

DIGITAL HUMAN CAPITAL IN THE DEVELOPMENT OF AGRICULTURAL COOPERATIVES: A LITERATURE REVIEW AND IMPLICATIONS FOR VIETNAM

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ABSTRACT

This research reviews the role of digital human capital in the development of agricultural cooperatives and proposes implications for Vietnam. By synthesizing existing literature, it highlights the contributions of digital skills and competencies to improving efficiency, governance, innovation, and market integration, while identifying key barriers such as limited digital literacy, infrastructure gaps, and financial constraints. Based on these findings and Vietnam's current context, the study suggests policy directions to strengthen digital human capital as a core driver of cooperative modernization and sustainable development in the digital era.

Keywords: Digital human capital, agricultural cooperatives, digital transformation, Vietnam, rural development.

1. INTRODUCTION

The cooperative movement originated in the late 18th century as a response to the socio-economic challenges of industrialization, when workers organized collective structures to meet their economic and social needs [1]. The modern cooperative model is often traced to the Rochdale Society established in England in 1844, whose foundational principles continue to guide cooperative development worldwide. Over time, cooperatives expanded across Europe and evolved into diverse forms, including agricultural cooperatives, which play a crucial role in supporting farmers' livelihoods, enhancing market access, and promoting rural development.

In recent decades, the agricultural sector has entered a new phase characterized by rapid technological advancement and digital transformation. The integration of digital technologies—such as artificial intelligence, the Internet of Things (IoT), big data, and automation—is fundamentally reshaping agricultural production systems, governance models, and value chains. These changes not only create new opportunities for improving productivity, sustainability, and competitiveness but also impose new requirements on the skills and capabilities of the workforce.

In this context, digital human capital has emerged as a critical factor underpinning the success of digital transformation. It encompasses the digital skills, knowledge, and competencies that enable individuals and organizations to effectively adopt and utilize digital technologies [2, 3]. A growing body of literature highlights its role in enhancing operational efficiency, innovation, governance, and network development within agricultural cooperatives. Digitalisation offers important opportunities to improve governance, operational efficiency, and market access [4]. Empirical evidence indicates that the development of digital competencies is

positively associated with innovation and productivity. By investing in digital human capital, cooperatives can strengthen their adaptability and competitiveness, thereby fostering sustainable growth [2].

However, despite its recognized importance, the development of digital human capital in agricultural cooperatives remains constrained by multiple barriers. These include disparities in digital literacy, limited access to digital infrastructure, high investment costs, and organizational and cultural resistance to change. Such challenges are particularly pronounced in developing countries, where structural limitations and resource constraints hinder the effective adoption of digital technologies. Moreover, existing studies tend to focus primarily on technological adoption or institutional factors, while the role of digital human capital-especially in the context of agricultural cooperatives-remains relatively underexplored.

Building on this foundation, the present study undertakes a systematic review of prior research on digital human capital and agricultural cooperatives. By synthesizing theoretical and empirical findings, it clarifies the key contributions and challenges associated with digital human capital in cooperative development. Drawing from these insights, the study proposes policy implications tailored to Vietnam, aiming to strengthen digital human capital as a central pillar for effective and inclusive digital transformation in the cooperative sector.

This study contributes to the literature in three main ways. First, it systematizes the concept of digital human capital in the context of agricultural cooperatives by identifying five core dimensions. Second, it synthesizes emerging evidence on the relationship between digital competencies and cooperative performance in the digital economy. Third, it provides context-specific policy implications for Vietnam, where agricultural cooperatives are undergoing simultaneous digital and green transformation.

2. LITERATURE REVIEW

2.1. Research methodology

This study employs a systematic literature review approach to synthesize existing research on digital human capital and agricultural cooperatives. Relevant studies were collected from major academic databases, including Scopus, Web of Science, ScienceDirect, and Google Scholar, with a focus on publications from 2020-2026, a period characterized by the rapid expansion of digital transformation across the agricultural sector and the broader economy.

To ensure comprehensive coverage, the original research question was expanded into several specific search queries related to digital human capital in agricultural cooperatives. The search process employed keywords such as “digital human capital”, “digital skills”, “agricultural cooperatives”, “digital transformation in agriculture”, “cooperative governance”, and “inclusive development” across different regional contexts. Based on the established inclusion and exclusion criteria, 173 initial studies were identified.

The review process further applied backward and forward citation chaining to identify foundational studies and recent developments in the field, resulting in an additional 96 papers. After removing duplicates and screening for relevance, 263 studies were considered relevant to the research topic, of which 50 highly relevant papers formed the core analytical basis of the study.

The selected literature includes both conceptual and empirical studies related to digital transformation, cooperative governance, digital skills, and rural development. Studies focusing solely on technical engineering aspects without implications for human capital or cooperative development were excluded. This approach helped ensure the comprehensiveness, reliability, and scientific rigor of the review process.

