Journal of Agricultural Science and Supply Chain Management, 2026, 2(1), 92-105
https://doi.org/10.71204/ztb59z98

Digital-Intelligent Green Reconstruction of the County Mutton Sheep Industry Chain: A Case Study of Wulian County, Shandong Province

Chenghan Ruan [1], Jiahe Zhang [1], Yibo Wang [1], Qianxi Hu [1]

[1] Department of Economics and Management, Beijing City University, Beijing 101309, China

*** Correspondence**:

Jiahe Zhang

zjh519921@qq.com

Received: 17 October 2026/ Accepted: 12 November 2026/ Published online: 18 November 2026

Abstract

This study examines the digital-intelligence-driven green transformation of the county-level mutton sheep industry, using Wulian County, Shandong Province, as a case study. Based on a field survey, it assesses the low-carbon development status and key bottlenecks across the industry chain and analyzes how digital technologies can support green reconstruction. The study follows a four-part framework: green diagnosis, technology integration, model construction, and implementation planning. Using a life cycle assessment (LCA) approach, it identifies major sources of emissions and inefficiency and proposes an integrated, digitally enabled emission-reduction framework. It then develops a "Four-Chain-in-One" model comprising low-carbon breeding, green processing, smart logistics, and carbon-labeled branding. Finally, it outlines a three-stage implementation roadmap: pilot demonstration, standard promotion, and region-wide replication. The proposed framework is intended to inform the low-carbon transformation of the mutton sheep industry in Wulian County and comparable hilly regions of China.

Keywords: Digital Technology; Mutton Sheep Industrial Chain; Green and Low-Carbon Transformation; County Economy

1. Introduction

Against the backdrop of global climate governance and the continued implementation of China's "dual carbon" strategy, the green and low-carbon transformation of agriculture has become an important priority for rural revitalization and agricultural development. The report to the 20th National Congress of the Communist Party of China emphasized the need to advance rural revitalization and build a stronger agricultural sector, highlighting the importance of integrating agricultural digitalization with green development. In 2024, the Ministry of Agriculture and Rural Affairs issued guiding opinions on the development of smart agriculture, emphasizing the potential

of digital and intelligent technologies to improve livestock production efficiency and reduce environmental impacts. However, the county-level mutton sheep industry faces substantial structural challenges in its green transition, including fragmented small-scale operations, limited digital infrastructure, insufficient life-cycle carbon management, and weak coordination between upstream and downstream actors. Using digital technologies to overcome information barriers, improve resource allocation, and reconstruct the green value chain is therefore a pressing challenge.

By reorganizing production factors and facilitating data exchange, digital-intelligence technologies create opportunities for greener industrial development. Previous studies have examined livestock carbon-emission measurement, smart breeding technologies, and industry-chain digitalization. Nevertheless, much of this research focuses on individual stages or organizations rather than coordinated reconstruction across an entire county-level industry chain. The adaptability and economic viability of these technologies for small- and medium-scale breeders also require further attention. Accordingly, this study examines Wulian County, Shandong Province, through field research and the design of an integrated green reconstruction framework for its mutton sheep industry chain.

This study has both theoretical and practical implications. From a theoretical perspective, it applies a life cycle assessment (LCA) framework to identify emission-related bottlenecks in breeding, processing, and logistics. It also proposes a digital-intelligence-driven "Four-Chain-in-One" model encompassing low-carbon breeding, green processing, smart logistics, and carbon-labeled branding. This model extends discussion of green industry-chain reconstruction to the county level. In response to Wulian County's limited industrial and digital capabilities, the study further proposes a three-stage roadmap comprising pilot demonstration, standard promotion, and region-wide replication. From a practical perspective, it identifies technology needs and explores mechanisms for improving information sharing, resource integration, and the adoption of low-carbon practices across the industry chain. These proposals provide an implementation framework for Wulian County and potentially for other hilly counties undergoing similar transitions.

The study aims to assess the current status and key bottlenecks of low-carbon development in Wulian County's mutton sheep industry, formulate a digital-intelligence-enabled emission-reduction framework, construct a "Four-Chain-in-One" model, and propose a three-stage implementation roadmap. In 2025, the research team conducted fieldwork in Wulian County, collecting 116 valid questionnaires and completing 18 in-depth interviews with farmers, cooperatives, slaughtering and processing enterprises, cold-chain logistics firms, and government authorities. The analysis is organized around four stages: green diagnosis, technology integration, model construction, and implementation planning. Its objective is to offer an adaptable framework for the green transformation of Wulian County and similar county-level livestock industries.

1.1. Research on the Low-Carbon Transformation of the Livestock Industry

In recent years, the low-carbon transformation of the mutton sheep industry has attracted increasing academic attention. Wang and He (2021) examined how digital technology can reshape livestock production and support a low-carbon transition. Zhang et al. (2025) discussed the use of a smart livestock platform to support the coordination of harmless treatment and insurance

mechanisms. Hu and Wang (2020) assessed carbon emissions in China's livestock sector and discussed emission-reduction pathways. Together, these studies provide perspectives on technological mechanisms, platform-based governance, and carbon-emission reduction.

