Recommendations for the Development of China's Swine and Feed Industries (Postprint)

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Date: 2023-03-19T00:00:00+00:00

Abstract

The pig industry is fundamental to national livelihood. The development of the feed industry provides impetus and assurance for the growth of the pig farming sector. This article addresses challenges confronting China's pig industry, including breed resource security, livestock product safety, environmental security, and low efficiency, and proposes recommendations focusing on breed resource security, developing an "environmentally friendly and resource-conserving" dual-type feed industry, and advancing antibiotic alternative technologies.

Full Text

Preamble

Policy & Management Research
ChinaXiv Partner Journal

Suggestions on the Development of China's Pig-Breeding and Feed Industries

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Abstract
The pig-breeding industry is vital to China's economy and people's livelihoods, while the feed industry provides the driving force and security for its growth. This article addresses critical challenges facing China's pig industry, including germplasm resource security, food safety, environmental safety, and low production efficiency. We propose focusing on germplasm resource protection, developing an environment-friendly and resource-efficient "two-type" feed industry, and advancing antibiotic replacement technologies.

Keywords: pig-breeding industry, germplasm resources, environmental safety, antibiotic replacement, probiotics

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Introduction

The year 2018 marked the inaugural year for implementing the spirit of the 19th CPC National Congress, a critical juncture for executing the 13th Five-Year Plan, and a pivotal period for deepening supply-side structural reforms. It was also a core year for addressing China's economic transition from high-speed to high-quality growth, guided by the five development concepts of innovation, coordination, green development, openness, and sharing. Against this policy backdrop, we examine development trends and dynamics in the pig-breeding and feed industries.

The Strategic Importance of Pig Industry Development

Pig farming is a pillar industry in Chinese agriculture and holds significant importance in the national economy, with an annual output value of approximately 1.7 trillion RMB—comparable to the automotive industry. As the world's largest pig producer and pork consumer, China accounts for 11.6% of total agricultural output value and 51% of total animal husbandry output value from pig production, with pork comprising 65% of total meat consumption [1]. The Chinese character for "home" (家) is composed of a "roof" (宀) atop a "pig" (豕), symbolizing how pigs relate to the health, harmony, and happiness of every household. Furthermore, pigs are among the most productive livestock: a single sow can produce approximately 1,700 kg of meat annually when calculated by the number of market pigs produced per sow per year multiplied by the average meat yield per pig.

Pork is a staple food for Chinese families, and ensuring pork safety addresses 50% of China's food security concerns at the dinner table. As the saying goes, "no meat is more fragrant than pork," reflecting its indispensable role in the Chinese diet. Recent research has revealed that pork fat is actually beneficial to human health. A 2017 study found that "moderate consumption of lard and its combination with vegetable oil (soybean oil) has significant anti-obesity effects" [2], challenging global medical and public perceptions. This research was the first worldwide to reveal one of the mysteries behind China's lower obesity rates compared to Western countries—the traditional Chinese dietary habit of blending lard with vegetable oil. It also identified the most important cause of China's rapidly rising obesity rates over the past two decades: excessive and unbalanced oil consumption. Additionally, the *Compendium of Materia Medica* and *Thousand Golden Prescriptions* document over 30 medicinal formulas using lard, explaining its efficacy: "sweet, slightly cold, non-toxic, benefits the stomach and intestines, unblocks urination, eliminates five types of jaundice and edema, promotes hair growth; breaks cold accumulations, disperses stagnant blood; benefits blood vessels, disperses wind-heat, and moistens the lungs."

Critical Challenges in Pig Industry Development

In recent years, China's pig industry has maintained rapid growth momentum with increasing intensification. However, it continues to face significant challenges regarding germplasm resource security, environmental safety, food safety, low production efficiency, and prominent disease issues.

China is the world's largest pig-raising country but far from being a pig industry powerhouse. Compared with developed pig-farming nations, China's production level still lags, with lower per-capita meat output and heavy reliance on imported breeding pigs characterized by high reproductive rates, high lean meat percentage, high slaughter rates, and low feed-to-meat ratios. This import-dependent pattern exacerbates reliance on foreign germplasm. Direct importation presents three major problems: (1) high prices for quality foreign breeding pigs increase costs; (2) it creates a vicious cycle of "import—degeneration—reimport—re-degeneration"; and (3) obtaining great-grandparent stock is difficult [3]. Additionally, some regions have pursued short-term interests while neglecting the protection and utilization of superior local pig breeds, pushing valuable indigenous genetic resources to the brink of extinction and threatening China's pig industry with the potential loss of its germplasm advantages.