2.2. Literature review

2.2.1. Digital Human Capital

Conceptually, digital human capital encompasses the digital skills, competencies, and knowledge embedded within cooperative members and management, which interact with digital infrastructure and organizational processes to enhance capacity and performance [3]. It refers to the integration of digital competencies, technologies, and skills into the broader concept of human capital, which traditionally encompasses the knowledge, abilities, and expertise of individuals acquired through education and experience. In the digital age, this concept has evolved to emphasize the role of digital skills and technologies in enhancing workforce capabilities, organizational performance, and economic growth. Digital human capital plays a critical role in enhancing labor productivity and competitiveness in the digital economy [5, 6].

The literature identifies several key components that collectively shape digital human capital. Based on the reviewed literature, this study classifies digital human capital into two interrelated dimensions: (1) individual digital competencies and (2) enabling support factors that facilitate the development and application of such competencies within agricultural cooperatives.

At the individual level, *knowledge and skills* constitute the foundational element. This includes both technical competencies-such as the ability to work with artificial intelligence, big data, and automation-and non-technical skills, including adaptability, problem-solving, and a commitment to continuous learning [7-9]. In the context of rapid technological change, lifelong learning becomes essential, requiring individuals to continuously upgrade their capabilities through retraining and advanced education aligned with evolving digital environments [8, 10].

Digital literacy is another essential component. Digital literacy plays a critical role in enabling individuals to effectively utilise digital tools and platforms [10, 11]. This involves not only basic proficiency but also the ability to apply advanced technologies, such as cloud computing, HR analytics, and virtual systems, in professional contexts [11]. At the same time, addressing disparities in digital literacy is necessary to ensure inclusive participation and to reduce the digital divide [8, 10].

In addition, the *integration of technology* reflects the capacity of cooperative members and managers to interact with and effectively use digital systems in agricultural and organizational activities. This includes the practical application of technologies such as artificial intelligence, the Internet of Things (IoT), and digital management systems to improve operational efficiency, decision-making, and productivity [12]. In organisational settings, the adoption of digital human resource practices-such as e-recruitment, HR analytics, and AI-based management systems-further enhances workforce efficiency and performance [13, 14].

At the supporting ecosystem level, *education and training systems* are central to the development of digital human capital. Both formal education and informal learning mechanisms contribute to building digital competencies and must evolve to incorporate innovative teaching methods and digital content [14, 15]. Furthermore, customised training programs tailored to specific industry needs, including the use of advanced tools such as artificial intelligence and digital simulations, are increasingly important [15].

Finally, *social and relational capital* represents a complementary dimension of digital human capital. Collaborative networks, knowledge-sharing mechanisms, and external linkages facilitate learning, innovation, and adaptability [16, 17]. Moreover, cultural and intellectual capital support creativity and the effective utilisation of digital technologies, thereby strengthening overall organisational and sectoral performance [17].

2.2.2. Agricultural cooperatives

Cooperative are defined as “an autonomous association of persons united voluntarily to meet their common economic, social and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise” (Recommendation No. 193). This definition is derived from the internationally agreed statement on cooperative identity, which was adopted in 1995 by the International Cooperative Alliance (ICA).

According to ICA, cooperatives are founded on core values such as self-help, self-responsibility, democracy, equality, equity, and solidarity. In line with the principles established by their founders, cooperative members also uphold ethical values including honesty, transparency, social responsibility, and concern for others.

Cooperative principles provide guidelines for translating cooperative values into practice. These include: (1) voluntary and open membership without discrimination; (2) democratic member control based on equal voting rights; (3) equitable member economic participation and shared benefits; (4) autonomy and independence in decision-making; (5) education, training, and information dissemination; (6) cooperation among cooperatives; and (7) commitment to sustainable community development.

Cooperatives are diverse organizations that serve various economic, social, and community needs, such as agricultural cooperatives, financial cooperatives, worker cooperatives, consumer cooperatives, social solidarity cooperatives. Agricultural cooperatives are one of the most common forms. Agricultural cooperatives play a key role in enhancing farmers’ productivity and income by facilitating access to financial resources, agricultural inputs, technologies, and markets [18-20]. In addition, they support the marketing of agricultural products and contribute to broader rural development [20].

Agricultural cooperatives face several challenges and limitations that affect their performance and sustainability. A key concern is declining member commitment, often reflected in low levels of participation loyalty, and identification with the cooperative [21]. In addition, structural and financial constraints, such as limited access to capital, inadequate integration, and insufficient training and education-poses significant barriers, particularly in developing contexts [22]. Governance-related issues, including lack of trust in leadership, weak institutional structures, and inequitable distribution of benefits, further undermine member satisfaction and organisational effectiveness [23, 24]. Moreover, cooperatives frequently struggle to balance their foundational principles with the pressures of competitive market economies, which may lead to reduced autonomy or increasing dependence on dominant agri-food systems [25].

