

# Research on the Impact of Green Technology Innovation by Muyuan Group on Corporate Performance

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**Abstract:** Against the backdrop of global climate change and tightening resource constraints, sustainable agricultural development has emerged as a central issue for countries worldwide in addressing environmental challenges. As a major agricultural nation, China's livestock industry accounts for over 35% of the total agricultural output value, serving as a crucial pillar for ensuring national nutritional security and rural economic development. However, traditional farming models have long relied on high-density rearing, excessive use of chemical inputs, and end-of-pipe pollution control measures. These practices have resulted in greenhouse gas emissions accounting for 45% of the agricultural total, an annual generation of over 3 billion tons of livestock manure, and a resource utilization rate of less than 60%. This "high-input, high-emission, low-efficiency" development path has not only exacerbated ecological issues such as soil degradation and water eutrophication but also undermined the industry's international competitiveness and consumer trust due to food safety hazards like antibiotic residues and heavy metal contamination. In this context, Muyuan Group has actively pursued green technology innovation to achieve simultaneous enhancement of economic and ecological benefits.

**Keywords:** Corporate performance; Green technology innovation; Livestock farming

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## 1. Literature Review

### 1.1. Impact of green technology innovation on corporate economic performance

Most scholars generally agree that green technology innovation significantly promotes corporate economic performance in terms of economic outcomes. However, a small number of scholars hold the opposite view. Using a sample of Shanghai and Shenzhen A-share listed companies from 2007 to 2021, Guo found that green technological innovation can significantly enhance a company's economic performance, leading to an increase in its return on assets<sup>[1]</sup>. Based on her research, Miao concluded that the implementation of green technological innovation has multiple positive impacts on the performance of highly polluting enterprises<sup>[2]</sup>. Nevertheless, Zhou

posited that the process of technological innovation undergoes significant dynamic changes, and investment in innovation does not always directly result in improved corporate performance <sup>[3]</sup>.

## **1.2. The impact of green technological innovation on corporate environmental performance**

Current research generally agrees that green technological innovation significantly and positively promotes environmental performance. Zhai believes that it helps companies reduce the costs of complying with environmental regulations, thereby avoiding substantial fines and reputational damage that may result from non-compliance <sup>[4]</sup>. Xue et al. argued that by optimizing production processes and introducing advanced energy-saving equipment, companies can effectively enhance energy efficiency and reduce resource waste <sup>[5]</sup>.

## **1.3. The impact of green technological innovation on corporate social performance**

Green technological innovation significantly and positively influences social performance through multiple pathways, such as enhancing corporate image, strengthening environmental compliance, optimizing resource utilization efficiency, promoting harmonious stakeholder relationships, and driving sustainable social development. Zhang et al. found that implementing green innovation strategies can effectively enhance a company's reputation, gain social recognition, and thereby promote its long-term development <sup>[6]</sup>.

# **2. Overview of green technological innovation at Muyuan**

## **2.1. Company introduction**

Muyuan Foods Co., Ltd. was established in 1992 and successfully went public in 2014. Nowadays, the company has established a full-chain pork industry layout that encompasses feed processing, pig breeding, pig farming, and slaughter processing. Guided by the core vision of “enabling people to eat safe pork,” Muyuan has always been dedicated to supplying society with high-quality pork products that are safe, delicious, and healthy, thereby helping to enhance the quality of life for the public and safeguarding their wonderful lives. The company has delved deeply into its primary pig farming business and innovatively adopted a “fully self-bred, full-chain, and intelligent” farming model. This approach has not only achieved industrialized production and information-based management in pig farming but also steadily advanced towards intelligent upgrades.

## **2.2. Drivers of green technological innovation**

### **2.2.1. External drivers**

The external drivers of green technological innovation are as outlined below:

- (1) Pressure from policy regulations, as the global attention to environmental issues has been continuously rising, and China has also placed increasing importance on green development and environmental protection. Against this backdrop, the government has successively introduced a series of supportive policies aimed at promoting green technological innovation. Following the proposal of the national “dual carbon” goals, Muyuan has further reduced carbon emissions through measures such as promoting low-soybean-meal diets and constructing distributed photovoltaic power stations to meet policy requirements;
- (2) Market demand compels green technological innovation, where with the upgrading of the consumer market, consumer demand for pork products has shifted from basic supply to a high degree of concern for quality, safety, low carbon emissions, environmental protection, and sustainability. The market share of high-end organic meat products has expanded with significant premiums. At the same time, society's tolerance for

farming pollution has decreased, with environmental regulations and public oversight exerting dual pressures. To meet market demand for “zero-emission, odor-free, and low-carbon footprint” products and seize premium opportunities in the high-end market, Muyuan Group has had to engage in green technological innovation;

- (3) Increased market access thresholds in overseas markets such as Vietnam have stringent environmental protection standards for farming. To expand its international business through technology exports, Muyuan Group must comply with local environmental regulations. For example, the solutions provided by Muyuan to Vietnam’s BAF company for pig farm design, biosecurity, environmental protection, and other aspects all need to comply with international green standards, which compels the company to continuously improve its technological capabilities.

