



Exploration of Sustainable Development Paths for the Caofan Crisp Walnut Industry: Taking E-Commerce as an Opportunity

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Abstract

Against the backdrop of the comprehensive advancement of the rural revitalization strategy and the in-depth penetration of the digital economy into the agricultural sector, agricultural product e-commerce has become a core driver for addressing the development bottlenecks of characteristic agriculture and promoting county economic revitalization. As a national geographical indication product, Caofan Crisp Walnut in Zhangqiu District, Jinan City, Shandong Province, boasts a solid industrial foundation. However, it has long been plagued by issues such as a short industrial chain, fragmented operations, weak brand competitiveness, and a single sales channel, which hinder its sustainable industrial development. From the research perspective of e-commerce empowerment, this paper systematically analyzes the current development status and core pain points of the Caofan Crisp Walnut industry through methods including field surveys, case studies, and quantitative research. Drawing on the successful experience of benchmark agricultural product e-commerce cases such as Chu Orange, this paper explores the sustainable development paths for the Caofan Crisp Walnut industry with e-commerce as an opportunity, covering dimensions such as industrial chain integration, brand building, e-commerce ecosystem cultivation, infrastructure improvement, and talent training. The aim is to construct a development pattern of “characteristic products - industrial clusters - regional economy” and provide a replicable reference for the e-commerce development of similar geographical indication agricultural products and the practice of rural revitalization.

Subject Areas

Development of Characteristic Agriculture

Keywords

E-commerce Empowerment, Caofan Crisp Walnut, Characteristic Agriculture, Sustainable Industrial Development, Rural Revitalization

1. Introduction

1.1. Research Background

The key to rural revitalization lies in industrial revitalization, and the digital economy has injected new vitality into the revitalization of the agricultural industry. The *14th Five-Year Plan for E-Commerce Development* explicitly lists “new rural e-commerce formats” as a development priority, proposing to promote the quality and efficiency of agricultural product e-commerce and facilitate the implementation of the “Digital Commerce for Rural Prosperity” project. In 2024, the national rural online retail sales reached 2.66 trillion yuan, a year-on-year increase of 6.4%, while the online retail sales of agricultural products stood at 0.59 trillion yuan, a year-on-year increase of 12.5%. E-commerce has become an important bridge connecting smallholder farmers with the broader market, serving as a core engine for advancing agricultural modernization and increasing farmers’ income.

As a signature characteristic agricultural product of Zhangqiu District, Caofan Crisp Walnut is a national geographical indication product in China. It has been awarded titles such as “Top Ten Fruit and Forest Production Bases in Jinan” and “Experimental and Demonstration Base of the Dry Fruit Branch of the Chinese Society for Horticultural Science”. With a planting area of 3,000 mu (approximately 200 hectares) and an annual output exceeding 2.5 million kilograms (data source: Field survey, 2024; Zhangqiu District Agriculture and Rural Bureau, 2024), Caofan Crisp Walnut boasts distinct product advantages, including large size, thin shell, white and fragrant kernel, and rich nutrition. However, constrained by factors such as geographical conditions, operational models, and digitalization levels, the Caofan Crisp Walnut industry has fallen into a predicament of “increasing output without increasing income”: traditional sales models account for over 60% of the market, with online penetration rate (defined as the proportion of e-commerce sales in total sales) less than 10% and low product added value (data source: Author’s calculation based on field survey, 2024); the industrial chain is short, with insufficient deep processing capacity, and sales mainly rely on primary products; brand building is lagging, lacking unified identifiers and cultural empowerment, resulting in low national market recognition; logistics infrastructure is weak, with cold chain (defined as the proportion of products transported by cold chain facilities) coverage rate less than 30%, leading to low distribution efficiency and high costs; e-commerce talent is scarce, and practitioners lack professional capabilities to adapt to the development needs of the digital economy. Against this backdrop, promoting the transformation and upgrading of the Caofan Crisp Wal-

nut industry and exploring sustainable development paths through e-commerce is not only a practical need to address the pain points of industrial development but also an inevitable choice to promote the revitalization of county-level economy in Zhangqiu District and support the implementation of the rural revitalization strategy.

1.2. Research Significance

1.2.1. Practical Significance

Targeting the specific pain points in the development of the Caofan Crisp Walnut industry, this study constructs an e-commerce-empowered sustainable industrial development system. It can effectively broaden the sales channels of Caofan Crisp Walnut, enhance product added value and market competitiveness, and increase farmers' income; promote the standardized, brand-oriented, and digitalized development of the Caofan Crisp Walnut industry, extend the industrial chain, build industrial clusters, drive the development of related industries such as packaging, logistics, and processing, create more employment opportunities, and support rural industrial revitalization [1]. The explored e-commerce empowerment paths can provide practical references for the development of similar national geographical indication agricultural products across the country, promote the in-depth integration of the digital economy with characteristic agriculture, and facilitate the implementation of the rural revitalization strategy.

1.2.2. Theoretical Significance

Existing studies mainly focus on the macro development paths of rural e-commerce, with insufficient research on the e-commerce development of geographical indication agricultural products. In particular, empirical research on issues such as industrial chain integration, cultural empowerment, and benefit-linking mechanisms of characteristic agricultural products under the smallholder operation model is relatively scarce. Taking Caofan Crisp Walnut as the research object, this study deeply analyzes the internal logic and implementation paths of e-commerce empowering the sustainable development of characteristic agricultural industries. It constructs the SECI Rural Revitalization Driving Model of “Characteristic Resource Endowment \times E-commerce Penetration Rate \times Cultural Added Value \times Institutional Innovation”, filling the theoretical gap in the e-commerce development of geographical indication agricultural products and enriching the theoretical system of e-commerce empowering rural revitalization [2].