2.2.3. Digital transformation in agriculture

Digital transformation in agriculture, often referred to as "Digital Agriculture" or "Agriculture 4.0," involves integrating advanced technologies to enhance productivity, sustainability, and efficiency in farming practices.

The digital transformation of agriculture is driven by the adoption of several key technologies that enhance productivity, efficiency, and sustainability. Among these, the Internet of Things (IoT) enables real-time monitoring of crop health, soil conditions, and weather patterns, thereby supporting precision agriculture and more informed decision-making [26-28]. In parallel, artificial intelligence (AI) and machine learning are increasingly applied for predictive analytics, pest detection, and the optimisation of resource use, allowing farmers and cooperatives to improve both productivity and risk management [26, 28, 29].

In addition, big data and cloud computing play a crucial role in processing and analysing large volumes of agricultural data, facilitating yield forecasting, resource allocation, and climate adaptation strategies [28, 30, 31]. Blockchain technology further contributes to

enhancing supply chain transparency, traceability, and trust, particularly in the context of food safety and fair-trade practices [31]. Meanwhile, robotics and automation improve operational efficiency by enabling the use of automated machinery and precision-based interventions, such as targeted pesticide application [26, 27]. Together, these technologies form the foundation for a more data-driven, efficient, and sustainable agricultural system.

Digital transformation brings significant benefits to the agricultural sector across multiple dimensions. It enhances productivity through precision farming and data-driven decision-making, enabling more efficient use of resources and higher yields [26, 27]. At the same time, digital technologies support sustainability by reducing waste, minimizing environmental impacts, and promoting greener agricultural practices [31, 32]. From an economic perspective, digital tools improve supply chain efficiency and facilitate access to new markets, particularly in developing countries [26, 33]. Furthermore, digital solutions strengthen climate resilience by optimizing the use of inputs such as water and fertilizers, thereby contributing to the reduction of greenhouse gas emissions [31].

Despite its potential benefits, the digital transformation of agriculture faces several significant challenges and barriers. A major constraint is the digital divide, as limited digital literacy and inadequate infrastructure-particularly in rural and developing regions-restrict the adoption of new technologies [27]. High upfront investment costs also pose a substantial obstacle, especially for small-scale farmers [31]. In addition, interoperability issues, such as fragmented data systems and the lack of standardized frameworks, hinder the effective integration of digital solutions[34]. Furthermore, resistance to change, driven by cultural factors, organisational inertia, and outdated training programs, continues to slow the pace of digital transition in the agricultural sector [35].

2.3. Empirical Research on Digital Human Capital and Cooperatives

2.3.1. Key Contributions of Digital Human Capital in Enhancing Agricultural Cooperatives

2.3.1.1 Improved Resource Allocation and Efficiency

Digital human capital plays a crucial role in enhancing resource allocation and operational efficiency within agricultural cooperatives. The transformation of human capital in agriculture involves the continuous upgrading of skills, the adoption of modern management approaches, and the integration of advanced digital technologies such as artificial intelligence and machine learning. Most studies emphasize the critical importance of digital literacy and competency among cooperative members and management for successful digital transformation and performance improvement [36, 37]. The benefits of digital technologies largely depend on the competencies of cooperative members and managers, including their ability to operate digital systems, interpret data, and integrate digital tools into production and governance activities [3]. This process enables the workforce to remain competitive and adaptable in the face of rapid technological and structural changes within the agricultural sector [38]. Digital skills also enable farmers to adopt climate-adaptive behaviors, such as technology-based and capital-based solutions, which are critical for resilience in the face of climate change [39].

The adoption of digital tools enables more precise planning, monitoring, and coordination of production activities, thereby supporting high-quality development and fostering technological innovation [40]. In particular, cooperative members equipped with digital skills are better able to adopt and manage technologies such as IoT, AI, and automation systems, thereby improving productivity, coordination, and sustainability [41]. However, the effectiveness of these technologies largely depends on the ability of human capital to adapt through continuous skill development and retraining, ensuring that workers can effectively utilize and manage digital systems [9].

2.3.1.2. Strengthened Cooperative Networks

Digital human capital contributes significantly to the strengthening of cooperative networks by enabling more effective use of digital platforms for collaboration and coordination. Digital competencies enable cooperative members to effectively participate in digital platforms, online learning networks, and e-commerce systems, thereby strengthening collaboration, information sharing, and market connectivity [42, 43]. In addition, they support the expansion of e-commerce, digital agribusiness models, and knowledge-sharing practices among members [42]. The ability to utilize digital tools for communication, traceability, and market coordination enhances supply chain management and strengthens cooperative networks [44].

Digital human capital also plays a significant role in increasing farmers' willingness to adopt green production practices, particularly through informal online learning and the use of social networks [45]. These channels facilitate knowledge dissemination, experience sharing, and awareness of sustainable practices. The impact is especially pronounced among small-scale and middle-aged farmers, who benefit from more accessible and flexible forms of digital learning [45].

