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Sustainable Growth in Rural China: A Case Study on Economic and Ecological Integration in Xiaoheifa Village

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Abstract: In the global pursuit of sustainable development, the green economic transformation has been given attention. Most existing studies have overlooked the urgent need for developing a green economy in rural areas, and there is still a lack of analysis on successful rural transformation cases. This research presents challenges and solutions to implementing the green transformation process in the rural areas of China, with a specific focus on Xiaoheifa village. The results of field studies showed that afforestation programs, the development of an under-forest economy, and wetland construction are the main components of green transformation in the village. Through a series of strengthening interventions, the environment in Xiaohefa village has been visibly improved, the economic income has increased, and the poverty relief goal has been achieved. The study highlights the importance of government policy support, the diversity of economic activities, the protection of ecological resources and their sustainable utilization, and community participation in creating sustainable rural economic models. The research offers perspectives and practical operations on green transformation for policymakers and professionals in similar rural communities.

Keywords: green economic development, rural China, under-forest economy, sustainable growth, Xiaoheifa village.

1. Introduction

Globally, a contradiction exists between economic development and environmental protection. Countries pursuing high-speed economic development, such as Brazil's large-scale deforestation of the Amazon Rainforest for agriculture and Canada's oil sand mining, all instantiate this dilemma [1],[2]. The concept of sustainable development was proposed as early as 1987 in the report "Our Common Future," emphasizing meeting the current needs without depriving future generations of the ability to meet their own. This report provides a theoretical basis for research on environmental and economic balance and points out the direction for policymaking in many countries [3].

Despite global awareness, the impact of economic activities on the local environment remains unclear, especially in rural areas. This paper addresses this gap by examining the effectiveness of green economic initiatives, specifically afforestation programs, under-forest economic development, and wetland construction, in promoting sustainable development and economic revitalization in rural China. The socioeconomic benefits of these green initiatives were comprehensively evaluated, and Xiaoheifa village was selected as a case study. By analyzing the village's experience and outcomes,

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this research seeks to provide actionable insights for effective rural development strategies centered on ecological enhancement.

China, as the largest developing country in the world, provides a unique context for research on sustainable practices as it faces environmental degradation and severe pollution problems with economic proliferation. Rapid urbanization and massive industrial production have heightened the environmental problems of air, soil, and water resources [4], leading to health risks and inhibiting future economic development [5]. After realizing the importance of sustainability, the Chinese government formulated increasingly strict environmental policies in recent years and strived to promote the construction of ecological civilization. The Master Plan for Reform of the System for Developing an Ecological Civilization issued in 2015, and the Thirteenth Five-Year Plan from 2016 to 2020 made ecological protection the first premise by putting forward a series of specific goals for green development [6],[7]. The latest policy, the Fourteenth Five-Year Plan, further raised the requirements for quantitative indicators such as air quality and forest coverage rate, emphasizing the expansion of green lifestyles and promotion of green technology innovation during 2021-2025 [8].

However, achieving effective policy implementation throughout the country remains challenging, especially in rural regions with unique economic structures and development conditions. According to data from the seventh national population census of China, more than 500 million people live in rural areas [9]. Promoting sustainable development in rural areas is a complex and vital task. Compared with cities, rural areas have weaker economies, more extensive modes of economic development, imperfect environmental protection infrastructures, and generally lack environmental awareness [10]. At the same time, their ecological and natural resources indicate potential for future development. The rural economy is highly dependent on the environment, and production methods are generally obsolete, making environmental governance difficult [11]. Direct payment of environmental costs or conditional cash transfers can only solve superficial problems temporarily. However, using the inherent advantages of rural areas to develop green economies is one of the best ways to promote sustainable growth in the long term [12].

Forestry economies, eco-tourism, and ecological agriculture are three ways that many researchers have studied. They were considered the best ways for rural areas to achieve sustainable development. Research by Xiongwen Chen and Hangbiao Jin shows that Zhuji City in China has achieved significant economic income by fully exploiting the multifunctionality of Chinese torreya, utilizing its social, cultural, environmental, and health functions [13]. A study in China's two river basins proves that combining agriculture and tourism can improve agricultural ecological efficiency and better achieve sustainable agricultural development [14]. Ecological agriculture can effectively reduce pesticide use, protect water resources, and increase economic income while reducing damage to soil health [15].

