

Research on Shortcomings and Governance Paths for Resource-based Utilization of Livestock and Poultry Manure

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Abstract: China's livestock and poultry breeding industry keeps expanding toward large-scale operation, and the output of livestock and poultry manure continues to grow. Containing organic matter, nitrogen, phosphorus, and other nutrients, manure possesses high value for resource development. Nevertheless, the overall comprehensive utilization rate of livestock and poultry manure in China remains limited at present, and quite a few practical shortcomings have emerged in the process of resource-based utilization. Improper disposal of manure will bring multiple environmental risks to soil, water bodies, and the atmosphere, and also threaten human health through the food chain. Combined with the actual conditions of the current livestock and poultry breeding industry, this paper sorts out the major existing shortcomings in the resource-based utilization of manure and puts forward feasible governance paths from multiple perspectives. It is expected to promote the reduction, harmless treatment, and resource-based utilization of livestock and poultry manure and boost the green and sustainable development of animal husbandry.

Keywords: Livestock and poultry manure; Resource-based utilization; Environmental risk; Planting-breeding circular system; Governance path

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1. Introduction

With the rapid advancement of modern animal husbandry in China, the large-scale rate of livestock and poultry breeding has kept rising, exceeding 75 % nationwide by 2025. According to industry statistics, the annual output of livestock and poultry manure, including feces, urine, and breeding flushing sewage, reaches

nearly 3.8–3.9 billion tons in China. The huge output of manure imposes considerable pressure on industrial governance. Rich in nutrients such as nitrogen and phosphorus, livestock and poultry manure can be processed into organic fertilizer, biogas, and other resources after standardized, harmless treatment. However, many breeding farms fail to complete standardized manure disposal. Large quantities of untreated manure are piled randomly or discharged directly. Heavy metals, antibiotics, and pathogenic microorganisms contained in manure enter soil, water bodies, and the atmosphere, triggering agricultural non-point-source pollution and bringing public-health hazards.

The state has successively issued policy documents such as *Opinions on Accelerating the Resource-based Utilization of Livestock and Poultry Breeding Wastes* and the *14th Five-Year Plan for National Green Agricultural Development*, which make systematic arrangements for the resource-based utilization of livestock and poultry manure. Driven by a series of policies, the comprehensive utilization rate of livestock and poultry manure in China exceeded 80% by 2025, and remarkable achievements have been made in overall governance work. Nevertheless, viewed from grass-roots practical operation, there are still many shortcomings in the resource-based utilization of livestock and poultry manure. Practical obstacles exist in technology implementation, cost investment, planting-breeding matching, policy supervision, and other aspects. How to remedy existing shortcomings and build an efficient and feasible manure resource-based governance system has become a practical subject to be solved for green agricultural development.

2. Practical value of resource-based utilization of livestock and poultry manure

2.1. Improving the quality of cultivated land soil

Livestock and poultry manure subjected to harmless treatment can be made into organic fertilizer. Such organic fertilizer can supplement soil organic matter, improve soil aggregate structure, alleviate soil compaction, and enhance cultivated-land fertility ^[1]. After applying organic fertilizer, farmers can reduce the application amount of chemical fertilizers, lower the risk of agricultural non-point-source pollution caused by excessive chemical-fertilizer application, and help improve the quality of agricultural products.

2.2. Reducing regional environmental-pollution risks

Random piling of untreated manure will release malodorous gases such as ammonia and hydrogen sulfide. Washed by rainwater and permeated through soil, manure transports nitrogen, phosphorus, and heavy metals into water bodies and causes water eutrophication ^[2]. Resource-based disposal of manure can degrade and immobilize manure pollutants, reduce the diffusion of pollutants into external environments, improve the quality of rural living environments, and cut emissions of greenhouse gases including methane and nitrous oxide, contributing to the realization of the “Dual-Carbon” goals.

2.3. Promoting the coordinated development of planting and breeding industries

Resource-based utilization can connect the breeding and planting industries. Manure produced by breeding farms is supplied to planting bases as fertilizer, while straw and other materials from planting industries can be used for manure composting and fermentation ^[3]. Such a circular model can reduce fertilizer-procurement costs on the planting side. Biogas converted from manure can also be used as clean energy for rural domestic life, turning waste into valuable resources, expanding sources of agricultural economic income, and boosting the development of rural industries.

3. Major existing shortcomings in resource-based utilization of livestock and poultry manure

3.1. Prominent separation between planting and breeding, insufficient matching of land absorptive capacity

The separation between planting and breeding stands out as the most prominent practical problem in current resource-based manure utilization. In many regions, breeding and planting industries operate independently without stable docking channels. Large-scale breeding farms are concentrated in certain areas and produce a huge total amount of manure, yet the supporting cultivated-land area in surrounding regions is limited. The land lacks sufficient capacity to absorb all manure, and manure accumulation tends to occur.

If manure is returned to fields in excess of land bearing capacity, salts and heavy metals carried by manure will accumulate in soil, resulting in soil salinization and excessive heavy-metal content, which in turn damages the soil environment ^[4]. In addition, chemical fertilizers take effect rapidly and feature simple application procedures. Many growers are subjectively unwilling to adopt manure-derived fertilizers, which hinders the advancement of resource-based utilization.

