

Research on Innovation and Sustainable Development Pathways of Rural Environmental Governance Driven by New Productive Forces

Dejun Zhou, Xinrui Zhi

School of Law, Jiangsu University, Zhenjiang, 212013, Jiangsu, China

ABSTRACT

New productive forces, characterized by digitalization, intelligence, and green technology, provide a novel theoretical perspective and practical pathway for rural environmental governance. Under the context of China's rural revitalization strategy, rural environmental governance faces challenges such as resource waste and suboptimal pollution management. This paper explores innovative pathways for rural environmental governance driven by new productive forces from four dimensions: technological advancement, mechanism innovation, cultural empowerment, and economic support. It proposes measures such as the application of smart agriculture and green technologies, the construction of multi-stakeholder collaborative governance mechanisms, the cultivation of green lifestyles, and ecological compensation coupled with industrial transformation and upgrading to advance rural environmental governance towards intelligence, ecology, and sustainability. The study indicates that new productive forces can not only improve the efficiency and effectiveness of rural environmental governance but also provide critical support for rural revitalization and sustainable development, laying a solid foundation for building beautiful rural areas where humanity and nature coexist harmoniously.

KEYWORDS

New productive forces; rural environmental governance; innovation pathways; sustainable development; rural revitalization

1 Theoretical Foundation and Conceptual Framework

1.1 Connotation and Characteristics of New Productive Forces

New productive forces refer to a novel form of productivity shaped by the driving forces of digitalization, intelligence, and sustainability, leveraging technologies such as next-generation information technology, artificial intelligence, and green technology.

Compared to traditional productive forces, new productive forces exhibit the following characteristics:

(1) Technological Advancement: Relying on digital transformation and technological innovation, they enable rapid improvements in production efficiency.

(2) Green and Sustainable Development: With a focus on resource conservation and environmental protection, they promote harmonious integration of economic activities and ecological systems.

(3) Intelligence and Synergy: Through the application of big data, artificial intelligence, and other technologies, they optimize production, distribution, exchange, and consumption across the entire

process.

(4) Openness and Sharing: They emphasize collaborative participation among multiple stakeholders and a shared approach to outcomes. These attributes position new productive forces as a key driver of socioeconomic transformation and provide innovative ideas and pathways for rural environmental governance.

1.2 Definition and Content of Rural Environmental Governance

With the continuous development of socialism with Chinese characteristics in the new era, rural ecological construction in Jiangsu Province has made significant progress. From the perspective of the rural revitalization strategy, rural ecological environment construction shows positive trends of improvement but also faces challenges. Ecological livability is an inherent requirement of rural revitalization, emphasizing effective governance of the environment, continuous improvement of village appearance, and the creation of livable, work-friendly, and beautiful rural communities.

Rural environmental governance refers to the comprehensive process of addressing issues such as environmental pollution, resource waste, and ecological degradation in rural areas through policies, technology, management, and cultural initiatives. The aim is to achieve a harmonious balance between ecological environmental protection and rural economic and social development. Its main components include:

(1) Water and Soil Resource Management: Addressing agricultural non-point source pollution, water resource protection, and soil conservation.

(2) Solid Waste Management: Reducing, recycling, and safely disposing of rural household and agricultural production waste.

(3) Ecosystem Protection: Protecting biodiversity, safeguarding arable land, and conducting ecological restoration.

(4) Enhancing Environmental Awareness: Improving farmers' environmental consciousness and participation levels through education and training. Rural environmental governance is not only a crucial part of the rural revitalization strategy but also a key step toward achieving sustainable development.

1.3 The Coupling Relationship Between New Productive Forces and Rural Environmental Governance

There is a strong coupling relationship between new productive forces and rural environmental governance. The technological driving force of new productive forces provides advanced tools and methods for environmental governance in rural areas. For instance, big data analytics can monitor changes in environmental quality, artificial intelligence can optimize governance strategies, and IoT devices enable real-time monitoring and management.

The green characteristics of new productive forces align closely with the ecological goals of rural environmental governance, enabling the reduction of environmental harm from agricultural production through the promotion of green technologies and sustainable industrial models. Additionally, the emphasis on multi-stakeholder collaboration and openness inherent in new productive forces introduces socialized participation mechanisms for rural environmental governance, encouraging governments, enterprises, farmers, and social organizations to jointly engage in environmental protection efforts.

Overall, new productive forces provide technical support, mechanism innovation, and value-driven leadership for rural environmental governance, facilitating the transformation of governance models from traditional extensive methods to intelligent, refined, and sustainable approaches.

1.4 Environmental Governance Theory from the Perspective of Sustainable Development

The rural revitalization strategy, introduced in the report of the 19th National Congress of the Communist Party of China, serves as a comprehensive framework for addressing issues related to "agriculture, rural areas, and farmers." It emphasizes not only the economic development of rural areas but also improvements in environmental governance.