1.2. Research on the Digital Transformation of County-Level Livestock Industries

Research on the digital transformation of livestock production has expanded rapidly, with particular attention to technology systems, implementation mechanisms, and industry-chain integration. Li and Wang (2023) reviewed key technologies and development prospects in smart animal husbandry. Li et al. (2020) examined international experience with climate-smart agriculture and its implications for China. Ma et al. (2024) discussed greenhouse gas emissions from large-scale breeding operations and the application of digital monitoring technologies. Yu and Zhang (2023) explored the mechanisms and implementation pathways of digital transformation across agricultural industry chains. These contributions inform the proposed integration of digital technologies with low-carbon livestock development.

2. Status Diagnosis

2.1. Survey Design

The survey targeted key stakeholders in the mutton sheep industry chain of Wulian County, Shandong Province, including farmers, cooperatives, slaughtering and processing enterprises, cold-chain logistics companies, and township animal husbandry and veterinary stations. It covered upstream, midstream, and downstream activities and organizations of different sizes to capture current conditions and challenges in the green transition. In-depth interviews with production managers, technical extension personnel, and enterprise executives provided contextual information for problem diagnosis and model development. Drawing on green supply chain management and low-carbon livestock transition research, the survey covered five dimensions: industrial foundation and digital maturity; life-cycle efficiency and emissions; digital–green technology needs; supply chain collaboration and information barriers; and green reconstruction benefits and support potential. The questionnaire contained 30 items. Table 1 presents the indicator system used in the survey.

Table 1. Indicator System for the Survey Questionnaire

Primary Indicator	Secondary Indicator
Industrial Foundation and Digital Maturity	Structure of operating entities
	Penetration rate of digital equipment
	Degree of data standardization
	Availability of interdisciplinary talent
	Emissions from feed production and breeding

Primary Indicator	Secondary Indicator
Life-Cycle Efficiency and Emissions	Energy consumption density in processing
	Carbon emissions in cold-chain logistics
	Environmental performance at retail outlets
Digital–Green Technology Needs	Adaptability of low-carbon breeding technology
	Adaptability of energy-saving processing technology
	Adaptability of smart logistics technology
Supply Chain Collaboration and Information Barriers	Willingness of entities to share data
	Capacity for organizational adaptation
	Benefit distribution mechanism
Benefits of Green Reconstruction & Support Potential	Economic feasibility expectations
	Contribution to brand price premiums
	Responsiveness to policy and regulations

2.2. Questionnaire Distribution and Collection

In 2025, the research team conducted fieldwork in Wulian County and visited organizations including Chaoyang Animal Husbandry Co., Ltd., Orchard Headquarters Group, and Shunjing Agricultural and Livestock Family Farm. The questionnaire was designed around the five dimensions described above. Table 2 shows the distribution of the 30 questions across these dimensions.

Table 2. Distribution of Questionnaire Items Across the Five Dimensions

Corresponding Primary Dimension	Question Numbers
Industrial Foundation and Digital Maturity	Q3, Q4, Q5, Q6, Q7, Q8, Q9
Life-Cycle Efficiency and Emissions	Q10, Q11, Q12, Q13, Q14, Q15
Digital–Green Technology Needs	Q16, Q17, Q18, Q19, Q20, Q21, Q22
Supply Chain Collaboration and Information Barriers	Q23, Q24, Q25
Benefits of Green Reconstruction & Support Potential	Q26, Q27, Q28, Q29, Q30

A total of 116 questionnaires were distributed, and all 116 were returned and deemed valid, yielding a valid response rate of 100%. In addition, 18 in-depth interviews were conducted with representatives of government departments, research institutions, leading enterprises, and family

farms. After data entry and cleaning, inconsistent responses and missing values were reviewed. Internal consistency was assessed using SPSS, yielding an overall Cronbach's alpha of .905. The Kaiser–Meyer–Olkin (KMO) measure was .876, and Bartlett's test of sphericity was statistically significant ($p < .001$). Questionnaire responses and interview transcripts were also compared to support triangulation between quantitative and qualitative findings.

2.3. Interview Framework

To investigate the causes of structural challenges in Wulian County's green transition, the interviews focused on four stakeholder groups: government officials, researchers and academics, leading enterprises, and local family farms. Table 3 summarizes the interview framework.

Table 3. Interview Framework Matrix

Interview Target	Interview Objective	Interview Core Topics
Officials from Wulian County Bureau of Agriculture and Rural Affairs & Bureau of Commerce	Clarify the implementation feasibility of top-level designs for green low-carbon transitions.	Strategic integration, infrastructure planning, carbon footprint oversight, and incentive mechanisms.
Researchers and university professors	Validate the cutting-edge nature of the "technical adaptation" solutions and the accuracy of the LCA model.	Algorithm empowerment, precision feeding, carbon labeling technology, and green standards.
Management of Shandong Chaoyang Animal Husbandry and Orchard Headquarters Group	Verify the return on investment (ROI) and practical barriers of the integrated "breeding + processing + logistics" model in business operations.	LCA evidence, cost–benefit trade-offs, collaboration barriers, and brand value creation.
Owners of Shunjing Family Farm and independent smallholders	Assess the suitability of lightweight digital tools and incentives for smallholders to participate in low-carbon transition.	Technical thresholds, emission reduction drivers, practical constraints, and profit-sharing mechanisms.

2.4. Diagnosis of Current Conditions and Key Problems

(1) Industrial Foundation and Digital Maturity

Figure 1 summarizes the survey findings on the industrial foundation and digital maturity of Wulian County's mutton sheep industry.

