

The Potential and Models of Agricultural Utilization of Reclaimed Mine Land

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Abstract: This study delves into the potential and models of agricultural utilization of reclaimed mine land, analyzing its significant role in environmental restoration, economic development, and social stability. The research indicates that through scientific planning and management, reclaimed mine land can be transformed into highly productive agricultural land, while also promoting the recovery of the ecological environment and the sustainable development of the socio-economy. The paper proposes agricultural utilization models that integrate the characteristics of reclaimed mine land, emphasizing the application of ecological agriculture concepts in land reclamation, and analyzes the positive impact of agricultural utilization on the socio-economic development of mining areas. The study also explores the relationship between agricultural utilization and the sustainable development of mining communities, highlighting the importance of policy support and community participation. Finally, the paper summarizes the innovative points and practical significance of the research and points out future research directions.

Keywords: Reclaimed Mine Land; Agricultural Utilization; Ecological Agriculture; Social Sustainable Development.

1. Introduction

Globally, mining activities have had profound impacts on the environment, with land degradation being one of the most serious issues. Mining not only destroys the original ecosystems but also leads to the tremendous waste of land resources. With the rise of environmental awareness and the spread of sustainable development concepts, land reclamation in mining has become an indispensable part of sustainable mining practices[1-3]. Mine reclamation is not just a restoration of damaged land but also a rational utilization of natural resources and an organic combination of socio-economic development[4-7] (Figure 1). In recent years, the topic of mine ecosystems has been one of the themes discussed at three consecutive World Conferences on Ecological Restoration. Reports and papers from these conferences cover a wide range of topics, including participating countries, main institutions, hot mining areas, restoration elements, types of mines, restoration technologies, etc., reflecting the latest research trends in the field of mine ecological restoration. Soil improvement research in reclaimed mining areas has received significant attention from the academic community and governments worldwide.

These studies focus not only on soil improvement techniques and methods but also on the green, stable, and sustainable development orientation of ecological restoration in mining areas[8].

Agriculture, as the basis of human survival, has significant practical and theoretical value in the application of reclaimed mine land. Through agricultural utilization, it is possible not only to improve land quality and restore ecological functions but also to provide employment opportunities for local residents and promote economic development. However, despite the development of research and practice in mine land reclamation globally, many challenges remain. Agricultural utilization of reclaimed mine land is one of the effective ways to address this issue. By employing agricultural utilization, it is possible not only to improve land quality and restore ecological functions but also to provide employment opportunities for local residents and promote economic development. This paper aims to review the potential and models of agricultural utilization of reclaimed mine land, discussing how to achieve agricultural production on reclaimed mine land while maintaining ecological balance and promoting socio-economic development.

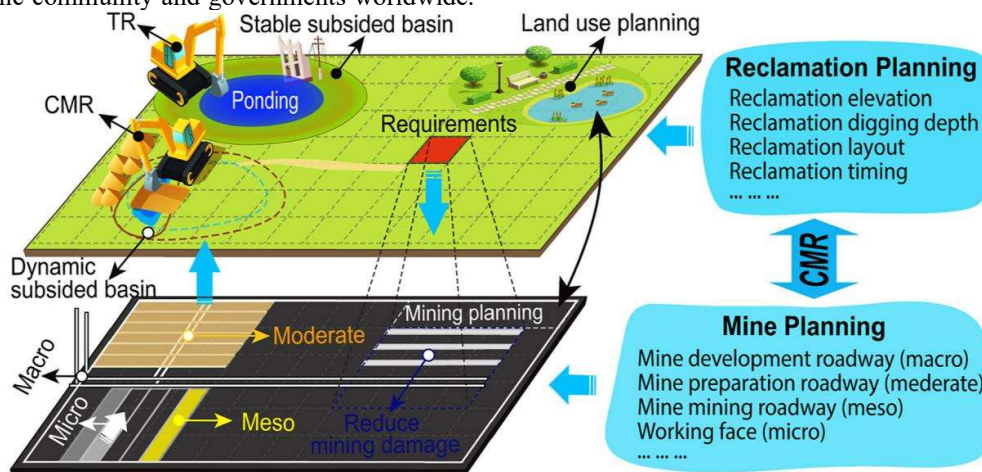


Figure 1. Integrated planning of underground coal mining and mine reclamation[8]

