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Strategies for Reducing Inequality in Agricultural Value Chains: A Systematic Review on Smallholder Participation in Developing Countries

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ABSTRACT

Strengthening smallholder integration in agricultural value chains across developing countries, particularly in Southeast Asia and Sub-Saharan Africa, requires an integrated approach to enhance efficiency, sustainability, and equitable market access. This study presents a systematic literature review (SLR) of SCOPUS-indexed articles published between 2000 and 2024, complemented by case studies from Vietnam and South Africa. Key interventions include the application of blockchain technology to improve transparency, digital platforms to facilitate market access, and the Internet of Things (IoT) to enhance production efficiency. The findings indicate that digitalization can increase smallholder farmers' incomes by up to 20% and reduce post-harvest losses by approximately 25%, although these figures vary by crop type and location. Persistent challenges include limited digital infrastructure, low digital literacy, and high adoption costs. Supporting strategies such as farmer training programs, inclusive financial access, product diversification, and national digital infrastructure policies are crucial to fostering sustainability. This paper recommends prioritizing rural digital investment, enhancing technological literacy, and strengthening multi-stakeholder collaboration to enable a more inclusive transformation of agricultural value chains, particularly in countries like Indonesia.

1. INTRODUCTION

Over the past two decades, value chain-based interventions have emerged as a dominant approach within the international development sector, particularly in agriculture. These interventions aim to connect smallholder farmers to broader markets, enhance value addition, and alleviate poverty. However, various studies have demonstrated that agricultural value chains are not socially neutral; rather, they are heavily shaped by cultural norms, gender dynamics, and the distribution of power and resources among actors. Inequitable access to information, capital, and markets continues to pose significant barriers for smallholder farmers, particularly women [1]. Thus, agricultural development must adopt a more inclusive, responsive, and structurally just approach.

Despite growing interest in value chain development, prior research has not sufficiently addressed the structural inequalities that limit smallholder participation, particularly within digital and financial interventions. This study addresses that gap.

This perspective aligns with several Sustainable Development Goals (SDGs), especially SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 5 (Gender Equality), SDG 9 (Innovation and Infrastructure), and SDG 10 (Reduced Inequalities).

The need for resilient and equitable systems became even more apparent during the COVID-19 pandemic, which exposed vulnerabilities within global food systems, particularly in developing countries. Research conducted in Ethiopia, Mali, Nigeria, and Uganda revealed that logistical disruptions and mobility restrictions severely hampered the distribution of agricultural inputs and outputs [2]. Similarly, in India, the nationwide lockdown made it difficult for tomato and wheat farmers to access labor and market their produce, highlighting the severe economic risks faced by smallholders in times of crisis [3]. In Ecuador, disruptions in the cocoa export sector—a key national commodity—demonstrated that even export-oriented value chains were not immune to the pandemic's impact [2].

In response to these challenges, digital transformation has emerged as a promising strategy to empower smallholder farmers. Globally, farmers have increasingly adopted technology to access markets directly and reduce dependency on intermediaries. In Morocco, mobile phone usage has reshaped farmers' economic relationships with local markets [4], while in India, platforms such as Kalgudi e-Market have facilitated alternative marketing channels and accelerated innovation adoption [5]. Thus, digitalization is not only relevant during crises but also holds long-term potential to restructure global agricultural value chains [6].

Nevertheless, access to technology remains uneven. Challenges related to digital literacy and financial inclusion persist, particularly in rural areas. Studies in Ghana on mobile money adoption demonstrate that while technology can enhance productivity, limitations in access and trust remain significant barriers [7]. In Kenya, institutional factors and trust issues similarly influence horticultural farmers' market decisions, underscoring the need for context-sensitive approaches [8].

Youth and women, in particular, continue to experience pronounced barriers. In many sub-Saharan African countries, youth inclusion has become a priority to address unemployment and revitalize the agricultural sector [9]. However, as studies in South Africa reveal, a lack of institutional support and limited access to technical training continue to impede young farmers' participation [10]. Meanwhile, research in Vietnam and Tanzania highlights gender-based challenges that limit women's equal engagement in agricultural production and distribution [11, 12].

These barriers reinforce the importance of multi-actor collaboration in restructuring value chain governance. Mishra et al. [13] identified effective collaborative models that enhance smallholder bargaining power, such as Agricultural Value Chain Finance (AVCF) initiatives that engage financial institutions, NGOs, and market actors to create more adaptive agricultural financing ecosystems [14]. Examples from South Africa and Turkey, involving reforms in agricultural extension services and contract farming arrangements, further illustrate how institutional innovations can sustainably support smallholder farmers [15, 16]. Additionally, cooperatives and household assets such as access to information and production inputs have been shown to be crucial for overcoming supply chain constraints, as evidenced by research from Kenya [17].

The effectiveness of these interventions, however, is highly context-dependent. Although examples from countries like India, Ecuador, and Morocco are included to illustrate global patterns, this paper focuses on drawing broader lessons applicable to Southeast Asia, especially Indonesia, where smallholder marginalization remains an urgent policy concern. In Indonesia, studies on the indigenous Tebat Benawa community reveal how kinship-based social networks shape farmers' economic interactions with traders [18]. In Ethiopia, low value addition in tomato production and weak connectivity among supply chain actors impede sustainable local development [19]. Furthermore, post-harvest losses, which are estimated at up to 30% in many developing countries, underscore the urgent need for improved storage and processing infrastructure at the farm level [20].

The unequal distribution of profits along value chains also remains a major concern. Research in Nigeria's cassava value chain shows that farmers receive the smallest share of profits compared to processors and traders [21]. Similarly, agribusiness corridor projects in Africa, often driven by state-supported global investments, have not guaranteed smallholder inclusion without strong social accountability mechanisms [22]. In Mexico, formally organized farmer groups with managerial capacity and collective adoption of information technology have demonstrated greater competitiveness [23].

Efforts toward agricultural industrialization are also being explored through bioeconomy frameworks. Experiences from Argentina and Malaysia indicate that bioeconomy strategies can add value to commodity crops like soybeans and palm oil but require safeguarding policies to prevent exacerbating inequalities [24]. In China, collaborative models between large enterprises and smallholders show that fair, incentive-based contracts—often framed through game theory—can improve production partnerships [25]. Moreover, post-liberalization land reforms highlight the necessity of context-specific intervention design [26, 27].