As shown in Figure 1, 78.45% of breeding operations are run by individual smallholders, and more than half of respondents report using no digital equipment. Nearly 80% report a lack of data connectivity between industry-chain segments, while shortages of personnel with combined technical and managerial skills are also evident. These findings reflect a fragmented industry structure characterized by small-scale operations, limited organizational integration, low adoption of digital equipment, inconsistent data standards, and information silos. Together, these constraints

limit the sector's capacity to implement detailed carbon management and complicate the transition to low-carbon production.

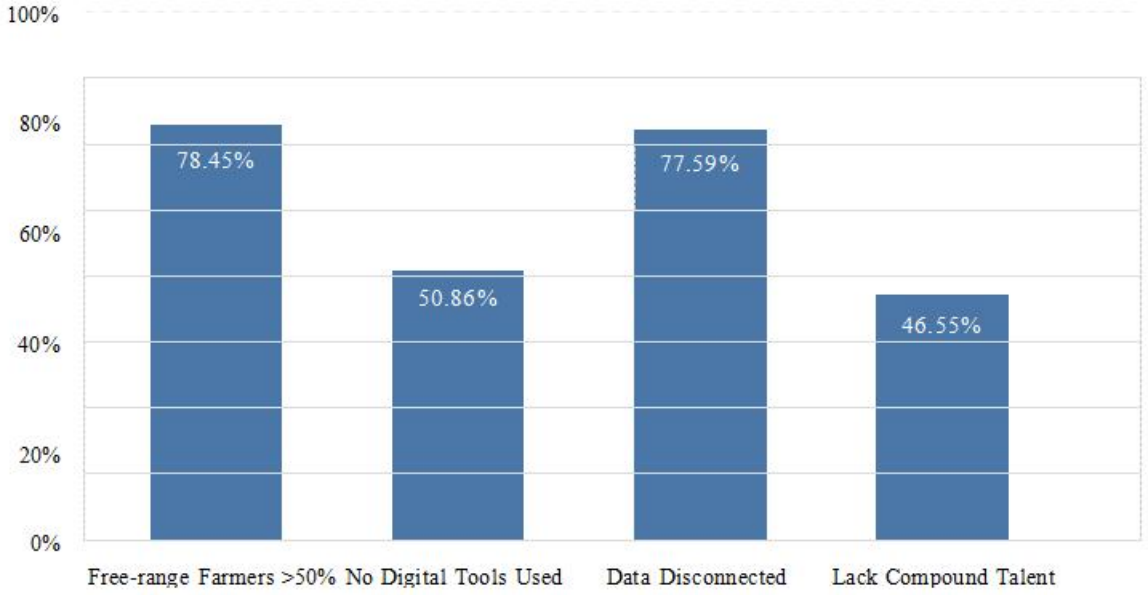


Figure 1. Industrial Foundation and Digital Maturity in Wulian County

(2) Life-Cycle Efficiency and Emissions

Interviews suggest that the limited utilization of mutton sheep by-products contributes to lower resource efficiency and higher emission intensity across the industry chain. Figure 2 presents the survey findings for this dimension.

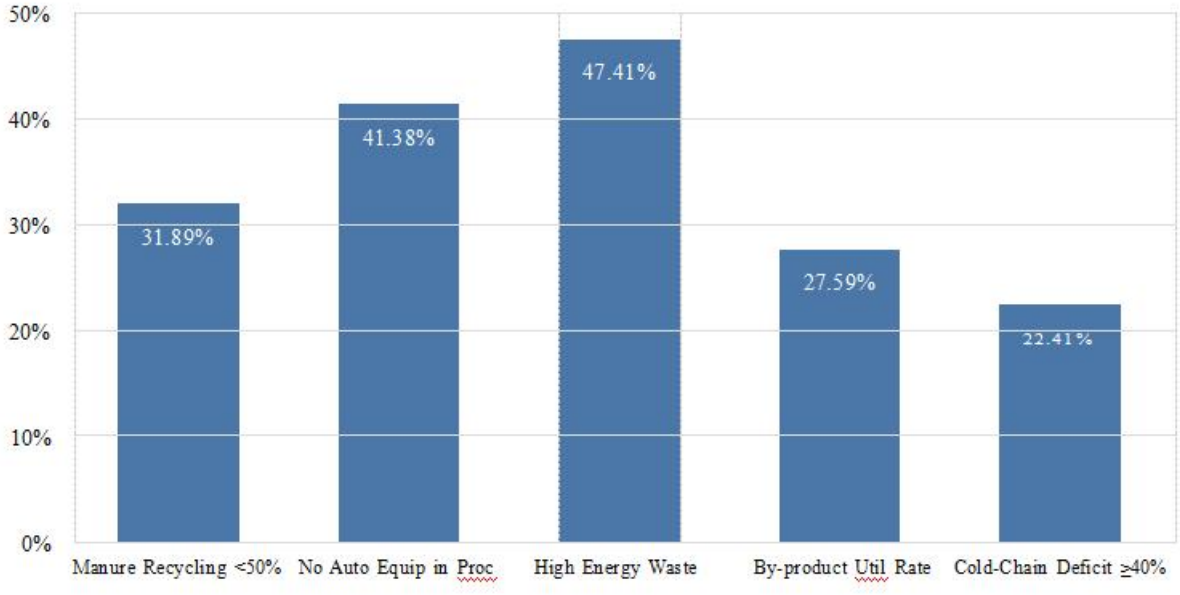


Figure 2. Life-Cycle Energy Efficiency and Emissions in the Mutton Sheep Industry Chain

Figure 2 indicates that breeding is a major source of emissions along the industry chain. Under prevailing free-range practices, manure collection and recycling remain limited, indicating insufficient waste-management capacity. In processing, fewer than half of facilities use automated equipment, and the utilization rate of by-products such as bones and blood is below 30%, increasing waste and limiting value added through further processing. In logistics, cold-storage capacity is

reported to fall short of demand by 40%, while continuous temperature monitoring remains limited. The study estimates an average product carbon footprint 15% above the referenced advanced-industry benchmark, underscoring the challenges of integrated low-carbon management.

