ISSN: 2710-0588

Current State of Research and Development Of Technologies To Improve The Quality of Arable Land

Nan Lu[1, 2, 3, 4, *] and Yuhu Luo[1, 2, 3, 4]

[1] Shaanxi Land Engineering Construction Group Co., Ltd., Xi'an, China

[2]Key Laboratory of Degraded and Unused Land Consolidation Engineering, the Ministry of Natural Resources, Xi'an, China

[3]Shaanxi Land Consolidation Engineering Technology Research Center, Xi'an, China

[4]Institute of Land Engineering and Technology, Shaanxi Land Engineering Construction Group Co., Ltd., Xi'an, China

[*] Corresponding Author

Abstract

This paper focuses on the current situation, existing problems, and future R&D directions of farmland quality improvement technology, and details the current situation of the application of farmland quality improvement technology in different regions, including the farmland quality problems and corresponding technological measures in the typical regions of northeastern black soil area, northern drylands, and southern paddy fields. The current challenges of soil quality improvement technology are analyzed in detail. The future direction of research and development of soil quality improvement technology is discussed, including technological innovation and R&D, policy support and guarantee, capital investment and diversified financing, etc., with the aim of providing scientific basis and technical support for soil quality improvement in China.

Keywords

Acreage; Quality improvement; Technological innovation; Development direction.

1. Introduction

Arable land constitutes a fundamental resource for agricultural production, with its quality being intrinsically linked to national food security and ecological security. In the context of China's rapid economic development and its continuously growing population, arable land resources are confronted with mounting challenges, including the degradation of arable land and the decline in its fertility. Consequently, enhancing the quality of arable land has emerged as a pivotal undertaking for ensuring the sustainable development of agriculture in China. In recent years, the state has placed significant emphasis on enhancing arable land quality, implementing a range of policies and measures to encourage research and the adoption of technologies aimed at improving arable land quality. The objective of this paper is to provide a comprehensive overview of the current state of arable land quality improvement technology, highlighting the prevailing challenges and identifying future research directions. This paper is intended to serve as a valuable reference for related research and practical applications.

2. Current Situation of Arable Land Quality Improvement Technology

The problem of degradation of arable land quality in China is serious and has become an important factor limiting food production capacity. The national average grade of arable land

ISSN: 2710-0588

quality is 4.76 (grade 1-10), and the proportion of medium and low yielding fields is more than 2/3 [1], so the improvement of arable land quality is imperative [2].

Northeast black soil area is China's major commodity grain base, but the long-term high-intensity use of the face of thinning, thinning, hardening of the "three changes" predicament. Part of the black soil after 40 years of reclamation, soil organic matter content decreased by 50%, soil weight increased by 34%. In order to improve the quality of farmland in the black soil area, a series of technical measures have been taken, such as returning straw to the field, deep plowing and deep plowing, and organic fertilizer application. Returning straw to the field can increase the content of soil organic matter, improve soil structure and enhance soil fertility. Deep plowing can break up the subsoil layer, increase soil aeration and water permeability, and promote plant root growth. Organic manure application can increase soil nutrient content and improve soil microbial community structure. The combination of straw return to the field and deep plowing can significantly increase soil organic matter content and crop yield in the black soil zone [3-4].

The northern drylands are one of the major food production bases in China, but drought and water shortage, infertile soils, soil erosion, and other problems have severely limited agricultural production. In particular, saline soils are widespread in the northwest region, with 15.0% of the arable land area above moderate salinization in Huanghuang Irrigation District of Ningxia; and 9.6%, 12.5% and 9.9% of the arable land area above moderate salinization in Qinghai, Gansu and western Inner Mongolia, respectively [5]. To improve the quality of dryland cropland in the north, technical measures such as conservation tillage, water-saving irrigation, and soil improvement have been adopted. Conservation tillage can reduce soil moisture evaporation, improve soil water retention, and reduce soil erosion. Water-saving irrigation techniques, such as drip irrigation and micro-sprinkler irrigation, can improve irrigation water use efficiency and reduce water waste. Soil amendments improve soil structure and fertility through the application of organic fertilizers and green manures. Studies have shown that conservation tillage combined with water-saving irrigation can significantly improve water use efficiency and crop yields in northern drylands.