International projects such as SocialLab in Europe and rural transformation studies in China emphasize the importance of participatory, multidimensional approaches to strengthening local capacities in the face of climate change, modernization, and global market pressures [28, 29]. Similarly, post-conflict youth engagement in Northern Uganda's sweet potato agribusiness provides valuable lessons for fostering inclusive rural economic transitions [30]. These findings align with global analyses of smallholder farmers' social conditions across the Global South, which highlight how value chain governance, commodity characteristics, and national contexts critically influence agricultural actors' welfare [31].

In conclusion, there is an urgent need to rethink value chain interventions to prioritize social justice, technological adaptation, and active smallholder participation. This study seeks to synthesize best practices from diverse contexts and evaluate strategies that strengthen smallholders' positions within global agricultural systems. Emphasis is placed on adaptive, participatory, and context-sensitive approaches to address the increasingly complex challenges of our time.

Given this research gap and the global urgency for equitable transformation, this literature study aims to answer the central research question: How can agricultural value chain interventions be designed to be more equitable, inclusive, and contextually adaptive for developing countries, particularly Indonesia?

2. METHODOLOGY

This study employs a systematic literature review (SLR) approach to identify and analyze scholarly publications relevant to the participation and empowerment of smallholder farmers in global agricultural value chains. The review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and methodological rigor.

The review focuses on peer-reviewed articles published between 2000 and 2024 in reputable national and international journals. Data were sourced from SCOPUS and other credible electronic databases, yielding 530 initial records. After removing 5 duplicates and screening 525 irrelevant articles through keyword filtering and reference management tools, 326 articles were selected for abstract-level screening. Manual screening was conducted using the following inclusion criteria: (1) relevance to smallholder empowerment and participation, (2) focus on digital or institutional interventions in agricultural value chains, and (3) studies conducted in developing countries. Exclusion criteria involved non-peer-reviewed sources, non-English articles, and studies not addressing agricultural value chains.

Subsequently, 199 articles were excluded, and 194 full-text articles were retrieved. 5 articles could not be accessed due to digital restrictions, resulting in 189 articles for eligibility assessment (Figure 1).

Eligibility was determined through a comprehensive reading based on criteria such as methodological quality, empirical contribution, and alignment with the research scope.

Literature quality was assessed using the Critical Appraisal Skills Programme (CASP) checklist to ensure consistency and reliability across studies. 35 articles were excluded due to weak methodology or lack of empirical data, leaving 6 articles for final synthesis. Although the final sample is limited in size, the selected studies offer diverse geographic coverage and intervention types, ensuring meaningful thematic depth.

Qualitative synthesis was conducted by systematically extracting and comparing key elements such as research context, objectives, methods, findings, and policy implications. The entire research process—from search to synthesis—was carried out between February and April 2025 and was thoroughly documented to ensure transparency and replicability.

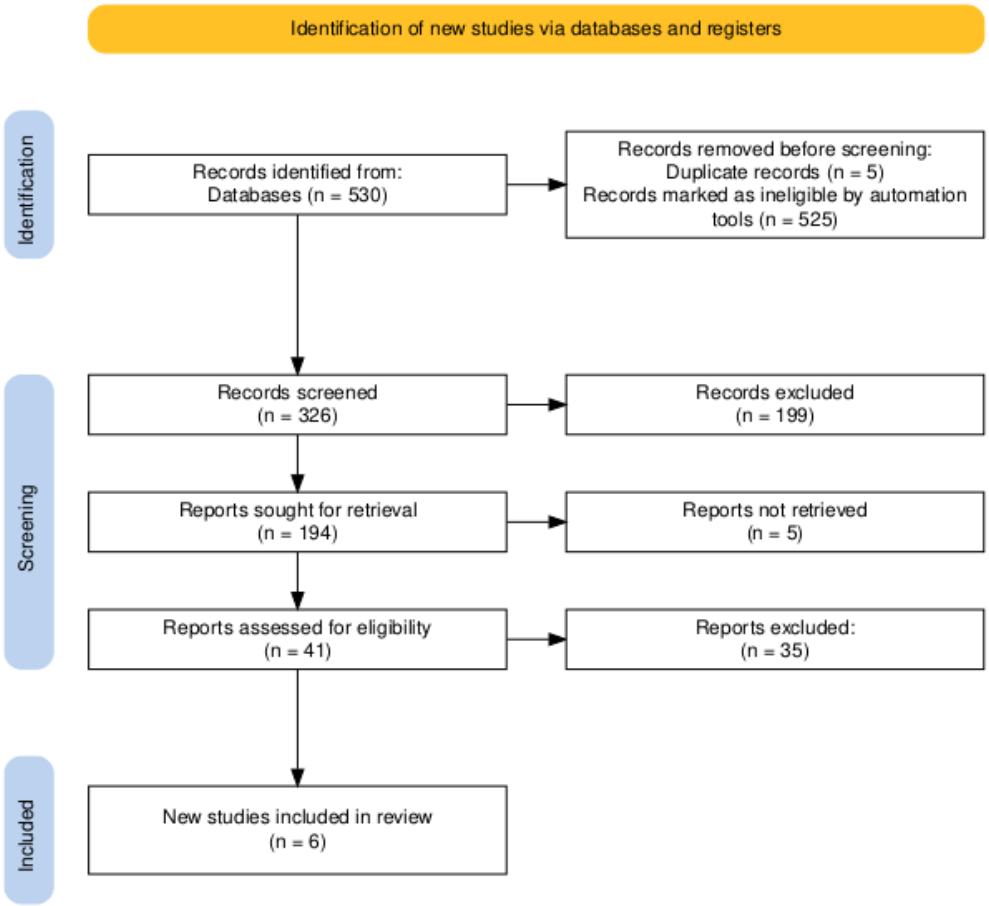

Figure 1. PRISMA diagram

3. RESULTS AND DISCUSSION

3.1 Summary of agricultural value

The analysis in this section is based on a carefully curated set of studies selected through a structured and systematic screening process. This process ensured that only research directly related to agricultural value chains was included, allowing for a focused and in-depth exploration of key themes. The following synthesis highlights the main contributions of these studies, offering insights into various aspects of agricultural value creation, distribution, and stakeholder involvement across different contexts.

Based on the screening results in Table 1, ten research questions were formulated to address various issues related to the agricultural value chain. These ten research questions are illustrated in Figure 2. The diagram was developed by the author based on a synthesis of various reviewed literature sources.