The theory of environmental governance from a sustainable development perspective highlights the need to balance economic, social, and ecological objectives, aiming for long-term harmony between human development and the natural environment. Within this theoretical framework, environmental governance extends beyond pollution control and resource management to encompass a holistic and dynamically adaptive process. Its core principles include:

(1) Systematic Approach: Adopting a comprehensive view of ecosystems and coordinating relationships among the environment, economy, and society.

(2) Participatory Governance: Stressing the involvement of multiple stakeholders, particularly the active participation of farmers in rural environmental governance.

(3) Forward-Looking Perspective: Balancing long-term objectives with short-term actions to ensure sustained benefits from governance measures.

(4) Technological Innovation: Recognizing technology as a key driver for enhancing governance efficiency and effectiveness.

By integrating sustainable development theory with the advantages of new productive forces, rural environmental governance can adopt a comprehensive guiding framework, further promoting green transformation and high-quality development in rural areas.

2 Current Status and Analysis of Rural Environmental Governance

2.1 Current Status of Rural Environmental Governance in China

In recent years, China has made significant progress in rural environmental governance. On the policy front, the government has issued several key documents, such as the *Five-Year Action Plan for Improving the Rural Living Environment* and the *Regulations on Rural Environmental Protection*, providing a legal and regulatory framework for governance efforts. In terms of financial support, both central and local governments have increased investments in rural infrastructure, leading to improvements in waste and sewage treatment systems. Additionally, emerging technologies, including green technology, ecological agriculture, and smart agriculture, have been increasingly adopted, significantly enhancing governance efficiency and outcomes.

Despite these advancements, rural environmental governance faces persistent challenges. The overall environmental quality in rural areas remains suboptimal, failing to meet the ambitious goals set by the rural revitalization strategy.

2.2 Major Challenges in Rural Environmental Governance

Rural environmental governance is critical for improving the quality of life in rural areas. The creation of beautiful and livable rural environments aligns with the broader societal pursuit of better living conditions. However, various challenges limit the comprehensive effectiveness of governance measures. These challenges can be categorized as follows:

(1) Infrastructure Deficiencies: Insufficient infrastructure remains a major obstacle. Many rural areas lack adequate sewage treatment facilities and waste collection systems, particularly in remote and impoverished regions. The absence of such facilities results in untreated wastewater discharge

and random garbage dumping, leading to environmental pollution and adverse effects on residents' health and livelihoods. This lack of infrastructure perpetuates a "symptom-focused" governance approach that fails to address root causes effectively.

(2) **Inadequate Governance Capacity:** Local governments, as primary actors in rural environmental governance, face significant limitations in technical expertise, financial resources, and human capital. In some cases, limited understanding of the importance of environmental governance leads to insufficient investment and a lack of specialized teams and strategic planning. These challenges are particularly pronounced in economically underdeveloped areas, where fiscal resources are prioritized for economic growth, leaving environmental governance efforts underfunded and unsustainable.

(3) **Single Governance Model:** Environmental governance in many rural areas relies heavily on government-led administrative measures, with limited engagement from markets and communities. While these top-down approaches may deliver short-term results, their sustainability is compromised by a lack of active involvement from farmers and businesses. Furthermore, this approach overlooks community autonomy and creativity, restricting governance model diversification and resource integration.

(4) **Challenges in Pollution Control:** Non-point source pollution from agriculture, such as excessive fertilizer and pesticide use and improper livestock waste disposal, is a significant contributor to rural environmental degradation. These pollutants infiltrate soil and water through leaching and runoff, causing groundwater contamination, water eutrophication, and soil degradation. The dispersed and hidden nature of these pollutants makes traditional governance methods ineffective.

(5) **Weak Environmental Awareness:** Many rural residents lack awareness of environmental issues and are unmotivated to participate in governance initiatives. Resistance to governance measures, such as waste sorting, often stems from inadequate understanding of their importance. Insufficient public education campaigns further weaken residents' engagement and diminish the overall effectiveness of governance efforts.

In summary, rural environmental governance faces both structural and awareness-related challenges. Addressing these issues requires a multifaceted approach that combines policy implementation, technological advancements, institutional innovation, and public education to enhance community participation and resource integration.

2.3 Contradictions Between Rural Environmental Governance and Sustainable Development

Rural environmental governance and sustainable development are interlinked but also present inherent contradictions. These contradictions stem from the complexity of governance and the characteristics of China's socioeconomic development stage.

(1) **Short-Term Gains vs. Long-Term Goals:** Many rural areas prioritize short-term economic growth over long-term environmental sustainability. For instance, some regions relax environmental standards to attract investments, leading to resource overexploitation and ecological damage. While this "pollute first, clean up later" approach may boost short-term growth, it imposes long-term costs, undermining sustainable development goals.