Moreover, social networks and digital tools act as important mediating mechanisms between human capital and cooperative performance [46]. By enhancing communication, transparency, and information exchange, these tools help build trust and foster deeper collaboration among stakeholders, thereby improving overall organisational effectiveness [46]. Consensus exists that digital human capital and technological integration improve operational efficiency, financial performance, and member satisfaction in agricultural cooperatives [36].

2.3.1.3. Enhanced Governance and Decision-Making

Digital human capital strengthens governance capacity by enabling cooperative leaders and managers to utilize digital information, data analytics, and management platforms in decision-making processes [47]. The recruitment of managers with digital expertise enables more effective use of data and digital tools to implement standardized production practices, strengthen farmland quality management, and support long-term strategic planning [47]. Cooperatives with digitally capable managers are more likely to successfully adopt technologies such as CRM systems and digital logistics platforms, leading to improved operational efficiency and organizational performance [48, 49]. These technologies enable more effective customer management, streamline supply chain processes, and support data-driven decision-making, thereby enhancing overall organisational performance.

Furthermore, digital transformation promotes more participatory and inclusive governance models by facilitating information transparency and stakeholder engagement. This is particularly evident in cooperatives that aim to empower marginalized groups, such as women, where digital tools help expand leadership opportunities and enhance their involvement in decision-making processes [23].

The impacts of digitalisation on agricultural cooperatives are not uniform but vary significantly across regions and sectors [40]. Empirical evidence suggests that cooperatives in less-developed regions, such as western China, tend to benefit more from digitalisation initiatives, largely due to targeted government support and policy interventions [40].

However, smaller farms and cooperatives often face substantial barriers in adopting digital technologies, including high investment costs, limited access to digital infrastructure, and insufficient technical capabilities [50]. These challenges highlight the need for context-specific financial mechanisms and technical support programs to ensure more inclusive and effective digital transformation across the agricultural sector.

Overall, the literature suggests that digital technologies alone do not guarantee improved cooperative performance. Their effectiveness largely depends on the availability of digital human capital, including the skills, adaptability, and managerial capabilities required to integrate technologies into cooperative operations and governance.

2.3.2. Barriers and Challenges to Developing Digital Human Capital in Agricultural Cooperatives

Despite its significant potential to improve productivity, governance, and sustainability, the development and integration of digital human capital in agricultural cooperatives face numerous barriers. These challenges are complex and interrelated, arising from structural inequalities, technological limitations, and capacity gaps within the cooperative sector. In particular, disparities in access to resources, infrastructure, and skills continue to constrain the effective adoption of digital technologies. Accordingly, these barriers can be broadly categorized into four key dimensions: socio-economic, technological, educational and skill-related, and organizational and cultural factors.

2.3.2.1. Socio-Economic Barriers

Digital transformation in agriculture is significantly constrained by a range of socio-economic challenges. Demographic issues, including rural out-migration, an aging workforce, and limited participation of younger generations, reduce the availability of human capital capable of adopting digital innovations [51]. At the same time, high investment and maintenance costs of digital technologies, combined with limited access to financial resources, pose substantial barriers, particularly for small and medium-sized cooperatives [52-55]. Additionally, restricted market access and regulatory constraints further complicate the adoption and scaling of digital solutions, thereby exacerbating existing inequalities within the agricultural sector [55].

2.3.2.2. Technological Barriers

The adoption of digital technologies in agriculture is further constrained by significant technological barriers. A persistent digital divide exists between large and small agricultural cooperatives, reflected in unequal access to digital infrastructure and advanced technologies [56]. In many regions, inadequate broadband connectivity limits access to digital training, online learning, and the practical application of digital skills among cooperative members [52, 56]. Additionally, the complexity of technologies, coupled with the lack of user-friendly interfaces and local language support, reduces usability and adoption rates [56]. Concerns related to data security, system reliability, and rapid technological obsolescence also contribute to resistance among users [57]. Moreover, high entry barriers to advanced tools such as artificial intelligence and digital platforms continue to restrict their accessibility, particularly for small-scale cooperatives [53, 57].

2.3.2.3. Educational and Skill Barriers

Educational and skill-related limitations remain a critical obstacle to digital transformation in agriculture cooperatives. Some studies highlight persistent low levels of digital literacy, especially in rural and small-scale cooperatives, posing barriers to adoption and performance gains [58]. Low levels of digital literacy among farmers and cooperative members significantly restrict their ability to effectively adopt and utilize digital technologies [52]. Moreover, persistent inequalities in digital human capital further exacerbate disparities in cooperative performance, as organisations with lower levels of digital capability are less able to benefit from technological advancements [59]. This digital divide poses a major challenge to achieving inclusive and sustainable development within the cooperative sector.