3.2 Synthesis of findings based on research questions

The research questions posed in this study are addressed in this subsection through conclusions drawn from the evaluated literature. The synthesis reveals that digitalization, partnerships, policies, and integrated management collectively answer the research questions formulated. Moreover, the synthesis highlights both consistencies and discrepancies among the findings of various studies, particularly concerning digitalization in remote areas where the potential benefits often conflict with challenges related to technological access. The implications of this synthesis either reinforce or question the inclusive value chain theory within sustainable agribusiness models and provide recommendations for future research, particularly regarding hybrid strategies (combining high-tech and low-tech solutions) and adaptive policies that are responsive to local contexts.

How can agricultural value chains be optimized to enhance efficiency and sustainability in developing countries?

Optimizing agricultural value chains requires collaboration among farmers, governments, and the private sector to improve distribution and reduce post-harvest losses. Digitalization enhances efficiency and transparency—blockchain enables traceability [32], while platforms like TaniHub reduce intermediary layers and raise farmer profits.

The effectiveness of digital technologies varies by crop type. Cash crops such as cassava and sugarcane benefit more due to export orientation and private investment, while food staples like rice and maize often see lower gains due to weak infrastructure and market access.

In South Africa, Internet of Things (IoT) increased sugarcane yields by an average of 20% (range: 18–23%), while in Vietnam, mobile apps improved cassava productivity by 15% on average (range: 10–18%) [33, 34]. Beyond technology, success also depends on training, access to finance, and product diversification.

Geographical adaptability plays a significant role in digital agricultural development. Vietnam may benefit from centralized digital policies and relatively uniform cropping systems, which support streamlined implementation. In contrast, countries like Ghana and Zimbabwe often face challenges such as complex or fragmented land tenure arrangements and variability in digital infrastructure. Meanwhile, Indonesia's archipelagic geography presents unique logistical hurdles, making localized digital strategies more appropriate and necessary.

Table 1. Screening results

Article Title	Authors	Findings
Study on Improvement of Cassava Value Chain in Quang Binh	Son D.V., Lam D.X., Fahrney K., Thi C., Thuy L.	Consolidating harvests through cooperatives enhances distribution efficiency and strengthens the competitiveness of cassava products in export markets.
Barriers to Market for Subsistence Farmers in Fijia-A Gendered Perspective	Singh-Peterson L., Iranacolaivalu M.	Digitalization of value chains enables women farmers in Fiji to reduce post-harvest losses and improve market access.
Room at the Margins for Energy-Crops? A Qualitative Analysis of Stakeholder Views on the Use of Marginal Land for Biomass Production in Denmark	Shortall O.K., Anker H.T., Sandøe P., Gamborg C.	Blockchain technology increases transparency within the bioenergy value chain, allowing smallholder farmers to capture greater benefits.
Does Market Participation Promote Generalized Trust? Experimental Evidence from Southern Africa	Siziba S., Bulte E.	Market participation through cooperatives fosters general trust and strengthens the bargaining position of smallholder farmers.
Gender Gap in Rice Productivity: Evidence from Vietnam	Tran T.K., Van Elahi E., Zhang L., Bui V.H., Pham Q.T.	Achieving gender equality in rice productivity in Vietnam requires evidence-based policies that specifically support women farmers.
Determinants of Soybean Market Participation by Smallholder Farmers in Zimbabwe	Zamasiya B., Nelson M., Kefasi N., Shephard S.	Smallholder farmers' participation in the soybean market in Zimbabwe is influenced by access to financial capital and logistical infrastructure.