2. Current Status of Agricultural Utilization of Reclaimed Mine Land

2.1. Cases of Agricultural Utilization of Reclaimed Mine Land

Worldwide cases of agricultural utilization of reclaimed mine land provide valuable experience. For example, in the United States, through the implementation of the Surface Mining Control and Reclamation Act, mine land has been successfully transformed into agricultural land, not only restoring the productivity of the land but also enhancing local biodiversity. In Australia, the government and mining companies have cooperated to transform abandoned mine land into farmland and pastures by adopting advanced soil improvement techniques and water resource management strategies. In Xunwu County, Jiangxi Province, China, which was once severely ecologically damaged due to rare earth mining and known as the "Southern Desert," a series of comprehensive management measures have been taken to transform from "abandoned mines" to "green waters and green mountains," and then to "gold and silver mountains."

2.2. Comparative Analysis of Agricultural Utilization of Reclaimed Mine Land at Home and Abroad

Although there are successful cases of agricultural utilization of reclaimed mine land globally, the situation varies from country to country. Developed countries usually have more comprehensive laws and technical support, while developing countries face dual constraints of funding and technology. In addition, the geographical environment, climate conditions, and socio-economic background of different countries also affect the agricultural utilization of reclaimed mine land.

2.3. Main Problems and Challenges of Agricultural Utilization of Reclaimed Mine Land

The agricultural utilization of reclaimed mine land faces various problems and challenges[9]. Firstly, soil degradation and pollution are the main issues. Mining activities often lead to soil structure damage, fertility decline, and heavy metal

pollution. Secondly, the shortage and pollution of water resources are also serious problems[10]. Additionally, ensuring the safety and quality of agricultural products, as well as improving the acceptance and participation of local residents, are issues that need to be addressed in the agricultural utilization of reclaimed mine land[11]. Furthermore, insufficient funding is a problem; mine land reclamation requires substantial financial support, but often, due to a lack of sufficient investment, reclamation work cannot be effectively carried out. In developing countries, the level of reclamation and ecological restoration of damaged mine land is far below that of most countries in the world, one of the main reasons being the lack of investment funds. The reclamation activities of mining enterprises are usually limited to the reclamation of the occupied land, and the environmental governance and ecological restoration beyond the occupied area are not included in the governance scope. The actual environmental damage caused by mining activities is far greater than the area occupied by mining, but existing regulations do not adequately stipulate mine ecological restoration.

3. Soil and Water Resource Assessment of Reclaimed Mine Land

The study of the potential and models of agricultural utilization of reclaimed mine land cannot be separated from a detailed assessment of soil and water resources. Soil and water resources are the foundation of agricultural production and are key factors in determining whether reclaimed land can be successfully transformed into agricultural land.

3.1. Soil Fertility and Pollution Status

Mining activities often lead to soil structure damage, fertility decline, and heavy metal pollution. Therefore, assessing the soil fertility and pollution status of reclaimed land is a primary task. This includes a comprehensive analysis of the physical properties (such as texture, structure, density), chemical properties (such as pH value, organic matter content, nutrient element content), and biological properties (such as microbial diversity and activity) of the soil.

