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The Role of Agriculture Cooperatives in Green Agri-Food Value Chains in China: Cases in Shandong Province

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Abstract

While escalating environment and food safety challenges underscore the need for sustainable agri-food systems, promoting green agri-food production provides a promising pathway. The green agri-food value chain integrates green agri-food production with coordinated value-adding activities across the value chain. In developing such value chains, agricultural cooperatives emerge as a key player. This research integrates sustainability and value chain theories, aiming to study the role of China's cooperatives in enabling green production and green value chains. It used qualitative methodology and interviews with management and members of three green vegetable cooperatives in Shandong Province, China, to offer an initial examination into this research area. The findings reveal that cooperatives play an important role in the green vegetable value chain and have a different level of vertical integration, with some having control over the whole value chain from input supply to retail. They also provide essential input, technical, and market support to enable green vegetable production and facilitate various value-adding activities. The study offers valuable insights into recommendations for enhancing value addition and facilitating green value chains. It also holds practical implications for practitioners and policymakers to strengthen cooperative development in China as an important intermediary for advancing agriculture sustainability.

Keywords: agriculture cooperative; green value chain; vegetables; vertical integration; China

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1. Introduction

In an era where customer satisfaction and sustainability define success, the value chain approach and sustainability thinking are widely recognized as key strategies for building competitive advantage [1,2]. These two concepts are increasingly seen as interwoven, with sustainability emerging as a key source of value addition [3], and the value chain approach providing an effective means to address sustainability challenges [4]. This has led to a growing interest in developing sustainable value chains that emphasize value addition, coordination, and overall sustainability (economic, social, and environmental) [3,5].

However, promoting sustainable agri-food value chains is particularly challenging in developing economies, where agri-food production is dominated by smallholder farmers [6]. Due to their limited access to essential resources, new technologies, and markets, and their small farming scale, smallholders face challenges in adding value, improving transaction relationships, delivering sustainable practices, and ensuring consistent food

quality [7,8]. Therefore, integrating smallholders into a sustainable agri-food value chain is a main concern, and agricultural cooperatives have exhibited capabilities to address this issue. Fernando et al. suggest that cooperatives support smallholders by enhancing their bargaining power, facilitating production aggregation, and enabling resource sharing [9,10]. In developing countries, cooperatives have also played a critical role in addressing complex production and marketing challenges faced by smallholders, including high transaction costs in accessing input and output markets, limited availability of modern technologies, and inadequate access to credit [11–13].

China's agriculture sector comprises a large number of smallholders and faces sustainability issues, particularly those related to environmental degradation and food safety [14,15]. These issues are especially pronounced in the vegetable sector in the country. Vegetables are a major constituent of Chinese diets, but their production is highly susceptible to pests and diseases, which often leads to excessive pesticide use, posing significant food safety and environmental risks [16]. To address these challenges, China has initiated programs such as Green Food Strategy and Agriculture Green Development and established China Green Food Development Center (CGFDC) [17], marking a step towards broader sustainability goals. CGFDC defined and applied the concept of green food, particularly requiring the production stage to realize significant reduction in chemical input such as synthetic fertilizers and pesticides to ensure food safety and environment conservation [18,19]. Additionally, to empower smallholders, China has been promoting the development of agricultural cooperatives, which has led to a rapid increase in the number of specialized farmers' cooperatives, reaching 2216 thousand in 2023 [20]. These cooperatives have evolved into various governance models led by government or entrepreneurs [21,22]. While cooperatives in China are studied in terms of typology [23,24], the role of government [25,26], and membership benefits [27,28], questions remain on how these cooperatives help members to enable green production and enhance their level of vertical integration in the value chain.

Previous research in China has focused on green production using and applying organic fertilizers and integrated pest management technology [29,30], or agricultural green innovation and value addition [31–33]. However, the role cooperatives in facilitating green food development across the entire value chain remains limited, and such research is particularly scarce in the vegetable sector of China. Therefore, this research aims to study the role of China's cooperatives in enabling green production and green value chains with a particular focus on Shandong Province, China's largest vegetable production region.

This study applies multidisciplinary research by integrating sustainability and value chain theories. The paper provides novel and empirical insights into how Chinese cooperatives engage in different stages of the green agri-food value chain and what support they provide to their members to enable green production. The findings offer critical insights for policymakers to enhance their support for the development of cooperatives and meaningful implications for practitioners to deepen their support in the production stage while extending their value adding activities along the entire value chain.

The rest of the paper is structured as follows. Section 2 provides a literature review and Section 3 explains the methodology. Results and discussion are presented in Section 4, followed by the conclusion in Section 5.

2. Literature Review

A value chain is defined as a range of activities required to bring a product from its conception, through various sequential links, to create and deliver value to consumers [34,35]. A green agri-food value chain is a value chain that creates value at each stage of the value chain while proactively reducing negative environmental impact or generate positive im-

pact on natural environment [36]. As a subset of the sustainable agri-food value chain, it places more emphasis on environmental sustainability and food safety [37]. It highlights the integration of value chain approach and green food production.

The core concepts of the value chain discipline are value addition and governance [38]. Value addition focuses on high value creation, while governance is defined as the 'integrated and collaborative multilevel value sharing' [39]. A green agri-food value chain includes different value chain stages where players engage in various value-adding activities [3,9,40,41]. While food producers, such as those in the crop and livestock sectors, traditionally create less value compared to other actors in the chain, some researchers highlight opportunities for producers to enhance value addition through innovation and coordination [40,42]. These include producing differentiated products, such as green and organic products, and employing advanced technology. Apart from the specific operational activities ranging from grading to delivery, activities safeguarding food safety also contribute to value addition. They involve labeling, hazard control, quality certification, and traceability [43,44]. Additionally, extending activities to other value chain stages constitutes another source of value addition [40,45].