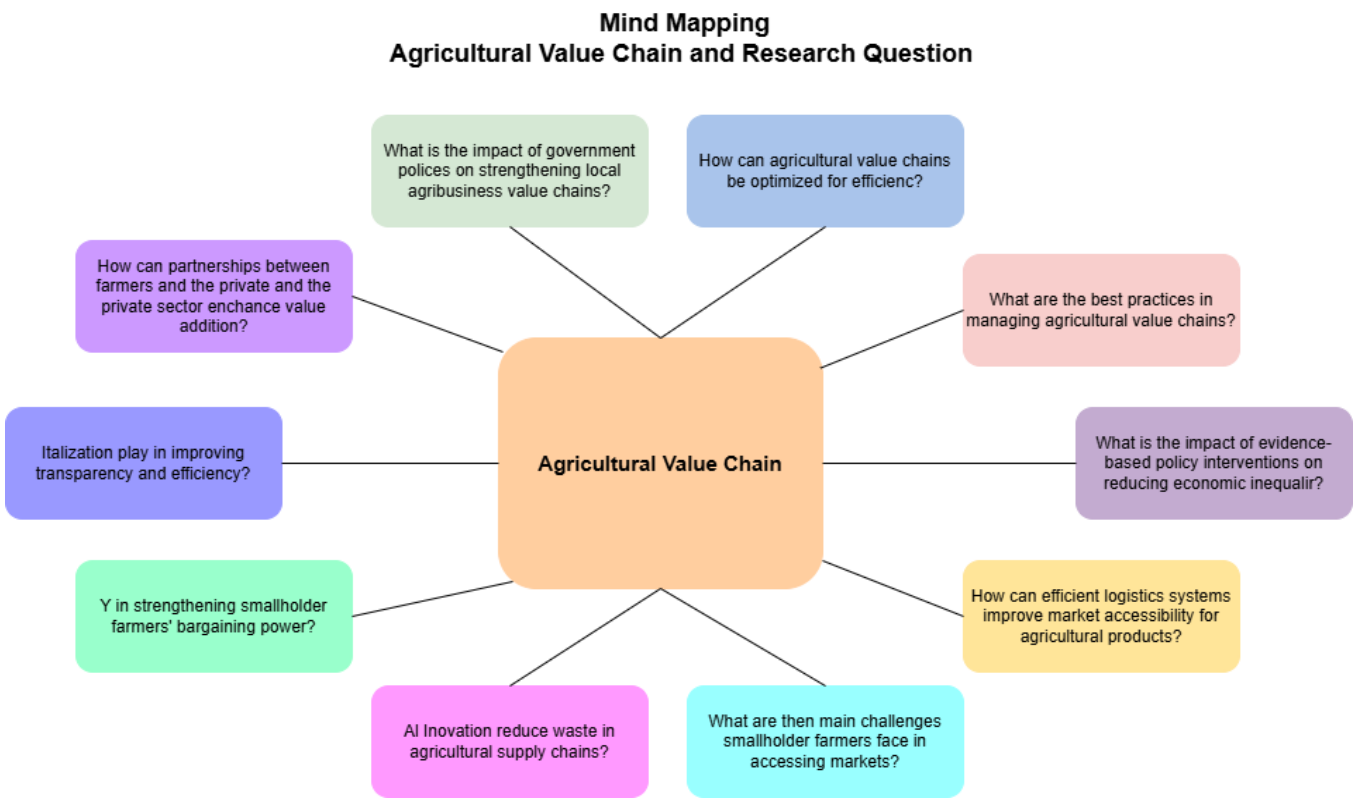

Figure 2. Mind mapping 10 research questions

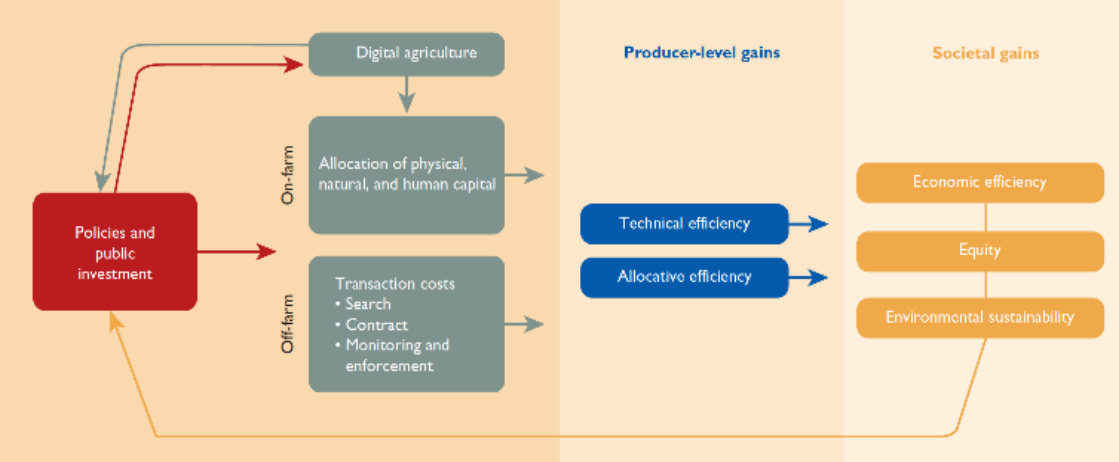

Figure 3. Strategies for improving efficiency and sustainability in agricultural value chains [35]

Various efforts have been identified to improve the performance of agricultural value chains, as illustrated in Figure 3, including the integration of digital technologies, multi-stakeholder partnerships, and improvements in logistics systems. However, the implementation of these strategies often faces major barriers such as limited digital access, low digital literacy, and high adoption costs. Potential solutions include farmer training, technology subsidies, and public-private partnerships to support inclusive digital transformation and enhance global competitiveness.

What are the main challenges faced by smallholder farmers in accessing markets through agricultural value chains?

Smallholder farmers face persistent challenges in accessing markets, including information asymmetry, poor logistics, limited financing, and low levels of digital and technical capacity.

In Fiji and South Africa, reliance on intermediaries due to a lack of price transparency and weak distribution networks has led to low profit margins [32, 33].

In Vietnam, inadequate storage facilities contribute to significant post-harvest losses, especially among cassava farmers, while fragmented production structures increase distribution costs [34].

Cultural norms further restrict women's participation in market decisions, limiting their access and agency.

These challenges vary geographically. Vietnam has benefited from strong cooperative systems that facilitate market aggregation, whereas countries in Sub-Saharan Africa continue to struggle with structural and institutional barriers.

Several key solutions have been identified to support farmers in accessing markets, as illustrated in Figure 4, including digitalizing market information, investing in rural logistics infrastructure, expanding access to finance through microcredit and cooperatives, and strengthening technical and managerial training, particularly for women farmers [36]. Addressing barriers such as limited digital access, low literacy, and dependency on intermediaries requires integrated strategies that go beyond technological and institutional interventions, incorporating needs-based empowerment approaches. These efforts are critical to improving smallholder market participation and enhancing the inclusiveness of agricultural value chains.

What is the role of digitalization in enhancing transparency and efficiency in agricultural value chains?

Digitalization improves transparency and efficiency in agricultural value chains by reducing information asymmetry and enabling traceability. Mobile apps provide real-time market data, while blockchain builds trust across the supply chain [36]. IoT allows real-time monitoring, reducing logistical costs, as seen in South Africa [33]. In Vietnam, cassava value chain digitalization increased farmer income by an average of 15%, with a range of 10–18% depending on infrastructure and digital literacy [34].

Figure 4. Four key solution pillars for farmers in accessing markets [37]

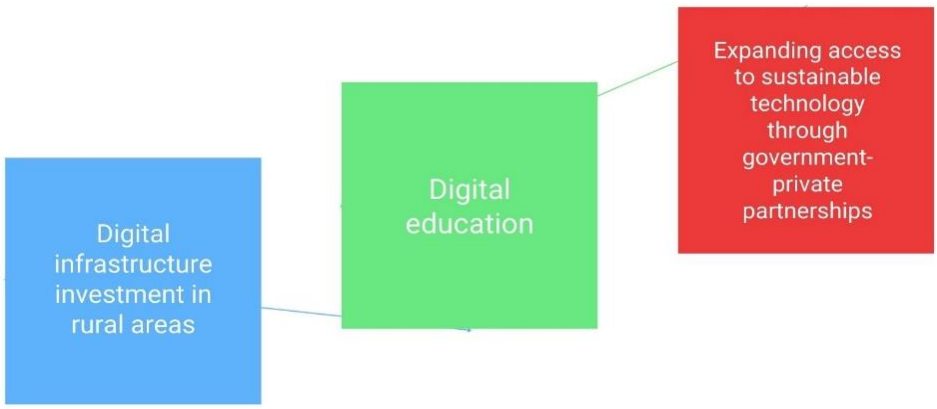

Figure 5. Enhancing digitalization in the agricultural value chain [37]