1.3. Research Methods and Content

1.3.1. Research Methods

To ensure the scientific rigor and validity of the research, a multi-method integrated approach is adopted in this paper, as elaborated below:

- **Field Survey Method:** The field survey adopted a typical sampling approach. A total of 30 planting households (including large planters, smallholders, and demonstration households), 5 professional cooperatives, and 2 e-commerce

enterprises were selected from the core production areas of Caofan Crisp Walnut. Semi-structured interviews and on-site observations were conducted from September 2024 to December 2024. The survey focused on planting management, sales channels, e-commerce operation status, logistics conditions, brand promotion, cost-benefit situation, and industrial development dilemmas, so as to obtain first-hand data and ensure the authenticity and representativeness of the research data.

- **Case Study Method:** Benchmark agricultural product e-commerce models such as Chu Orange and Three Squirrels were taken as research objects. Their core experiences in brand building, supply chain management, and marketing strategies were systematically analyzed, and localized adaptations were conducted in light of the inherent characteristics of the Caofan Crisp Walnut industry [3].
- **Quantitative Analysis Method:** Sales data of Caofan Crisp Walnut on mainstream e-commerce platforms from 2022 to 2024 were collated. Regression analysis was performed using SPSS software to quantify the influence weights of factors including logistics timeliness and live broadcast frequency on sales volume and repurchase rate.
- **Literature Review Method:** Over 150 domestic and foreign literatures related to agricultural product e-commerce and rural revitalization, as well as 12 policy documents, were systematically reviewed. This process clarified the current research status and policy orientation, laying a solid theoretical foundation for the research.
- **SWOT Analysis Method:** The strengths, weaknesses, opportunities, and threats (SWOT) of the Caofan Crisp Walnut industry were comprehensively identified and analyzed, so as to accurately pinpoint the core entry points for e-commerce empowerment.

1.3.2. Research Content

With e-commerce empowerment as the central thread, this research is structured into three sequential layers: Firstly, a comprehensive investigation into the current development status of the Caofan Crisp Walnut industry was conducted, with a focus on identifying the core challenges in terms of industrial foundation, e-commerce sales performance, brand development, logistics and distribution systems, and talent reserves. Secondly, the feasibility of e-commerce empowering the sustainable development of the industry was analyzed by integrating the policy context and market trends, and actionable insights were extracted from benchmark cases [4]. Finally, sustainable development paths for the Caofan Crisp Walnut industry, leveraging e-commerce as a catalyst, were proposed from six dimensions: industrial chain standardization, brand cultural empowerment, e-commerce ecosystem construction, infrastructure improvement, talent cultivation, and benefit-linking mechanism optimization. Corresponding supporting guarantee measures were also explicitly outlined.

1.4. Data Sources

All local indicators in this paper are derived from four types of sources: official government statistics, field surveys, e-commerce platform data, and the author's calculations. Planting area, annual output, and industrial basic data are obtained from the Zhangqiu District Agriculture and Rural Bureau and official industrial documents. Cold-chain coverage rate, delivery time, logistics cost share, and e-commerce practitioner data are collected through field surveys and interviews. The number of online stores and e-commerce sales are collected from mainstream e-commerce platforms. Market recognition rate, e-commerce penetration rate, repurchase rate, and delivery accuracy rate are calculated by the author based on survey data and platform data.

2. Current Development Status and Core Pain Points of the Caofan Crisp Walnut Industry

2.1. Industrial Development Foundation of Caofan Crisp Walnut

Caofan Crisp Walnut boasts unique natural endowments and a solid industrial foundation, serving as a core category of characteristic agriculture in Zhangqiu District. Firstly, it has distinct quality advantages: leveraging the unique soil and climatic conditions in Caofan, the walnut features plump kernels, a crispy taste, and is rich in protein, unsaturated fatty acids, vitamin E, as well as minerals such as calcium, iron, and zinc. As a national geographical indication product, its edible characteristic of being easy to crack by hand and high nutritional quality endow it with strong market competitiveness. Secondly, it has a considerable planting scale: the planting area of Caofan Crisp Walnut reaches 3,000 mu (approximately 200 hectares) with an annual output exceeding 2.5 million kilograms (data source: Field survey, 2024; Zhangqiu District Agriculture and Rural Bureau, 2024). The planting areas cover multiple villages including Caofan Village and Fannan Village, forming a development pattern of agglomeration in core production areas. From 2020 to 2024, the output remained stable at about 2.5 million kilograms, with a growth rate of 40%. Thirdly, it enjoys favorable policy support: at the national level, rural e-commerce has been incorporated into the key work of rural revitalization; Shandong Province explicitly supports the creation of "regional characteristic agricultural product e-commerce brands"; Zhangqiu District has included Caofan Crisp Walnut in the characteristic industry support plan, providing policy guarantees for industrial development.

Meanwhile, the e-commerce development of Caofan Crisp Walnut has initially taken shape. Currently, it has settled on mainstream e-commerce platforms such as Taobao, Pinduoduo, and Douyin Stores, with a total of 51 stores. From 2022 to 2024, the e-commerce sales volume increased from 5 million yuan to 7 million yuan, with an average annual growth rate of approximately 20%, and the proportion of e-commerce sales stays below 10%, consistent with the overall online penetration rate (data source: Author's calculation based on field survey, 2024), demonstrating considerable potential for e-commerce development.

2.2. Core Pain Points in the Development of the Caofan Crisp Walnut Industry

Despite its sound development foundation, the Caofan Crisp Walnut industry is constrained by both traditional operation models and lagging digital transformation, facing numerous pain points that hinder its sustainable development. Specifically, these pain points are reflected in the following six aspects:

2.2.1. Low Industrial Standardization and Uneven Product Quality

The cultivation of Caofan Crisp Walnut is dominated by scattered smallholder farming, lacking unified industrial standards. Significant variations exist in operational practices such as fertilization, irrigation, and pest control during the planting phase, resulting in obvious differences in nut size and uneven shell coloration. Compared with carefully sorted competing products on the market, Caofan Crisp Walnut has insufficient visual appeal and weak competitiveness in the high-end market. Similarly, the processing and packaging links lack standardized norms, leading to inconsistent product specifications. Some products suffer from simple packaging and inadequate preservation measures, which impair product quality and market image [5]. Additionally, the absence of a sound quality traceability system fails to effectively guarantee product quality, resulting in insufficient consumer trust.

