

Top-Down Implementation and Fragmented Bureaucracy: An Analysis of the Livestock Waste Prevention Regulation in China

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How to cite this paper: Jin, S. Q., Mao, K., Han, D. M., & Hu, Y. (2022). Top-Down Implementation and Fragmented Bureaucracy: An Analysis of the Livestock Waste Prevention Regulation in China. *Open Journal of Social Sciences*, 10, 1-17.
<https://doi.org/10.4236/jss.2022.108001>

Received: June 7, 2022

Accepted: July 26, 2022

Published: July 29, 2022

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Abstract

Livestock and poultry raising is the largest source of agricultural non-point source pollution and an essential aspect of environmental governance. To resolve the issue, China has introduced a series of policies to promote the recycling of livestock and poultry excrement since 2014. This study uses data from government documents, policy papers, and official husbandry statistics to understand the effects and policy implications of husbandry waste regulations from 2014 to 2019. We examined the planning and implementation guidelines of husbandry waste control programs and supplemented the archival data with 29 in-depth interviews with local environmental protection officers as well as husbandry operators in five provinces from 2015 to 2018. Our findings indicate that the new regulatory regime has three fundamental issues: First, the inconsistency between national and ministerial policy goals; Second, the binding targets of these policies create unforeseen consequences in their implementation, which has hindered the establishment of a national resource recycling system; Third, the regulations provide few incentives to promote the development of sustainable husbandry industry.

Keywords

Agricultural Non-Point Source Pollution, Livestock and Poultry Pollution Prevention, Agricultural Development in China, Environmental Governance in China, Sustainable Agriculture

1. Introduction

The livestock and poultry industries are integral to China's economy, with a

production value second only to crops. The Chinese National Bureau of Statistics reported the total production value for animal husbandry in 2017 at 2.936 trillion yuan, constituting 26.9% of the total production value of the agriculture and forestry sector (National Bureau of Statistics of China, 2018). China's hog-raising industry has expanded significantly in the last decade in tandem with accelerated agricultural modernization and environmental damage. In 2017, the hog-raising industry generated more than 20% of total pollutants discharged by China's agricultural sector. The Report to the 19th National Congress of the Communist Party of China explicitly states that one of the main tasks of China's environmental governance is to alleviate pollution caused by the expansion of hog raising industry. Consequently, the Chinese central government-endorsed livestock and poultry manure as organic fertilizers to reduce pollution and promote sustainable agriculture. The "2018-2022 Rural Revitalization Strategic Plan" released by the State Council of China further states that the sustainable development of China's animal husbandry is crucial to rural development and the restructuring of China's agricultural economy.

Livestock and poultry manure contain multiple nutritional ingredients necessary for crop cultivation, including nitrogen, phosphorus, potassium, and volatile organic compounds (VOCs). In the traditional small-scale family farm model, farmers utilize livestock and poultry manure as a source of fertilizer by returning the composted excrement to their fields. Research on the agricultural benefits of livestock and poultry manure has increased with the expansion of the scale of animal husbandry in China. As investment in agricultural technology increases, new approaches to improve manure utilization have been proposed, including microbial fermentation, pyrolysis, and thermosol processes, biogas, and the production of ethyl alcohol. Researchers have also focused on critical factors that shape the likelihood of policy adoption at the micro-level, including the costs and benefits of using livestock and poultry manure and the behavioral characteristics of farming households (Jin et al., 2018; Qiu et al., 2013). However, few studies have examined how institutional barriers in China's fragmented bureaucracy influence the implementation environmental regulations for industrialized agriculture.

This article discusses results from the initial implementation of the "Regulation on the Prevention and Control of Pollution from Large-Scale Livestock and Poultry Husbandry" (hereafter the Regulation) from 2014 to 2017. The State Council of China issued the Regulation in 2014 as the first national-level environmental law to control environmental pollution generated by commercial animal husbandry operators. The Regulation attempts to reduce the unregulated discharge of pollutants by establishing an incentive structure to promote manure use. To evaluate the strengths and limitations of the Regulation, we first provide a brief overview of China's environmental governance and the state's attempts to regulate the growing environmental impacts of the commercial animal husbandry sector. We then analyze the conflicting policy goals embedded in the Regula-

tion and examine the subsequent policy outcomes since 2014. Finally, the paper concludes with a broader discussion of how the initial implementation results of the Regulation extend our understanding of the fragmentation of environmental governance in rural China.