Governance in a value chain has different coordination arrangements such as vertical integration and contract farming [46]. Among these arrangements, vertical integration is considered as a mechanism of vertical coordination where an actor unifies asset ownership and transactions under a single entity and exerts centralized control over the value chain [47]. To gain better control over the value chain, cooperatives have been found implementing vertical integration.

Previous literature found the wide application of this strategy by cooperatives in developed countries such as France and Ireland [48,49] and various levels of vertical integration in developing countries such as Sri Lanka [10]. Some research explains the reason behind cooperatives' vertical integration through the lens of organization theory and transaction cost economics [50]. The benefits of implementing vertical integration have also been investigated. By adopting such strategy, a firm controls two or more successive stages of a value chain, thus performing more value-adding activities, improving farmers' financial performance [10], and ensuring consistent food quality and safety [51,52]. From transaction cost economics perspective, implementing vertical integration contributes to the reduction in transaction costs and the mitigation of risks related to high asset specificity [50,53]. However, progress toward vertical integration may be hindered by the cooperative's democratic governance structure, a challenge described by Bijman et al. as the 'democracy dilemma', which arises from the potential conflict of interest between individual members and the cooperative as a whole [50].

Green food production in developing countries faces challenges due to the difficulty of promoting this production model among smallholders. This model is associated with higher costs related to inputs, technology, and transitional trials, as well as various uncertainties and risks [54,55]. The risk aversion attitude of smallholders, their resource constraints, and their weak awareness about environment sustainability impede their adoption of green production practices [55,56]. As a result, it is unlikely that smallholders will independently initiate green food production and external support is essential to enable their adoption of sustainable practices [57]. Cooperatives have proven to be a key actor to provide such support.

Previous studies have demonstrated various supports cooperatives provide to members. Researchers found that cooperatives provide essential input, training, and financial support [58–64], as well as foster informal social networks that facilitate knowledge sharing among members [65]. In addition, cooperatives play a significant role in providing market support to members. They enhance market access, thereby lowering members'

perceived risks of unsold produce [57,66], a factor highlighted as critical in enabling green production [67]. By offering higher prices on members' products, cooperatives provide direct economic benefits in the short term [68]. However, researchers also point out that in the long run, farmers' perceived environmental benefits become a stronger motivator for their green production [67,69].

Regarding China's context, only a few studies have examined cooperatives' level of vertical integration. Luo et al. and Gao et al. note that despite the economic growth, China's cooperatives exhibit a low level of integration [31,32]. However, other researchers find that some cooperatives implement vertical integration and extend to other value chain stages [25,33,57]. With respect to the support cooperatives provide, previous studies typically focus on one specific type of support, such as training, credit, or land use rights transfer facilitation [62,70–72]. Very few studies present a broader range of supports cooperatives provide [56,68]. Regarding the variations in support provision across different types of cooperatives, research is very limited. Huang et al. regard government-led cooperatives in China as weak in this aspect [73]. Qu et al. and Liu et al. suggest that there are regional differences in the support Chinese cooperatives provide to their members [74,75]. Despite some research on Chinese cooperatives, value chains and support provision, their role in facilitating green agri-food value chains remain underexplored.

This paper studies the role of China's cooperatives in enabling green agri-food value chains, focusing on their level of vertical integration and the support they provide to encourage green food production. By integrating the sustainability and value chain theories, it offers a meaningful exploration of cooperatives' engagement in China's green agriculture development, both at the production stage and beyond. The research framework of this paper is presented in Figure 1.

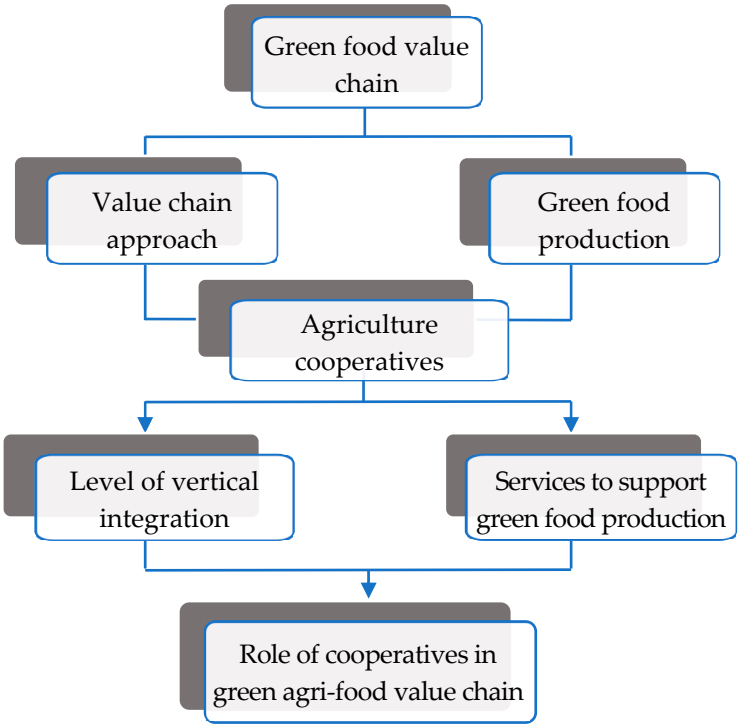

Figure 1. Research framework of the study.