Development Recommendations

1. Safeguarding Germplasm Resources and Innovating in Organ Transplantation Research

China possesses the world's richest livestock and poultry genetic resources, with over half of pig germplasm resources found domestically, particularly the Taihu pig, renowned globally for its high litter size. However, China's primary commer-

cial breed remains the imported "Duroc-Landrace-Yorkshire" (DLY) three-way cross [Note: The DLY combination, widely used in China, involves crossing Duroc (terminal sire), Landrace (maternal sire line), and Yorkshire (maternal dam line) breeds]. Regarding germplasm security, we propose two recommendations:

First, utilize indigenous breeds to develop precision animal husbandry and produce high-end pork to meet public demand for quality food. By leveraging China's superior local pig resources alongside imported breeds, China can develop strategically important new pig varieties with independent intellectual property rights. Gene editing technology offers a pathway to improve local breeds—for example, our research team has developed a gene-editing system for Taoyuan black pigs, successfully isolating and expanding primary porcine cells and preparing "molecular scissors" for precise genome editing. This technology is expected to significantly increase lean meat percentage and reduce feed-to-meat ratios.

Second, innovate research and applications of pig organs for xenotransplantation. The U.S. Department of Agriculture categorizes pig production into two industries: traditional livestock farming for nutritious pork, and organ provision for human transplantation. China has made significant breakthroughs in this area: Central South University achieved major success with pancreatic transplantation using the local Shaziling pig breed, while Chinese Academy of Sciences research teams have succeeded with skin and corneal transplants and are currently researching heart and other organ transplants. Pigs represent a major potential industry for organ transplantation.

2. Ensuring Environmental Safety Through "Two-Type" Feed Industry Development

The concept that "lucid waters and lush mountains are invaluable assets" has become national consensus, making environmental safety a paramount concern. Developing an environment-friendly and resource-efficient "two-type" feed industry is both an inevitable trend and the necessary path forward for sustainable breeding models. Reducing livestock waste emissions at the source will effectively decrease environmental pollution from nitrogen, phosphorus, copper, zinc, and other elements. China has achieved preliminary results in developing and applying two-type feeds: by formulating low-protein diets and reducing trace mineral supplementation, protein resources can be saved by 25–30% and major trace element emissions reduced by 30–50% [7].

Zero-pollution pig farming is achievable through several approaches. First, provide pigs with "five-star" housing that ensures environmental comfort. Southern China's high temperature and humidity and northern cold are unsuitable for pig growth and increase disease susceptibility. Modified pig houses using thermal insulation panels can maintain stable temperatures around 24°C, not exceeding 28°C even in hot weather, keeping pigs healthy under comfortable conditions.

Second, reduce emissions at the feed source by applying two-type feeds. Third, achieve "zero wastewater discharge" during production through: (1) source reduction of wastewater; (2) separation of feces and urine (including rainwater diversion); (3) using semi-slatted floors combined with ground spraying of beneficial bacteria instead of water washing—this reduces daily wastewater discharge from 150 m^3 in traditional houses to just 5 m^3 for a 10,000-head farm (a 90% reduction); and (4) utilizing vertical aeration, fermentation treatment, and integrated crop-livestock systems.

3. Ensuring Food Safety Through Antibiotic Replacement Technologies and Industry

Multiple approaches exist for replacing antibiotics in pig production. For instance, reducing pig diarrhea can significantly decrease antimicrobial use. This requires improving breeding environments and innovating feed processing technologies. Feed extrusion, which degrades nutrients like starch before feeding, improves digestibility and reduces diarrhea. Fermented feed, containing inherent probiotics such as lactic acid bacteria, bacillus, and yeast, can eliminate anti-nutritional factors and produce secondary metabolites that generate trans-fatty acids in the pig intestine, thereby inhibiting harmful bacteria [8].

Probiotics represent a common antibiotic alternative. A mixture of five bacterial types—photosynthetic bacteria, yeast, lactic acid bacteria, actinomycetes, and bacillus—demonstrates multiple benefits when added to feed: (1) **Impact on pork quality**: Experimental data show that pigs fed this five-strain probiotic mixture exhibit significantly better meat color, viscosity, elasticity, odor, and broth quality than control groups. The mechanism involves production of trans-fatty acids and lactic acid that directly improve meat quality. (2) **Impact on diarrhea**: The probiotic mixture significantly reduces diarrhea rates while improving feed-to-meat ratios.

Other functional feed additives show promise. Taurine regulates immune systems, stabilizes cell membranes, and provides antioxidant functions, improving growth, reproductive performance, and immunity in livestock [9]. Previously limited by high synthesis costs, taurine application has become economically feasible with technological advances. Adding 300–600 grams per ton of feed costs only 20 RMB, making taurine a viable antibiotic alternative.

Plant extracts also represent important antibiotic alternatives [10]. The former Ministry of Agriculture's Veterinary Bureau has proposed classifying plant extracts as a feed additive category, though standards are needed. Unlike corn, soybean meal, and amino acids with established nutritional standards, plant extracts require defined specifications for protein content, energy value, and other parameters. While traditional Chinese medicine and feed plant extracts show efficacy, concentrations exceeding 2% in feed can impair pig growth performance, necessitating further research on optimal utilization.

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Note: The "Duroc-Landrace-Yorkshire" (DLY) three-way cross system, also known as "三元猪" (three-way hybrid pigs), represents the most widely applied breeding program in China, typically structured as A×(B×C), where A is the terminal sire (usually Duroc), B is the maternal sire line (usually Landrace), and C is the maternal dam line (usually Yorkshire).

Note: Figure translations are in progress. See original paper for figures.