Although there is more research on these three types of rural green economy, researchers rarely discuss how specific communities can develop under-forestry economies through existing forestry resources. In addition, comprehensive cases of ecological construction from scratch in poor villages and successful promotion of community economic improvement are rare in the literature. The case of Xiaoheifa village is unique; this village has the economic characteristics of residing people with disabilities and a unique historical background, showing the development potential of a series of green development models such as the under-forestry economy in rural areas during its poverty alleviation process. Through field investigations and visits, this study revealed the interaction of this village's environmental, economic, and social factors. Their comprehensive impacts on regional development were evaluated in detail. This paper provides strategic inspiration and experience sharing for other similar rural areas to promote economic transformation and rural revitalization through ecological improvement.

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The remainder of the paper proceeds as follows. Section 2 introduces the historical background of Xiaoheifa village and outlines the methodology and data collection process. Section 3 discusses the village's three primary initiatives of green economic development as the research results. These include the afforestation program, the development of the under-forest economy, and wetland construction. Section 4 further analyzes the key development strategies that contributed to the village's successful transformation, and section 5 concludes.

2. Methods

2.1. Introduction to Xiaoheifa village

Xiaoheifa village is located in the eastern part of Changziying, Daxing District, about 40 kilometers from the center of Beijing (Tiananmen Square), and is a typical rural community in northern China. In the early Ming Dynasty, immigrants from Hongtong County, Shanxi Province, built this village today. The area of Xiaoheifa village, originally named Beiheifa, is 3300 mu (All land measurements in this study are reported in mu, the traditional Chinese unit of land. For reference, one mu is equivalent to approximately 666.67 square meters or 0.165 acres.), with 660 mu of homestead land. The registered population of the whole village is 1265 people, and the permanent population is 820 people, among which 144 people are considered the floating population. The village has a long history, and the villagers traditionally relied mainly on agriculture. In recent years, under the support of environmental and poverty alleviation policies, Xiaoheifa village has achieved significant environmental improvement. It has obtained significant economic benefits in developing a green economy, successfully lifting itself out of poverty.

Xiaohefa village has experienced long-term poverty, one of the primary reasons is the "Flour Poisoning" incident in 1990. At that time, the local mill's lubricating oil was accidentally stored in an iron barrel containing rat poison. The leakage of lubricating oil led to the contamination of flour, causing more than 60% of the villagers to suffer from peripheral nerve damage, and 227 people were paralyzed in the lower body. Agriculture was the primary source of income, and the resulting loss of labor force caused the villagers to fall into extreme poverty and could not work in the fields or go out to work. The village suffered from a weak economy and degraded environment, with garbage and sewage water everywhere. For a long time, Xiaohefa village had been listed as a low-income village in Beijing. Therefore, the city, district, and town governments began targeting poverty alleviation for Xiaohefa, focusing on plain afforestation and wetland resources.

2.2. Research process and data sources

This study mainly adopted qualitative analysis methods to examine the economic development and environmental governance in Xiaoheifa village. The researcher went to the village for detailed field investigations in April, May, and June 2024. Multiple methods were utilized to collect and analyze the data.

First, the researcher used participatory survey methods to observe the village's landscape characteristics, infrastructure, and daily economic production mode. Second, in-depth interviews were conducted with key stakeholders and representatives from the Xiaohefa village Committee, Under-forest Poultry Farm, Under-forest Plantation, and Beijing Enterprises Industrial Environmental Technology Co., Ltd. These interviews sought to understand insights regarding strategies implemented, difficulties encountered, and final achievements. Third, event analysis was employed to review the historical events and policy transformations, providing the context for the village's gradual progression. Eventually, qualitative data analysis was guided by the Grounded theory approach, uncovering the key themes and theoretical ideas reflected by the empirical data.

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These comprehensive approaches ensure a thorough examination of Xiaoheifa village's afforestation program, under-forest economic development, and wetland construction. Their outcomes and factors under the success or challenges faced were assessed. The following research provides first-hand information obtained from the staff of various organizations during field investigations.