1.1. Environmental Governance in China

Though the Chinese central government has promulgated national pollution laws since the early 2000s, enforcing environmental regulations has often remained inadequate (Kostka, 2017; van Rooij et al., 2017). The inefficiency in China's environmental governance is not due to the lack of political will from the Chinese central government, which has advanced the realization of an "ecological civilization" that maintains a "harmonious relationship between citizens and nature" as central to its development strategy since 2001 (Xiao & Zhao, 2017). In recent years, the Chinese central government has used a top-down implementation model that incorporates the completion of environmental targets into the cadre evaluation system to provide swift responses to environmental degradation and subsequent social issues (Ahlers, 2018; Eaton & Kostka, 2014; Kostka & Mol, 2013). Nevertheless, research on environmental governance in China reveals that the effectiveness of the state's environmental policies has been weakened by a fragmented governing structure, where national policy goals became diluted by competition among government departments (Kostka & Mol, 2013; Mao et al., 2022; Zhu et al., 2015). Moreover, the contradiction in environmental governance can be traced to political decentralization, which has caused lower-level governments to prioritize economic interests and social stability over environmental protection (Ran, 2013; Mao et al., 2020a). Due to promotion requirements, grassroots cadres often interpret environmental policies differently from the central government. Additionally, current environmental legal and litigation frameworks have constrained public participation and the institutionalization of environmental interests (Balme & Tang, 2014).

Limited state capacity at the local level has impeded the enforcement of environmental regulations, as local politics depend on short-term political campaigns to balance competing interests in the fragmented bureaucracy (Li, 2019; Mertha, 2009). In recent years, China's environmental governance has undergone a significant wave of "centralizing trends", which utilize binding policy goals and cadre evaluations within the top-down bureaucracy to strengthen the implementation of environmental regulations at the local level (van Rooij et al., 2017; Kostka & Nahm, 2017; Xu, 2017). Consequently, external support from political leaders has strongly shaped policy design and implementation (Mao et al., 2020a; He, 2019). Recent studies have also shown that center-local relations have shaped the effectiveness of environmental regulations, regional differences, and local institutional variations (Aarnoudse et al., 2019, Mao et al., 2020b). More nuanced case studies are needed to understand how the top-down implementation of national regulations influences policy outcomes in diverse economic sectors and social contexts.

1.2. The Development of the Animal Husbandry Waste Regulation Framework in China

The Chinese central government has paid close attention to agricultural pollution caused by the livestock and poultry husbandry industry since the beginning of the 21st century. In 2001, the former State Environmental Protection Administration of China (SEPA) promulgated the “Administrative Measures for the Prevention and Control of Pollution from Large-scale Livestock and Poultry Raising” (hereafter Administrative Measures), the “Technical Standards of Preventing Pollution from Livestock and Poultry Operation” (HJ/T81-2001), and the “Discharge Standards of Pollutants for Livestock and Poultry Operation” (GB18596-2001). Combined, these regulations create the technical specifications and discharge standards for pollutants from livestock and poultry raising. Livestock and poultry farms must establish storage facilities for animal waste and prevent the leakage, scattering, overflow, and rainwater leaching of livestock and poultry waste into the surrounding environment. To ensure cleanliness, livestock and poultry farms should divert wastewater from freshwater sources and separate dry fecaluria from wet fecaluria. Also, many laws in China contain clauses to control waste from the animal husbandry industry, such as the 2005 Animal Husbandry Law of the People’s Republic of China and the 2008 Law of the People’s Republic of China on Prevention and Control of Water Pollution. From 2004 to 2013, a series of provincial-level regulations, industry standards, and technical specifications were developed to reduce animal husbandry waste. These provincial-level administrative measures were implemented in Zhejiang, Fujian, Ningxia, Sichuan, Guangxi, and Shandong provinces. Further, local discharge standards for pollutants for livestock and poultry husbandry were formulated in Guangdong and Zhejiang, and technical guidance documents such as the technical standard for pollution from livestock and poultry raising were introduced in Ningxia.

Nevertheless, these regulations had limited effects on pollution control. According to the 2007 Communiqué of the First National Census of Pollution Sources, the livestock and poultry industry in China generated 12.6826 million tons of chemical oxygen demand (COD) and 0.7173 million tons of ammonia nitrogen discharge, which represented 95.8% and 78.1% of COD and ammonia nitrogen discharge released from agricultural sources as well as 41.9% and 41.5% of the total national COD and ammonia nitrogen discharge. Though the Chinese central government continued to issue new regulations to alleviate the environmental impact, the pollution caused by large-scale husbandry persisted. According to the 12th Five Year Plan for National Husbandry Pollution Prevention (2013), the total COD and ammonia nitrogen discharge have increased to 11.48 million tons and 0.65 million tons, respectively, constituting 45% of the total national COD discharge and 25% of the ammonia nitrogen discharge. To date, large-scale animal production remains the most severe non-point source of environmental pollution in agriculture and a significant threat to China’s water resources and food security.