3.2. Soil Improvement Techniques and Methods

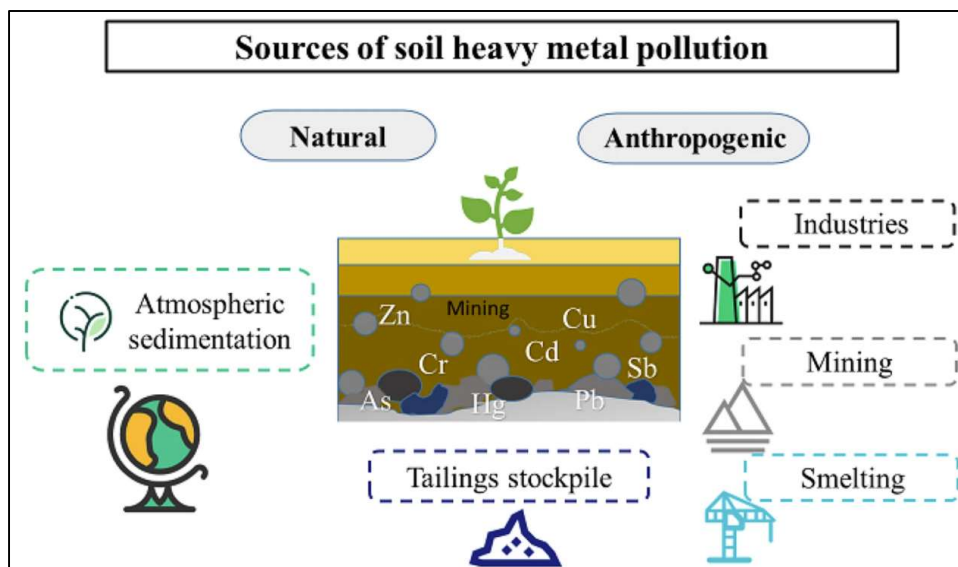


Figure 2. Microbial remediation technology for heavy metal contamination of mine soil[16]

Effective soil improvement techniques and methods are needed to address soil degradation and pollution issues. This may include physical remediation techniques: managing environmental pollution caused by mining operations through physical means such as isolation, electrokinetics, soil replacement, and covering. For example, the isolation method uses impermeable materials such as cement and slate to separate contaminated soil or water from the surrounding environment, preventing the spread of pollutants[12, 13]. Chemical remediation techniques: include using water or chemical reagents to leach heavy metals from the soil, promoting the resolution of heavy metals, and transferring them from the solid phase to the liquid phase; or by adding curing agents and other chemical methods to suppress or reduce the water solubility, mobility, and bioavailability of pollutants[14, 15]. Bioremediation techniques: utilize the natural functions of plants and microorganisms (Figure 2), and through their growth metabolism, absorb, accumulate, transform, or degrade heavy metals to reduce the concentration of pollutants in the soil[16]. Combined remediation techniques: combine physical, chemical, and biological remediation techniques to achieve the best results at low cost. For example, by adding ethylenediaminetetraacetic acid (EDTA) to the cathode tank, the current in the physical remediation process is significantly increased, enhancing the effect of electrokinetic remediation.

3.3. Sustainable Management of Water Resources on Reclaimed Mine Land

Sustainable management of water resources is another important aspect of the agricultural utilization of reclaimed mine land. This involves the assessment of water resources (such as water quantity and quality), the protection of water resources (such as preventing pollution and rational allocation), and the utilization of water resources (such as the construction and management of irrigation systems). Especially in arid and semi-arid regions, how to efficiently use limited water resources is key to achieving agricultural utilization of reclaimed mine land[17].

4. Construction of Agricultural Ecosystems on Reclaimed Mine Land

When utilizing reclaimed mine land for agriculture, it is crucial to construct a healthy and sustainable agricultural ecosystem. This involves not only the selection of crops and planting patterns but also the application of ecological agricultural concepts and the maintenance of biodiversity and ecological balance.

4.1. Crop Selection and Planting Patterns

Choosing crops that are suitable for local environmental conditions is key to successful reclamation[18]. Factors to consider include soil adaptability, selecting crops that can adapt to the characteristics of reclaimed soil, especially those that can grow in soils with heavy metal pollution or poor nutrition. Climate conditions, considering local climate conditions such as temperature, precipitation, and sunlight duration, and selecting crops that can adapt to these conditions. Economic value, choosing crops with market demand and high economic benefits to ensure the economic sustainability of reclaimed land. Ecological function,

prioritizing crops with good ecological functions, such as nitrogen-fixing and deep-rooted plants, which can improve soil structure and increase biodiversity. The choice of planting patterns should be based on principles that enhance land use efficiency and promote ecological restoration, including crop rotation, intercropping and relay cropping, three-dimensional planting, and precision agriculture.