3. The development of the green economy

3.1. Afforestation program

In 2012, Beijing carried out the one million mu afforestation project in the plains area, aiming to improve the capital's ecological environment and promote green development and the construction of ecological civilization. During 2012-2015, the project invested 34.3 billion yuan in planting trees such as black locust, elm, and oil pine, which increased the forest coverage rate from 14.85% to 25.6% in the plains area(All Financial data in the study are reported in Renminbi (RMB). For reference, the exchange rate at the time of the study was approximately 1RMB = 0.14 USD). During this period, 2400 mu of land in Xiaoheifa was transferred for landscape ecological forest construction, and a transfer compensation fund of 1500 yuan per mu totaled 3.6 million yuan per year was received. This afforestation project was not compulsory, and land transfer was one of the main driving factors for Xiaoheifa's sustainable development.

Firstly, due to the lack of labor force in Xiaoheifa, many farmlands were abandoned, and villagers made meager profits. Due to high costs and low mechanization rates, the net income per mu per year of two-season harvest-type farmland in Xiaoheifa was less than 1000 yuan. The land transfer increased the villagers' monthly income and saved human resources. Villagers no longer need to work in the fields for a long time but can choose other more relaxed and flexible jobs.

Secondly, after completing the afforestation plan, 120 green jobs were created to take care of the newly planted forests, with simple watering, pest control, and pruning of branches and leaves as the job duties. Apart from technical personnel, all recruited personnel were local villagers in Xiaoheifa. Villagers earned a wage of 100 yuan and worked about 8 hours daily. At that time, many polluting enterprises in the village were relocated out of Beijing to reduce environmental pollution in the capital, such as electroplating, non-woven fabric, and plastic packaging factories. Creating green jobs has alleviated the economic pressure on villagers and promoted stability in the village. At the same time, planting large forest areas further improved the village's natural environment, with an annual AQI index below 50 and suitable humidity.

3.2. Development of under-forest economy

Although the afforestation plan was successfully implemented and brought economic benefits, 62% of the 370 households in the village were still low-income families at that time. In 2014, Xiaoheifa village discovered the prospects for developing an under-forest economy. The under-forest economy refers to industries developed by utilizing the multi-dimensional spatial resources and environment of forests, which can effectively increase the additional value of forestry and stimulate the sustainable development potential of forestry [16]. Underground planting and breeding can not only rely on the agricultural production skills of villagers to improve the productivity of forest land and increase the income of villagers but also better protect existing forest resources. Since then, the 4-meter gap between trees in Xiaoheifa village's forest land has been effectively utilized. In 2014, 3.5 million marigolds were planted in the village's 1100 mu of forest land. Marigolds avoided direct sunlight and sunburn under sparse tree shade, such as ginkgoes, and obtained sufficient light, growing very well.

In 2016, Xiaoheifa village received help from the Beijing Academy of Agriculture and Forestry Sciences. Agricultural and forestry scientists selected Chinese medicinal herbs and lilies suitable for

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local planting and taught local villagers techniques to increase agricultural productivity. Chinese medicinal herbs such as honeysuckle and Isatis root can earn 600 yuan per mu annually. Lilies are both ornamental and edible, and their seeds can be frozen for planting every year. The first batch of planting test fields brought more than 900,000 yuan of additional income to the village. Seeing the success of underground planting, Xiaoheifa village decided to expand the types of crops and planting areas further.

In 2017, Xiaoheifa village built 97 mushroom greenhouses under the forest, specifically for growing shiitake mushrooms and black fungus. Mushrooms prefer shady conditions and have incredibly high yields under dense tree species, with a maximum daily yield of 1000 kilograms. The sale of mushrooms has been directly connected to the Dayang Road wholesale market, obtaining financial returns, and a characteristic edible mushroom industry chain has been established in the village.

In 2019, the Science and Technology village program (Beijing Science and Technology Agriculture Help Group) settled in the village for scientific guidance. In just a few years, the village's contribution rate to agricultural science and technology has exceeded 72%, far higher than the national level. After 2020, new crops were introduced into the village: 700,000 high-quality onions, 120 mu of lilies, and 50 mu of carrots were planted. More than 6,000 hens and ducks were raised under the forest, with a breeding area of 100 mu. With poultry raised under trees, trees are effectively prevented from being severely damaged or parasitized by pests, saving more than 500,000 yuan in tree maintenance costs each year. Nowadays, several hundred thousand Beijing oil chickens have been introduced, and the breeding area has risen to 500 mu. The high prices of oil, chicken, eggs, and meat bring a considerable income to the village.