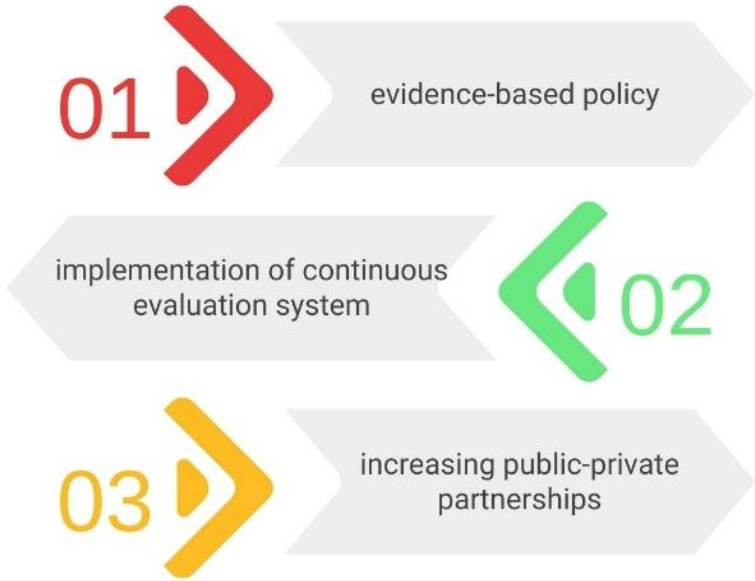

Figure 6. The impact of government policy implementation on strengthening local agribusiness value chains [38]

Figure 7. Partnership models between farmers and the private sector [39]

Cash crops like cassava benefit more due to export demand and traceability value, while food crops like rice show lower gains due to weaker market digitization.

Adoption also varies geographically. Vietnam's cooperative-led platforms and digital subsidies enable scale, whereas Ghana and Kenya face fragmented systems and low

connectivity.

Challenges include limited rural access, low digital skills, and high infrastructure costs. Solutions include investing in rural networks, tech subsidies, inclusive training, especially for women and youth, and public-private collaboration for sustainability. As illustrated in Figure 5, digitalization plays a vital role in enhancing transparency and efficiency in agricultural value chains.

What is the impact of government policy implementation on strengthening local agribusiness value chains?

Government policies play a critical role in strengthening local agribusiness value chains by promoting smallholder participation, improving efficiency, and enhancing competitiveness. Subsidies facilitate technology adoption, as observed in Vietnam, where cassava subsidies led to an average 20% increase in production efficiency, ranging between 17% and 22% depending on region and farmer capacity [34].

Infrastructure investments, such as rural roads and storage facilities, have reduced post-harvest losses and improved market access, especially in cash crop contexts like cassava and sugarcane. In contrast, food crops such as rice have benefited less due to weaker integration into commercial value chains.

Government support for digitalization, including blockchain policy incentives, has improved supply chain transparency, as seen in Denmark's bioenergy sector [36]. In Fiji, rural infrastructure projects empowered women farmers, while in South Africa, import tax policies have stabilized local markets and protected domestic agribusiness [32, 33].

However, the effectiveness of these policies varies by region. Vietnam's success stems from coordinated state-subsidy programs and farmer cooperatives, whereas countries like Ghana and Kenya face issues such as fragmented policy implementation, lack of monitoring systems, and limited digital capacity.

Despite their promise, policy implementation faces challenges including misaligned programs, corruption, and uneven subsidy distribution. Addressing these issues requires evidence-based policymaking, continuous evaluation systems, and strong public-private partnerships to support sustainable digital transformation in agriculture. Figure 6 presents the impact of government policy implementation on strengthening local agribusiness value chains.

How can partnership models between farmers and the private sector enhance the value addition of agricultural products?

Partnerships between farmers and the private sector are highly effective in enhancing the value addition of agricultural products through technological adoption, access to financing, supply chain integration, and market expansion. In Vietnam, partnerships with cassava processing companies have improved product quality and competitiveness [34]. In Fiji, collaborations have enabled smallholder farmers to access regional markets through improved distribution facilities [32]. In South Africa, farmer cooperatives have worked with private firms to access low-interest credit, enhancing input investment [33]. Training programs have also played a key role; for instance, blockchain training in Denmark has strengthened bioenergy traceability [36]. However, these examples largely involve cash crops such as cassava, sugarcane, and biomass. Similar partnerships for staple food crops like rice or maize are less common and often face challenges due to limited export orientation and weaker private-sector incentives.

While detailed quantitative data is limited, estimates in Vietnam show that cassava-processing partnerships have increased net farmer income by approximately 12–18%, depending on access to technology and market infrastructure [34].

Geographic context also shapes partnership outcomes. Vietnam's success reflects coordinated value chain support and export demand, while in Sub-Saharan Africa, fragmented markets and weak contract enforcement reduce long-term sustainability. In contrast, Denmark's high-tech training programs have succeeded due to institutional strength and consistent digital infrastructure.

Partnerships typically focus on improving technology access, financing, and market integration. Tools such as processing machines and IoT improve product quality and logistics. However, challenges including power asymmetries, lack of transparency, and weak commitment threaten sustainability. Therefore, fair contracts, third-party monitoring, and active government mediation are essential to ensure equitable and long-term benefits for smallholder farmers. As shown in Figure 7, partnership models between farmers and private actors can significantly enhance value addition and market access.

What are the best practices in agricultural value chain management that support environmental and economic sustainability?

Sustainable management of agricultural value chains must integrate environmental, social, and economic dimensions. Product diversification helps farmers reduce risk and enhance income, as demonstrated by the development of high-value cassava varieties in Vietnam [34]. Agricultural waste can be repurposed into compost or bioenergy, helping to reduce emissions and generate additional income, as seen in Denmark [36]. However, such diversification strategies tend to be more effective for cash crops like cassava and sugarcane, while food crops such as rice or maize require different post-harvest handling systems and have lower market-driven incentives for value-added transformation.

Digital technologies such as IoT and blockchain enhance efficiency and transparency, illustrated by initiatives in Fiji [32]. Integrated farming systems that combine crops, livestock, and aquaculture have proven advantageous for smallholders in South Africa [33]. For instance, IoT-supported irrigation and pest control systems have been shown to reduce input costs by approximately 10–15%, while improving yields and sustainability metrics in both cash and food crop systems [33].

Moreover, education and training programs, such as blockchain training sessions in Denmark, have empowered farmers to adopt sustainable practices [36]. Active community involvement, including the empowerment of women, also fosters social equity and enhances overall community well-being [32].

Geographical differences also shape implementation success. Vietnam benefits from a strong cooperative infrastructure and export linkages, enabling scale-up of diversification and processing efforts. In contrast, countries like Ghana or Uganda face logistical, institutional, and market barriers that constrain the replicability of these best practices.