(3) Digital–Green Technology Needs

Figure 3 presents the reported demand for digital and green technologies among industry-chain stakeholders in Wulian County.

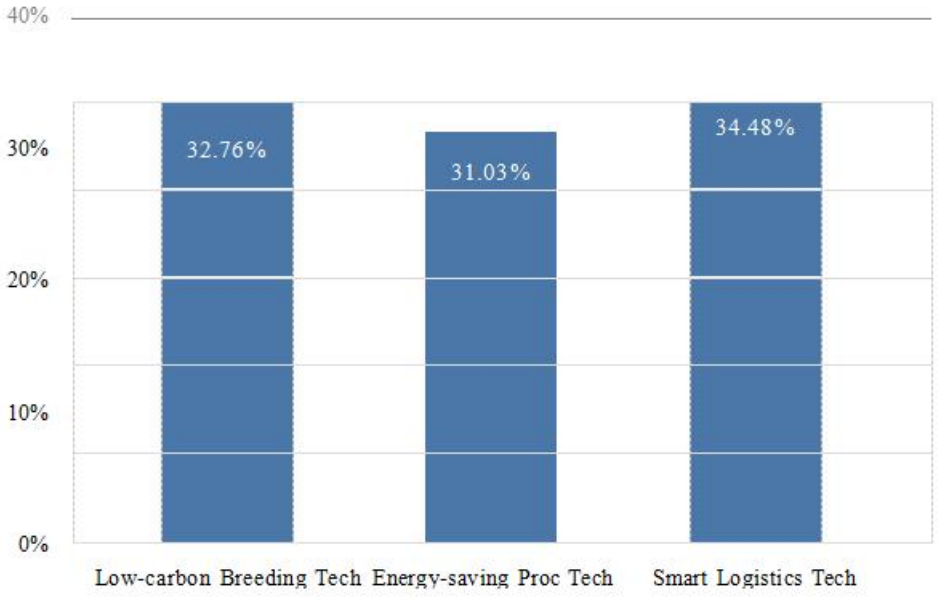


Figure 3. Demand for Digital–Green Technologies

As shown in Figure 3, the reported demand for low-carbon breeding technologies, energy-saving processing, and smart logistics management is 32.76%, 31.03%, and 34.48%, respectively. Interviews with the director of Wulian Shunjing Family Farm and the supply chain director of Shandong Chaoyang Animal Husbandry Co., Ltd. nevertheless suggest a mismatch between commercially available solutions and local conditions. Breeders need affordable, easy-to-use precision-feeding systems; processors require intelligent scheduling and higher-value utilization of by-products; and logistics firms need temperature monitoring and vehicle tracking throughout distribution. Existing commercial platforms are often designed for large-scale intensive operations, leaving a gap in affordable, lightweight options for small- and medium-sized operators.

(4) Supply Chain Collaboration and Information Barriers

Figure 4 presents respondents' willingness to share data and their perceptions of collaboration barriers. As shown in Figure 4, 56% of respondents indicated that they were either "highly willing" or "willing" to share data, suggesting potential for collaboration. However, interviews with farm owners indicate that governance constraints, rather than technology alone, impede cooperation. Unclear data ownership, valuation, and exchange arrangements limit opportunities to derive economic value from data. Concerns about data security, the absence of formal benefit-sharing mechanisms, and low trust between organizations further discourage stakeholders from sharing operational records. As a result, the county-level supply chain remains geographically concentrated but poorly connected, hindering life-cycle carbon tracking and coordinated emission reduction.

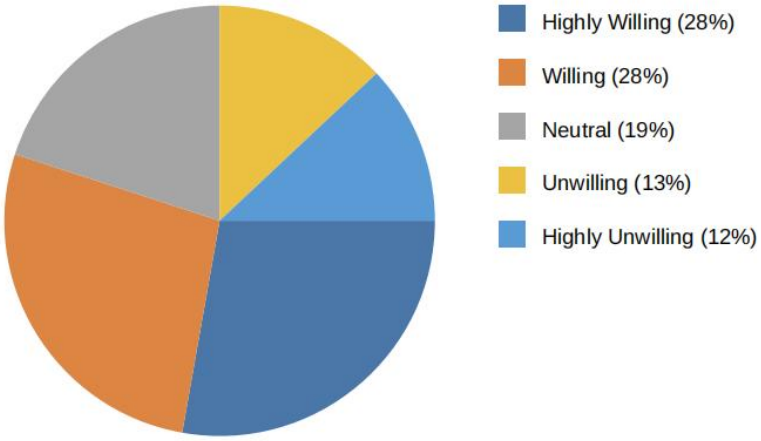


Figure 4. Willingness to Share Data and Perceived Information Barriers

(5) Benefits of Green Reconstruction and Support Potential

Figure 5 summarizes perceptions of economic feasibility, potential benefits, and policy support.