However, agricultural production can not produce ongoing prosperity for the villagers. In the next few years, Xiaoheifa village hopes to turn the "forest economy" into its characteristic label, launch rural tourism, and attract tourists from cities. It is also expected to build guesthouses out of idle rooms, make full use of the village's ecological resources, and launch activities such as "picking eggs," "picking vegetables," "forest go-karting," and "forest walking," transforming ecological advantages into economic benefits to promote sustainable development. The experience of rural areas can easily be converted into a premium for goods. For example, even if the eggs sold on the market for 4 yuan per half kilogram are sold for 15 yuan during the "picking eggs" experience in the village, consumers will readily accept it.

3.3. Wetland construction

In addition to the two initiatives mentioned above, the two wetlands constructed in Xiaoheifa also contributed significantly to the village’s environmental enhancement and diversified economic growth. The large wetland park covers more than 200 mu and the small functional wetland covers 2.25 mu.

The location of the large wetland park was originally an abandoned pond, emitting foul smells and filled with flying mosquitoes. It was successfully integrated and transformed in 2014. Now, the wetland is planted with lotus flowers and reeds, and many corridors and walkways have been built, making it a place for villagers to relax and entertain themselves. This wetland is mainly used for recreational landscape purposes, laying a solid foundation for Xiaohefa's future development of the rural tourism industry. Tourists can experience boating, fishing, and other recreational activities here, feeling the beauty of ecology and nature.

The small functional wetland was completed in 2020; its primary function is to treat the domestic sewage of Xiaohefa village, with a maximum daily treatment capacity of 145 tons. Before the functional wetland was built, Xiaohefa village adopted a combined drainage system of rainwater and sewage, and the sewage from the village toilets was generally cleaned up by regular pumping. The

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rest of the sewage was eliminated through natural evaporation and seepage, which caused the sewage to flow across the village.

The reason behind this was that villages are scattered in rural China, therefore, the volume of domestic sewage per unit area is not large. The infrastructure construction is immature, and many areas do not have directly connected sewage treatment systems. The sewage easily penetrated the groundwater system, polluted the groundwater source, and threatened Xiaohefa's drinking water and agricultural irrigation water sources. The soil quality also deteriorated due to the residual harmful substances, reducing agricultural productivity.

The modular functional wetland was flexibly designed according to the amount of domestic sewage in the village, which is a way to ecologically treat the sewage. After treatment, the wetland-treated effluent meets the "Rural Domestic Sewage Treatment Facility Water Pollutant Discharge Standard" (DB11/1612-2019) Level II A discharge standard and is reused on-site as a supplementary water source for plain afforestation, saving Xiaohefa village tens of thousands of yuan in irrigation costs each year. The construction of the two wetlands not only revitalizes the environment in the village but also generates significant economic benefits, becoming one of the driving forces for Xiaohefa village's development of the green economy.

4. Development strategies analysis

Before analyzing the key development strategies, it is relevant to learn about the aggregate economic growth that Xiaoheifa village has achieved. Line graphs show the rise of Xiaoheifa village's collective revenue and per capita disposable income. These figures reflect the cumulative impact of green economic initiatives, policy support, and community efforts.

Figure 1 shows the annual revenue of the Xiaoheifa village Collective Economic Organization from 2016 to 2023 after initiating green economic development. The annual revenue was relatively substantial. However, due to the impacts of the COVID-19 pandemic and other factors, the revenue began to decline in 2020, dropping by about 25% within three years. However, in 2023, post-pandemic, the recovery of China's economic market also led to a peak in the revenue of the Xiaoheifa village Collective Economic Organization. The cooperative revenue reached 4.56 million yuan, an increase of over 111% compared to 2022. Although 2024 has not yet ended, the under-forest economy planting industry in the Xiaoheifa village is now relatively mature, with stable agricultural product markets and it is expected to bring further revenue increases.

Figure 1: Cooperative revenue of Xiaoheifa village (2016-2023, unit: ten thousand yuan).

Figure 2 compares the per capita disposable income of Xiaohefa villagers and the average income of rural residents in Beijing. Since 2016, the per capita disposable income of Xiaohefa villagers has increased at an average rate of 7%, and the proportion of low-income families has dropped from 62% to 0, which is strong proof of the success of green economic development. However, there is still a gap of about 3,000 yuan between this income and the average income of rural residents in Beijing,

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which reflects the specific difficulties in developing a green economy compared to the traditional one. The introduction of green development strategies has successfully alleviated poverty in the village. However, future income growth will rely on expanding the under-forest economy and other diversified development approaches.