4.2. Application of Ecological Agriculture Concepts on Reclaimed Mine Land

4.2.1. Integration of Ecological Restoration and Land Reclamation

The concept of ecological agriculture emphasizes the application of ecological restoration principles during reclamation, transforming abandoned mines into productive land by restoring soil fertility, water quality, and biodiversity[19]. This includes using organic fertilizers, green manures, and bio-agents to improve soil quality, and vegetation restoration to prevent soil erosion and enhance the ecological value of the land.

4.2.2. Promotion of Low-Carbon Technologies

Promote research on low-carbon land reclamation technologies, scientifically reduce the energy consumption of reclamation techniques, and enhance the overall carbon sequestration level of land reclamation. This involves choosing low-energy-consuming agricultural machinery, optimizing agricultural production processes, and reducing the use of chemical fertilizers and pesticides to lower the carbon footprint of agricultural activities[20].

4.2.3. Development of Ecological Landscape Agriculture

Develop ecological landscape agriculture that combines the characteristics of reclaimed mine land, beautifying the environment while providing agricultural products[21]. For example, by planning and constructing a green ecological industry chain, developing agricultural planting industries, and using modern technological achievements to transform mining waste resources into agricultural resources, such as processing weathered coal into humic acid fertilizer for soil improvement and fertility enhancement.

4.2.4. Returning Farmland to Forests and Greening Vegetation

Implement returning farmland to forests in suitable areas and ensure that the region's ecological issues are effectively addressed by planting greening vegetation. This helps restore ecosystem service functions, such as water conservation, biodiversity protection, and soil erosion control.

5. Economic Benefits of Agricultural Utilization of Reclaimed Mine Land

The agricultural utilization of reclaimed mine land not only has a positive impact on the environment but also plays an important role in local economic and social development. It increases employment and income, as agricultural activities directly provide jobs in planting, management, and harvesting, offering employment opportunities for local residents. Other links in the agricultural industry chain, such as processing, packaging, transportation, and sales, also create more jobs due to increased agricultural production. Agricultural production not only increases the direct income of farmers but also improves the economic level of the entire community by promoting the development of related industries. For local

economic development, agricultural production can drive the development of related industries such as the agricultural product processing industry, agricultural supply industry, and logistics industry, forming a complete industrial chain. The agricultural utilization of reclaimed mine land helps diversify the local economy, reducing dependence on single mineral resources. Successful agricultural utilization projects can attract external investment, increase local fiscal revenue, and provide financial support for other community development projects.

6. Conclusion

This study comprehensively explores the potential and models of agricultural utilization of reclaimed mine land, analyzing the important role of mine reclamation in environmental restoration, economic development, and social impact. The research shows that through scientific and reasonable planning and management, reclaimed mine land can be transformed into highly productive agricultural land, while also promoting the recovery of the ecological environment and the sustainable development of the socio-economy. This research proposes agricultural utilization models that integrate the characteristics of reclaimed mine land, emphasizing the application of ecological agriculture concepts in reclaimed land. It analyzes the positive impact of agricultural utilization on the socio-economic development of mining areas, especially in providing employment opportunities and promoting industrial chain development. The study provides theoretical guidance and practical cases for the agricultural utilization of reclaimed mine land, aiding in the formulation and implementation of related policies.

Through this research, it can be seen that the agricultural utilization of reclaimed mine land has tremendous development potential and broad application prospects. In the future, with the advancement of technology and the perfection of policies, the agricultural utilization of reclaimed mine land will play an even more important role in promoting the sustainable development of mining areas.

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