3. Methodology

This paper aims to study the role of cooperatives in green agri-food value chains, including their level of vertical integration and support they provide to enable green production. The study context is the green vegetables in the Shouguang region of Shandong

Province, China, and data was collected from green cooperatives engaged in producing and marketing capsicums in Shouguang region, with location shown in Figure 2. Shouguang was selected for this study because it is the largest production and distribution center for vegetables, earning it the title of the 'home of vegetables' in China. The region is also a notable center for greenhouse farming, hosting an impressive 157,000 greenhouses as of 2023. More importantly, after years of greenhouse farming, Shouguang has transitioned to green vegetable production through various measures, including the adoption of cutting-edge technologies, promotion of environmental conservation and food safety [16,17,71]. The green vegetable production model of Shouguang has been set as an example to influence production methods nationwide, showcased by the China (Shouguang) International Vegetable Science and Technology Fair, held annually since 2000 as a platform to exhibit innovations in vegetable production and promote green agricultural practices. Furthermore, the Shouguang government has promoted the development of cooperatives since 2007, resulting in over 1600 farmer cooperatives in operation by 2023, incorporating 80 percent of local farmers. The cooperatives in Shouguang are also improving in quality and sharing their experience beyond Shandong Province. For instance, by 2023, eight farmer cooperatives have been recognized as national exemplary cooperatives (In China, agricultural cooperatives can apply to be recognized as exemplary cooperatives at the county, municipal, provincial, or national levels. The evaluation criteria include democratic governance, operational scale, service effectiveness, product quality, and social impact. Source: Ministry of Agriculture and Rural Affairs of the People's Republic of China). These cooperatives are attracting nationwide policymakers and practitioners to visit and learn from their experience. Capsicum is chosen for this study due to: (1) its projected national and international market growth opportunities. A research report anticipates a 26 percent increase in global capsicum market value from 2024 to 2030, with China holding 45 percent of the total market size [76]. (2) capsicum is the vegetable with the third-largest growing area in Shouguang [77].

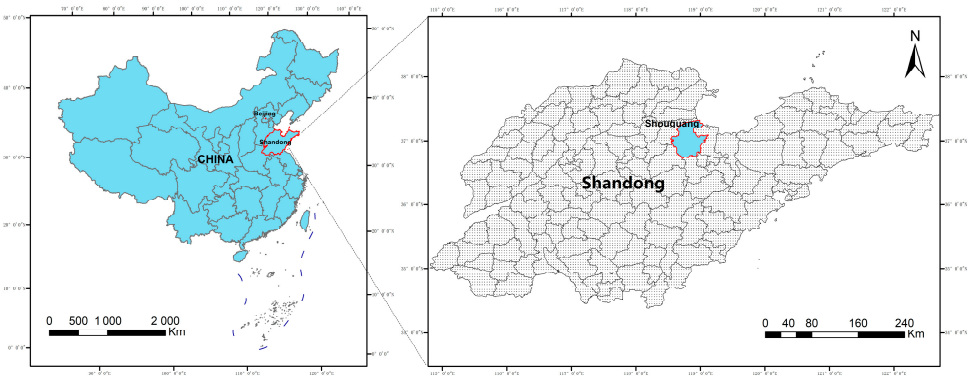

Figure 2. Location of Shouguang of Shandong Province.

This study used qualitative methodology and employed multiple case study approach. Qualitative research is particularly well-suited for addressing "how" and "what" research questions [78]. Yin argues that using multiple case studies enables theoretical replication, reinforcing confidence in the credibility of the underlying theory [78]. Purposive sampling was employed to select the case cooperatives, as it offers a unique perspective relevant to this study and allows for a deeper understanding of the phenomenon under investigation [78]. A list of green vegetable production cooperatives was generated based on the following criteria: operational longevity (over 5 years of operation), minimum annual sales (100 million yuan (100 USD = 719.98 Chinese yuan at the exchange rate of 2 June 2025)), and exemplary status (rewarded as at least provincial-level exemplary cooperatives). Further

consultation with local cooperative affairs officials, along with accessibility constraints, narrowed the list to three national exemplary cooperatives that expand green production experience by either receiving visitors or assisting greenhouse farming in other provinces. These three cooperatives, like many others, exemplify the adoption of emerging sustainable agricultural practices, as confirmed by the cooperative affairs officials. At the same time, they vary in their degree of value chain involvement, governance structure, and green production support, reflecting the diversity within the broader cooperative landscape. Meanwhile, as national exemplary cooperatives, their demonstration effect could generate spillover impacts on other cooperatives within Shandong province and beyond.

Data was collected in 2023 through semi-structured interviews with five respondents from each cooperative and officials overseeing local cooperative affairs. The respondents within a cooperative are senior leadership members nominated by the chairperson based on their knowledge of the cooperative and their availability. Semi-structured interviews were employed because they allow researchers to maintain a focus on key themes while offering flexibility during the conversation [79]. In this study, respondents were encouraged to share their in-depth understanding of the questions and their experiences related to green vegetable value chain, particularly regarding cooperative characteristics, levels of vertical integration, and support provided to enable green production. Key questions regarding the vertical integration and the support offered by cooperatives include 'What businesses do you operate along the value chain, and how do you specifically conduct them?' and 'how do you support members' green production?' The questions were reviewed and approved by three domain experts, and further pilot-tested through interviews with representatives from two other cooperatives and local officials prior to the final data collection. To enhance the reliability and validity of the data, interviews were supplemented with photographs, audio recordings, and relevant secondary data from journal articles, local press, and reports from cooperatives and government bodies.

This study used thematic analysis to analyze the data, which involved data transcription, coding, themes and subthemes formation, and connection identification between themes [80,81]. This approach identified core themes related to green agri-food value chains and cooperatives.

4. Results and Discussion

4.1. Overview of the Cooperatives Studied

The profiles of the three cooperatives studied were presented in Table 1.

Cooperative A was established by five vegetable traders who contributed all the capital for the cooperative registration and hold dominant control. The cooperative leased land from local villagers, who hold land use rights, and used bank loans to construct 60 standard greenhouses. These facilities were then leased to cooperative members for vegetable production, while the cooperative retained greenhouse ownership and the responsibility for their maintenance. The remaining 252 greenhouses were constructed and owned by members. The cooperative also owns a transportation company that handles transporting vegetables to destination markets and export ports. In some wholesale markets, the cooperative rents one or two booths to sell members' products.