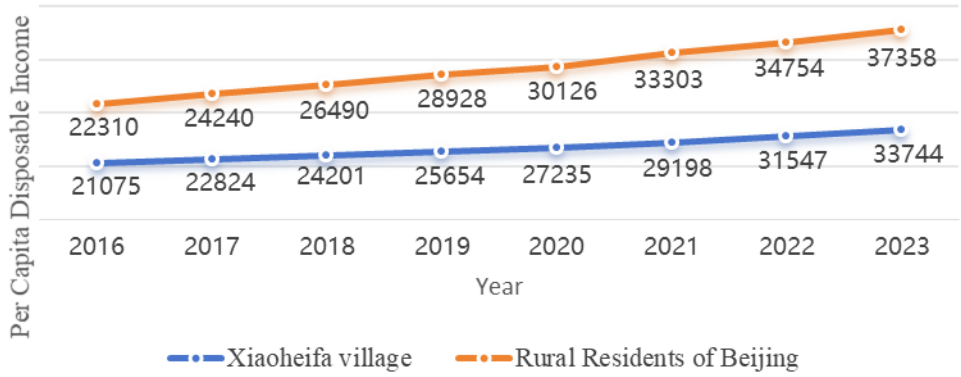

Figure 2: Comparison of per capita income between Xiaohaifa villagers and rural residents of Beijing(2016-2023, unit: yuan).

4.1. Governmental support

The development of Xiaoheifa in the past ten years is closely tied to the support of Beijing government policies for rural development. The poverty alleviation policy issued is the key to Xiaoheifa's reliance on a green economy to get rid of poverty. Other regional governments can also learn this point and promote regional development through policies tailored to local conditions. The funds set up by the government were directly used to improve public services and infrastructure construction in the village, such as water treatment facilities and road construction, to ensure the reasonable use of funds. At the same time, developing the rural industry itself is essential. The government encouraged the development of characteristic agriculture, handicrafts, or service industries in the village by providing low-interest loans or direct subsidies, coupled with a direct connection to the market, and villagers' income significantly increased.

In terms of ecological construction, the government directly rewarded villagers who participated in ecological protection and construction through ecological compensation policies, such as land transfer compensation and ecological forest subsidies, to maintain or even increase the income in the village. In addition, the government also sent agricultural experts and technicians for on-site guidance, providing advanced ecological protection and agricultural technology. These environmental improvements and economic policies were effectively implemented through the coordination of three levels of government, thus ensuring the effectiveness and coverage of the policy. At the same time, the established detection system can track and evaluate the implementation effects of the policy, make timely adjustments, and ensure that the policy can be continuously effective. Thus, strong support was provided to guarantee the sustainable development of the rural region.

4.2. Industrial transformation and diversified development

Xiaoheifa village has succeeded in industrial transformation and diversified development. Traditional agriculture in Xiaoheifa was challenging in meeting the economic needs of the villagers because of

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competition from large-scale mechanized agriculture and a lack of labor force. Plain afforestation and land transfer projects have improved land use efficiency and economic benefits, laid the foundation for developing an under-forest economy, and created new jobs and income sources for villagers. In the next few years, to further enhance the income level, Xiaohefa village will rely on the unique label "under-forest economy" to develop rural tourism, striving to improve the capacity for tourist reception and service quality to implement diversified development fully.

4.3. Ecological protection and sustainable utilization

The efforts of Xiaoheifa in ecological protection not only improved the quality of the environment but also provided new economic growth points for the development of the village. Other rural areas should also learn from this experience and promote green development through environmental engineering, such as wetland construction and forest planting. Villagers have obtained places for leisure and entertainment, and rural tourism has been promoted, achieving a win-win situation between ecological and economic benefits. The treatment method of domestic sewage prevented the formation of black and odorous water bodies, effectively improved the sanitary environment level, and protected groundwater sources and soil quality.