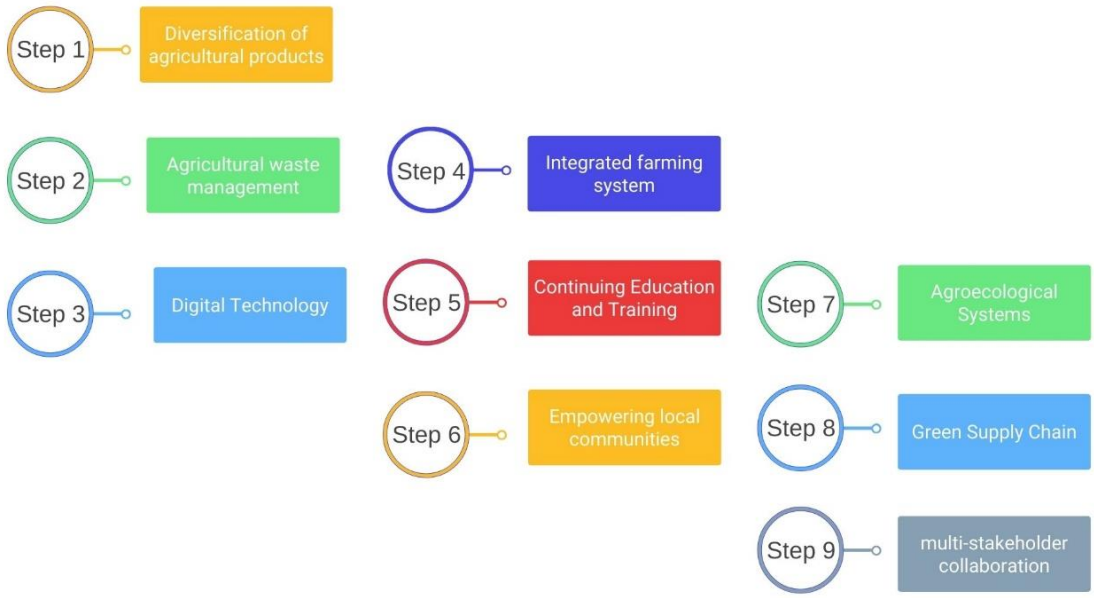

Figure 8. Agricultural value chain management practices [40]

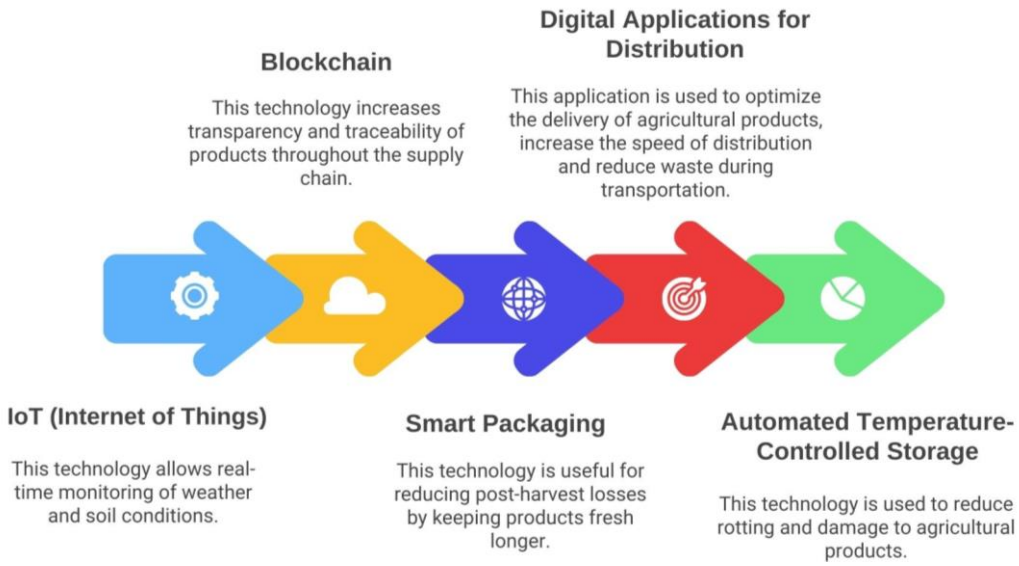

Figure 9. Technological innovations in agricultural supply chains [41]

Sustainable agricultural value chain management requires the integration of environmental, social, and economic dimensions. Product diversification reduces crop risk and maintains soil health, while agricultural waste conversion supports low-emission productivity. Technologies like IoT and blockchain increase efficiency and traceability. Integrated and agroecological systems reduce the environmental footprint while enhancing resilience.

Sustainable education programs and inclusive community engagement strengthen local capacities. Effective collaboration between governments, private actors, and rural communities is key to building resilient and adaptable agricultural value chains. Figure 8 illustrates best practices in managing agricultural value chains that support both environmental and economic sustainability.

How can technological innovations reduce waste in agricultural supply chains?

Technological innovations play a crucial role in minimizing waste within agricultural supply chains by improving efficiency, reducing losses, and enhancing transparency. IoT solutions enable real-time monitoring of weather and soil conditions, leading to an average 13–15% reduction in harvest losses for cash crops such as sugarcane and soybeans in Denmark [36].

Blockchain technology supports product traceability and helps identify waste points across distribution systems, with notable results among women-led vegetable cooperatives in Fiji, primarily involving food crops like leafy greens [32].

Packaging innovations, such as vacuum systems used in Vietnam, have contributed to approximately 10% average post-harvest loss reduction in cassava, depending on storage duration and climate conditions [34]. Distribution apps in South Africa reduced shipment-related waste by 18–22%, particularly in perishable cash crops like tomatoes and citrus [33]. Automated storage systems in Denmark have also helped maintain crop quality and reduce spoilage significantly [36].

Geographic variation influences innovation success. Denmark and Vietnam benefit from strong infrastructure and cold-chain systems, enabling rapid tech integration.

Conversely, countries like Kenya and Nigeria face infrastructure gaps and fragmented supply chains, limiting the scalability of similar solutions. Figure 9 highlights how technological innovations such as IoT and blockchain reduce waste and improve supply chain performance.

Technologies such as IoT, blockchain, smart packaging, digital logistics, and temperature-controlled storage have proven effective in reducing waste and extending shelf life. These tools optimize supply chains, but are more impactful for high-value cash crops with export potential than for staple crops with shorter domestic distribution paths.

Barriers include high implementation costs, digital illiteracy, and limited infrastructure, especially in remote areas. Solutions include tech subsidies, inclusive digital training, and investment in logistics infrastructure to ensure equitable and sustainable technology adoption across crop types and regions.

What is the role of cooperatives or farmer groups in strengthening the bargaining position of smallholder farmers within agricultural value chains?