Cooperative B is a cooperative established and led by the local CPC (Communist Party of China) party branch (Village Party-branch-led cooperatives are a special form of specialized farmers' cooperatives initiated by CPC village Party branch members, incorporating the village collective economic organization as a member, with the Party branch secretary typically serving as chairperson). It required all its members to contribute an equal amount of capital and democratically share the cooperative control rights. It facilitated land use rights transfer among farmers to expand their farming scale. It also offers loans

to members to renovate or construct their own greenhouses, while implementing unified construction planning and developing key facilities such as a high-voltage electrical system. These efforts resulted in 640 large greenhouses owned by members, with two-thirds newly built. Rather than directly marketing vegetables, the cooperative established a marketplace and leased its operation rights to four members who work as agents to facilitate direct transactions between farmers and wholesalers/exporters. Although there is no market transaction between the cooperative and its members, this represents an alternative way for the cooperative to market members' products. To ensure green production and food safety, the cooperative requires both input suppliers and its members to sign a compliance agreement prohibiting the sale or application of prohibited inputs. Random field inspections are conducted for any signs of violation.

Table 1. Overview of the cooperatives studied.

	Cooperative A	**Cooperative B**	**Cooperative C**
Key founders	Former vegetable traders	Village party branch	Village party branch
Year of establishment	2012	2008	2014
Year starting green production	2014	2008	2016
Current number of members	102	375	165
Land size (mu)	1000	4486	1500
Number of greenhouses	312	640	360
Percentage of capsicum in terms of production volume	60%	90%	10%
Percentage of capsicum exported in terms of volume	60%	60%	80%
Level of exemplary cooperative	National	National	National
Main activities	Greenhouse leasing Collective marketing Transportation	Facilitating the sales of products Loan service	Input supply Collective marketing Loan service
Certification	Green certification by CGFDC (2020)	Green certification by CGFDC (2013)	Global GAP and China GAP by CQC (2022)

Source: Data collected by authors from three cooperatives in Shouguang of Shandong province. Note: 1 ha = 15 mu; CGFDC: China Green Food Development Center; CQC: China Quality Certification Center, a national certification institute in China; GAP: Good Agriculture Practice.

Cooperative C was also established and led by the local CPC party branch. Members hold shares ranging from 3 to 100, based on their capital contribution to the cooperative, and equally share the control rights. Similar to Cooperative B, it also facilitated the land use rights transfer, implemented unified greenhouse construction planning, and provided loans for members' greenhouse construction. The efforts have contributed to the development of 360 high-standard greenhouses, of which members hold ownership. To ensure food quality and safety, the cooperative supplies and requires its members to purchase quality inputs from the cooperative. Stricter oversight of vegetable production includes random field inspections, greenhouse CCTV monitoring, and detailed pesticide usage records by members.

To save labor and improve productivity, most of the greenhouses are equipped with automation systems for ventilation, supplemental lighting, and thermal insulation cover rolling. Most members can perform these activities using a mobile app. More importantly, various technologies are adopted in the greenhouses to implement green production. These involve water saving through using drip irrigation and scientific waste treatment such as straw amendments. Soil conservation is practiced by applying organic or bio-fertilizers, fertigation, and high-temperature solarization techniques to disinfect and fertilize the soil. Integrated pest management is widely adopted in the cooperatives, with physical control measures (such as insect nets, traps, and lights) prioritized, while residue-free pesticides are used only when necessary. To further safeguard food quality and safety, the three

cooperatives simultaneously enforce food traceability and implement sample product testing for chemical residues.

The profiles of the cooperatives reveal that cooperatives vary in their scale in terms of land and membership size, as well as in their main activities and initiators, consistent with the findings by Bijman and Hu [68]. Regarding governance, this study presents some differences between the three cooperatives. Cooperative A was established and is controlled by the five former traders, aligning with the findings that core members contribute most of the capital and dominate the governance [22,68]. By contrast, Cooperatives B and C are led by the local CPC Party branch and are more democratically controlled by all members. This type of cooperative is much less studied, particularly in research published in English, with few exceptions such as the study by Liu et al. [21]. Building on the research of Liu et al., Cooperative A could be positioned as an entrepreneur-led cooperatives, whereas Cooperatives B and C fall into the category of government-led cooperatives [21].

4.2. Green Capsicum Value Chain

A value chain mapping of the green capsicum is shown in Figure 3, illustrating key actors: input suppliers, farmers, intermediaries, wholesalers/exporters, and retailers.

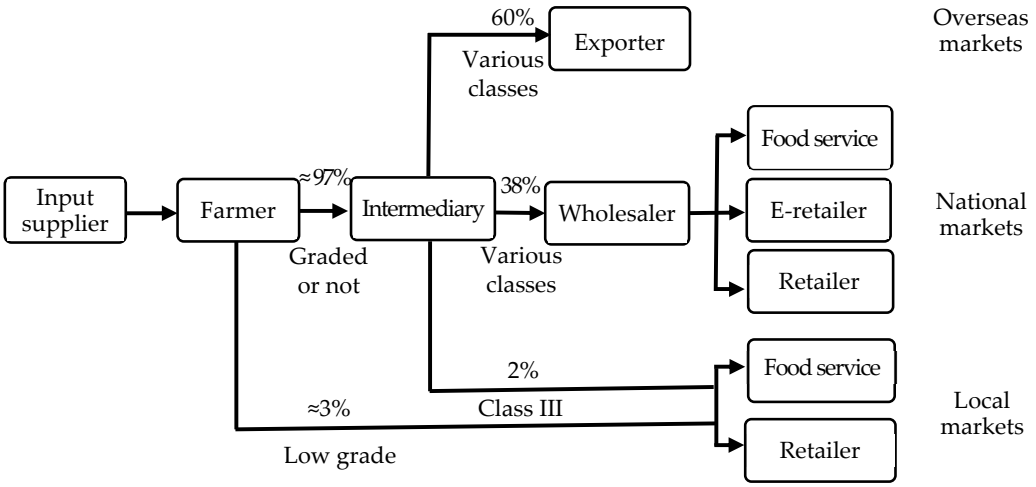

Figure 3. Value chain mapping of the green capsicums in this study. Source: Data collected by authors.