4.4. Community participation

In the development process, Xiaoheifa village has paid continuous attention to villagers' participation and the community's construction. Agricultural skills training and environmental protection education have improved the villagers' production skills and environmental awareness, enhancing their sense of responsibility for ecological protection. Creating green jobs has improved the villagers' happiness and quality of life. Regular discussions in the village allow villagers to determine the direction of village development jointly. The established under-forest economy agricultural cooperative centralized production and sales. This model of community construction has vital reference significance for other villages. The comprehensive quality and ability of villagers were improved, community cohesion was enhanced, and a virtuous cycle was formed, jointly promoting the sustainable development and management of the village.

4.5. Difficulties of future development

Multiple challenges and obstacles to the village's future development remain, and practical solutions still need to be formulated. Firstly, compared with traditional agriculture, forest-based agriculture has certain disadvantages, such as limited planting space and the inability to use sizeable agricultural machinery for operation. Although vegetables, medicinal herbs, and fungi planted under the forest have significantly increased the economic income of the village, the yield of these crops is still limited, and the market risk is high, which limits further income growth.

Secondly, the development of rural tourism is also a challenge. There is currently a lack of sufficient tourism infrastructure in the village, such as homestays and restaurants. In addition, due to compliance with China's 1.8 billion mu farmland red line policy, the construction of tourist toilets and restrooms is restricted, and the approval process is time-consuming. At the same time, Xiaoheifa village is far from the urban area and has low visibility, and competing with other rural tourism destinations requires careful consideration. The village needs to create other attractions and distinctive features besides forestry agriculture. For instance, it should invest in tourism advertising and promotion to enhance its attractiveness.

The last issues are the out-migration of young people and aging, a common phenomenon in rural China. Many village parents want their children to leave for city employment as a sign of social status improvement, even if the economic benefits in cities are lower than those of rural agriculture. This

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tendency partly results from insufficient job opportunities and traditional concepts that lead to village labor shortages. However, developing tourism in villages requires the participation and support of young people, so it is essential to develop strategies to attract young people back to the village for development.

5. Conclusion

Xiaoheifa village was chosen as a case study for this research to identify the efficacy of green economic strategies in promoting sustainable growth in rural China. This study analyzed the village's afforestation program, under-forest economy, and wetland construction, assessing their roles in Green economic growth. Xiaoheifa village witnessed a drastic improvement in the natural environment and increased income levels, and all families have been lifted out of poverty. The success of green economic growth was only possible with the support of government policies, implementation of diversified development strategies, emphasis on ecological protection, sustainable use of resources, and active community participation.

The study demonstrates that the afforestation program improves the village's natural ecology, employment conditions, and living standards by providing green subsidies and jobs. Fully utilizing forestry resources to develop the under-forest economy further enhances villagers' income and reduces the costs associated with forestry care. Wetland construction optimizes the local water management and sanitation system, safeguarding the soil's productivity and saving irrigation costs.

Further, specific additional measures are crucial to the success of the above initiatives. For instance, expertise and technological assistance contribute significantly to selecting the most suitable crops and plating patterns, improving agricultural productivity. These measures facilitate green transformation and make it easier for villagers to embrace environment-friendly economic techniques.

In conclusion, the paper provides sufficient evidence for the green development strategies among the villages in China. The Xiaoheifa village is an accomplished case in point, which achieved substantial economic development and sustainable environmental improvement through comprehensive planning. The research findings bring valuable experiences and insights to the road of rural sustainable development in China and the rest of the world.

However, this research is not without limitations. Although the in-depth case study of Xiaoheifa village provides valuable lessons and experiences on rural sustainable development, these strategies should be flexibly adjusted by villages and policymakers based on local contexts. Firstly, it is challenging for other regions to replicate the Beijing government's strong policy support for rural economies. Instead, policy frameworks based on conditions of local resources and capabilities should be developed.

Secondly, factors such as Xiaoheifa village's climate suitability, fertile soil, and agricultural history contributed significantly to the success of its green economy. Therefore, other rural regions should conduct holistic environmental assessments to identify suitable green economic approaches for their development. Lastly, convenient market access and technical support are provided to Xiaoheifa village due to its location in Beijing. In contrast, it takes much time and resources for other local governments to establish comparable foundations.

Future research should focus on assessing the adaptability of green economic strategies in different environmental, economic, and policy contexts. Comparative studies on multiple regions and villages should be conducted, helping villages with low market access to identify the most appropriate sustainable development measures.

Such research will provide constructive feedback for developing more effective and targeted policy interventions in the future.

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