2.2.2. Lagging Brand Building and Insufficient Cultural Empowerment and Market Awareness

Despite being a national geographical indication product, Caofan Crisp Walnut suffers from severely lagging brand building. It has not yet formed a unified and recognizable brand identity—most merchants use simple logos that fail to reflect product characteristics and regional culture. The brand positioning is vague, failing to accurately target core consumer groups or highlight key selling points such as “national geographical indication” and “nurtured by spring water,” resulting in an indistinct brand image. Brand promotion methods are traditional and singular, relying mainly on offline agricultural product fairs and farmers’ market stalls. Online promotion is inadequate, with simplistic advertising formats and limited reach, leading to low national market recognition (defined as the proportion of consumers who have heard of Caofan Crisp Walnut) (less than 10% among non-local consumers; data source: Field survey, 2024). Furthermore, local cultural resources such as Zhangqiu’s blacksmith culture and spring water culture have not been explored, resulting in low brand cultural added value and difficulty in forming differentiated competitive advantages in the homogenized market.

2.2.3. Imperfect E-commerce Ecosystem and Constrained Operational Capabilities and Sales Channels

The e-commerce development of Caofan Crisp Walnut is still in its initial stage, with an urgent need to improve the e-commerce ecosystem: Firstly, the sales channel is singular, overly relying on e-commerce platform retail. Emerging channels such as group buying, live streaming e-commerce, and community marketing are

underutilized—live streaming is only conducted during holidays, and community marketing mainly relies on self-built WeChat groups with limited members and poor interactivity, failing to fully leverage the channel advantages of e-commerce. Secondly, the level of store operation is low: most settled stores have simple page designs and unprofessional product displays, lacking operational capabilities such as data analysis and precision marketing, leading to low customer stickiness and repurchase rates (defined as the proportion of consumers who place a second order within six months). Thirdly, the integration of e-commerce and the industry is insufficient—e-commerce only serves as a sales channel and has not been deeply integrated with planting, processing, logistics, and other links. It is difficult to guide production and processing through big data to achieve industrial digital transformation.

2.2.4. Weak Logistics Infrastructure, Low Distribution Efficiency, and High Costs

Located in mountainous areas, Caofan faces backward logistics infrastructure construction, which has become a major bottleneck for e-commerce development: Firstly, the coverage of logistics outlets is inadequate—some remote planting areas have not yet achieved full coverage of logistics outlets, making it inconvenient to ship agricultural products. Secondly, warehousing facilities are simplistic: there is a lack of professional agricultural product warehousing centers, and most merchants use simple warehouses with poor moisture-proof, insect-proof, and ventilation conditions, affecting product storage quality. Thirdly, the development of cold chain logistics is lagging: the cold chain coverage rate is less than 30% (data source: Field survey, 2024). As Caofan Crisp Walnut has high fresh-keeping requirements, the lack of cold chain facilities leads to high product loss rates, with cold chain logistics costs accounting for 20%. Fourthly, distribution efficiency is low and costs are high: the average delivery time from the place of shipment to major consumer cities is 5 days, 2 days longer than the industry's high-quality level, with a delivery accuracy rate (defined as the proportion of orders delivered to the correct address on time) of only 85%. Logistics costs account for 25% of the total product cost, among which high transportation costs are mainly caused by insufficient optimization of transportation routes and low vehicle loading rates.

2.2.5. Scarce E-commerce Talents and Insufficient Professional Capabilities and Training Mechanisms

The number of e-commerce practitioners in the Caofan Crisp Walnut industry is small and their professional capabilities are low, with a talent gap becoming a key constraint on industrial e-commerce development: Currently, there are only about 30 personnel engaged in e-commerce business related to Caofan Crisp Walnut, among whom only 20% are graduates of relevant majors (data source: Field survey, 2024) such as e-commerce, marketing, and logistics management. Most are transformed from planters or local residents, lacking systematic e-commerce professional knowledge and skills. The skill structure of practitioners is singular—they only master basic e-commerce operation skills, and the proportion of per-

sonnel with capabilities such as store decoration, data analysis, live streaming, and logistics optimization is extremely low, making it difficult to meet the diversified needs of e-commerce development. Meanwhile, a sound e-commerce talent training mechanism has not been established locally, with limited cooperation with universities and professional training institutions. The internal training system is inadequate, lacking professional teachers and systematic courses, which cannot meet the talent needs of industrial e-commerce development [6].

2.2.6. Inadequate Benefit-Linking Mechanisms and Insufficient Policy Implementation and Industrial Support

The operation of the Caofan Crisp Walnut industry is fragmented, and the benefit-linking mechanism among the government, enterprises, cooperatives, and farmers is inadequate, failing to form a synergetic development force: Smallholder farmers operate scattered, and their cooperation with enterprises and e-commerce platforms is mostly simple purchasing and selling relationships. There is a lack of stable benefit-linking models such as order agriculture, minimum price purchase, and equity cooperation, making it difficult for farmers to share the value-added benefits of the industry. Meanwhile, the transformation of policy dividends is hindered: although the state, province, and district have issued a number of supportive policies for characteristic agriculture and rural e-commerce, the implementation of policies in cold chain logistics construction, e-commerce talent training, and brand building is not in place, resulting in a phenomenon of “government enthusiasm but market apathy.” The industrial support system is imperfect: the deep processing capacity is insufficient, with sales mainly relying on primary products and low product added value. Supporting links such as packaging design, financial support, and technical services are lagging—e-commerce practitioners face difficulties in financing and lack professional packaging design and technical support, which restricts the large-scale and standardized development of the industry.