### **2.2.2. Internal drivers**

The internal drivers of green technological innovation are as follows:

- (1) Strategic positioning, whereby Muyuan Group has elevated green and low-carbon practices to a long-term strategic priority for the enterprise, clearly setting the “five environmental protection steps” goal of “zero emissions, no hidden dangers, no odors, reduction of smog, and carbon reduction,” and establishing a full life-cycle carbon management system covering feed, breeding, and waste treatment;
- (2) The breeding industry faces cost pressures from multiple aspects, with feed costs being one of the primary sources. Feed accounts for as much as 60%–70% of the total breeding costs. In 2025, soybean meal prices increased by 28% year-on-year, and corn futures prices broke through the 3,000 Chinese Yuan/ton mark, significantly increasing breeding costs;
- (3) The costs of disease prevention and control cannot be overlooked. In recent years, frequent outbreaks of diseases have required breeding farms to increase investments in disinfection, isolation, and vaccines;
- (4) Small and medium-sized breeding farms may also experience higher incidence rates due to inadequate facilities and extensive management, further increasing treatment costs and breeding cycles;
- (5) Strict environmental protection policies have imposed additional expenses on the breeding industry, such as the transformation of manure treatment facilities. Failure to meet standards may result in fines or business suspensions for rectification.

Coupled with rental costs arising from land circulation and systemic costs caused by outdated supporting facilities and inadequate infrastructure, breeding costs remain high. Traditional breeding models face challenges such as high feed costs, significant losses from diseases, and high environmental governance expenses. Green technological innovation has become the key to overcoming cost dilemmas.

## **2.3. Current status of green technological innovation at Muyuan Group**

Muyuan Laboratory has developed a soybean meal-free diet solution using the concept of green synthetic biology. Without compromising animal production performance, it utilizes crystalline amino acids to achieve soybean meal-free feeding, reducing the breeding industry’s reliance on soybeans and enhancing the stability of the supply chain.

In terms of breeding technology innovation, Muyuan Group has innovatively developed and applied equipment such as intelligent feeding systems, intelligent inspection robots, and intelligent environmental control systems. These systems can dynamically adjust feed formulations based on the age and weight of pigs, ensuring precise feeding. At the same time, they can monitor the breeding environment and pig vital signs in real time, precisely regulating parameters such as temperature and humidity. Regarding air pollution, Muyuan has implemented the application of air-filtered pigsty technology. The air intake end utilizes a four-layer filtration

system, achieving a virus interception rate of 99.3% and a sterilization and deodorization rate of 99.9%. This effectively prevents disease transmission and improves the surrounding environment of the breeding farms.

Muyuan Group has established an ecological model of crop-livestock integration, where pig manure and urine generated during the breeding process undergo solid-liquid separation and anaerobic fermentation. Biogas is reused as a clean energy source, while the liquid portion is converted into liquid fertilizer for surrounding farmland. Pig manure and biogas residue are made into organic fertilizers to meet the fertilization needs of cash crops. Muyuan Group operates over 1,100 breeding farms nationwide, and its established crop-livestock integration system processes 120 million tons of manure annually, serving 4.72 million acres of farmland and reducing chemical fertilizer usage by 154,600 tons. Additionally, the company has established an internal and external dual-cycle water resource utilization system, achieving 100% resource utilization of pig manure and urine, and cumulatively saving 179 million cubic meters of agricultural irrigation water. In terms of energy utilization, distributed photovoltaic power generation facilities have been constructed, promoting a “livestock-solar synergy” model with an annual power generation capacity exceeding 205 million kilowatt-hours and reducing carbon dioxide emissions by 108,400 tons.

The novel biodegradable material developed by the Muyuan Laboratory is recyclable, biodegradable, and has a relatively short degradation cycle. Its performance surpasses that of existing biobased materials on the market and has the potential to fully replace traditional petroleum-based materials in the future. The development of high-performance biobased degradable mulch film material has completed pilot-scale production and demonstration field mulching work.

### **3. Performance analysis of green technology innovation at Muyuan Group**

#### **3.1. Economic performance**

It is clear from **Table 1** that the core of Muyuan’s economic performance is reflected in the significant expansion of production capacity. In 2020, the company’s hog slaughter volume stood at 18.115 million head, which had surged to 71.602 million head by 2024, marking a nearly fourfold increase. Particularly after 2021, the growth rate accelerated noticeably, indicating a rapid release of production capacity.

This growth was largely attributable to the widespread application of integrated livestock-crop farming technology. This technology recycles livestock and poultry manure for use as a substitute for traditional chemical fertilizers, helping to reduce costs in the planting sector while also boosting crop yields, thereby providing strong support for the expansion of production capacity.