This challenge is further exacerbated by the lack of updated training programs and educational curricula that address the digital competencies required in modern agricultural practices [60]. Training programs and education systems need to be modernized to address these gaps [38, 61]. Tailored strategies are required to address the diverse needs of different farmer groups, particularly smallholders and those with lower levels of education, in order to ensure equitable access to digital tools and training opportunities [39, 62]. Such inclusivity not only promotes social equity but also strengthens the overall resilience and long-term development of rural economies [3].

2.3.2.4. Organizational and Cultural Barriers

Organizational and cultural factors present significant challenges to digital transformation in agricultural cooperatives. The transition requires fostering an innovation-oriented culture that encourages adaptability and continuous improvement [55]. Cultural resistance to change and a continued preference for traditional farming methods hinder the acceptance of new technologies, underscoring the need for both capacity-building initiatives and a shift in mindset [54, 55]. However, resistance to change remains prevalent among farmers and cooperative members, particularly due to risk perceptions and a strong preference for traditional farming practices [52].

In addition, concerns regarding data privacy, security, and trust in digital systems further hinder technology adoption [55]. The complexity of cooperative governance structures, characterized by diverse membership and participatory decision-making, also makes institutional restructuring more difficult [51]. Moreover, unequal access to digital resources contributes to disparities between cooperatives of different sizes and regions, limiting the overall effectiveness of digital transformation efforts [53].

2.3.3. *Policy recommendations to strengthen digital human capital in agricultural cooperative development*

The following policy recommendations are synthesized from previous studies and empirical findings on digital transformation in agriculture. They highlight key measures to strengthen digital human capital, address existing barriers, and support the effective and inclusive development of agricultural cooperatives in the digital era.

2.3.3.1. Enhancing Digital Literacy and Competencies through Targeted Training

Improving digital human capital must begin with strengthening the digital proficiency of farmers and cooperative staff. This requires developing targeted training programs and updated educational curricula that promote continuous learning through online and informal platforms [60]. Special attention should be given to vulnerable groups, such as smallholders and middle-aged farmers, who often face greater barriers to digital adoption.

At the same time, addressing digital inequalities is essential to ensure inclusive transformation. Raising awareness of digital technologies through farmer groups, extension services, and field schools can enhance understanding and encourage adoption [63]. In addition, targeted policy support for small and medium-sized agricultural enterprises—such as digital capital incentives and financial assistance—can help reduce entry barriers and promote more equitable access to digital tools [59]. Collectively, policy support should raise awareness through extension services and field schools, encouraging members to move beyond basic digital use toward advanced "digital practice" in their daily agricultural operations.

2.3.3.2. Building Infrastructure to Facilitate Remote Learning and Digital Practice

Limited internet access and the high cost of digital technologies remain major barriers to adoption, particularly for smallholder farmers and agricultural cooperatives [50]. Expanding digital infrastructure in rural areas should aim to facilitate remote learning, providing

cooperative members with access to virtual training and digital knowledge repositories. That helps enabling access to digital tools and platforms that support production, market access, and cooperative management [50, 58]. In parallel, the development of affordable and user-friendly technologies is essential to ensure usability for farmers with lower levels of ICT literacy [63]. Furthermore, establishing centralized digital platforms can streamline access to resources, training, and market information, thereby enhancing operational efficiency and decision-making within cooperatives [64]. Ensuring interoperability across platforms, regions, and systems is equally important to promote wider adoption, facilitate data sharing, and strengthen collaboration [65]. Initiatives such as “smart villages” can further support the creation of inclusive digital ecosystems by integrating infrastructure, digital services, and community engagement, contributing to the sustainable transformation of agricultural cooperatives.

2.3.3.3. Strengthening Policy and Financial Support Mechanisms

Effective policy frameworks and financial incentives are critical to accelerating digital human capital. Governments should provide targeted subsidies and incentives to reduce the cost burden of digital adoption, particularly for small and medium-sized cooperatives [46]. Such targeted support not only lowers financial barriers but also enables cooperatives to invest in retraining programs and continuous digital education, thereby directly strengthening the skills and competencies of their members.

Policies like India's National Cooperative Policy 2025 emphasize digitization, transparency, and member participation, which are crucial for modernizing cooperatives and enhancing their competitiveness [66]. By embedding member participation into digitization strategies, these policies foster collective learning processes that enhance digital human capital within cooperative structures. At the same time, financial institutions should also develop tailored financial products for cooperatives to support digital investments [46]. These products can be explicitly designed to subsidize the recruitment of digital-savvy managers or professionals with expertise in data management and digital marketing, thereby bridging internal skill gaps.

Encouraging cooperatives to participate in equity-based digital investments can improve product quality and market demand, though care must be taken to balance benefits between cooperatives and governments [67]. Such investments also create opportunities for members to acquire advanced digital competencies through exposure to new technologies and market practices. Establishing clear regulatory frameworks, especially in data protection and digital services, is also necessary to build trust and facilitate private sector participation [46].