3. Feasibility and Experience Reference of E-Commerce Empowering the Sustainable Development of the Caofan Crisp Walnut Industry

3.1. Feasibility of E-commerce Empowering the Sustainable Development of the Caofan Crisp Walnut Industry

E-commerce empowerment provides a crucial opportunity for the Caofan Crisp Walnut industry to break through development bottlenecks and achieve sustainable development, with its feasibility reflected in four aspects: policy, market, industry, and technology.

Firstly, **policy support provides a guarantee for e-commerce empowerment.** At the national level, the “Digital Commerce for Rural Prosperity” project is continuously promoted, with multiple policies issued to support the development of rural e-commerce and the construction of characteristic agricultural product brands. Shandong Province and Zhangqiu District have included Caofan Crisp

Walnut in the characteristic industry support plan, offering support in terms of funds, land, and training, which lays a solid policy foundation for e-commerce empowering industrial development.

Secondly, **market demand provides momentum for e-commerce empowerment.** With the improvement of residents' living standards and the popularization of healthy consumption concepts, the market demand for nut-based agricultural products has maintained steady growth, with an annual growth rate of 12% in the nut consumption market. Consumers' demand for high-quality, geographical indication, and green and healthy agricultural products is increasing. The superior quality and national geographical indication attribute of Caofan Crisp Walnut are in line with market demand. E-commerce platforms can break geographical limitations, reach consumers nationwide, and tap into market potential.

Thirdly, **industrial foundation provides support for e-commerce empowerment.** Caofan Crisp Walnut boasts a considerable planting scale, high-quality product quality, and a brand foundation as a national geographical indication. It has initially settled on mainstream e-commerce platforms and accumulated certain e-commerce operation experience, providing a solid industrial basis for e-commerce empowerment. Meanwhile, local cooperatives and e-commerce enterprises have gradually developed, offering mainstay support for industrial chain integration and e-commerce ecosystem cultivation.

Fourthly, **digital technologies provide means for e-commerce empowerment.** The development and popularization of digital technologies such as big data, artificial intelligence (AI), blockchain, and the Internet of Things (IoT) have furnished technical support for the standardized, brand-oriented, and digitalized development of the Caofan Crisp Walnut industry: big data enables precision marketing and market demand analysis to guide production and processing; blockchain and IoT can establish a quality traceability system to ensure product quality; new media technologies such as live streaming and short videos can enrich marketing models, enhance brand visibility, and promote the in-depth integration of the industry with e-commerce.

3.2. Experience Reference from Benchmark Agricultural Product E-commerce Cases—Taking Chu Orange as an Example

This study selects Chu Orange and Three Squirrels as benchmark cases for three reasons: they are typical successful practices of geographical-indication agricultural products, focus on brand building and supply chain upgrading, and rely on e-commerce to expand markets. However, transferability boundaries must be noted: Chu Orange has a stronger personal brand story and more mature cold-chain systems; Three Squirrels focuses on deep processing and standardized packaged snacks. Caofan Crisp Walnut is a fresh agricultural product with small-holder-based production, shorter supply chains, and weaker brand awareness. Therefore, this paper only draws lessons in quality control, cultural branding, e-commerce operation, and supply chain optimization, while avoiding blind copy

of their investment scale and marketing model.

As a benchmark case of agricultural product e-commerce branding, Chu Orange has achieved a leap from a characteristic agricultural product to a high-end brand through the development model of “quality + story + brand + supply chain.” Its successful experience provides important localized reference for the e-commerce development of the Caofan Crisp Walnut industry.

The core of Chu Orange’s success lies in four aspects: Firstly, **strict quality control**. It has established a full-process standardized system covering planting, harvesting, processing, and packaging. Product quality is guaranteed through measures such as soil improvement, scientific fertilization, and biological pest control, with multiple quality inspection checkpoints set up to ensure stable product quality. Secondly, **in-depth cultural empowerment and brand building**. It has explored the legendary life story of Chu Shijian, endowing the brand with the cultural connotation of an “inspirational orange” to form a unique brand story. By accurately targeting mid-to-high-end consumer groups, it has created a differentiated brand image. Thirdly, **innovative e-commerce marketing models**. It has fully utilized internet platforms to carry out marketing activities such as online pre-sales, crowdfunding, and live streaming e-commerce, and leveraged social media for word-of-mouth communication to achieve omni-channel marketing (online-offline integration), thereby enhancing brand visibility. Fourthly, **efficient supply chain management**. It has built a sound cold chain logistics system to realize full-process cold chain transportation from orchards to consumers, ensuring product freshness. Meanwhile, it has optimized supply chain processes to reduce logistics costs and improve operational efficiency [7].

Combined with the actual development of the Caofan Crisp Walnut industry, Chu Orange’s experience can be summarized into three core reference points: First, **quality is the foundation**. It is essential to construct a full-process industrial standardization system to ensure stable product quality, laying a solid foundation for e-commerce development. Second, **brand is the core**. It is necessary to tap into local cultural resources, create brand stories with cultural connotations, accurately target core consumer groups, and enhance brand added value and market competitiveness. Third, **integration is the key**. It is crucial to promote the in-depth integration of e-commerce with all links of the industrial chain, including planting, processing, and logistics, build an efficient supply chain system, and realize industrial digital transformation.

4. Empirical Findings

4.1. Descriptive Statistics from Field Survey

The field survey was conducted in the core planting areas of Caofan Crisp Walnut from September 2024 to December 2024. A total of 30 farmer households, 5 cooperatives, and 2 e-commerce enterprises were investigated. The main findings are as follows: First, the production of Caofan Crisp Walnut is still dominated by smallholder farmers, and the degree of standardization in planting, processing,

and packaging is low, leading to unstable product quality. Second, online sales account for less than 10% of total sales, and most practitioners lack professional e-commerce operation capabilities. Third, cold-chain coverage is less than 30%, logistics costs are high, and distribution efficiency is low, which restricts the development of e-commerce. Fourth, brand promotion is insufficient, and market recognition among consumers outside Jinan is lower than 10%. Fifth, the interest linkage mechanism among farmers, cooperatives, and enterprises is weak, and farmers share few industrial value-added benefits.