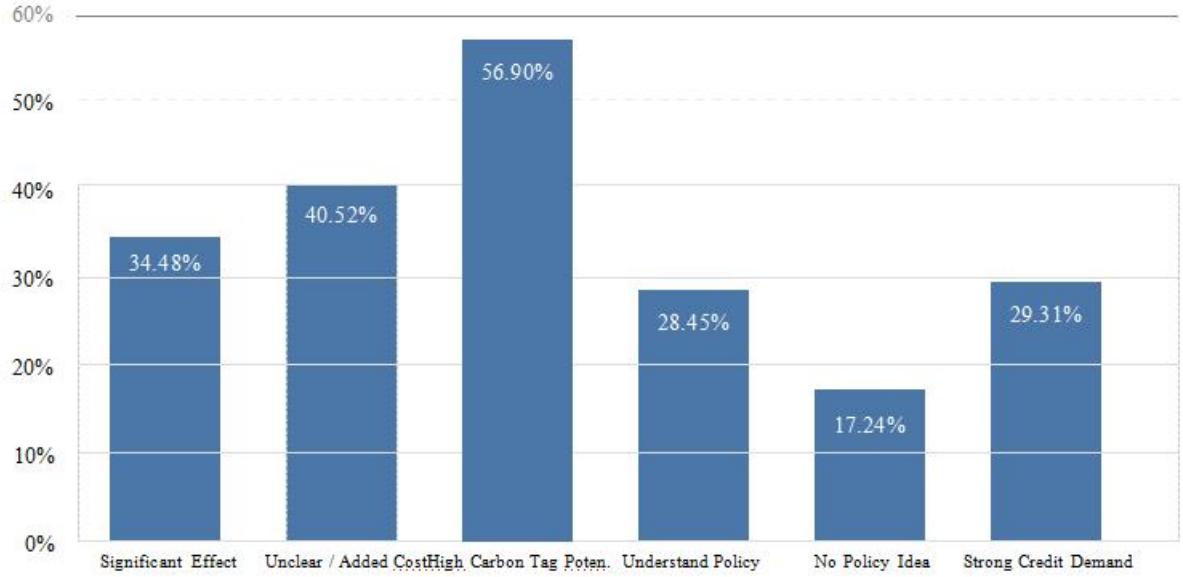


Figure 5. Perceived Benefits of Green Reconstruction and Support Needs

Figure 5 shows that more than half of respondents recognize the potential for carbon labeling to generate a price premium. However, respondents reporting uncertain benefits or increased costs from previous digital investments outnumber those reporting substantial positive effects. These findings suggest that smallholders may be reluctant to invest without clear short-term returns, highlighting the need for targeted financial support and locally validated pilot projects.

3. Technology Integration

Drawing on the literature and interviews with industry experts, this study proposes an integrated technical framework for digitally enabled emission reduction across the mutton sheep industry chain. Figure 6 summarizes the proposed architecture.