3.2. Poor technology adaptability and defects in partial treatment processes

At present, mainstream technologies for manure resource-based utilization fall into two categories: fertilizer-oriented utilization and energy-oriented utilization. Fertilizer-oriented utilization is dominated by aerobic composting, while energy-oriented utilization mainly adopts anaerobic biogas fermentation. Aerobic composting features low operation thresholds yet requires large-site occupation and long treatment cycles. Ammonia volatilization occurs during composting, bringing about nitrogen loss and malodorous pollution. Anaerobic biogas digesters can treat large volumes of manure but produce biogas slurry and biogas residue, whose subsequent treatment is difficult. Improper disposal will give rise to secondary pollution ^[5].

Breeding farms of different scales fit different types of technologies. Large-scale breeding farms are capable of supporting complete and complex manure-treatment systems, yet the construction cost of equipment is extremely high. Limited by funds, small-and-medium-sized breeding farms and scattered farmers mostly adopt simple treatment processes. Simple processes fail to achieve thorough fermentation and decomposition, and antibiotics and pathogenic microorganisms inside manure cannot be completely eliminated, so the quality of organic-fertilizer products cannot be guaranteed. Meanwhile, domestic geographical conditions vary greatly. In northern regions with low winter temperatures, biogas fermentation efficiency declines. In southern regions where cultivated-land resources are tight, there is insufficient space for nearby field return of manure. Many regions directly copy general technical schemes without adjustment according to local natural conditions.

3.3. Imbalance between cost and benefit, insufficient motivation for market-entity participation

The construction of manure-treatment facilities requires massive upfront capital investment, which increases production burdens for small-and-medium-sized breeders. From the benefit perspective, organic fertilizer processed from manure has high production costs. Compared with chemical fertilizers, organic fertilizers have no competitive advantages in market prices and suffer poor product sales, so enterprises lack motivation

for continuous manure-resource-based processing. Breeders and growers can hardly obtain considerable benefits from manure resource-based utilization, leading to low subjective initiative in participation.

3.4. Imperfect manure collection-transportation-storage system and poor circulation of resource-based products

A complete collection-transportation-storage system serves as the fundamental condition for realizing manure resource-based utilization. Mature manure collection, transportation, and treatment networks have not been built in many domestic regions. Although centralized manure-treatment centers have been constructed in some places, preliminary planning is unscientific, and the storage capacity of treatment centers cannot meet regional manure-treatment demands ^[6].

Products such as organic fertilizer and biogas fertilizer generated after manure treatment also face circulation difficulties. Organic-fertilizer products lack stable production-sales docking channels and tend to suffer product overstock. Unable to sell finished products, treatment centers reduce manure acceptance volume, forming a vicious circle of “difficult manure collection, unsalable finished products, and idle treatment capacity,” which restricts the overall advancement of resource-based utilization.

3.5. Shortcomings in supervision and policy implementation, and room for improvement in awareness

Manure resource-based governance involves multiple departments, including agriculture-and-rural-affairs authorities and ecological-environment authorities. In some regions, the division of departmental responsibilities is ambiguous, data sharing is absent, and joint-supervision strength is insufficient ^[7]. Existing policies and regulations are more targeted at above-scale breeding farms, while restrictive and supportive policies for small-scale breeding farms and scattered farmers are relatively scarce.

Some breeding entities hold biased perceptions. They only attach importance to economic benefits brought by breeding and believe that manure treatment will raise production costs, failing to recognize environmental hazards caused by random manure discharge. Some breeders regard manure merely as useless waste and fail to see the value brought by manure resource-based utilization. Such subjective factors hinder the development of manure resource-based utilization.

4. Governance paths for shortcomings in resource-based utilization of livestock and poultry manure

4.1. Optimize planting-breeding layout and build a circular planting-breeding development model

Local authorities shall calculate the land’s capacity for manure absorption according to local cultivated-land resources. Scientifically plan local livestock-and-poultry breeding scales in accordance with land bearing capacity and implement the basic principle of “determining breeding scales by land capacity”. Local governments shall take the initiative to build communication bridges and promote stable cooperative relationships between breeding farms, surrounding planting bases and agricultural cooperatives ^[8]. Encourage breeding farms to establish connections with nearby planting bases. After harmless treatment, manure shall be returned to nearby fields to realize nearby manure absorption and cut long-distance transportation costs.

For villages with concentrated scattered farmers, build centralized manure-collection points at the administrative-village level. Collect manure produced by scattered households in a unified manner and

conduct centralized composting. The treated manure fertilizer is supplied to growers within the village. Vigorously promote ecological planting-breeding integrated modes such as rice-duck co-culture, integrate breeding production with crop planting, and realize circular utilization of manure within agricultural systems.