4.2. SWOT Analysis Results

The SWOT analysis shows that:

Strengths: Caofan Crisp Walnut is a national geographical indication product with good taste, nutrition, and local policy support.

Weaknesses: Low standardization, weak brand building, insufficient e-commerce talent, and backward logistics infrastructure.

Opportunities: Rising demand for healthy nuts, policy support for “Digital Commerce Boosts Agriculture”, and the popularization of live-streaming e-commerce.

Threats: Homogeneous competition from other walnut-producing areas, unstable market prices, and low consumer loyalty.

4.3. Quantitative Analysis Results

SPSS regression analysis was carried out using 2022-2024 e-commerce sales data. The results show that: Logistics timeliness, live-streaming frequency, packaging grade, and product uniformity are significantly positively correlated with online sales. Among them, live-streaming frequency and logistics efficiency have the strongest impact on sales growth. This indicates that improving operation professionalism and logistics infrastructure can effectively promote the development of Caofan Crisp Walnut e-commerce.

5. Specific Paths for the Sustainable Development of the Caofan Crisp Walnut Industry Under E-commerce Empowerment

To promote the sustainable development of the Caofan Crisp Walnut industry with e-commerce as an opportunity, it is necessary to base itself on the industrial development pain points, rely on policy, market, industrial, and technological advantages, learn from the experience of benchmark cases, and start from six dimensions: industrial chain standardization, brand cultural empowerment, e-commerce ecosystem construction, infrastructure improvement, talent training, and benefit-linking mechanism construction. A industrial development system of “government guidance + enterprise leadership + cooperative coordination + farmer participation” should be built to promote the standardized, brand-oriented, digitalized, and clustered development of the industry.

5.1. Promote Full-Process Standardization of the Industrial Chain and Lay a Solid Quality Foundation for E-Commerce Development

Product quality is the fundamental of e-commerce empowering industrial development. Guided by e-commerce needs, it is necessary to promote the full-process standardization of the planting, processing, packaging [8], and traceability of Caofan Crisp Walnut to ensure stable product quality:

Firstly, formulate planting standards. Led by the government, in conjunction with agricultural scientific research institutions and cooperatives, formulate unified planting technical specifications for Caofan Crisp Walnut, covering links such as fertilization, irrigation, pest control, pruning, and harvesting. Conduct planting technology training to promote smallholder farmers to plant in accordance with standards, solving the problems of uneven product quality and significant appearance differences. Introduce AI sorting and grading equipment to conduct refined screening of harvested walnuts, classifying them by size, color, and quality to improve the consistency of product appearance and meet the needs of different consumer markets. Secondly, standardize processing and packaging standards. Formulate processing technical specifications for Caofan Crisp Walnut, encourage enterprises to carry out deep processing, develop high-value-added products such as walnut oil, candied walnuts, and walnut nutrition bars, and extend the industrial chain [9]. Design unified brand packaging, develop various packaging forms such as family packs, gift packs, and portable packs according to different consumption scenarios to improve the grade of product packaging, while focusing on the freshness and environmental friendliness of the packaging.

Thirdly, establish a quality traceability system. Utilize IoT and blockchain technologies to build a full-process quality traceability system for Caofan Crisp Walnut from planting, processing, packaging to sales. Endow each product with a unique QR code, allowing consumers to query information such as product origin, planting process, processing technology, and test reports by scanning the code. This realizes the traceability of product quality and enhances consumer trust.

5.2. Strengthen Brand Cultural Empowerment and Create a Differentiated Brand Image

Brand is the core for the Caofan Crisp Walnut industry to enhance market competitiveness and achieve sustainable development. It is necessary to take e-commerce as a platform, tap into local cultural resources, and build a brand system of “geographical indication + cultural connotation + precise positioning” to create a differentiated brand image:

Firstly, **clarify brand positioning**. Relying on the attribute of a national geographical indication product, accurately target the mid-to-high-end healthy food market, focus on core consumer groups such as urban white-collar workers, mothers, and the elderly, and highlight the key selling points of Caofan Crisp Wal-

nut—”nurtured by spring water, easy to crack by hand, and rich in nutrition”—to form a differentiated brand positioning.

Secondly, **tap into cultural connotations and create brand stories**. Deeply integrate local cultural resources such as Zhangqiu’s blacksmith culture and spring water culture to create the brand story of “Millennium Iron Charm · Spring Water Crisp Walnut”. Combine Zhangqiu’s historical culture with the planting and growth of Caofan Crisp Walnut to endow the brand with unique cultural connotations and enhance brand added value [10]. Design a unified and recognizable brand logo and visual image, highlighting geographical indication and cultural elements to form a consistent brand visual system.

Thirdly, **diversify brand promotion and communication**. Construct a brand promotion system with “online as the mainstay and offline as supplementary support”. Online, rely on new media platforms such as Douyin, Kuaishou, Xiaohongshu, and WeChat Channels to release short videos and graphic content including product popularization, planting processes, health-preserving recipes, and cultural stories; carry out activities such as live streaming e-commerce and influencer store visits to enhance brand visibility. Offline, set up brand experience stores at tourist attractions such as Zhangqiu Baimai Spring and Zhujia Valley Ancient Village [11]; cooperate with chain supermarkets and convenience stores to establish brand counters; hold the “Caofan Crisp Walnut Cultural Festival” and carry out activities such as product tasting and picking experiences to realize the linkage of online and offline brand promotion.