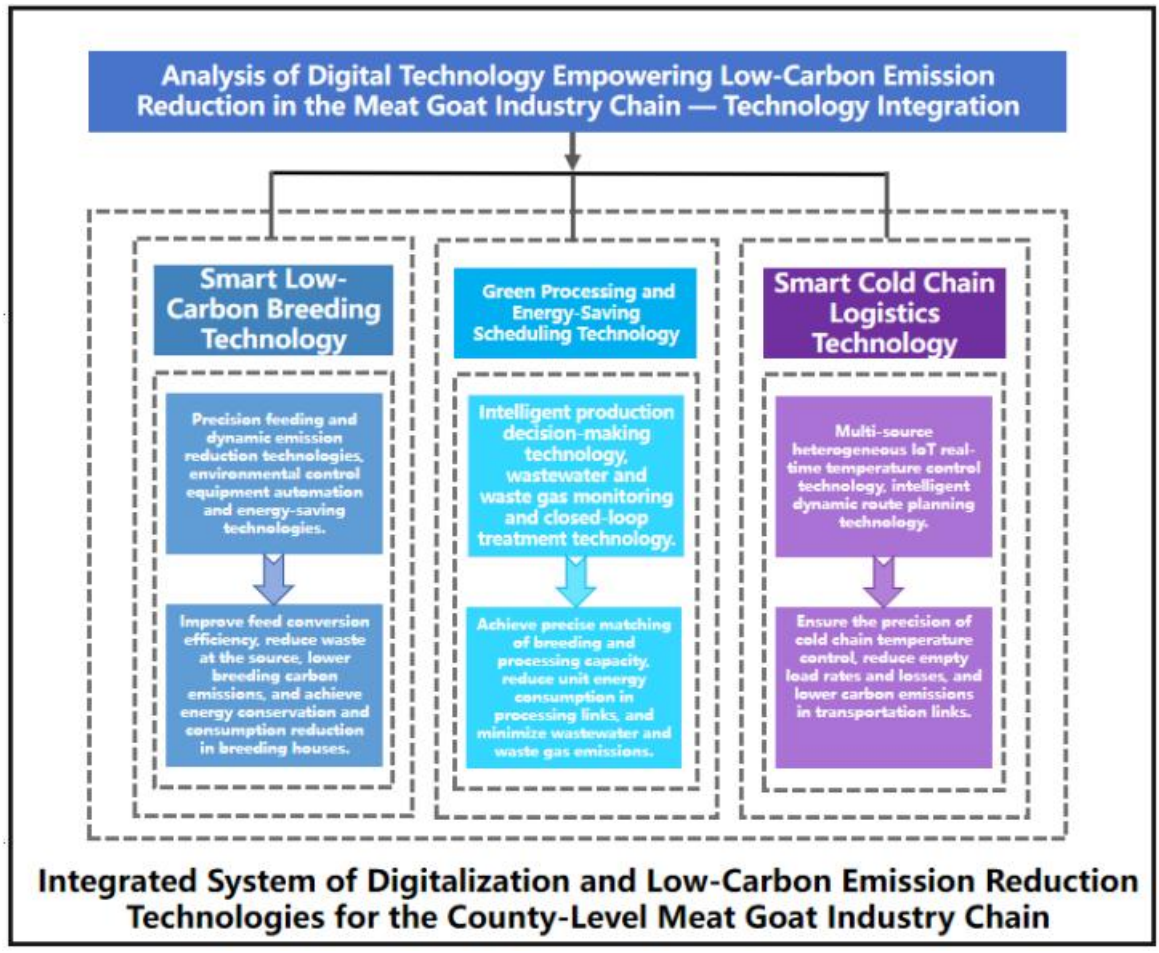


Figure 6. Proposed Digital-Intelligence Architecture for Emission Reduction

3.1. Smart Low-Carbon Breeding Technology

Drawing on the industry-chain assessment and consultations with experts from the Institute of Automation, Chinese Academy of Sciences, this study proposes a system for dynamically balancing feed formulations according to individual animal growth requirements. Edge-based Internet of Things (IoT) sensors would collect physiological indicators and metabolic data to support real-time adjustments to feed composition. The proposed approach aims to improve feed conversion efficiency while reducing enteric methane emissions and nitrogen and phosphorus excretion. An automated barn-environment management system would also monitor temperature, humidity, ammonia, and CO_2 concentrations and adjust ventilation, heating, and lighting to meet animal welfare requirements. These measures are intended to improve energy efficiency and reduce farm-level emissions.

3.2. Green Processing and Energy-Efficient Scheduling

For processing operations, the proposed framework combines intelligent production scheduling with automated pollution monitoring. Regional transaction data would be used to forecast the timing and volume of livestock deliveries, allowing slaughtering and processing facilities to align throughput with supply and reduce equipment idling and unnecessary energy consumption. At the same time, an online sensor network would monitor wastewater chemical oxygen demand (COD) and relevant gaseous pollutants as part of a closed-loop treatment system. The intended outcomes

are better compliance with environmental requirements, more effective by-product recovery, and lower processing-related emissions.

3.3. Smart Cold-Chain Logistics Technology

For logistics, the framework combines IoT-based temperature monitoring with dynamic route optimization. Sensors would track conditions inside refrigerated containers and issue real-time alerts when temperatures deviate from specified ranges, helping preserve product quality and reduce spoilage. These data would be integrated with vehicle locations and traffic conditions to optimize delivery routes, reduce empty travel, limit refrigeration fuel consumption, and lower emissions per tonne-kilometer.

4. Model Innovation

Integrating the findings from the diagnostic assessment and technical framework, the study proposes a "Four-Chain-in-One" model for reconstructing the county-level industry chain. Figure 7 illustrates the proposed structure.