1.3. The 2014 Regulation on the Prevention and Control of Pollution from Large-Scale Raising of Livestock and Poultry

The 2014 Regulation stipulates specific requirements for preventing and controlling pollution in two aspects. First, the development of national and provincial husbandry plans should consider the environmental carrying capacity, the efficiency of structures, and the utilization of scientific evidence to determine the varieties, scale, and total quantity of livestock and poultry industry in each region. The Regulation bans the construction of livestock and poultry farms in ecologically fragile areas and requires environmental impact assessments for any construction, rebuilding, and expansion of livestock and poultry farms. Second, the Regulation stresses that the “comprehensive utilization and treatment” of husbandry manure should be the principal mechanism to prevent pollution. Sub-national level governments are required to support the return of processed manure to fields, the expansion of biogas facilities, and the production of organic fertilizer. To promote these policy goals, the Regulation provides a series of incentive measures. For example, using livestock and poultry manure to produce organic fertilizer is eligible for government subsidies intended initially for producing and transporting chemical fertilizer. Those purchasing and using organic fertilizer products also benefit from subsidies initially designed to promote chemical fertilizer. Electricity used to prevent and control livestock and poultry pollution is priced as agricultural, not industrial, usage. Finally, the Regulation defines legal sanctions for the violation of its provisions. The Environmental Protection Department of the local people’s governments at or above the county level has the legal authority to stop the construction of livestock and poultry farms in prohibited areas. The fine for violating the Regulation is between 30,000 and 100,000 yuan. The county government can also shut down operations and demolish farms. Based on the goals outlined in the 2014 Regulation, the Chinese central government has unveiled a series of action plans and guiding opinions to establish detailed descriptions of policy goals in different implementation stages. **Table 1** provides a brief overview of these supplementary policy documents on manure utilization and the expected policy goals by 2020.

2. Data and Methods

This study uses data from government documents, policy papers, official husbandry statistics from the “Chinese Statistical Yearbook”, and reports to understand the effects and policy implications of husbandry waste regulations from 2014 to 2019. We examined the planning and implementation guidelines of husbandry waste control programs in Anhui, Zhejiang, Sichuan, Heilongjiang, and Fujian provinces, incorporating ecological, geographical, and regional development diversity into the analysis. The husbandry pollution control programs provided substantive information for understanding formal approaches to developing industrial animal agriculture and managing husbandry waste during the centralization period in China’s environmental governance. Additionally, we

Table 1. Expected 2020 policy goals on the utilization of livestock and poultry manure in supplementary policy documents.

Policy Document Titles	Year Formulated	Approved and released by	Goal Statement on the Recycling of Livestock and Poultry Manure by 2020
The “Regulation on the Prevention and Control of Pollution from Large-scale Breeding of Livestock and Poultry”	2014	The State Council of China	This document does not set clear goals by 2020. The Regulation only provides a qualitative description stating that it should “boost the comprehensive utilization and non-hazardous treatment of livestock and poultry waste, protect and improve the environment, guarantee the physical health of the general public, and promote the sustainable and healthy development of the livestock husbandry.”
The “Action Plan for Prevention and Control of Water Pollution”	2015	The State Council of China	Before the end of 2017, livestock and poultry farms (breeding areas) and households specializing in breeding should be closed down or relocated to forbidden areas, with one-year early completion in Beijing-Tianjin-Hebei Region, the Yangze River Delta, Pearl River Delta.
The “National Plan for Agricultural Modernization (2016-2020)”	2016	The State Council of China	The comprehensive utilization rate of husbandry waste shall reach 75% by 2020.
The “National Sustainable Agricultural Development Plan (2015-2030)”	2015	Upon approval by the State Council, this document was jointly printed and distributed by eight ministries and commissions, including the MARA.	The comprehensive utilization rate of husbandry waste will exceed 75% by 2020.
The “Plan for Promoting Pilot Program of Agricultural Waste Recycling”	2016	This document was examined and approved by leaders of the State Council and jointly printed and distributed by six ministries and commissions, including the MARA.	About 80% of the large-scale farms in the pilot county will be equipped with excrement treatment facilities that recycle livestock and poultry excrement.
The “Implementation Opinions of the Ministry of Agriculture on Conducting Campaign of Non-point Pollution Control”	2015	MARA	Over 75% of large-scale livestock and poultry farms will have waste treatment facilities.
The “Guiding Opinions about Promoting the Adjustment and Optimization of Pig Breeding Layout in Water Network Areas in Southern China”	2015	MARA	(In water network areas in southern China) Over 85% of the large-scale pig farms will be equipped with excrement treatment facilities, and the comprehensive utilization rate of pig excrement will exceed 75%.
The Guiding Opinions about Fast Tracking the Resource Utilization of Husbandry Manure in China	2017	The State Council of China	By 2020, the total utilization rate of husbandry waste will reach 75%, and over 95% of large-scale livestock and poultry farms (breeding areas) will be equipped with waste treatment facilities.