In terms of cost control, economic performance also showed positive changes. The unit breeding cost gradually declined from a peak of 2,750 Chinese Yuan per head in 2020 to 1,537 Chinese Yuan per head. Soybean meal, a primary component of pig feed that provides the protein source necessary for pig growth, is costly. Muyuan has continuously increased its research and development efforts into low-soybean diets, investing 143 million Chinese Yuan to promote their application. This has reduced soybean meal usage, lowered breeding costs, and also decreased the supply of excess nitrogen, thereby reducing nitrogen and nitrous oxide emissions, achieving simultaneous enhancement of economic and ecological benefits.

However, in terms of changes in operating revenue, economic performance exhibited a certain degree of instability. The operating revenue growth rate peaked at 178.31% in 2020 but subsequently experienced a fluctuating decline, even registering a negative growth rate of -11.19% in 2023. This was primarily due to the persistent sluggishness in the hog market in 2023, with hog prices plummeting significantly. This highlights the significant impact of external market conditions on economic performance. In 2024, market conditions improved, with a rebound

in market demand and an increase in hog prices. Consumers' willingness and ability to consume pork strengthened, enabling Muyuan to sell its hog products at better prices, thereby driving growth in operating revenue.

### 3.2. Environmental performance

Through technologies such as crop-livestock integration, amino acid substitution for soybean meal, non-heated pigsties, and air filtration, Muyuan has significantly reduced its carbon emissions. As shown in **Table 1**, the carbon emission intensity has been declining year by year since 2021. Even with a slight increase in 2024, the overall level remains stable. This indicates that green technological innovation has achieved remarkable results in reducing carbon emissions. Meanwhile, the energy consumption intensity has remained stable at around 0.2 over the past five years.

Muyuan has collaborated with local governments and research institutions to implement projects focused on soil improvement, terrestrial vegetation restoration, and biodiversity conservation. The area of improved saline-alkali land has increased from 130,000 mu in 2020 to 318,200 mu in 2024, showing a year-on-year increase. This reflects the positive role of the company's green technological innovation in ecological governance, particularly in saline-alkali land improvement, and contributes to the improvement of the ecological environment.

### 3.3. Social performance

Employee training expenditures were 200 million Chinese Yuan in 2020, decreased in 2021, and then increased year by year from 2022 to 2024, reaching 720 million Chinese Yuan in 2024. This demonstrates the company's growing emphasis on enhancing employee skills and development. By increasing training expenditures, the company supports employee growth and fulfills its social responsibilities. Despite fluctuations, the localization rate of employment has remained at a relatively high level overall, indicating the company's commitment to providing local employment opportunities and promoting local economic development. The number of agricultural technical services provided has increased from 4,000 in 2020 to 9,293 in 2024, reflecting the company's efforts to support agricultural technology promotion, industry development, and surrounding agricultural growth through the provision of agricultural technical services, thereby fulfilling its social service functions.

**Table 1.** Performance table of green technology innovation at Muyuan Group

| Performances                                   | 2020    | 2021    | 2022    | 2023    | 2024    |
|------------------------------------------------|---------|---------|---------|---------|---------|
| Economic performance                           |         |         |         |         |         |
| Slaughter volume (10k heads)                   | 1,811.5 | 4,026.3 | 6,120.1 | 6,381.6 | 7,160.2 |
| Unit breeding cost (Chinese yuan/head)         | 2,750   | 2,185   | 1,798   | 1,723   | 1,537   |
| Revenue growth rate                            | 178.31% | 40.18%  | 58.23%  | -11.19% | 24.43%  |
| Environmental performance                      |         |         |         |         |         |
| Carbon Emission Intensity                      | 0.48    | 1.05    | 1.00    | 0.964   | 1.461   |
| Energy consumption intensity (tce/ton product) | 0.17    | 0.21    | 0.23    | 0.20    | 0.20    |
| Improved saline-alkali land (10k mu)           | 13      | 18.52   | 22.44   | 22.95   | 31.82   |
| Social performance                             |         |         |         |         |         |
| Employee training expenditure (100 million)    | 2       | 1.28    | 5       | 7       | 7.2     |
| Local employment rate                          | 77.02%  | 74.90%  | 85.51%  | 75.98%  | 84.79%  |
| Agricultural technical services (times)        | 4,000   | 8,334   | 9,680   | 9,759   | 9,293   |

## 4. Conclusion

The practices of Muyuan Group demonstrated that green technological innovation is not only a fulfillment of environmental responsibilities but also a core driver for enhancing corporate performance. By transforming low-carbon goals into quantifiable technical indicators, resource recycling into cost advantages, and social values into brand premiums, Muyuan has constructed a sustainable development model that integrates “technology-economy-society” triple benefits. This model provides a replicable path for the transformation of traditional agriculture towards a green and low-carbon future.

## Disclosure statement

The authors declare no conflict of interest.

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