Cooperatives play a vital role in strengthening the bargaining power of smallholder farmers by improving market access, enabling production consolidation, and facilitating access to financing and training. In Vietnam, cassava cooperatives have helped farmers meet export standards [34], while in South Africa, they negotiate fairer prices to improve income security [33]. These successes are more prominent in cash crops such as cassava and sugarcane; in contrast, food crops like rice often lack cooperative-based value chain structures due to lower commercialization and domestic price controls.

Cooperatives also offer access to technology and training, such as blockchain traceability programs in Denmark's bioenergy sector [36], and support women's access to microcredit in Fiji [32]. In Quang Binh, Vietnam, cooperative membership increased farmer income by approximately 10–15% on average, driven by better input coordination and collective marketing [34].

However, cooperative effectiveness varies by region. Vietnam benefits from strong institutional frameworks and centralized support, while in Sub-Saharan Africa, weak governance and low trust limit cooperative performance. In Denmark, high farmer participation and digital infrastructure contribute to long-term cooperative sustainability.

While cooperatives enhance bargaining power through collective action and certification support, challenges such as low participation and donor dependency persist. Solutions include building management capacity, diversifying services, and partnering with private actors to strengthen long-term sustainability and competitiveness. As depicted in Figure 10, cooperatives and farmer groups play a crucial role in strengthening the bargaining power of smallholder farmers.

Figure 10. Cooperatives and farmer groups in agricultural value chains [42]

How can the development of efficient logistics systems improve market accessibility for agricultural products?

Efficient logistics systems are critical for reducing post-harvest losses, lowering distribution costs, and expanding market access for smallholder farmers. In Vietnam, rural road infrastructure has accelerated delivery and improved export competitiveness [34]. In Denmark, the use of modern storage facilities has reduced biomass losses by an average of 18–20%, especially in high-moisture cash crops such as sugarcane and maize silage [36].

In Fiji, logistics digitalization has helped women farmers plan distribution and cut costs [32], while in South Africa, cooperatives have optimized logistics through bulk consolidation [33]. However, such improvements are more accessible for cash crops like cassava and coffee, which are export-oriented. For food crops like rice and corn, poor cold-chain integration and low private-sector engagement limit logistical upgrades.

Geographic context also influences logistics efficiency. Vietnam's centralized policy support contrasts with countries like Kenya or Uganda, where fragmented road systems and weak investment mechanisms slow progress. In Denmark, strong institutional planning enables automation and cold-chain integration at scale.

Efficient logistics systems such as automated storage, rural transport infrastructure, and digital platforms improve competitiveness and reduce loss. Yet high investment costs, limited rural infrastructure, and stakeholder fragmentation remain barriers. Overcoming these requires public-private partnerships, inclusive digital logistics programs, and targeted infrastructure investment, especially for remote and underserved regions. Figure 11 shows how efficient logistics systems improve market accessibility and reduce post-harvest losses.

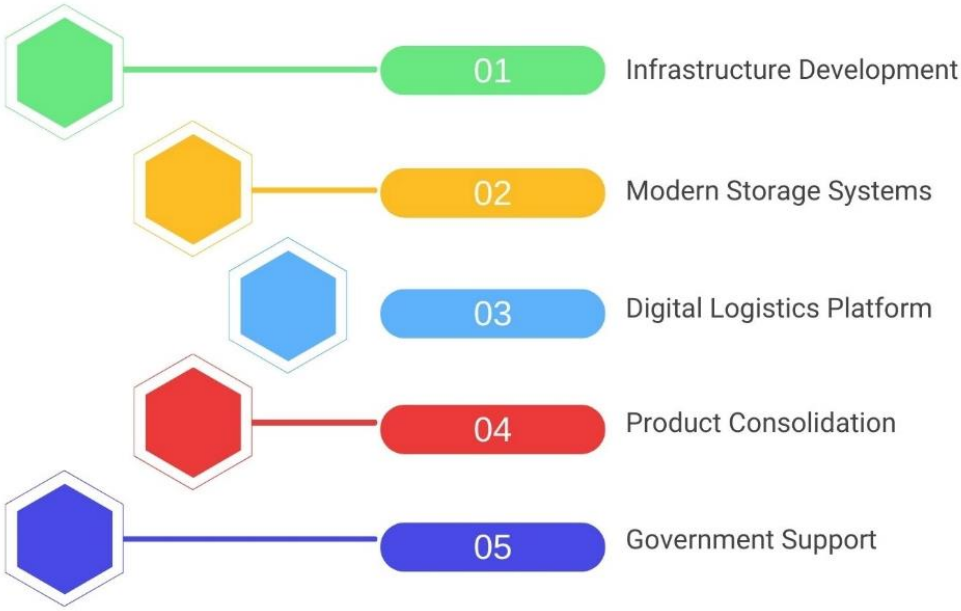

Figure 11. Development of logistics systems to improve market accessibility [43]

What is the impact of evidence-based policy interventions on reducing economic inequality in agricultural value chains?

Evidence-based policies are highly effective in addressing economic inequalities within agricultural value chains because they are grounded in data and rigorous analysis. In South Africa, government support for cooperatives has helped smallholder farmers secure better market prices [33]. In Vietnam, targeted subsidies have improved cassava productivity and competitiveness. Estimates suggest income gains between 12–18% for cooperative members compared to non-members, depending on access to market infrastructure and training [34].

In Denmark, investment in biomass storage has strengthened smallholders' position in the bioenergy sector [36]. In Fiji, gender-sensitive, data-driven policies have expanded market access for women farmers [32]. However, most policy interventions show greater success in cash crops such as cassava, sugarcane, and biomass due to higher commercial interest, while staple food crops like rice benefit less due to limited private-sector engagement and policy fragmentation.

Furthermore, the use of blockchain in Denmark has improved transparency and supported fairer income distribution [36]. But results vary by region. Vietnam has integrated data systems and strong coordination among stakeholders, whereas Sub-Saharan African countries struggle with fragmented implementation and weak monitoring. In Fiji, gender-based policies work well due to a strong NGO presence, but limited funding constrains scalability.

Evidence-based policies reduce inequality by strengthening cooperatives, providing subsidies, and improving infrastructure. Digital tools such as blockchain promote transparency, while gender-responsive policies help narrow income gaps. However, gaps in data, elite resistance, and inconsistent evaluation systems remain obstacles. These must be addressed through improved governance, real-time policy feedback, and cross-sectoral collaboration tailored to local contexts. Figure 12 presents key evidence-based interventions that help reduce economic inequality in agricultural value chains.