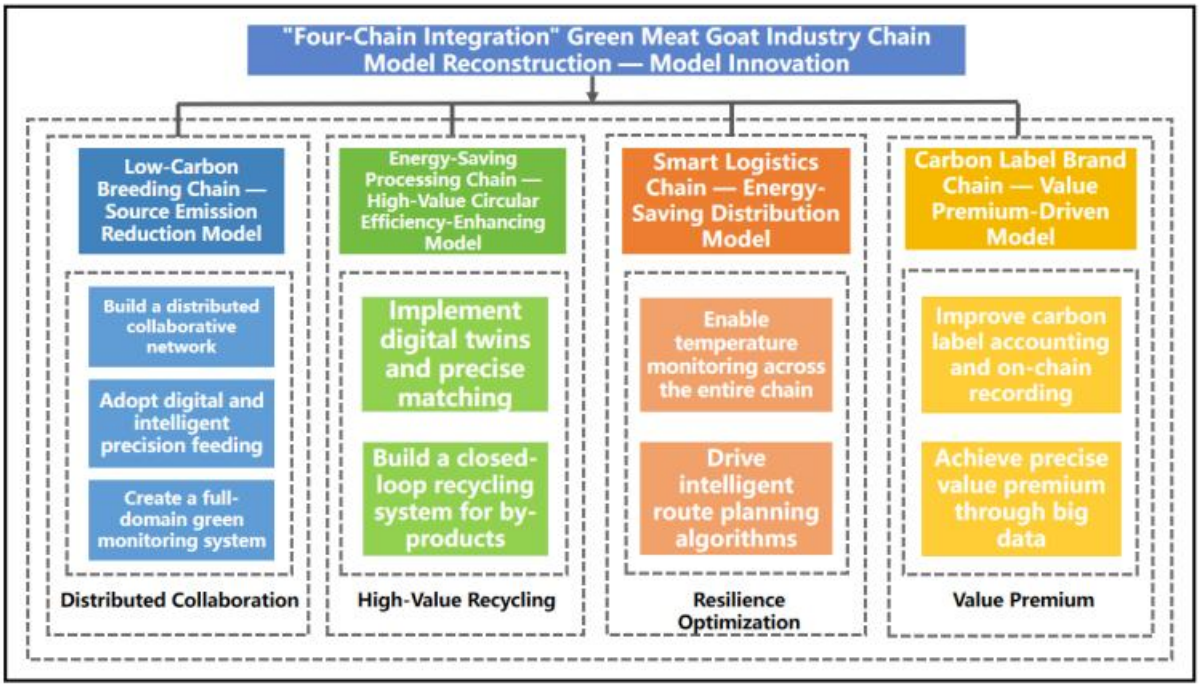


Figure 7. Proposed "Four-Chain-in-One" Green Supply Chain Model

4.1. Low-Carbon Breeding Chain: Source Reduction Model

The field assessment suggests that breeding accounts for more than 60% of carbon dioxide equivalent emissions across the industry chain. The proposed model links leading enterprises, a shared cloud platform, and cooperative family farms. Enterprises such as Chaoyang Animal Husbandry would supply standardized breeding practices and green feeding protocols to local smallholders. Data collected through edge devices would support precision feeding and efforts to reduce enteric emissions. Field-based model estimates suggest that this arrangement could increase net earnings by approximately RMB 350 per sheep, potentially aligning environmental and economic incentives.

4.2. Energy-Efficient Processing Chain: High-Value Circular Model

Local slaughtering activities are currently concentrated on basic processing, while the reported rate of comprehensive by-product utilization is below 20%. To address this limitation, the proposed model integrates production scheduling with resource recovery. A digital twin would represent processing operations and match incoming livestock grades to appropriate orders. Historical production data would inform scheduling decisions, reducing equipment idling and unnecessary electricity use. At the same time, improved treatment and recovery of materials such as bones and blood could increase the value obtained from by-products. The model sets a target of raising the comprehensive by-product utilization rate from below 20% to above 80%.

4.3. Smart Logistics Chain: Eco-Friendly Routing Model

To address the reported temperature-monitoring coverage of less than 35% and a 40% cold-storage capacity deficit, the model proposes end-to-end temperature management. IoT sensors would track conditions during transportation, helping prevent spoilage and associated losses. Geographic information system (GIS) data and dynamic dispatch tools would support route optimization. The model estimates a potential 18% reduction in fleet fuel consumption, with corresponding improvements in logistics efficiency and resilience.

4.4. Carbon-Labeled Brand Chain: Value-Premium Model

The carbon-labeled brand chain is intended to create market incentives for adopting low-carbon technologies. The proposed system would track emissions across feed production, breeding, processing, and distribution, with records stored on a blockchain-based ledger. Verified emissions information could support carbon labeling for the "Wulian Black Sheep" brand and make low-carbon performance more visible to consumers. Market analysis could then help target consumers willing to pay a green premium, supporting a reinforcing cycle of emission reduction, efficiency improvement, and reinvestment.

5. Implementation Roadmap

Based on the proposed technologies and organizational model, and informed by interviews with the Wulian County Bureau of Agriculture and Rural Affairs, the study outlines a three-stage implementation roadmap: pilot demonstration, standard promotion, and region-wide replication.

5.1. Pilot Demonstration Phase

The first phase would use the production facilities and research partnerships of Shandong Chaoyang Animal Husbandry Co., Ltd. to pilot selected technologies under local conditions. IoT sensors and automated environmental controls would be deployed to assess the effects of precision feeding on enteric emissions. Life cycle assessment indicators would establish baseline measurements across feed production, breeding, processing, and transportation. The resulting data would support a county-level baseline carbon database and subsequent performance evaluation.

5.2. Standard Promotion Phase

The second phase would involve collaboration with the Institute of Automation, Chinese Academy of Sciences, and other research partners to improve data processing and model design. Common data interfaces, communication standards, and low-carbon reporting protocols would be introduced to facilitate information exchange between organizations. System specifications would

cover activities from feed-source tracking to by-product recovery. This phase would promote horizontal integration and vertical upgrading while addressing data ownership and transfer constraints.

5.3. Region-Wide Replication Phase

In the third phase, local policy instruments, including the Digital Economy Development Incentive Measures, would support the broader integration of carbon reduction into industrial upgrading. Affordable, modular cloud-based and mobile tools would be offered to individual smallholders to reduce the financial and technical barriers to participation. Connecting product traceability and verified carbon information with carbon-labeled marketing could help extend the proposed model across Wulian County.

6. Conclusions and Recommendations

6.1. Main Conclusions

National policies linking agricultural modernization with China's "dual carbon" objectives provide an institutional context for the green transition of the county-level mutton sheep industry. Although local measures offer subsidies and training, implementation barriers remain. The "Four-Chain-in-One" model proposed in this study aims to connect measurable emission reduction with economic value creation. The field assessment identifies a fragmented industry structure, low life-cycle resource efficiency, limited digital adoption, and weak coordination among stakeholders. Although demand for digital technologies exists, unclear data rights and benefit-sharing arrangements present important barriers. Technology adoption alone is therefore insufficient; technical, organizational, and institutional innovation must be coordinated. The study also proposes three complementary mechanisms: horizontal integration through shared data infrastructure, vertical upgrading through improved processing and market information, and the inclusion of family farms through affordable digital tools. Together, these mechanisms could support a more integrated and inclusive industry chain. The three-stage roadmap and four supporting areas—infrastructure, data standards, coordination mechanisms, and policy guarantees—provide a structured approach to implementation.