(2) **Regional Disparities:** Significant differences in economic development, infrastructure, and governance capacity among regions hinder national environmental governance effectiveness. Developed regions benefit from advanced technology, higher funding, and better management, while underdeveloped areas struggle with limited resources and weak policy implementation, leading to uneven governance outcomes.

(3) **Modern Agriculture vs. Ecosystem Conservation:** Large-scale, high-intensity agricultural practices, including excessive chemical use and unregulated livestock waste, exert significant pressure on rural ecosystems. These practices lead to soil degradation, water pollution, and biodiversity loss, threatening environmental and agricultural sustainability.

(4) **Resource Supply vs. Governance Demand:** Effective environmental governance requires substantial technical, financial, and human resources, which are often lacking in rural areas. Limited fiscal capacity and a shortage of skilled personnel hinder the implementation of governance measures, exacerbating existing challenges.

Addressing these contradictions requires balancing short-term economic objectives with long-term sustainability goals, reducing regional disparities through targeted support, and promoting green technologies to mitigate agricultural impacts on ecosystems.

2.4 Necessity of Introducing New Productive Forces into Environmental Governance

The introduction of new productive forces offers novel opportunities and momentum for rural environmental governance.

(1) **Technological Innovation:** Advanced technologies, such as IoT, big data, and artificial intelligence, enable precise monitoring and intelligent optimization of governance strategies, enhancing efficiency and effectiveness.

(2) **Green and Sustainable Development:** New productive forces emphasize reducing resource consumption and pollution, aligning closely with ecological sustainability goals and driving rural economic growth.

(3) **Collaborative Governance Models:** The synergy and inclusivity of new productive forces foster multi-stakeholder governance frameworks, encouraging active participation from governments, enterprises, farmers, and social organizations.

(4) **Public Awareness Enhancement:** Through education and advocacy, new productive forces improve environmental awareness and skills among rural residents, strengthening the social foundation for governance.

In conclusion, integrating new productive forces into rural environmental governance is not only necessary to address current challenges but also essential for advancing sustainable development and achieving rural revitalization goals.

3 Innovative Pathways for Rural Environmental Governance Driven by New Productive Forces

3.1 Technological Drivers: Application of Smart Agriculture and Green Technology

Technological innovation is a core pathway through which new productive forces drive rural environmental governance. In the context of dual demands for agricultural development and environmental protection, smart agriculture and green technologies have emerged as critical tools for addressing governance challenges.

Smart agriculture represents a modernized production model that leverages technologies such as the Internet of Things (IoT), big data, and artificial intelligence (AI) to achieve precision management in agricultural processes. For instance, precision fertilization technology adjusts fertilizer usage and application methods in real-time based on crop growth needs, avoiding soil and water pollution caused by over-fertilization while enhancing fertilizer efficiency. Similarly, precision irrigation technology distributes water resources effectively based on soil moisture and crop demand, significantly reducing water waste. Additionally, drones have been widely employed for

pest monitoring and green control, reducing chemical pesticide usage and alleviating environmental pressure.

Green technology also plays a pivotal role in rural environmental governance. Organic waste resource utilization technologies can convert agricultural and household waste into organic fertilizers or energy, achieving resource recycling. Bioremediation technologies address soil and water pollution by employing biological methods to decompose or adsorb pollutants, thereby restoring ecosystems. Solar-powered wastewater treatment technologies leverage renewable energy for efficient wastewater treatment, reducing both energy consumption and costs. The application of digital technologies enhances the efficiency and sustainability of rural living environment management, improving residents' quality of life. These technological advancements not only increase governance efficiency but also reduce the long-term economic burden of environmental governance, providing a solid technological foundation for sustainable development in rural areas.

3.2 Mechanism Innovation: Multi-Stakeholder Collaborative Governance

The complexity and long-term nature of rural environmental governance necessitate a collaborative governance mechanism involving multiple stakeholders. This model emphasizes the organic integration of government, enterprises, farmers, and social organizations to jointly promote governance efforts.

The government serves as the leading actor in collaborative governance, responsible for formulating relevant policies and regulations, improving environmental standards, and providing necessary funding and technical guidance. Additionally, governments should actively foster inter-regional coordination and cooperation, establishing cross-regional governance mechanisms to address the mobility and cross-boundary nature of environmental issues.

Enterprises, as critical participants in rural environmental governance, can contribute through green investments, technological innovation, and resource support. For example, enterprises can engage in the treatment and resource utilization of agricultural waste, promote the development and dissemination of green agricultural technologies, and directly invest in rural environmental infrastructure.