Input suppliers, referring specifically to material input suppliers, provide essential inputs for green production, such as seedlings, organic fertilizers, bio-fertilizers, and residue-free pesticides. They, ranging from small-scaled family-run stores to large franchise companies, typically deliver inputs to farmers except for small-volume sporadic purchases.

The majority of farmers have joined cooperatives for better prices (inputs and output) and market access. They operate on small-scale farms of various sizes. They make heavy investments in constructing or leasing greenhouses as their production facilities, as well as in automation systems to improve productivity. In the greenhouses, they employ quality inputs (e.g., organic fertilizer) and various high-tech technologies for green production. After harvesting, farmers cull the products with defects in appearance and deliver to local intermediaries only the marketable products, those meeting the minimum size requirements and free of defects. Around 97 percent of the products are delivered to intermediaries, either in bulk without grading or separately in low and high grades based on size. The low-grade capsicums, accounting for less than 3 percent of farmers' total, are mostly collected by local wet market vendors or food services. At the farm level, value is mainly added by green production, farming by using high-tech automation, and initial grading.

Intermediaries of various scales manage the aggregation of products. They may act as traders, buying and selling agricultural products, or as commission agents who collect farmers' products and sell on their behalf, earning a commission from both farmers and buyers. They typically handle further grading and packaging of capsicums. Based on the size (large, medium, and small), they grade capsicums into Class I, II, and III, using different packages for each class. On each package, markings are made to indicate specific producers for traceability purposes. About 60 percent of various capsicum classes are distributed to exporters, with most of the remainder going to national wholesalers, after pre-chilling in the storage house to ensure freshness and extend the shelf life of the product. A portion of the Class III capsicums, approximately 2 percent, are directed to local market retailers. At this stage, additional value is created through product testing for chemical residues, traceability, labeling, certification, and branding, all contributing to food safety assurance.

Wholesalers consist of first and second-tier wholesalers. The first-tier wholesalers transport pre-chilled capsicums to destination markets, where they sell them in full packages without unpacking to second-tier wholesalers, who manage the product distribution to adjacent cities, or directly to various retailers. At this stage, additional storage is needed only when there is an oversupply. Exporters handle logistics using cold chain transportation and deal with overseas customers including international wholesalers and retailers. In this stage, value is added mainly through transportation and storage.

Wholesalers are selling the product to local and national retailers and food services of various sizes. Retailers include wet market vendors, e-retailers, convenience stores, and supermarkets. They source capsicums of various grades and engage in activities such as displaying, marketing, and repackaging to add value, depending on the nature of their business. Supermarkets usually perform testing again for food safety. E-retailers, as an emerging and rapidly expanding retailing force in China's vegetable market, offer multiple services, particularly community group buying and home delivery, to lower purchase prices and enhance convenience for consumers. Food services, ranging from street food stalls to branded restaurants, mainly add value by marketing and cooking products and serving dining consumers.

The results of this study revealed that the green capsicum value chain shares similarities with those observed in other developing countries, where value chain actors engage in various value-adding activities. These findings are consistent with previous literature, such as that by Siddique and Garnevska and Hidayati et al. [9,41]. Farmers, who are the key players in the value chain, are producing green vegetables as a differentiation strategy to distinguish their products from traditional products. However, farmers in this study are using high technology and automation systems to create more value, which is different from the food production practices in other developing countries. Their practices and higher value addition also provide evidence for the claim that innovation facilitates value addition in the food production stage [40,42]. This is also the stage where cooperatives, as a farmer organization, play a significant role in enabling green production among members to produce high-quality green vegetables.

4.3. Cooperatives in the Green Capsicum Value Chain

In this study, the cooperatives practice differing value-adding activities across the value chain, ranging from input supply to retailing, as illustrated in Figure 4.

Beyond acting as a farmer and intermediary, both Cooperative A and C extend their roles to other stages. Cooperative A rents booths in agri-food wholesale markets in cities such as Chongqing and Chengdu, where it operates as a first-tier wholesaler. Cooperative C extends its business scope to cover all stages of the value chain. It sources material inputs

(including high-quality seedlings, organic fertilizers, pesticides, etc.) from suppliers and sells them to members, acting as an input supplier. After purchasing members' products, it markets them to exporters, using long-term contracts. In some cases, Cooperative C bypasses exporters to directly supply some overseas retailers, effectively functioning as an exporter. For example, it has a long-term supply contract with an Irkusk supermarket in Russia. Additionally, it serves as a retailer by selling directly to local and national consumers, respectively, in its retail stores and via online platforms.