conducted 29 in-depth interviews during nine research trips to Anhui, Zhejiang, Sichuan, Heilongjiang, and Fujian provinces between 2015 and 2018. We utilized a relational approach in their interviews that recorded the contending narratives of parties with conflicting interests over time to understand how the implementation of environmental regulations structured social relationships over time (Ann, 2017). Initially, the authors interviewed local environmental protection, agricultural husbandry officials, and township and village cadres. We then used snow-

ball sampling to build on initial respondents' contacts to identify operators with firsthand knowledge operating different scales of pig farms. In all, we conducted 12 in-depth interviews with the operators of the backyard, specialized household, and large-scale CAFO pig farms, as well as 12 grassroots state agents working for the villages and townships near the husbandry operations. We also conducted 15 in-depth interviews with prefectural and county environmental protection officials to record the evolving government responses to implementation difficulties. These interviews were recorded with consent from the informants and transcribed for later review. Data from national statistics, our archival research, and in-depth interviews provided nuanced perspectives of the implementation challenges of the 2014 Regulation and provide the evidentiary foundation of the analysis below.

3. Results: Challenges in the Implementation of the 2014 Regulation

3.1. Significant Gaps in the Expected Outcomes of Supplementary Policies

Article I of the 2014 Regulation states that “this law is formulated to prevent and control pollution from livestock and poultry husbandry, boost the comprehensive utilization and non-hazardous treatment of livestock and poultry wastes, protect and improve the environment, guarantee the physical health of the general public, and promote the sustainable and healthy development of the animal husbandry sector.” As such, the expected policy outcomes of the Regulation are to encourage the comprehensive utilization of livestock and poultry manure rather than achieve specific standards for pollutant discharges. This represents a new approach to agricultural pollution control. The Ministry of Agriculture (MOA) was the first central government Ministry to explicitly put forward a quantitative goal for reducing pollution from the livestock and poultry sector. The 2015 Implementation Opinions of the Ministry of Agriculture on Conducting a Campaign on Non-point Pollution Control declares that, by 2020, “over 75% of large-scale livestock and poultry farms will be equipped with waste treatment facilities.” At the same time, the State Council of China approved the 2015 to 2030 National Sustainable Agricultural Development Plan that the MOA jointly formulated, the National Development and Reform Commission (NDRC), and six other ministries and national commissions. In the Development Plan, the Chinese central government proclaims that, by 2020, “the comprehensive utilization rate of husbandry waste will exceed 75%.” The Chinese State Council continued to use this statement in its National Plan for Agricultural Modernization (2016-2020) in 2016 and elevated the 75% total utilization rate to a national-level binding target by 2020.

However, a closer examination of the 2015 Implementation Opinions released by the MOA and the National Plan for Agricultural Modernization sponsored by the State Council of China shows that these policies have conflicting expected

outcomes. First, these two policy goals are different in their scope of application. The goal set by the MOA in 2015 only focuses on large-scale pig farms, whereas the binding target set forth by the State Council of China does not delimit the farm scale. As defined by the China Animal Agriculture Association in 2014, large-scale farms are those operations that have over 500 heads for sale yearly. According to the MOA's estimation, only 54% of national livestock farms fit that description in 2015. In other words, the MOA's 2015 Implementation Opinions only regulate around half of China's yearly pig farming capacity.

Second, the expected policy outcomes were phrased differently in the MOA Implementation Opinions and the State Council's National Plan for Agricultural Modernization. In the former, the evaluation indicator is "supporting the construction of waste treatment facilities," whereas, in the latter, it is the "comprehensive utilization rate". To achieve the projected policy outcomes detailed in the National Plan for Agricultural Modernization, the MOA needs to ensure waste treatment facilities have sufficient treatment capacity and consistent operating conditions and that the end product of processed livestock manure would be completely non-hazardous. However, since only 54% of hog-raising operations were regarded as large-scale farms, the MOA Implementation Opinions' goal of thoroughly treating the husbandry waste generated by 75% of large-scale farms only translates into 40.5% of China's total hog raising capacity. Estimating that 80% of hog farms would expand to large-scale operations by 2020, the building of waste treatment facilities in 75% of these operations would cover 60% of hog farms in China, constituting a significant implementation gap compared with the national goal of a 75% total utilization rate. Although we can expect the utilization rate of manure to increase to the level specified by the National Plan gradually, the MOA will still function as the lead administrative apparatus to implement the 2014 Regulation. Thus, the differences between the ministerial and national policy goals have significantly affected the enforcement of the 2014 Regulation, hindered policy outcome evaluations, and caused significant implementation gaps.