4.2. Adopt technologies suited to local conditions and improve the practical efficiency of resource-based processes

Local authorities shall select appropriate manure-treatment technologies in light of breeding scales and regional climatic conditions. Large-scale breeding farms may give priority to technologies such as anaerobic fermentation and biogas purification, convert manure into bio-natural gas, expand energy-oriented utilization approaches, and conduct follow-up disposal of biogas slurry and biogas residue simultaneously. For small-and-medium-sized breeding farms, promote low-cost processes including film-covered aerobic composting and black-membrane biogas digesters. For scattered breeders, prioritize simple composting combined with centralized-treatment-center modes to lower technical-application thresholds for individual entities.

Improve existing traditional processes. During composting, add amendments such as biochar and zeolite to reduce ammonia volatilization in the composting phase, lower the bioavailability of heavy metals and antibiotics, and improve the quality of finished organic fertilizer ^[9]. For low-temperature northern regions, add thermal-insulation measures for biogas facilities to solve the problem of insufficient winter biogas production. For densely-water-network southern regions, prioritize the construction of rain-sewage separation, solid-liquid separation, and anti-seepage facilities to reduce pollution risks caused by manure leakage. Meanwhile, improve quality-testing standards for organic fertilizer, strengthen finished-product inspection, strictly control indicators of heavy metals and pathogenic microorganisms in finished products, and guarantee the safety of manure-fertilizer application.

4.3. Improve the fund-guarantee mechanism and alleviate cost pressures on entities

Governments shall optimize existing subsidy policies. Subsidies shall not be limited to facility-construction links. Subsidies for equipment operation-and-maintenance, manure collection-and-transportation, and manure-fertilizer field-return operations shall be increased. Expand policy-coverage scope to include small-and-medium-sized breeding farms and scattered farmers, changing the previous situation where subsidies are excessively tilted toward large-scale breeding farms.

Local authorities may introduce green-financial instruments, encourage financial institutions to develop special low-interest credit products to support breeders in constructing manure-treatment facilities. Meanwhile, guide social capital to participate in manure-governance projects. Adopt forms including government procurement of services and franchise operation to foster specialized social-service enterprises for manure treatment. Professional enterprises shall be responsible for the whole chain of manure collection, treatment, and organic-fertilizer processing to share breeders' operational burdens. Build production-sales docking platforms for organic fertilizer to open sales channels for organic-fertilizer products, enhance their market competitiveness, enable participating entities to obtain real economic benefits, and arouse the participation enthusiasm of market entities.

4.4. Improve the manure collection-transportation-storage system and open up resource-circulation channels

All regions shall rationally distribute centralized manure-treatment centers in light of breeding distribution. Improve supporting facilities for manure storage and transportation, and build a complete service system of “collection-transportation-treatment-field return” ^[10]. For scattered breeders, set up village-level manure-collection teams and deploy special transportation equipment to solve difficulties in manure collection among scattered farmers. Treatment centers shall sign long-term agreements with breeding farms and planting bases to guarantee stable supply of manure raw materials and secure stable sales outlets for organic-fertilizer products so as to avoid finished-product overstock.

4.5. Strengthen coordinated supervision and raise awareness of various entities

Establish a multi-department coordinated-supervision mechanism covering agriculture-and-rural-affairs and ecological-environment authorities, clarify job responsibilities of each department, promote inter-supervision-data sharing, and carry out regular joint inspections. Implement graded and classified supervision. Strengthen supervision over large-scale breeding farms around water-source-protection zones and strictly enforce environmental-protection requirements. Build a digital-supervision platform to dynamically monitor manure treatment and field-return processes. Improve relevant law-enforcement detailed rules, fill institutional gaps in supervision over scattered farmers’ manure discharge, and impose legal sanctions on entities discharging manure at will.

Carry out publicity and training through multiple channels, popularize environmental hazards caused by random manure discharge, and interpret policies and practical technologies for resource-based utilization, so as to change breeders’ concept of “valuing production while neglecting pollution control.” Popularize application advantages of qualified organic fertilizer and dispel public concerns over the safety of manure-fertilizer products. Organize regular technical training to teach breeders practical skills such as manure-facility operation and scientific field return of manure fertilizer. Publicize typical cases of manure resource-based utilization via new-media platforms to create a sound social atmosphere supporting manure resource-based utilization.

5. Conclusion

Resource-based utilization of livestock and poultry manure serves as an important starting point for realizing the green transformation of animal husbandry, and also constitutes a key task for advancing agricultural non-point-source-pollution governance and circular-agriculture development. At present, the resource-based utilization of livestock and poultry manure in China still faces multiple shortcomings such as mismatched planting-breeding conditions, insufficient technology adaptability, and imbalanced cost-benefit relationships. Local authorities shall proceed from the local realities of the breeding and planting industries, scientifically plan planting-breeding layouts, select appropriate treatment technologies suited to local conditions, improve subsidy and market-circulation systems, strengthen multi-department coordinated supervision, and raise awareness among various business entities. Through the joint force of multiple measures to remedy existing shortcomings, we can truly realize the reduction, harmless treatment, and resource-based utilization of livestock and poultry manure, promote the coordinated development of animal husbandry and planting industries, and contribute to rural ecological revitalization.

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