5.3. Construct a Sound E-Commerce Ecosystem and Enhance E-Commerce Operation and Channel Capabilities

Taking e-commerce as the core starting point, build an e-commerce ecosystem featuring “diversified platforms, professional operations, and full-link channels”, promote the in-depth integration of e-commerce and the industry, and give full play to the channel and resource advantages of e-commerce:

Firstly, **build a diversified e-commerce platform matrix**. Consolidate the operation of flagship stores on traditional e-commerce platforms such as Taobao, JD.com, and Pinduoduo, and customize product combinations according to the user portraits of different platforms—for example, Pinduoduo focuses on cost-effective family packs, while JD.com emphasizes high-end gift packs. Vigorously develop live streaming e-commerce and social e-commerce: settle in Douyin Stores and Kuaishou E-commerce, cultivate local internet celebrities as hosts, carry out origin traceability live streams and product popularization live streams, and cooperate with food influencers and rural bloggers to improve the effectiveness of live streaming sales. Establish a WeChat mini-program mall and community marketing system, and enhance customer stickiness and repurchase rates through activities such as “refer-a-friend rewards”, exclusive member discounts, and birthday gifts [12].

Secondly, **improve the professional level of e-commerce operations**. Guide

e-commerce enterprises and cooperatives to introduce professional e-commerce operation talents to carry out specialized operations including store decoration, product optimization, data analysis, and precision marketing. Use big data to analyze consumer needs, purchasing habits, and market trends on e-commerce platforms, and guide product planting, processing, and packaging to realize “production based on sales” and promote industrial digital transformation.

Thirdly, **expand full-link sales channels**. On the basis of doing a good job in online retail, actively expand emerging channels such as corporate welfare procurement, community group buying, and cross-border e-commerce: launch customized corporate gift boxes, cooperate with community group buying platforms such as Meituan Youxuan and Duoduo Maicai to broaden sales channels. Targeting the overseas Chinese market, carry out sales through cross-border e-commerce platforms such as AliExpress, and set up offline experience stores in Chinese communities in Los Angeles, Singapore, and other cities to realize “offline display + online global shopping”.

5.4. Improve Infrastructure Construction to Reduce Logistics Costs and Enhance Distribution Efficiency

Logistics infrastructure serves as a crucial pillar for e-commerce empowering the Caofan Crisp Walnut industry. Led by the government, it is necessary to integrate social resources, improve the construction of logistics, network, and other infrastructure, and build a three-level logistics system (county-town-village) to reduce logistics costs and enhance distribution efficiency:

Firstly, **improve logistics network and warehousing facilities**. Construct a professional agricultural product warehousing and logistics center in Caofan Town, and set up village-level logistics service stations in all administrative villages to achieve full coverage of logistics networks [13]. Promote the “unified warehousing and joint distribution” model, integrate resources of postal and express delivery enterprises, optimize logistics distribution routes, improve vehicle loading rates, and reduce per-unit logistics costs.

Secondly, **accelerate the construction of cold chain logistics system**. Provide a 50% subsidy for the purchase of cold chain logistics vehicles, introduce more than 10 cold chain transport vehicles, and promote the cold chain coverage rate to over 80%. Build professional cold chain warehousing facilities in the warehousing and logistics center to realize the full-process cold chain transportation of Caofan Crisp Walnut from harvesting, storage to distribution, thereby reducing product loss rates and ensuring product freshness.

Thirdly, **optimize network infrastructure**. Increase investment in network infrastructure in the mountainous areas of Caofan, expand the coverage of 5G networks, and solve problems such as network blind spots and unstable signals to guarantee the smooth development of e-commerce activities such as live streaming and online transactions. Introduce an intelligent route planning system to optimize logistics distribution routes, shorten the average delivery time to within 3

days, and improve distribution efficiency.

5.5. Strengthen E-commerce Talent Training and Introduction to Enhance Industrial Talent Support

Talent is a core element for e-commerce empowering the sustainable development of the Caofan Crisp Walnut industry. It is necessary to build a talent training system of “local training + external introduction + mentor guidance” to address the shortage of e-commerce talents and improve the professional capabilities of practitioners:

Firstly, **carry out local e-commerce talent training**. Launch an “e-commerce literacy campaign” targeting planters and local residents, training more than 1,000 people annually. The training focuses on practical skills such as live streaming scripts, photo shooting, order processing, and store operation [14]. Certificates and entrepreneurship subsidies will be awarded to those who pass the assessment. Cooperate with Alibaba Digital Village Academy and local universities to offer advanced courses for “Golden E-commerce Operators”, cultivating professional e-commerce talents with capabilities in data analysis, brand planning, and live streaming operation.

Secondly, **intensify efforts in introducing e-commerce talents**. Implement the “Homing Swan Program” (a talent introduction initiative), providing policy support such as 3-year interest-free loans and priority allocation of logistics and warehousing land for college students returning to their hometowns to start e-commerce businesses. Introduce MCN agency hosts and professional e-commerce operation talents, offering policies such as household registration subsidies and tax incentives to attract outstanding external talents to engage in the development of the Caofan Crisp Walnut industry.

Thirdly, **establish an e-commerce mentor guidance system**. Invite e-commerce platform operation experts, internet celebrity hosts, and agricultural researchers to form an “e-commerce mentor pool”, implementing a pairing assistance model of “one mentor + ten model households” to provide one-on-one guidance for e-commerce practitioners and improve their professional capabilities.

5.6. Establish an E-commerce Profit Feedback Mechanism to Promote Synergistic Development of Industry and Rural Areas

Innovatively establish a sustainable development mechanism of “e-commerce profits feeding back rural infrastructure”, earmarking 5% of the e-commerce sales revenue of Caofan Crisp Walnut for the construction of rural infrastructure such as logistics, networks, and irrigation, forming a positive cycle of “industrial upgrading - infrastructure improvement - sales growth”. Meanwhile, taking the development of the e-commerce industry as an opportunity, drive the development of related industries such as rural tourism and agricultural product processing.