Given the conflicting policy goals, the State Council of China promulgated the *Guiding Opinions about Fast Tracking the Resource Utilization of Livestock Manure in China* in June 2017. This policy clarifies the goals listed in previous ministerial and national policies by stating, "the comprehensive utilization rate for livestock and poultry manure shall reach 75% nationally by 2020, and more than 95% of large-scale husbandry operators should be equipped with fecal sewage treatment facilities." The 2017 State Council Guiding Opinions not only clarifies the objectives of past manure utilization policies but also establishes for the first time divide goals for the comprehensive utilization of manure and the completion of waste treatment facilities. Notably, the 2017 Guiding Opinions significantly raise the waste treatment facility goal by 20 percentage points, which may generate further confusion and implementation issues in the future.

3.2. Stringent and Comprehensive Ban on “Large-Scale” Hog Farms

The 2014 Regulation explicitly designates four types of ecological areas as prohibited zones for large-scale hog and poultry husbandry. The 2015 Water Pollution Control Action Plan further sets the end of 2017 as the deadline for removing all large-scale husbandry operations from these forbidden areas. Husbandry farms in the Beijing-Tianjin-Hebei metropolitan area, the Yangtze River Delta, and the Pearl River Delta were ordered to relocate by the end of 2016. While the delimitation of ecological prohibited zones has received much attention, large-scale husbandry in other areas has also faced relocation orders from the Chinese central government. Interestingly, the 2014 Regulation allows local governments to determine what constitutes “large-scale husbandry operations,” resulting in varied definitions and outcome evaluations across China. For example, the Work Plan for Delimitation and Renovation of Prohibited Areas for Livestock and Poultry Raising in Nanjing defines large-scale hog farms as those that average at least 50 hogs for sale yearly. In comparison, the Work Plan for Prevention and Control of Pollution from Livestock and Poultry Raising in Guangxi sets the minimum as having at least 500 hogs for sale or 200 head yearly. In places with no prior definitions of large-scale husbandry, the implementation of the 2014 Regulation forces the local governments to remove all operators so forbidden zones would be utterly free of livestock.

Figure 1 shows that the number of hogs slaughtered in China reached its peak in 2014 at 735.11 million heads. The number began to decline steadily to 685.02 million in 2016, with an annual reduction rate of 6.86% (Yun & Song, 2017). The MOA stipulated in its 2016 National Plan for the Development of the Hog Industry that the MOA would eliminate hog husbandry in the Yangtze River and Pearl River deltas to avoid further degradation in the watersheds. At the same time, the MOA requested provincial governments to provide financial incentives to encourage the development of large-scale, industrialized hog farms in China’s northeastern region. Therefore, although almost all the provinces in China experienced a reduction of hogs raised and slaughtered from 2014 to 2017, southern provinces such as Fujian, Zhejiang, Sichuan, and Shanghai disproportionately contributed to the national reduction rate (**Figure 2**).

For instance, because of the strict prohibition against the husbandry industry in the Zhejiang province, the region contributed to 11.1% of the national reduction rate from 2014 to 2017, which translated to a 38% decline of hogs for sale in Zhejiang. During the same period, Shanghai saw a reduction rate of 29.6%, and Fujian experienced a decline of 13.6% (**Figure 3**). During this time, provinces in the northeastern region rapidly expanded the scale of hog farms. For example, Heilongjiang province received more than 80 billion yuan of capital investment from 20 Chinese agricultural conglomerates, and in 2016 alone, the province developed 197 hog farms with an average capacity exceeding 3000 heads (Yun & Song, 2017). The excessive enforcement of forbidden zones caused significant

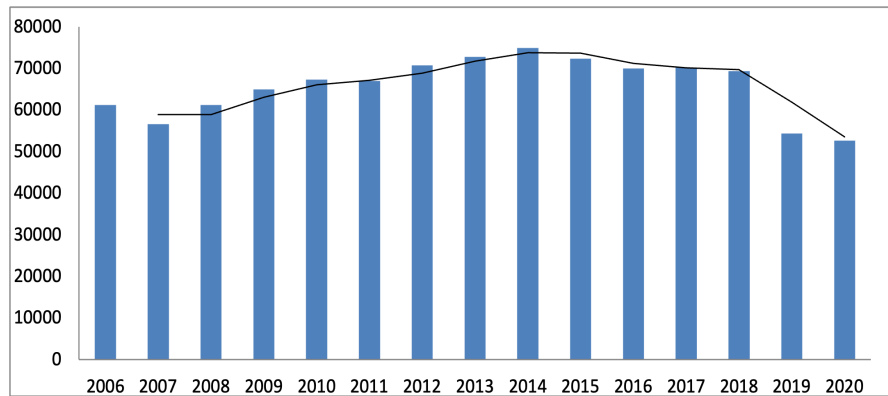


Figure 1. Numbers of hogs for sale in China from 2006 to 2020 (y-axis: 10 thousand heads; x-axis: year). Source: Yearbook of Chinese animal husbandry and veterinary medicine, China agriculture press.

