synchronized action across four stakeholder groups. Table 7 distills specific, evidence-derived recommendations tailored to agribusiness managers, financial actors, policymakers, and research institutions.

Table 7. Actionable Managerial and Policy Roadmap for Developing Afghanistan's Food Processing Ecosystem

Stakeholder Group	Strategic Priority	Concrete Actionable Measures	Expected Performance & Welfare Outcome
SME Managers & Agribusiness Cooperatives	Pursue staged, capability-aligned upgrading and market diversification	Prioritize Tier 1 investments (hygienic grading, standardized packaging, shared solar cold storage) before capital-heavy machinery; adopt agile inventory/supply-chain practices and digital B2B e-marketing; formalize cooperative aggregation from existing informal AFNs.	Cuts post-harvest spoilage, strengthens product consistency and brand recognition, lowers unit costs, and secures higher wholesale/export margins.
Investors, Financial Institutions & DFIs	De-risk SME capital access and finance shared infrastructure	Design blended-finance facilities, equipment leasing, and warehouse-receipt credit lines tailored to seasonal agro-processing cash flows; co-finance shared regional cold-storage and packaging centers rather than isolated single-firm plants.	Overcomes collateral and credit-rationing bottlenecks, expands SME capacity utilization, and raises enterprise total factor productivity.
Policymakers & Multilateral Donors	Align hard infrastructure with soft institutional and labor governance	Pair rural road and off-grid energy investments with accredited food-safety testing laboratories and simplified export-certification windows; redirect development aid from short-term relief toward productive agro-industrial skills and formal-employment incentives; negotiate predictable regional transit corridors.	Eliminates export compliance rejections, crowds in private processing investment, formalizes rural nonfarm jobs, and narrows regional poverty gaps.

Universities, R&D & Technology Intermediaries	Build sectoral absorptive capacity and diaspora knowledge bridges	Establish practical university–industry food technology extension hubs (e.g., quality control, hygienic drying, basic non-thermal sanitation); create structured fellowships and consulting linkages engaging Afghan food-engineering diaspora specialists abroad.	Closes technical skill deficits, accelerates appropriate technology transfer, and strengthens long-term sectoral resilience to economic shocks.

Note. Recommendations synthesize empirical mechanisms across reviewed international and Afghanistan-focused studies (Ahmadzai, 2024; Akhavan et al., 2026; Amirzai & Chau, 2024; Asaleye et al., 2023; Chankseliani et al., 2025; Edo et al., 2026; Fariady & Aman, 2024; Lu, 2025; Rahimi & Artukoğlu, 2023; Sahraei & Mafi Balani, 2023; Yoruk et al., 2023).

At the managerial level, SME leaders and cooperative entrepreneurs should resist premature investment in complex frontier machinery and instead build dynamic capabilities incrementally (Reardon et al., 2021). Pooling resources across smallholder networks to share solar-assisted cooling, standardized sorting, and export-compliant packaging offers the fastest return on scarce capital while directly lifting product grade and farm-gate earnings. Concurrently, investing in basic digital marketing, inventory agility, and traceable buyer relationships enables domestic processors to move beyond passive local spot markets (Babaei Meybodi & Rostapisheh, 2017; Sahraei & Mafi Balani, 2023).

At the policy and institutional level, governments, development finance institutions (DFIs), and multilateral donors must shift from fragmented, single-link interventions to coordinated ecosystem investment. Consistent with evidence on foreign-aid allocation (Asaleye et al., 2023), enterprise productivity programs (Lu, 2025), and infrastructure complementarity (Heriqbaldi et al., 2025), public and donor capital yields the highest poverty-reduction returns when transport and energy upgrades are bundled with SME credit guarantees, accredited export-testing laboratories, vocational food-safety training, and diaspora knowledge-reintegration initiatives (Chankseliani et al., 2025). Embedding formal employment standards and renewable-energy incentives within these support packages ensures that agro-industrial growth translates into decent, climate-resilient livelihoods rather than low-wage informality.

Review Limitations

Four methodological and evidentiary limitations qualify the conclusions of this review and should guide readers' interpretation. First, although structured around SANRA quality

domains and explicit eligibility rules (Baethge et al., 2019), an integrative narrative review does not execute an exhaustive, database-wide PRISMA enumeration or quantitative meta-analysis; consequently, source selection retains an element of purposive scholarly judgment and cannot yield pooled statistical effect sizes. Second, because direct empirical scholarship on Afghanistan's food processing firms remains scarce—comprising mostly descriptive macroeconomic, agricultural, or export diagnostics—several economic and managerial mechanisms synthesized here rely on structured analytical analogy from comparable developing and transition economies (such as China, Ethiopia, Iran, Bolivia, Indonesia, and Poland). Third, macro-level indicators and conceptual frameworks adapted from secondary sources (such as national GDP shares and post-harvest loss ranges) could not be independently audited against primary firm-level survey data in Afghanistan. Fourth, while incorporating Persian-language peer-reviewed journals reduced English-only publication bias, relevant unpublished local government assessments or Pashto-language field reports may fall outside the accessible indexed literature. Addressing these evidentiary gaps through primary, firm-level empirical studies represents the core mandate of the research agenda proposed in Table 6.

Conclusion

This review demonstrates that food processing innovation can convert Afghanistan's substantial agricultural endowments into productive employment and durable poverty reduction only when technological upgrading is embedded within a coordinated institutional, financial, and value-chain ecosystem. Comparative evidence confirms that agro-industrial expansion alleviates household vulnerability most effectively when it generates formal, productivity-enhancing work rather than precarious informal labor, yet mutually reinforcing deficits in capital, energy, cold-chain logistics, technical skills, and export certification currently lock Afghan small and medium-sized enterprises into low-margin raw commodity trading. Interpreting these bottlenecks through Global Value Chain governance theory and the dynamic capabilities framework reveals why isolated investments in physical infrastructure or capital-intensive frontier processing technologies fail to yield systemic welfare gains in fragile agrarian settings. Ultimately, bridging informal community agribusiness networks with formal quality standards through staged, capability-aligned processing innovation provides the central pathway for transforming Afghanistan's food industry into a resilient engine of sustainable and inclusive economic development.

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CRediT authorship contribution statement. A.M.Z.: Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review and editing. A.H.H.: Investigation, Validation, Writing – review and editing. Z.M.: Data curation, Visualization, Writing – review and editing.

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Ethics statement. This study is an integrative narrative review based exclusively on published peer-reviewed literature and publicly available institutional reports. Therefore, institutional ethical approval and informed consent were not required.

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