Build an integrated development model of “Caofan Crisp Walnut + rural tourism”, develop rural tourism products including walnut picking, pastoral experience, and cultural research, and promote the in-depth integration of industrial development and rural revitalization to achieve the development goal of “prosperous industry, beautiful countryside, and wealthy farmers”.

6. Guarantee Measures for the Sustainable Development of the Caofan Crisp Walnut Industry

6.1. Organizational Guarantee

Establish a leading group for the development of the Caofan Crisp Walnut industry, led by the Zhangqiu District Government, with the participation of relevant departments including Agriculture and Rural Affairs, Commerce, Culture and Tourism, Finance, and the Caofan Town Government. Clarify the responsibilities of each department to coordinate and promote the standardized, brand-oriented, and e-commerce-driven development of the industry. Establish a joint working meeting system to regularly hold meetings to study and solve problems in industrial development, coordinate resources from all parties, and form a synergetic work force. Give play to the role of industry associations by setting up the Caofan Crisp Walnut Industry Association, formulating industry norms, strengthening industry self-regulation, and promoting the coordinated development of enterprises, cooperatives, and farmers.

6.2. Financial Guarantee

Integrate financial support funds at all levels and set up a special fund for the development of the Caofan Crisp Walnut industry, focusing on supporting infrastructure construction, brand cultivation, talent training, and the development of deep-processed products. Guide social capital to participate in industrial development, encourage enterprises, cooperatives, and financial institutions to increase investment in the Caofan Crisp Walnut industry, and form a diversified financial guarantee system of “financial guidance + social participation + financial support”. Provide policy support such as loan interest subsidies and financing guarantees for eligible industrial development projects to reduce financing costs.

6.3. Technical Guarantee

Establish long-term cooperative relationships with universities and scientific research institutions such as Shandong Agricultural University and Shandong Academy of Agricultural Sciences, and set up an industrial technology R&D team to carry out research and promotion of planting technologies, deep processing technologies, preservation technologies, and e-commerce technologies. Establish technical service stations to provide free technical guidance and training for planters and enterprises, solving technical problems in industrial development. Encourage enterprises to introduce digital technologies such as big data, artificial intelligence, blockchain, and the Internet of Things to promote the digital and

intelligent upgrading of the industry.

6.4. Supervision Guarantee

Establish a product quality supervision system for Caofan Crisp Walnut. Led by departments such as Market Supervision and Administration and Agriculture and Rural Affairs, strengthen quality inspection and supervision over planting, processing, sales, and other links of the product. Prohibit products that do not meet standards from entering the market, and severely crack down on illegal activities such as false advertising and passing off inferior products as high-quality ones to safeguard the brand image [15]. Establish an assessment and evaluation mechanism for industrial development, incorporate the development of the Caofan Crisp Walnut industry into the annual assessment content of the Caofan Town Government, clarify assessment indicators and reward and punishment measures, and ensure the effective implementation of various tasks. Give play to the role of social supervision by opening quality complaint hotlines and online complaint channels to accept supervision from consumers and all sectors of society.

7. Conclusion and Prospect

7.1. Research Conclusion

As a national geographical indication product, Caofan Crisp Walnut boasts a solid industrial foundation and product advantages. However, it has long been hindered by issues such as low industrial chain standardization, lagging brand building, an imperfect e-commerce ecosystem, weak logistics infrastructure, talent scarcity, and an inadequate benefit-linking mechanism, which impede its sustainable industrial development. Against the backdrop of the in-depth integration of the digital economy and the rural revitalization strategy, e-commerce empowerment has emerged as a crucial opportunity for the Caofan Crisp Walnut industry to break through development bottlenecks and achieve sustainable growth. Its feasibility is reflected in four aspects: policy support, market demand, industrial foundation, and technological development.

From the core perspective of e-commerce empowerment, this paper proposes specific sustainable development paths for the Caofan Crisp Walnut industry by drawing on the successful experience of benchmark agricultural product e-commerce cases such as Chu Orange: taking quality as the foundation to promote the full-process standardization of planting, processing, packaging, and traceability; taking the brand as the core to tap into local cultural resources and create a differentiated brand image integrating “geographical indication + cultural connotation”; taking e-commerce as the starting point to build a diversified e-commerce platform matrix, improve the professional level of e-commerce operations, and expand full-link sales channels; taking infrastructure as the support to improve the construction of logistics and network infrastructure, build a three-level logistics system, and reduce logistics costs while enhancing distribution efficiency; taking talent as the key to construct a talent training system of “local training + ex-

ternal introduction + mentor guidance” and strengthen industrial talent support; taking benefit linkage as the bond to build a collaborative development mechanism among the government, enterprises, cooperatives, and farmers, and improve policy and industrial supporting measures; taking sustainability as the goal to establish a mechanism of “e-commerce profits feeding back rural infrastructure” and promote the synergistic development of the industry and rural areas. Meanwhile, guarantee measures from four dimensions—organization, finance, technology, and supervision—are proposed to ensure the effective implementation of the development paths.

E-commerce empowerment for the sustainable development of the Caofan Crisp Walnut industry is not merely about using e-commerce as a sales channel, but about promoting the in-depth integration of e-commerce with the entire industrial chain. It aims to realize the standardized, brand-oriented, digitalized, and clustered development of the industry, and ultimately construct a development pattern of “characteristic products - industrial clusters - regional economy”. This will increase farmers’ income, revitalize the industry, boost county-level economic development, and provide solid support for the implementation of the rural revitalization strategy.

7.2. Research Prospect

This study explores the sustainable development paths of the Caofan Crisp Walnut industry under e-commerce empowerment. However, its implementation requires the collaborative efforts of the government, enterprises, cooperatives, farmers, and other stakeholders. In future development, it is necessary to continuously optimize and improve the development paths according to market changes and the actual development of the industry, and promote the effective implementation of various measures. Meanwhile, the e-commerce development of the Caofan Crisp Walnut industry is a long-term process that requires continuous brand cultivation, talent training, and industrial chain extension, promoting the industry’s transformation from “scale expansion” to “quality improvement” and “added value enhancement”.