2.3.3.4. Fostering Collaborative Ecosystems

Strengthening collaboration among key stakeholders is essential to accelerate digital transformation in agricultural cooperatives. Collaborative structures enhance digital human capital by embedding collective learning processes into cooperative governance, allowing knowledge and skills to diffuse more rapidly among members. Public–private partnerships between governments, technology providers, and cooperatives can facilitate the development and delivery of high-quality digital services, supported by appropriate subsidies and regulatory frameworks [46, 60]. In addition, adopting a penta-helix approach-linking government, educational institutions, the private sector, and farmer communities can create a more dynamic and supportive innovation ecosystem by combining resources, knowledge, and technical expertise [60]. Leveraging farmer networks and cooperative membership structures further enhances knowledge sharing, trust, and collective learning, which are critical for digital adoption [39]. Moreover, promoting international collaboration can enable the exchange of

best practices and technological innovations, thereby strengthening the global competitiveness and sustainability of agricultural cooperatives [65, 68].

2.3.3.4. Ensuring Continuous Evaluation and Inclusive Development

Finally, systematic evaluation ensures that human capital development remains central, enabling policies to adapt to the evolving skill requirements of cooperative members and to address gaps in digital competencies. Regular assessment of digital transformation policies and their impacts on cooperatives is essential to maintain their effectiveness [64]. This can be achieved by establishing systematic feedback channels, including workshops, webinars, and advisory services, which enable stakeholders to share insights and support timely policy adjustments [64]. Besides, digital transformation policies should be designed with flexibility to reflect regional conditions and sector-specific characteristics [50]. Tailored interventions are needed to address particular challenges, such as technological complexity in vegetable production or labor shortages in livestock farming, thereby enhancing the relevance and practical applicability of policies [50].

3. IMPLICATIONS FOR VIETNAM

3.1. Current Context of Agricultural Cooperatives in Vietnam

In recent years, agricultural cooperatives in Vietnam have undergone significant transformations, moving beyond traditional collective models to become a vital backbone of the rural economy. The current context of agricultural cooperatives in Vietnam is characterized by rapid growth in numbers, a fundamental shift in legal frameworks, and an increasing emphasis on digital and green transformation.

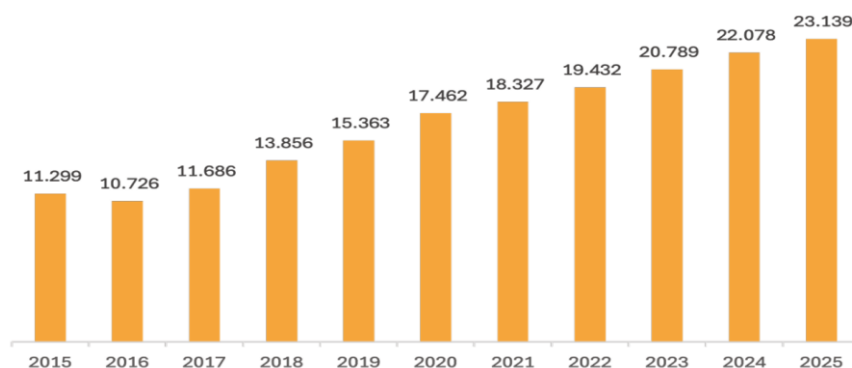


Figure 1. Number of agricultural cooperatives in Vietnam during the period 2015-2025
Source: Vietnam Cooperatives Overview Report 2025 (Ministry of Agriculture and Environment)

Figure 1 illustrates the steady growth in the number of agricultural cooperatives in Vietnam over the period 2015–2025. The total number increased significantly from 10,299 cooperatives in 2015 to 23,129 in 2025, nearly doubling within a decade. Although a slight decline was observed in 2016, the overall trend from 2017 onward shows consistent and robust expansion. Notably, the period from 2018 to 2020 recorded a rapid increase, followed by continued but more stable growth in subsequent years. This upward trend reflects the increasing importance of agricultural cooperatives in Vietnam’s rural economy, supported by policy initiatives and institutional reforms aimed at strengthening the cooperative sector.

Based on the Vietnam Cooperatives Overview Report 2025, on average, an agricultural cooperative in 2025 generates a revenue of 2.7 billion VND and a profit of 450 million VND per year. Geographically, the Red River Delta maintains the highest density with 10

agricultural cooperatives per commune, while the Mekong Delta and Central Highlands are emerging as hubs for specialized large-scale raw material areas.

Regarding legal and governance frameworks, the sector is currently navigating a major institutional milestone with the implementation of the Law on Cooperatives 2023 (effective from July 1, 2024). This law is considered a "revolution in thinking," positioning cooperatives as co-owned organizations and removing long-standing bottlenecks in capital access, land, and internal transactions. Furthermore, the transition to a two-level local government model (Province and Commune) since July 2025 has redefined the administrative environment, requiring agricultural cooperatives to interact more directly and digitally with provincial authorities for certifications and support policies.

