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The development and countermeasures of household biogas in northwest grain for green project areas of China



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ABSTRACT

The Grain for Green Project (GGP) is an important ecological construction program in China from 2002. Household biogas plays an important role in the GGP of northwest of China. This article, according to the research results of the Clean Development Mechanism (CDM) project and previous relevant studies, discusses the development of household biogas in the northwest Grain for Green Project areas of China (NGGP), including its necessity, policies and laws and present situation. Furthermore, this article analyzes the constraints on household biogas development and suggests countermeasures to promote the development of household biogas in NGGP. After using household biogas in NGGP, the proportion of straw and firewood fuel decreases 60%–88%, 0.03–0.20 ha of the forest land area is protected per biogas user annually, the emission reduction of greenhouse gas is 1.23–1.34 t CO₂ equivalent per biogas user annually, and the results of the GGP are promoted. There are several constraints for household biogas development in NGGP, including low-quality biogas construction, biogas education, imperfect service system, low biogas fermentation temperature in winter, low biogas, biogas slurry and biogas residue (three-biogas) utilization rate, low biogas digester utilization rate and improper policy support. Thus, biogas construction quality should be ensured, the biogas service system and comprehensive utilization of three-biogas should be improved, and biogas knowledge should be increased; additional research needs to be performed in low-temperature fermentation technology, straw fermentation technology and simple biogas technology and operation; the biogas policies and regulations of NGGP should be perfected to encourage the development of household biogas. The information presented in this article not only will provide a reference for the development of biogas and the improvement of policy in NGGP, but also will be helpful for household biogas development in other countries with similar situations.

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1. Introduction

Current environmental issues, including global warming and soil erosion, are increasingly gaining attention. While some people believe that global warming and the greenhouse effect are not connected [1], most experts say that the increasing greenhouse effect is leading to the observed increase in global temperature, and the reason for the greenhouse effect promotion is the increasing amount of greenhouse gases from human activity [2,3]. CO₂, N₂O and CH₄ are the three important greenhouse gases that cause the greenhouse effect, and these gases account for 60%, 5% and 15%, respectively, of the total warming from the greenhouse effect [4]. Due to the unreasonable exploitation of the land, water loss and soil erosion have also become prominent environmental problems. Therefore, how to reduce greenhouse gas emissions and reduce water loss and soil erosion are public concerns.

Forest carbon sequestration and conserving soil and water have been given much attention. In the process of growth, forests absorb carbon dioxide from the atmosphere and release oxygen, meaning that carbon is fixed in plants, thereby reducing the concentration of carbon in the atmosphere and slowing down global warming [5,6]. Studies have shown that for every cubic meter of volume growth, forests absorb an average of 1.83 t of carbon dioxide and release 1.62 t of oxygen [7]. Rainfall and overland flow are the important factors causing soil and water loss. Forests reduce the impact of precipitation on the ground, reduce surface runoff, increase water retention in the soil, and fix soil with their root systems, thereby significantly reducing soil erosion [8,9]. According to one study, 8.191 billion tons of soil is fixed by forests in China every year [10].

China is vast, with complicated natural conditions, a diverse climate and very rich forest resources. According to China's eighth forest resource inventory (2009–2013), China's forest area is 2.08×10^8 ha, accounting for 5.15% of the world's forest area, ranking fifth in the world; China's forest coverage rate is 21.63%; and the per capita possession of forest areas is only 25% of the world average [11]. The northwest Grain for Green Project areas of China (NGGP), which includes the Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang provinces, has a temperate continental climate; its forest characteristics are shown in Table 1. In recent years, to

meet the growing population's need for food, the forest land of northwest China has been converted, particularly by farmers illegally converting forest land to farming land, seriously damaging the forests. In addition, to meet energy needs due to lowered living standards, a large number of forests have been cut down. The destruction of forests has caused a series of problems, such as soil erosion, land desertification, water resource shortages, frequent droughts and floods, and ecological deterioration [12]. To solve these problems, improve the environment and develop sustainably, the Grain for Green Project (GGP) was officially launched in 2002 as an important ecological construction project in China.

The GGP converts land that is unsuitable for cultivation (usually with a slope of more than 25°) to forest land in a planned way [13]. In 10 years of implementation of the GGP in China, we have accumulated more than 0.27×10^8 ha of forest, and the environment has greatly improved. In NGGP, as a key area for the GGP in China, GGP can increase peasants' income, enhance the sustainability and stability of the society and protect the ecosystems [14]. Now we need to promote the results of the GGP, and the GGP area in northwest China needs security, which requires a social focus. The rural energy supply in NGGP determines the results of the GGP. Farmers in NGGP give priority to biomass energy, and if a new type of energy is not the most effective, a large number of farmers will continue to use wood as fuel, causing great forest damage in NGGP [15]. Some scholars have noted that fuel rejuvenation can reduce the pressure on forest environments [16]. Therefore, optimizing the structure of rural energy has become an important method to promote the results of the GGP.

Table 1
Situation of forest in northwest of China.

Province	Forest coverage (%)	Forest area (10 ⁴ ha)	Forest stock volume (10 ⁴ m ³)
Shaanxi	41.42	853.24	39592.52
Gansu	11.28	507.45	21453.97
Qinghai	5.63	406.39	4331.21
Ningxia	11.89	61.80	660.33
Xinjiang	4.24	698.25	33654.09

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