3.3 Discussion of agricultural value chain

The systematic literature review (SLR) shows that optimizing agricultural value chains (AVCs) in developing countries requires synergy between digital technology adoption, evidence-based policies, and multi-stakeholder collaboration. Digitalization enhances efficiency and transparency, though its impact depends on infrastructure quality and farmers' digital literacy.

Smallholder farmers still face major barriers limited access to information, capital, markets, and training. Strengthening cooperatives, improving logistics, and enabling public-private partnerships are key to enhancing bargaining power and product value.

The benefits of digital technologies differ by crop. Cash crops like cassava and sugarcane benefit more from blockchain and export platforms due to traceability and private-sector incentives, while food crops like rice and maize see smaller gains due to market and infrastructure constraints.

For instance, mobile apps in Vietnam increased cassava yields by 10–18%, averaging 15%, whereas rice improved only 7–10%. Similarly, in South Africa, IoT raised sugarcane yields by 18–23%, averaging 20%, depending on local readiness.

While targeted subsidies and gender-responsive policies have boosted inclusion, they must be backed by strong institutions and monitoring to be effective.

Geographic context also matters: Vietnam's centralized support enables scale, while fragmented systems in Sub-Saharan Africa and Indonesia's archipelagic diversity require localized strategies.

The development of sustainable agricultural supply chains must balance economic goals with environmental protection. Practices such as crop diversification, waste management, and integrated farming systems can enhance farmer income while supporting ecological resilience. Figure 13 synthesizes these interconnected strategies.

Agroecological and green supply chain approaches are emerging as essential paths forward. Therefore, building inclusive and adaptive value chains requires a holistic strategy integrating technological innovation, policy reform, farmer

education, and cross-sector collaboration. Figure 14 presents the publication trend of agricultural value chain studies over the years, highlighting the increasing scholarly attention on this topic.

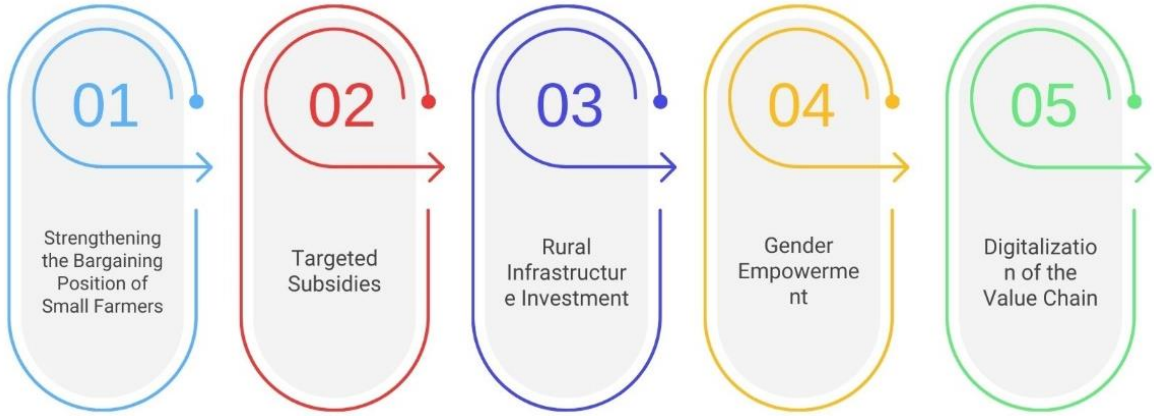

Figure 12. Evidence-based interventions for addressing economic inequality [44]

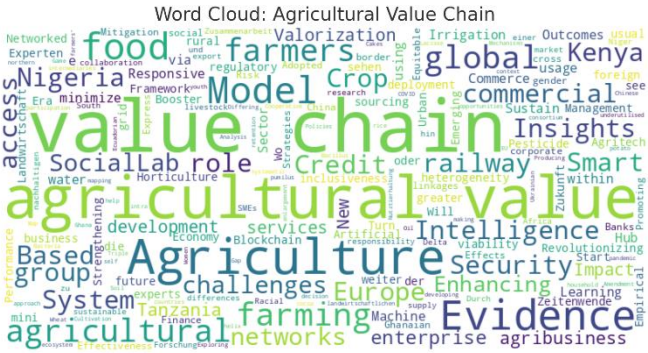

Figure 13. Word cloud agricultural value chain

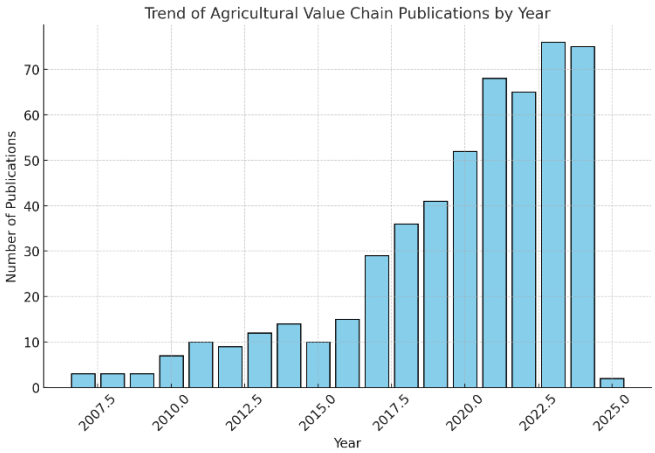

Figure 14. Trend of agricultural value chain publication by year

4. CONCLUSIONS

This study aims to explore the dynamics of agricultural value chains (AVCs) through a systematic literature review (SLR) of 189 SCOPUS-indexed publications, focusing on developing country contexts. By synthesizing ten research questions, the study presents a comprehensive view of how digitalization, inclusive policies, and partnerships can enhance efficiency, transparency, and participation within global AVCs.

The findings confirm that digital technologies such as blockchain, IoT, and mobile platforms significantly enhance smallholder empowerment. However, the impact varies by crop type; cash crops like cassava and sugarcane show greater gains than staple crops due to export market integration and private sector incentives.

Policy-driven interventions, including targeted subsidies and gender-sensitive programs, further reinforce inclusion but are effective only when matched with strong institutional frameworks and consistent monitoring.

This study acknowledges limitations, including a small number of final articles (n = 6), regional concentration in Asia and Sub-Saharan Africa, and lack of empirical field validation. Thus, findings should be interpreted with caution and further verified through longitudinal or mixed-method studies.

The results provide actionable recommendations for institutions and policymakers, particularly in Indonesia and Southeast Asia, regarding digital infrastructure investments, multi-stakeholder governance, and localized policy design that bridges food security with equitable market access.

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