Integration into Global Value Chains and the "Green" Mandate Agricultural cooperatives have become the "nucleus" for linking smallholder farmers to global markets. By 2025, agricultural cooperatives played a decisive role in Vietnam's record-breaking agricultural export turnover of over 70 billion USD. Agricultural cooperatives are now leading the way in standardizing cultivation processes, securing thousands of growing area codes, and adopting sustainable practices to meet strict international standards like EUDR (EU Deforestation Regulation). Notable examples include the development of 1 million hectares of high-quality, low-emission rice in the Mekong Delta and certified sustainable coffee regions in the Central Highlands.

The Digital Transformation and Human Capital Imperative Digital transformation is no longer a choice but a survival requirement for Vietnamese agricultural cooperatives. Currently, approximately 3,000 agricultural cooperatives apply high technology in production. Data from 2025 shows a significant uptake of digital tools: 79% of Agricultural cooperatives use accounting software, 80% utilize digital signatures, and 35% sell products via e-commerce platforms. The application of advanced technologies such as drones for seeding and spraying, as well as IoT sensors for precision water management, is becoming more common in model cooperatives in An Giang and Dong Thap.

However, this technological shift has exposed a critical gap in digital human capital. Among the 78,467 agricultural cooperatives management staff nationwide, only 18% hold college or university degrees, while 37% have only elementary or intermediate training. The new context demands a shift from "production-based thinking" to "digital-economic thinking," requiring AC leaders to not only possess agricultural expertise but also the capacity to manage data, operate digital platforms, and navigate global supply chain transparency.

In sum, the current context of Vietnamese agricultural cooperatives is one of "New Space -New Stature". While agricultural cooperatives have successfully established their presence and standardized many production processes, the next phase of development heavily depends on professionalizing their human resources to master digital and green technologies, ensuring a sustainable and prosperous future for Vietnam's agriculture.

3.2. Policy and Practical Implications for Vietnam

Based on the current context of agricultural cooperatives in Vietnam and the emerging role of digital human capital, several policy and practical implications can be proposed to enhance their effectiveness, competitiveness, and long-term sustainability in the digital era.

First, it is essential to strengthen institutional support and ensure policy consistency for cooperative development, particularly in facilitating digital transformation. While various supportive policies have been introduced, their implementation remains uneven across localities. The government should further operationalize the 2023 Cooperative Law by developing specific guidelines that enable cooperatives to access digital resources. In particular, policies should prioritize financial incentives for "digital capital," including subsidies or preferential credit schemes to reduce initial investment costs in technology for

small and medium-sized cooperatives. Additionally, in the context of administrative restructuring, it is important to maintain policy continuity to avoid disruptions in the digitalization process. Such institutional and financial support should be explicitly tied to human capital development, ensuring that cooperatives can invest in training programs and skill upgrading alongside technology adoption.

Second, enhancing managerial capacity and promoting the development of digital human capital is a critical priority. Digital transformation requires not only technical skills but also adaptive thinking and strategic vision. Therefore, Vietnam should implement targeted training programs focusing on “digital farmers” and modern cooperative management. These programs should aim to improve the qualifications of cooperative leaders—who currently have relatively low levels of formal education—so that they can effectively utilize digital tools such as e-commerce platforms, digital signatures, and accounting software. At the same time, initiatives such as the “Young Smart Farmers” model should be promoted to attract educated youth to rural areas, while flexible and informal learning channels (e.g., social networks, peer learning within cooperative networks) should be leveraged to support older farmers. By directly addressing the low degree-holding rate among cooperative leaders, these programs strengthen digital human capital where gaps are most evident.

Third, professionalizing cooperative governance is necessary to overcome existing managerial limitations. Cooperatives should take advantage of the provisions in the 2023 Cooperative Law that allow for hiring external professional managers (CEOs). This approach helps separate ownership from management, thereby introducing market-oriented thinking, data-driven decision-making, and more transparent financial practices. Embedding digital tools into governance processes ensures that digital human capital is operationalized in daily management, from financial reporting to production monitoring.

Fourth, strengthening market linkages and value chain integration remains a key policy direction. Agricultural cooperatives in Vietnam continue to face challenges in accessing stable markets and building sustainable partnerships with enterprises. Policies should encourage cooperative–enterprise collaboration, contract farming, and participation in integrated value chains. At the same time, supporting cooperatives in branding, certification (e.g., VietGAP, organic standards), and digital marketing through e-commerce platforms will enhance product differentiation and market access. These activities also build digital competencies among cooperative members, who gain practical skills in online marketing, certification systems, and digital branding.