In the future, with the continuous development of digital technologies and the deepening of rural e-commerce, the Caofan Crisp Walnut industry can further explore an integrated development model of “e-commerce + cultural tourism + health and wellness”, combining industrial development with rural tourism and health care to tap into the diverse values of the industry. At the same time, leveraging cross-border e-commerce platforms, it can further expand overseas markets and build Caofan Crisp Walnut into a well-known geographical indication agricultural product brand at home and abroad. In addition, the e-commerce empowerment paths proposed in this study can provide a reference for the development of similar national geographical indication agricultural products across the country. It is expected that more regions will combine their own actual conditions to explore new models and paths for e-commerce empowering the sustainable de-

velopment of characteristic agricultural industries, promote the in-depth integration of the digital economy and rural revitalization, and contribute to agricultural modernization and comprehensive rural revitalization.

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Conflicts of Interest

The author declares no conflicts of interest.

References

- [1] Huang, J.K. (2024) New Productive Forces for Agriculture: Connotation, Denotation, Potential, Challenges and Development Thinking. *China Rural Observation*, **5**, 19-34. (In Chinese) <https://doi.org/10.20074/j.cnki.11-3586/f.2024.05.002>
- [2] Yuan, X.Y., Ma, R.Y. and He, X.Y. (2026) Operation and Financing Strategies of Agricultural Product Supply Chains Empowered by Platform Digital Technologies. *Control and Decision*, **41**, 175-185. (In Chinese) <https://doi.org/10.13195/j.kzyjc.2025.0296>
- [3] Deng, Y. and Lin, M.J. (2021) Research on the Optimization of Sales Paths for Agricultural Products in Yongtai, Fujian under the “Live Streaming+Agriculture Assistance” Model. *Light Industry Science and Technology*, **37**, 105-107. (In Chinese)
- [4] Zhang, S., Qiao, H., Zhang, Y.C., *et al.* (2022) Research Status and Prospects of Rural E-Commerce in Supporting Poverty Alleviation and Rural Revitalization. *Journal of Management*, **19**, 624-632. (In Chinese)
- [5] Deng, Y. and Xu, H.K. (2025) Can Digital Economy Promote Long-Term Farmer Income Growth? An Analysis Based on Economic Resilience. *Rural Economy*, **1**, 131-142. (In Chinese) <https://doi.org/10.26957/j.cnki.cn51-1029/f.2025.01.014>
- [6] Li, X.X. and Zhao, X.F. (2020) Live Streaming for Agriculture: A New Rural E-Commerce Model for the Integrated Development of Rural Revitalization and Online Poverty Alleviation. *Commercial Economics Research*, **19**, 131-134. (In Chinese)
- [7] Guo, K.K. and Gao, Q.J. (2022) Opportunities, Challenges and Countermeasures for the High-Quality Development of Rural E-Commerce. *Modern Economic Research*, **2**, 103-111. (In Chinese) <https://doi.org/10.13891/j.cnki.mer.2022.02.011>
- [8] Wang, X.T., Jing, L.B. and Feng, Z.W. (2025) Theoretical Deconstruction and Case Analysis of E-Commerce Driving Agricultural Digital Transformation from the Perspective of Industrial Chain, Also on the Experience and Enlightenment of Agricultural “Industrial Brain”. *China Rural Observation*, **1**, 43-62. (In Chinese) <https://doi.org/10.20074/j.cnki.11-3586/f.2025.01.003>
- [9] Dai, J.H., Tian, Y., Yang, S.W., *et al.* (2019) Current Situation and Countermeasures of Walnut Industry Development in Yunnan Province. *Processing of Agricultural Products*, **2**, 78-82+85. (In Chinese) [https://doi.org/10.16693/j.cnki.1671-9646\(X\).2019.01.055](https://doi.org/10.16693/j.cnki.1671-9646(X).2019.01.055)
- [10] Li, Z.X., Yang, L.L., Abulizi, B.S.T., *et al.* (2013) Research on the Development of

-
- China's Walnut Industry. *Journal of Chinese Agricultural Mechanization*, **34**, 23-28.
- [11] Wang, G., Hou, Y. and Shin, C. (2023) Exploring Sustainable Development Pathways for Agri-Food Supply Chains Empowered by Cross-Border E-Commerce Platforms: A Hybrid Grounded Theory and DEMATEL-ISM-MICMAC Approach. *Foods*, **12**, Article 3916. <https://doi.org/10.3390/foods12213916>
- [12] Wang, G.F., Zhang, Z.H., Li, S. and Shin, C. (2023) Research on the Influencing Factors of Sustainable Supply Chain Development of Agri-Food Products Based on Cross-Border Live-Streaming E-Commerce in China. *Foods*, **12**, Article 3323. <https://doi.org/10.3390/foods12173323>
- [13] Wang, G., Wang, Y., Li, S., Yi, Y., Li, C. and Shin, C. (2024) Sustainability in Global Agri-Food Supply Chains: Insights from a Comprehensive Literature Review and the ABCDE Framework. *Foods*, **13**, Article 2914. <https://doi.org/10.3390/foods13182914>
- [14] Ciesielkiewicz, M., Bonilla, C.F. and Olave-Lopez-de-Ayala, C. (2023) An Overview of AI Development and Its Location Relationship in Agricultural Supply Chains. *International Journal of Innovation, Management and Technology*, **14**, 29-46. <https://doi.org/10.18178/IJIMT.2023.14.2.935>
- [15] Jin, Z.R. (2024) Research on the Development Status and Countermeasures of Rural E-Commerce in China. Nankai University. (In Chinese) <https://doi.org/10.26914/c.cnkihy.2024.083202>