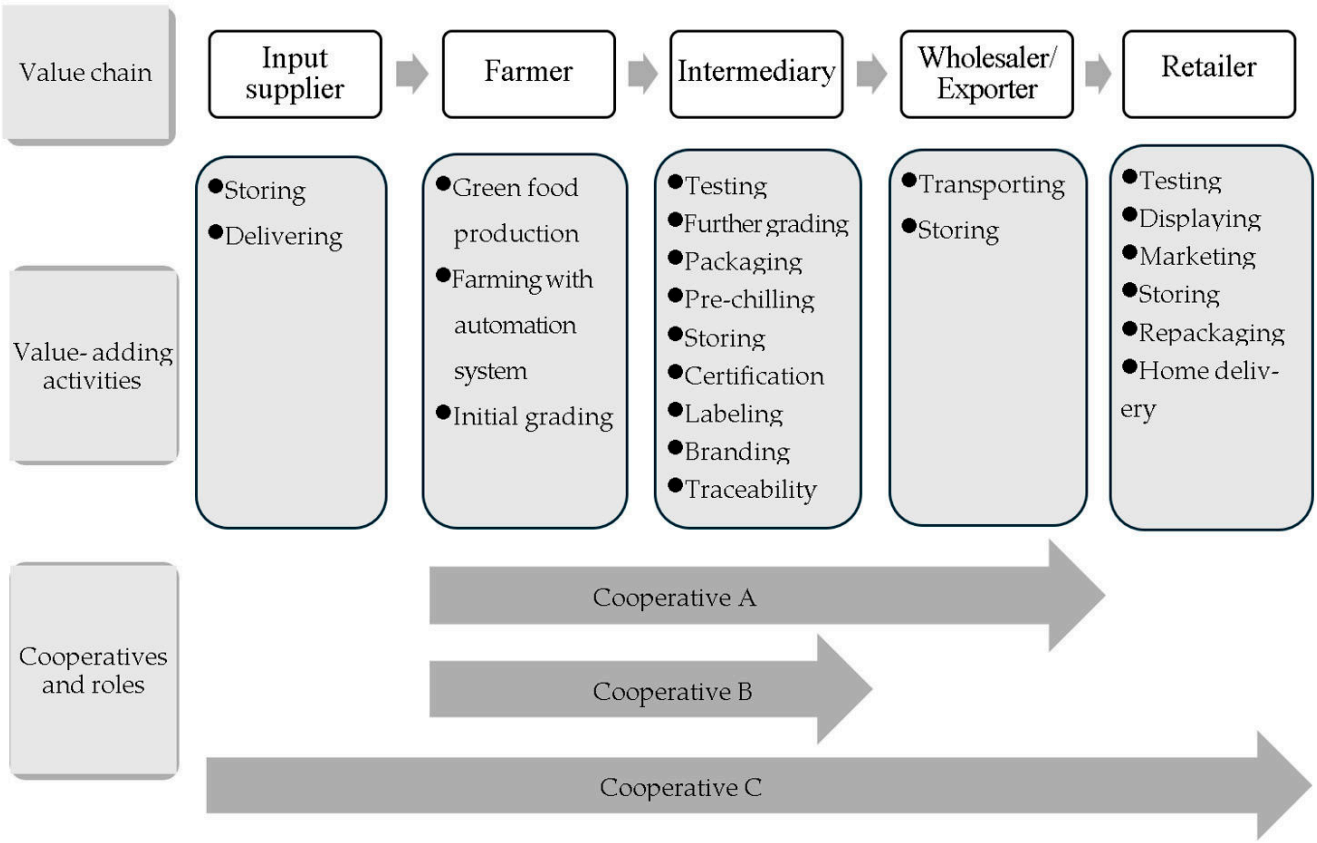

Figure 4. Roles of the cooperatives and their value-adding activities. Source: Data collected by authors.

The three cooperatives are implementing different levels of vertical integration. Cooperative A's extension to the wholesale stage of the value chain might be related to the experience of its key founders, five former vegetable traders who are familiar with downstream business. The intention of Cooperative C to better control the entire value chain might be associated with its acquisition of Global GAP and China GAP certifications, which motivates the cooperative to ensure consistent quality and food safety throughout the value chain. Comparatively, cooperatives B implements the lowest level of vertical integration, only playing its function at farming and intermediary stages. The vertical integration adopted by Cooperative B might be constrained by the physical marketplace it invested in, where farmers and wholesalers complete transactions directly, resulting in less motivation for the cooperative to further extend its business.

Although Cooperatives A and B are not as fully vertically integrated as Cooperative C, and the level of vertical integration in China still falls behind that in developed countries such as France and Ireland [48,49], this study shows that meaningful progress has been made by Chinese cooperatives in implementing vertical integration in the green vegetable sector. The findings align with previous research suggesting that China's cooperatives are increasingly exploring value-adding opportunities by extending their control along the value

chain [25,33,57]. However, they challenge the view of some studies that China's cooperatives exhibit low levels of integration but primarily serve as modest intermediaries [31,32].

The vertical integration achieved by Cooperative C, a government-led cooperative with a more democratic governance structure, challenges the assumption by Bijman et al. that democratic structures hinder vertical integration [50]. According to Bijman et al., democratic decision-making processes and divergent member interests tend to create conflicts between short-term needs of members and long-term strategic goals of the cooperative, thereby impeding efforts toward vertical integration. The case of Cooperatives C in this study, however, exhibits a deeper level of vertical integration and covers all stages of the value chain, suggesting that highly democratic cooperatives can also succeed in implementing this strategy, given that they can balance vertical integration with governance.

4.4. Support of Cooperatives to Enable Green Agri-Food Production

The three cooperatives studied actively provide various input, financial, and market support to their members to enable green production, see Table 2.

Table 2. Practices of cooperatives in enabling green production.