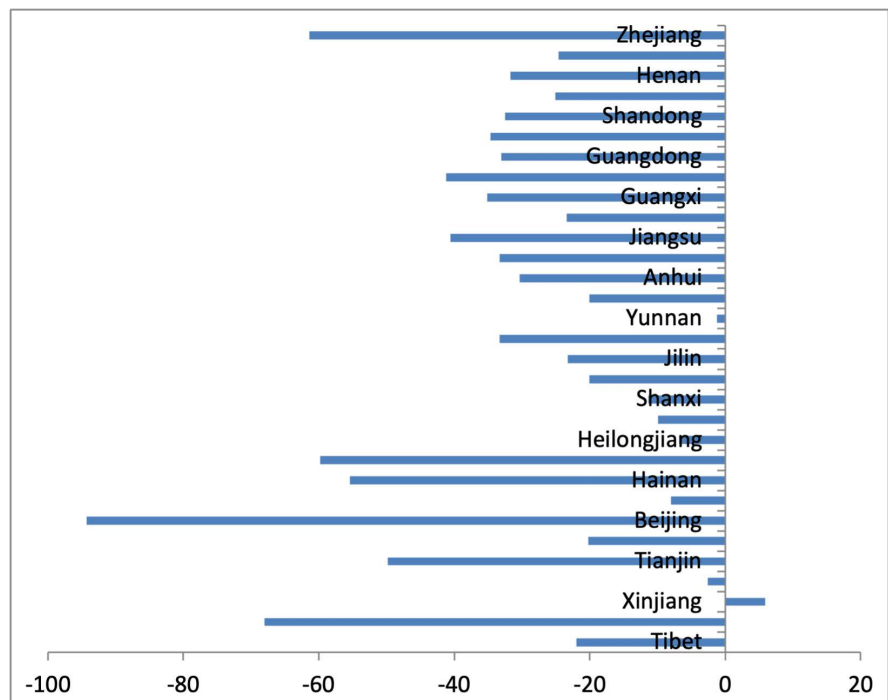


Figure 2. The provincial reduction rate of hogs slaughtered from 2014 to 2020 (Y-Axis: Province, X-Axis: % of reduction).

fluctuations in meat production and major disruptions in the regional agricultural economy. In September 2016, the vice-minister of the MOA responded by cautioning local governments to avoid “the blind prohibition and excessive restriction on animal husbandry.” Moreover, the rapid expansion of hog farming in the northeastern region represents a transference of environmental costs and ecological risks to northern China, which has not been reflected in the market value of pork due to various provincial subsidies and national price control. The relocation of hog farming to the arid-northern region may potentially become a serious environmental justice issue in the future (Mao et al., 2022).