6.2. Research Recommendations

As an exploratory single-case study, the applicability of the findings to other counties requires further examination. Several projected emission reductions and economic benefits, including an increase of approximately RMB 350 in earnings per sheep and an 18% reduction in logistics fuel consumption, are based on interviews and models rather than longitudinal field validation. Further research should also examine institutional questions involving data ownership, benefit distribution, and trust between organizations. Comparative studies across regions and livestock sectors could help assess the transferability of the framework. Game-theoretic approaches and agent-based modeling (ABM) may offer insights into the co-evolution of technological and institutional arrangements, particularly the allocation of data rights and green premiums. Future work should consider effects on rural governance and inclusive development to ensure that smallholders can participate in digital transformation. The potential of low-cost generative AI tools in county-level agricultural systems also warrants investigation.

Author Contributions:

Chenghan Ruan: Conceptualization; methodology; investigation; formal analysis; writing—original draft; writing—review and editing; supervision; project administration. Jiahe Zhang: Methodology; investigation; data curation; formal analysis; visualization; writing—review and editing. Yibo Wang: Literature review; investigation; methodology; formal analysis; data curation; writing—review and editing. Qianxi Hu: Investigation; data curation; methodology; visualization; writing—review and editing. All authors have read and approved the final manuscript.

Funding:

This work was supported by the "City New Star" Program (National Undergraduate Training Program for Innovation and Entrepreneurship) through the project "Research on the Digital Technology-Driven Restructuring and Upgrading of the County-Level Mutton Sheep Industry Chain: A Case Study of Wulian County, Shandong Province."

Institutional Review Board Statement:

Not applicable.

Informed Consent Statement:

Not applicable.

Data Availability Statement:

The raw data supporting the conclusions of this article will be made available by the authors on request.The original data presented in the study are openly available in SPSS athttps://www.ibmspss.cn/download.ht

Acknowledgments:

This research was completed under the meticulous guidance of Professor Cao Wei.Professor Cao provided detailed guidance and valuable suggestions throughout the entire process, from research ideas and methodology design to thesis writing, for which I express my sincere gratitude. At the same time, I would like to thank the 'Urban Rising Star Program' training project of Beijing City University for its funding and support of this research, and I am also grateful for the joint efforts and dedication of all members of the project team.

Conflict of Interest:

The authors declare no conflict of interest.

References

Hu, X., & Wang, M. (2020). Carbon emissions of China's livestock husbandry: Stage characteristics, decoupling effects and emission reduction pathways. Chinese Rural Economy, (7), 86–104.

Huang, R., & Li, M. (2025). Analysis of mechanism and implementation path of agricultural green transformation driven by digital economy. Northeast Agricultural Sciences, 50(6), 204–208, 239.

Leng, H., & Li, J. (2025). Research on countermeasures for digital development of animal husbandry in Shandong Province. Rural Forum, (6), 87–91.

Li, D., & Wang, C. (2023). Current situation and prospects of smart animal husbandry. Transactions of the Chinese Society of Agricultural Engineering, 39(11), 1–12.

Li, L., Liu, Y., Wang, H., & Bai, Z. (2020). Research on international experience of climate-smart agriculture and China's development strategy. World Agriculture, (12), 70–78. https://doi.org/10.13856/j.cn11-1097/s.2020.12.008

Liu, J. (2025). Facing rural revitalization: Analysis of full-chain industrial digital transformation of animal husbandry. Feed Research, 48(15), 190–194.

Ma, Q., Zhang, Y., et al. (2024). Characteristics of greenhouse gas emissions from large-scale breeding farms and application of digital monitoring technology. Journal of Agricultural Resources and Environment, 41(2), 312–321.

Sui, H., & Hu, H. (2025). Application of digital intelligent breeding system in livestock husbandry. Livestock Environment, (12), 136–137.

Wang, J., Yin, S., Han, H., & Ren, Z. (2025). Discussion on methods and paths for developing green and low-carbon livestock husbandry. Breeding and Feed, 24(5), 115–118. https://doi.org/10.13300/j.cnki.cn42-1648/s.2025.05.030

Wang, Y., & He, K. (2021). Technical logic and policy support of agricultural carbon emission reduction: From the perspective of livestock husbandry. Journal of Huazhong Agricultural University (Social Sciences Edition), (3), 45–53.

Xu, D. (2024). Current situation, problems and countermeasures of livestock husbandry development in Henan Province from the perspective of low carbon. Southern Agriculture, 18(16), 88–90.

Xu, M., Yao, X., & Dong, H. (2024). Green and low-carbon development status, problems and countermeasures of animal husbandry in Danjiangkou City. Central South Agricultural Science and Technology, 45(2), 97–101.

Yu, L., & Zhang, S. (2023). Internal mechanism and realization path of digital transformation of agricultural industrial chain. China Soft Science, (S1), 210–218.

Zhang, L., Zhoushu, N., Wang, S., et al. (2025). Construction of harmless treatment and insurance linkage mechanism based on smart livestock platform. Agricultural Engineering Technology, (8), 26–27.

License: Copyright (c) 2026 Author.
All articles published in this journal are licensed under the Creative Commons Attribution 4.0 International License (CC BY 4.0). This license permits unrestricted use, distribution, and reproduction in any medium, provided the original author(s) and source are properly credited. Authors retain copyright of their work, and readers are free to copy, share, adapt, and build upon the material for any purpose, including commercial use, as long as appropriate attribution is given.