Practices		Cooperative A	Cooperative B	Cooperative C
Input support	Land	Directly leasing land from farmers	Facilitating land use rights transfer	Facilitating land use rights transfer
	Credit input	Leasing greenhouses to members	Providing loans for greenhouse construction Providing financial support as working capital	Providing loans for greenhouse construction Providing financial support as working capital
	Technology	Facilitating the installation of drip irrigation and fertigation systems	Facilitating the installation of drip irrigation and fertigation systems	Facilitating the installation of drip irrigation and fertigation systems
	Infrastructure		Developing electricity system	Improving road condition
	Material input		Having one long-term partner supplying inputs at lower prices	Selling inputs to members at lower prices
Technical support	Training	Used to provide	Periodically provide	Periodically provide
	Technical assistance	Employing professional technical staff	Employing professional technical staff	Employing professional technical staff Inviting external experts for on-site guidance
Market support	Securing product sales	Mandatory purchasing of members' products Long-term cooperation with buyers Extending to other value chain stages	Facilitating transactions between members and buyers; Long-term cooperation with buyers	Mandatory purchasing of members' products Long-term cooperation or contract with buyers Extending to other value chain stages
	Economic incentives	Paying 20–30 percent more than non-green products Additional 40 cents per kilo for consistent high-grade products	Paying 20–30 percent more than non-green products Members obtaining wholesale price	Paying 20–30 percent more than non-green products Only purchasing high-grade products and paying an additional 40 cents per kilo

Source: Data collected by authors.

They offer input support related to land, credit, technology, infrastructure, and material inputs. All three cooperatives are involved in land use rights transfer, consolidating fragmented small plots into large farming areas, which helps members increase their farming scale. Regarding credit input, Cooperative B and C provide loans for members' greenhouse construction and offer financial assistance as working capital to support mem-

bers experiencing crop failures. However, Cooperative A provides credit support in an alternative manner by constructing and leasing some greenhouses to members. With respect to technology support, all three cooperatives facilitate the installation of drip irrigation and fertigation systems for water-saving and soil conservation. Cooperative B and C have also provided infrastructure support by developing the electricity system for greenhouse operations and improving the road condition, respectively. Regarding material inputs, Cooperative B leases specific space in its administrative area to a supplier for long-term provision of qualified inputs to members at discounted prices, though purchasing from this supplier is optional. Cooperative C purchases high-quality inputs from carefully selected suppliers through long-term partnerships to ensure consistent quality of green products. Its relationships with suppliers enable the cooperative to secure inputs at favorable prices and supply them to members at prices 20 percent below market rates. Members are required to purchase the inputs exclusively from the cooperative.

Technical support is primarily delivered through training and technical assistance. All three cooperatives employ professional staff to help members diagnose and resolve cropping issues. Cooperative C occasionally invites external experts to provide on-site guidance. Regarding training, Cooperative A provided intensive training during the first two years of green production but currently relies primarily on skilled farmers sharing their knowledge with other farmers. Cooperatives B and C continue to conduct periodic training sessions, although less frequently than in the initial years, focusing on green agricultural practices and knowledge of environmental conservation and food safety. As members have gained skills, knowledge transfer becomes increasingly valued, and members frequently exchange their experiences and information on green production. For example, during an interview, a member received two phone calls seeking advice on specific farming issues.

Since establishment, all three cooperatives have provided market support to secure market access and ensure better prices for members' products. Cooperative A and C mandate the purchase of members' qualified green products, those that pass pesticide residue testing and meet the cooperatives' minimum size requirements, regardless of the volume delivered. Cooperative B, while not purchasing members' products, facilitates the direct transactions between members and buyers, on any volume delivered by members. All three cooperatives have expanded markets and developed long-term relationships with multiple customers from various national and international markets. For instance, Cooperative C reached a USD 10 million sales agreement with exporters to supply Russian market. Notably, Cooperative A and C also implement vertical integration to better facilitate the sales of members' products.

Beyond securing the market, the three cooperatives also offer additional economic incentives to encourage green production. To begin with, members' green capsicums are sold to cooperatives at prices 20–30 percent higher than non-green products. In addition, Cooperative A provides a bonus of 40 cents per kilo to members who consistently deliver high-grade capsicums. Similarly, Cooperative C purchases only high-grade capsicums at a price 40 cents above the market rate per kilo. Members of Cooperative B can gain wholesale prices in their direct transactions with wholesalers. A stable market and higher prices lead to improved profitability and increased family wealth for members. Such consequences reinforce their commitment to their cooperatives and green food production, which was strongly expressed by the respondents.

Except for providing various supports to enable members' green production, the three cooperatives also establish certain institutional arrangements, such as enforcing traceability and sample testing for chemical residuals, to further safeguard food safety. Cooperatives B and C take more measures, such as requiring written agreements with members and suppliers on the application and supply of safe inputs, conducting random field inspections,

mandating detailed pesticide application records, and implementing CCTV monitoring. The implementation of these measures reduces opportunistic behavior among members and ensures consistent food quality.

The efforts of the three cooperatives have yielded significant results, with over 99 percent of products passing pesticide residue testing and no food safety incidents reported since the cooperatives' establishment.

These results align with the existing literature [58,59,63], which highlights the various input supports by cooperatives to enable members to produce high-quality products. However, this study also identifies additional input support in terms of land, technology and infrastructure. Facilitating land use rights transfer is a service unique to Chinese cooperatives. It is particularly important, as increasing land size and extending land tenure are essential for encouraging green production when farmers do not hold land ownership [82,83].

Regarding technical support, the findings of this study reveal that while training is often regarded as one critical member benefit [60,61], members' learning needs change over time. Once equipped with foundational knowledge from training, members increasingly rely on peer learning facilitated by the cooperative's social networks. This aligns with the view that emphasizes the informal yet vital role of cooperatives in fostering knowledge exchange among members [65]. However, the development of peer learning does not substitute for formal training. Luo et al. argue that training significantly enhances members' willingness to adopt green production practices and should be delivered through diverse methods and with broader training content [62]. Particularly, training aiming to improve members' awareness of food safety and environment conservation is critical in shaping their long-term willingness to conduct green production.