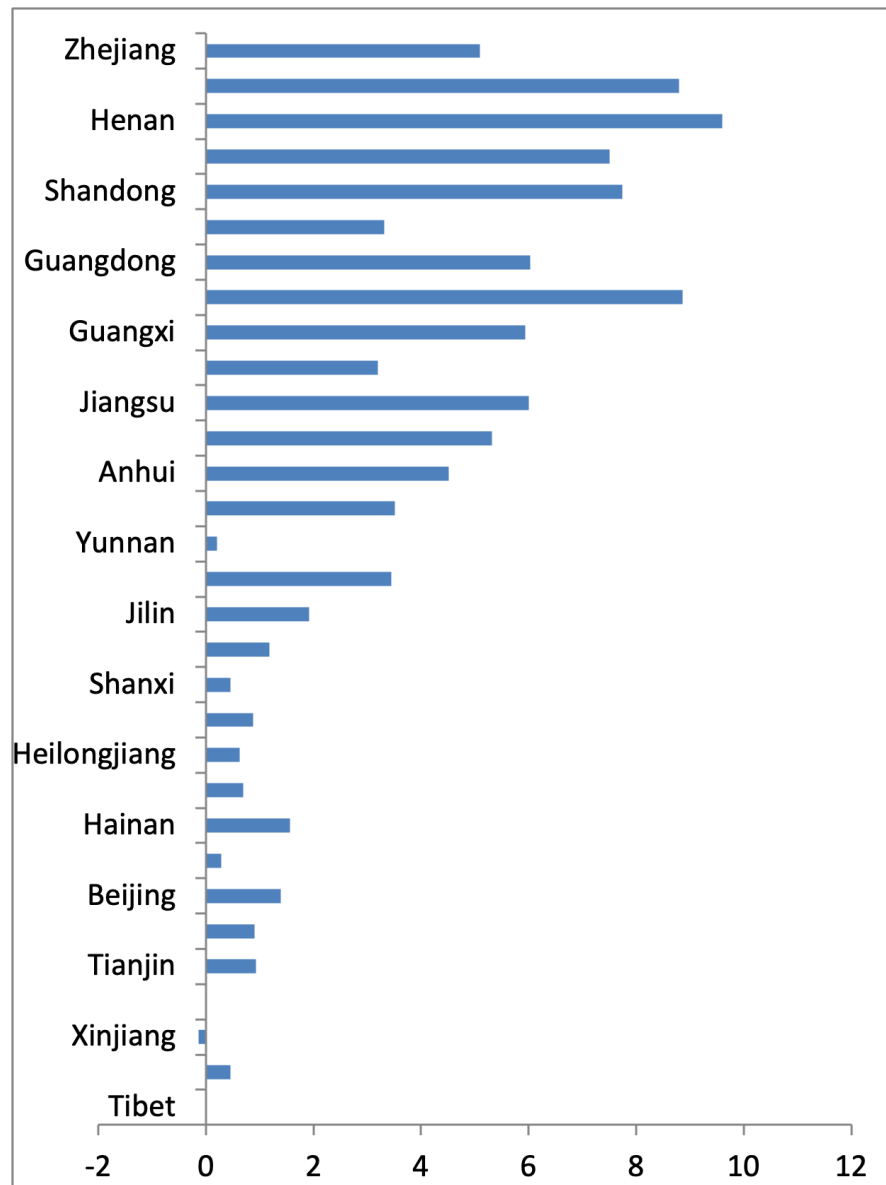


Figure 3. Provincial contribution to the national reduction rate from 2014 to 2020 (Y-Axis: Province, X-Axis: % of contribution)

3.3. Lack of Enforcement Criteria and Incentive Measures

The 2014 Regulation states that husbandry manure should be regarded as a renewable resource in sustainable agriculture rather than a pollutant. In other words, the MOA believes the best solution to the manure generated by livestock and poultry husbandry is to transform waste into organic fertilizers using biogas preparation. However, this innovative approach conflicts with the Ministry of Environmental Protection (MEP) standards, which views husbandry manure as a pollutant discharged by the agricultural industry. As a result, we have discovered that environmental protection agents in multiple counties across China prohibited the piping of processed biogas residue and slurry as organic fertilizers because they treated the processed manure as pollutants subject to industry pol-

lutant standards imposed by MEP (Interview #25). In many of our field sites, farmers had to circumvent the MEP regulation by using tankers to transport processed manure, adding to the cost of resource utilization (Interview #3).

Moreover, the Regulation's approach to utilizing the preferential policy of chemical fertilizers to encourage organic fertilizer production was misguided. The preferential policy for the chemical fertilizer industry originated from the Chinese central government's urgency to raise agricultural productivity in the early years of economic reform, including subsidies for production materials, energy price, product transport, VAT, and import/export trade. In recent years, subsidies for chemical fertilizers have been gradually phased out due to the necessity to combat environmental degradation and restructure the agricultural economy (Interview #9). In other words, the central government's control of chemical fertilizer production has meant that producers of organic fertilizer also had dwindling access to government subsidies. For example, we found that the power used to produce organic fertilizer from livestock manure was often priced at the rate for industry instead of the rate for agriculture, which significantly increased the production cost of organic fertilizer (Interview #5). During fieldwork in Sichuan in 2016, we observed a producer of chemical fertilizer that recently attempted to switch to producing bioorganic fertilizer but received no preferential policy for electricity, and as a result, the owners were forced to maintain a chemical fertilizer production line to receive the subsidized electricity price (Interview #19).

In addition, incentive measures specified by the Regulation have not been appropriately implemented. According to Article 31 of the Regulation, livestock and poultry farms that use manure to generate biogas and electricity should enjoy preferential pricing when they sell their surplus electricity to the national power grid. In practice, the local power department often prohibits husbandry farms from transmitting surplus electricity to the national network on the pretexts that they have "too small generating capacity" or "do not conform to technical standards" (Interview #16). This institutional barrier occurred because the power generated by biogas facilities in husbandry enterprises is usually around 20 - 500 kW, which is enough for the enterprises' lighting, heating, and feed processing needs but too low for the national power grid without the installation of additional transformers and circuits. To avoid paying these costs, local districts of the national power grid imposed conditions on the terms they would accept surplus electricity from husbandry enterprises. For example, the power company requires that the power output of a single generator should reach at least 500 kW, a condition few husbandry enterprises can satisfy (Interview #18). Even if husbandry enterprises want to supply their surplus electricity to nearby villages free of charge, they must consider the construction costs of transmission lines. As a result, these enterprises must depend on insufficient national subsidies to generate profits. The authors observed during field research in Anhui province in 2016 that a model "circular agricultural enterprise" that used husbandry biogas to process flour had over 4000 pigs for sale every year with a

50-kW biogas power generation capacity. Nevertheless, electricity generated by the enterprise did not enter the national system and was insufficient to meet the power demand of the flour processing facility (Interview #11). The enterprise had to purchase power to support its flour production and was charged the industrial electricity rate.