Farmers, as direct stakeholders, play a crucial role in governance implementation. Their environmental awareness and behavior significantly influence the success of governance measures. By encouraging farmers to actively participate in waste sorting, land protection, and other measures, comprehensive coverage of environmental governance can be achieved.

Social organizations also hold an irreplaceable position in collaborative governance. Through advocacy and supervisory mechanisms, they can raise rural residents' environmental awareness and sense of social responsibility. Furthermore, social organizations can act as resource coordinators, bridging communication gaps among governments, enterprises, and farmers to optimize resource allocation. By ensuring multi-stakeholder participation and clear responsibility distribution, governance efficiency, stability, and sustainability are enhanced.

3.3 Cultural Empowerment: Fostering Green Lifestyles

Cultural empowerment is a vital soft power in promoting rural environmental governance. Cultivating green lifestyles represents a long-term strategy for achieving environmental governance goals, requiring not only policy and technological support but also embedding environmental consciousness into farmers' daily lives.

Enhancing farmers' environmental awareness is a foundational step. Educational campaigns,

such as environmental knowledge lectures and green lifestyle demonstration village initiatives, help farmers recognize the importance of environmental protection and adopt resource-saving, environmentally friendly behaviors.

Practically, promoting waste sorting and resource recycling serves as an effective approach to fostering green lifestyles. Villages can establish categorized waste bins and conduct training programs to help residents master waste sorting methods. Incentive mechanisms, such as rewards for participation in waste sorting, can further increase engagement and effectiveness. Rural cultural activities and the preservation of traditional ecological practices also provide valuable opportunities for fostering green lifestyles. For example, organizing environmentally themed cultural events can communicate green development concepts in accessible ways, enhancing residents' environmental awareness.

Community governance also plays a critical role in promoting green lifestyles. Village committees can guide and supervise the incorporation of green living principles into community norms, fostering grassroots-level environmental actions and enhancing overall rural community governance capabilities.

3.4 Economic Support: Ecological Compensation and Industrial Transformation

Economic support is an essential guarantee for rural environmental governance, with ecological compensation and industrial transformation serving as core measures.

Ecological compensation mechanisms use economic incentives to encourage farmers' participation in environmental protection. For instance, governments can establish ecological compensation funds to provide subsidies for farmers engaged in vegetation preservation and ecological restoration, motivating their active involvement. Additionally, policies such as ecological tax reductions and exemptions can incentivize the adoption of green production techniques, reducing environmental harm.

Industrial transformation and upgrading are also critical pathways for achieving environmental governance objectives. The high-consumption, high-pollution characteristics of traditional agricultural practices compel rural areas to explore new green economic growth points. Developing ecological agriculture, leisure agriculture, and rural tourism not only alleviates environmental pressure but also creates new employment opportunities and income sources for farmers. For example, promoting organic agriculture reduces reliance on chemical inputs while meeting market demand for green products. Similarly, fostering rural tourism drives economic development, ecological preservation, and the inheritance of traditional culture.

By integrating economic support with industrial transformation, rural areas can achieve a win-win situation for ecology and economy, providing sustainable momentum for environmental governance.

In summary, the innovative pathways for rural environmental governance driven by new productive forces encompass technological drivers, mechanism innovation, cultural empowerment, and economic support. These pathways work synergistically to propel rural environmental governance toward greater precision, ecological sustainability, and long-term viability. Their implementation not only addresses current governance challenges but also lays a solid foundation for sustainable rural development.

4 Conclusion

Effectively addressing ecological environmental governance is crucial for achieving the goals of rural revitalization, as it forms the foundation for establishing sustainable agricultural development

models. Within the context of Chinese-style modernization, the conditions supporting rural ecological governance have improved, and governance objectives have been elevated accordingly.

Driven by the goal of high-quality development, long-term management mechanisms for rural living environment governance, characterized by their longevity, coordination, and systemic nature, have emerged as comprehensive institutional arrangements, critical governance methods, and integrated approaches to resolving environmental challenges.

The introduction of new productive forces provides novel perspectives and practical pathways for rural environmental governance. These forces not only address key challenges in current governance but also inject powerful momentum into rural revitalization and sustainable development.

In the future, only through continuous theoretical innovation, policy refinement, and practical exploration can the overall level of rural environmental governance be comprehensively enhanced, contributing to the creation of beautiful rural areas and the realization of harmonious coexistence between humans and nature.

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About the Author

Dejun Zhou was born in Funing, Jiangsu P.R. China, in 1978. He received the master's degree from Jiangsu University, P. R. China. Now, he is working in School of Law at Jiangsu University. His research interest includes higher education, environmental protection, intellectual property law, and population aging;

Xinrui Zhi was born in Dafeng, Jiangsu P.R. China, in 2005. Now, he is a Law major at Jiangsu University. His research interest includes environmental protection, intellectual property law.

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