The cooperatives involved in this study consistently provide market support by securing the sales of members' products and offering essential financial incentives. These arrangements directly mitigate perceived risks, particularly the asset specificity risk, and enhance members' economic benefits. In turn, these benefits serve as strong motivational factors for their continued membership and green production. This aligns with the view highlighting the effectiveness of lowered risks and economic benefits in the short run [67,69]. However, these authors also emphasize the stronger motivational role of the perceived environmental benefits over the long term. Therefore, cooperatives should increasingly pay attention to fostering environmental and safety awareness among members to sustain green production, given that sufficient market support is in place.

The study shows that cooperatives play important roles in enabling members' green production through various supports, consistent with the findings by Bijman et al. and Liang et al. [56,68]. Given the strong short-term motivation effect of lowered perceived risks and direct economic benefits, all three cooperatives place similar importance on market support. However, they differ in other types of support. Cooperative B and C, the two government-led cooperatives, provide a broader range of support, including credit, infrastructure, and material inputs, along with extensive technical support. The infrastructure support provided by government-led cooperatives also reflects how village party branches and village committees, as grassroot organizations in rural China, fulfill their role in revitalizing rural development. While Huang et al. regard government-led cooperatives in China as weak in support provision [73], this study provides fresh evidence that government-led cooperatives have been developing their capability to better serve members. Their efforts have expanded beyond supportive activities, further strengthened by the exertion of strict supervision to safeguard food safety, consistent with findings by Liang et al. and Yuan [56,84]. While various supports enhance members' capability and willingness for sustainable food production, supervision reinforces cooperatives' determination

and shapes members' behavior in ensuring food safety, thus reflecting long-term orientation of government-led cooperatives toward sustainable development. Comparatively, Cooperative A, the entrepreneur-led cooperative in this study, places greater emphasis on technical and market support, while imposing no strict supervision measures. This might be a reflection of its stronger profit orientation.

The results of this study demonstrate how cooperatives practice vertical integration and enable green production. These two strategies both enhance value addition, respectively, by engaging in activities along the value chain and producing differentiated products. Meanwhile, they also contribute to lowering the cooperatives' and members' transaction costs, respectively, by exerting greater control over the value chain and mitigating members' perceived risks. However, these strategies also reinforce each other. On one hand, green food production, supported by schemes such as certification and branding, leads to product differentiation and enhances the competitiveness of the value chain. This, in turn, increases the feasibility of vertical integration, as highlighted by Hu and Zhang [20]. On the other hand, according to Transaction Cost Economics [53], vertical integration internalizes the transaction cost and mitigates risks shifted to cooperatives when securing sales of members' products. Additionally, vertical integration can ensure consistent food quality and a higher level of food safety [42,51], which is also the aim of green food production.

Additionally, this study finds that CPC party-branch-led cooperatives, as a form of government-led cooperatives, do not undermine member democracy but instead demonstrate a more democratic governance structure. More importantly, government intervention in cooperatives' initiation and leadership does not seem to weaken these cooperatives' ability to extend their activities or diminish their service functions. On the contrary, they exhibit varying degrees of vertical integration along the value chain and provide more supports to enable green production than entrepreneur-led cooperatives. The findings suggest that government intervention, contrary to common concerns, does not necessarily hinder cooperatives' development.

5. Conclusions

This study examines the role of China's agricultural cooperatives in enabling the green agri-food value chain. The findings indicate that cooperatives facilitate the green agri-food value chain by implementing vertical integration and supporting green production.

A mapping and analysis of the green capsicum value chain shows that China's agriculture cooperatives have the potential to exert greater control over, and even lead, a green value chain through vertical integration. This study also indicates that cooperatives are adopting vertical integration to varying extents. Notably, the more democratically governed cooperative, a government-led one in this study, seems to overcome the 'democracy dilemma' by fully integrating all value chain stages. However, as cooperatives deepen this strategy, it remains unclear whether such progress might undermine their democratic governance, a concern highlighted as the 'hierarchy dilemma' by Bijman et al. [50].

The study analyzes how cooperatives provide various support to enable green agri-food production. Input and technical support, respectively, address members' immediate resource needs and cultivate their capability for long-term green production. Meanwhile, market support offers direct economic incentives, serving as highly effective short-term motivators for cooperative membership and green production. The analysis also reveals differences between government-led and entrepreneur-led cooperatives in the support they provide, with government-led cooperatives offering more input-related support, particularly in terms of credit, infrastructure, and material inputs.

This study integrates value chain and sustainability theories to provide an in-depth analysis of the role of China's cooperatives in green agri-food value chains. Empirically,

it offers valuable implications for policymakers seeking to further support cooperative development, particularly by directing preferential policies, such as access to credit facilities, towards cooperatives that strongly promote green production and extend their influence beyond the production stage. Additionally, in the context of China's sustainable agriculture development, cooperatives' contributions to green production should be considered a key criterion when assessing exemplary cooperatives. The study also sheds light on how cooperatives enhance value addition and facilitate the development of green value chains. At the farm level, various forms of support, particularly market support, are essential for enabling green agri-food production. However, to sustain green production, greater emphasis should be placed on raising farmers' awareness of its environmental benefits. Along the value chain, cooperatives can pursue vertical integration to add more value and control the delivery of high-quality green products from farmers to customers.

The study's limitations primarily arise from the small sample size of cooperatives in one province and the selection method of respondents. As a result, the generalizability of the findings may be limited, underscoring the need for further research to validate the results. This will be addressed through a follow-up quantitative study by the authors. Additionally, the study identifies several areas for future research, including the relationship between cooperatives' democratic governance and vertical integration, the underlying reasons for the performance of government-led cooperatives in vertical integration and support provision, and the potential consequences of cooperatives' vertical integration and service delivery.

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