4. Discussion

With the publication of the Study on Ecological Modernization by the Chinese Academy of Sciences in 2007, the Chinese central government has actively transformed itself into an environmental state by incorporating the ecological modernization perspective into its national development strategy (Chen et al., 2017; Zinda & He, 2020). Since the early 2000s, the Chinese state has adopted an integrated environmental governance approach that simultaneously focuses on pollution control and ecological conservation. The party-state has effectively utilized its relatively autonomous position from industry influences and public consultation to design and implement policies that fulfill the strategic environmental goals specified by senior leaders (Gilley, 2012). At the same time, environmental regulation enforcement has shifted from an administrative management-based approach to a system that relies on legal and economic instruments (Zhu et al., 2015).

The formulation of the 2014 Regulation has reflected the Chinese central government's strong emphasis on sustainable development in its agricultural and animal husbandry sectors; however, the above analysis shows that there is still a profound implementation gap between policy goals and current outcomes. The objectives of the regulations were to transform the point source control of husbandry manure into a nationwide resource-based utilization system. Nevertheless, the overlapping ministerial jurisdictions and the multitude of provincial-level initiatives have resulted in conflicting interpretations of national policy's scale and evaluation criteria, leaving half of the commercial husbandry farms exempt from the regulations. Additionally, in implementing the Regulation, the grassroots cadres of local Environmental Protection Bureaus still focus on the end-of-pipe treatment of waste and rely on the arbitrary use of administrative power to enforce compliance by commercial operators. At the same time, the conflicting interests of the fragmented bureaucracy have severely constrained the proper functioning of the Regulation's incentive mechanisms, which rely on economic instruments to promote the utilization of husbandry waste as a resource. The Regulation has not realized its goal of establishing a nationwide treatment network to transform husbandry manure into organic fertilizer. Instead, implementing the Regulation has generated a system of environmental binding targets based on different definitions.

The 2014 Regulation's inability to achieve the expected policy goals of promoting resource utilization of husbandry manure can be attributed to the unique dilemma the unitary party-state faces in its environmental governance. On the one hand, China's rapid transformation from an impoverished collective society

to the second-largest economy in the world has inevitably generated many environmental and social issues that require swift policy responses from the central state. On the other hand, China's immense geographical scale and profound regional differences in ecology and local cultures make policy implementation highly dependent on local state agents. As such, the formulation of environmental policies becomes a largely non-participatory process, with decision-making authority concentrated in selected executive agencies in the central government. Different central ministries often fail to align their diverse policy goals and coordinate incentive structures and technical standards. At the sub-national administrative level, the downstream stage of policy implementation often becomes highly dispersed and uneven as local officials and grassroots stage agents face contradicting demands from their supervisors in the fragmented bureaucracy (van Rooij et al., 2017).

To overcome this contradiction, the Chinese central government must utilize binding targets in job evaluations to mobilize the rank-and-file cadres, which motivates local officials to focus only on achieving short-term results and neglect the long-term sustainability of policy outcomes. Consequently, top-down implementation of the Regulation fails to institutionalize environmental interests at lower levels of governance. Instead, the dominant rationality of the bureaucracy remains the command-and-control quota system in which local state agents focus solely on quantitative targets regardless of the practicality of the assigned tasks and the unintended effects generated by the policy. In our case study, the stringent and comprehensive ban on large-scale hog farms in southern provinces inadvertently caused the transfer of environmental risks to the provinces in the northeastern region. Since the relocation of the husbandry industry requires considerable capital investment, most of the newly established hog farms are industrialized husbandry operations run by large agribusinesses, and these large-scale farms tend to congregate in prefectures that provide the most subsidies creating a significant threat to the ecological carrying capacity of the northeastern provinces. Without the full participation of stakeholders in the animal husbandry and crop-production value chains, the top-down implementation of the Regulation only generates passive compliance from polluters, further reducing the effectiveness and efficiency of policy implementation in downstream stages.

5. Conclusion

To resolve the Regulation's implementation gap, the Ministry of Agriculture and Rural Affairs should work with the Ministry of Ecology and Environment to reformulate environmental targets, so enforcement will focus on the resource attributes of livestock and poultry manure and the utilization of husbandry waste. In addition, incentive mechanisms detailed in the Regulation should be modified to allow timely implementation. The Chinese central government should separate subsidies for organic fertilizer from existing control mechanisms for

chemical fertilizer. Husbandry operations should be managed differently based on the production scale, and the state should provide preferential policies to agricultural enterprises that invest in waste treatment and biogas facilities. An integrated support system that includes financial subsidies, tax rebates, discounted prices for productive inputs, and agricultural extension must be firmly established before the intended policy outcomes of the Regulation can be achieved. Finally, expanding MOA-supported and university-based extension systems will provide the necessary expertise and enforcement capacity to enable the transition to a more effective and sustainable production system.

Acknowledgements

This study was supported by the National Social Science Fund of China (20AGL022).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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