Fifth, promoting technological adoption and developing a shared digital ecosystem are crucial for scaling up digital transformation. Rather than leaving cooperatives to adopt technologies independently, the government and relevant organizations should invest in building shared digital platforms tailored for agricultural cooperatives. These platforms should integrate national databases on agriculture, land, and population, enabling functions such as traceability (QR codes), production area identification, and compliance with international standards (e.g., EUDR). Expanding broadband infrastructure in rural and remote areas is also a prerequisite to bridging the digital divide and ensuring inclusive access to digital technologies. Shared platforms should be designed as collective learning environments, enabling members to strengthen their digital skills through everyday use.

Sixth, improving financial capacity remains fundamental to cooperative sustainability. Many cooperatives still face constraints in accessing formal credit due to limited collateral and weak financial transparency. Expanding cooperative support funds, developing tailored financial products, and strengthening partnerships with financial institutions can help address these challenges, particularly in financing digital investments. Financial products should be

linked to human capital development, for example by subsidizing digital training costs or incentivizing the recruitment of skilled digital managers.

Seventh, fostering multi-stakeholder collaboration through a “penta-helix” model is essential to building an inclusive innovation ecosystem. Stronger linkages among government, academia, enterprises, cooperatives, and the community will facilitate technology transfer (e.g., drones, IoT applications, smart irrigation) and support the transition from traditional production to a more sustainable and market-oriented agricultural economy. Within this ecosystem, cooperatives act as hubs of collective learning, accelerating the diffusion of digital knowledge and strengthening digital human capital.

Eighth, another critical issue is data security and privacy protection during the digital transformation process. As agricultural cooperatives increasingly rely on digital platforms, e-commerce systems, and data-sharing mechanisms, risks related to cyberattacks, data leakage, and misuse of farmer information may become more significant. Therefore, Vietnam should develop clear guidelines and legal frameworks regarding data governance, cybersecurity standards, and digital ethics in agricultural cooperatives. In addition, cooperative members and managers should receive basic training on digital security awareness and data protection practices to strengthen trust in digital systems. Such training directly enhances digital human capital by equipping members with essential competencies to operate safely and confidently in digital environments.

Finally, from a practical perspective, cooperative leaders need to adopt a more market-oriented and innovation-driven mindset. This includes shifting from production-focused to demand-driven approaches, investing in quality improvement and product differentiation, and proactively engaging in partnerships. Internal governance should also be strengthened to ensure transparency, member participation, and equitable benefit sharing-key factors for sustaining trust and long-term cooperation.

Policy interventions should also be differentiated across agricultural sub-sectors. For example, vegetable cooperatives may prioritize cold-chain logistics, traceability systems, and preservation technologies to reduce post-harvest losses and meet export standards. In contrast, livestock cooperatives require greater investment in disease monitoring systems, digital veterinary management, and environmental monitoring technologies to improve biosecurity and production sustainability. Such differentiated strategies would enhance the practical effectiveness of digital transformation policies in Vietnam’s diverse agricultural context.

In conclusion, advancing agricultural cooperatives in Vietnam requires an integrated approach that combines policy refinement, digital human capital development, governance reform, technological innovation, and ecosystem building. The success of this transformation ultimately depends not only on top-down policy support but also on the willingness and capacity of cooperative members to embrace change and continuously enhance their capabilities in the digital age.

4. CONCLUSION

This study provides a comprehensive synthesis of the existing literature on digital human capital and its role in the development of agricultural cooperatives, with particular implications for Vietnam. The findings confirm that digital human capital-encompassing digital skills, knowledge, and adaptive capabilities-has become a decisive factor in enabling cooperatives to improve operational efficiency, strengthen governance, enhance market integration, and foster innovation in the context of digital transformation.

The review also reveals that, despite its significant potential, the development of digital human capital in agricultural cooperatives is constrained by multiple interrelated barriers,

including socio-economic limitations, inadequate digital infrastructure, low levels of digital literacy, and organizational resistance to change. These challenges are especially pronounced in developing countries such as Vietnam, where disparities in resources and capabilities persist across regions and cooperative types.

From a policy perspective, the study highlights the importance of adopting a holistic and inclusive approach to digital transformation. Strengthening digital human capital requires not only investments in education and training but also improvements in digital infrastructure, financial support mechanisms, and institutional frameworks. In addition, fostering collaborative ecosystems and ensuring continuous policy evaluation are essential to sustain long-term development and adaptability.

In the case of Vietnam, the rapid growth and evolving role of agricultural cooperatives present both opportunities and challenges. While policy reforms and digital adoption are progressing, the shortage of qualified human resources remains a critical bottleneck. Therefore, enhancing digital human capital should be prioritized as a central pillar in the modernization of the cooperative sector, enabling it to effectively participate in global value chains and respond to the demands of a digital and green economy.

Overall, this study contributes to the literature by emphasizing the central role of human capital in digital transformation, an area that has been relatively underexplored in cooperative research. Future studies should further investigate empirical relationships between digital human capital and cooperative performance, as well as explore context-specific models for capacity building in different regions and agricultural subsectors.

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