In China, southern paddy fields are the primary region for rice cultivation; however, prolonged rice cultivation has resulted in several issues, including soil acidification, nutrient imbalance, and heavy metal pollution. Soil acidification is a salient problem in the southern region, and in recent years, the application of chemical fertilizers and acid deposition has led to a further exacerbation of acidification in farmland soil in the southern red soil area, with an expanding area of acidification [6]. To remediate these issues, various technical measures have been employed, including lime conditioning, organic fertilizer application, and heavy metal passivation.Lime conditioning, in particular, has emerged as a pivotal solution. This approach involves neutralizing soil acidity, increasing soil pH, and enhancing soil nutrient effectiveness. Additionally, organic fertilizer application has been found to augment soil organic matter content, thereby improving soil structure and fertility. Heavy metal passivation, a process that involves the application of passivators to reduce the bioefficacy of heavy metals in the soil, has also been employed to mitigate the uptake of heavy metals by crops.Empirical evidence has demonstrated that a combination of lime conditioning and organic fertilizer application can effectively address soil acidification issues in southern paddy fields, thereby enhancing rice yields [3].

3. Problems

3.1. Insufficient capital investment

The research, development and popularization of farmland quality improvement technology requires a large amount of capital investment. However, at present, China's capital investment

ISSN: 2710-0588

in this field is relatively insufficient, which makes it difficult for many advanced technologies to be widely applied. For example, soil remediation technology requires long-term financial support, but the actual investment is often difficult to meet the demand, which affects the effect of soil remediation.

3.2. Low adaptability of technologies

There are large differences in the quality status of farmland and agricultural production conditions in different regions, which requires the selection and application of farmland quality improvement technologies according to local conditions. However, at present, many technologies have the problem of poor adaptability in practical application. For example, some soil improvement technologies are effective in the northern drylands but ineffective in the southern rice fields, which need to be further optimized and improved.

3.3. Inadequate management and policy support

The popularization and application of farmland quality improvement technology requires perfect management and policy support. However, at present, China's management and policy support in this field is relatively insufficient, which makes it more difficult to promote the technology. For example, there is a lack of effective monitoring and evaluation system for farmland quality, which makes it difficult to grasp the changes in farmland quality in a timely manner, thus affecting the relevance and effectiveness of the technology.

3.4. Economic and social constraints

The popularization and application of the technology to improve farmland quality is also constrained by economic and social factors. For example, farmers have a low level of awareness and acceptance of the new technology, and lack the initiative to participate in the enthusiasm. In addition, the economic benefits of crop quality improvement technology often take a long time to materialize, and it is difficult to attract farmers and enterprises to participate in the short term.

3.5. Environmental and ecological constraints

Environmental and ecological factors must also be considered in the popularization and application of techniques to improve the quality of farmland. For example, the use of some chemical amendments may pollute soil and water and affect the ecological environment. Therefore, environmental and ecological risk assessment needs to be strengthened in the popularization and application of the technologies to ensure their safety and sustainability.

4. The Future Direction of Research and Development

4.1. Research and Development of New Technologies

In the future, research and development of new technologies to improve the quality of farmland should be intensified, focusing on biotechnology, information technology and new materials technology. For example, microbial fungicides with nitrogen fixation, phosphorus solubilization and potassium solubilization functions should be cultivated through biotechnology to improve soil fertility and plant resistance. Soil quality monitoring and early warning systems will be established through information technology to realize real-time monitoring and dynamic management of soil quality. Develop highly efficient and environmentally friendly soil conditioners and fertilizers through new material technology to improve the soil improvement effect and fertilizer utilization rate.

4.2. Technology Optimization and Integration

In the future, the optimization and integration of existing technologies for improving the quality of arable land should be strengthened to improve the adaptability and effectiveness of the

ISSN: 2710-0588

technologies. For example, by optimizing soil improvement technologies, their application effects in different regions and soil types can be improved. By integrating a variety of technologies, a comprehensive farmland quality improvement program will be formed to enhance the comprehensive benefits of the technologies.

4.3. Development of intellectualization and informatization

In the future, the development of intellectualization and informatization of farmland quality improvement technology should be promoted to improve the precision and efficiency of the technology. For example, through intelligent agricultural machinery and equipment, precise operation and management of arable land can be realized. Through informatization technology, the database and information platform of arable land quality should be established to realize the sharing and utilization of arable land quality information.

4.4. Policy and management innovation

In the future, the policy and management innovation of arable land quality improvement technology should be strengthened to improve the promotion and application of the technology. For example, through the formulation and improvement of relevant policies, the financial investment and policy support for cropland quality improvement technology should be increased. Through innovative management modes, establish the promotion and service system of cropland quality improvement technology to improve the popularization rate and application effect of the technology.

4.5. International cooperation and exchange

In the future, international cooperation and exchange on arable land quality improvement technology should be strengthened, and international advanced technologies and experience should be introduced and utilized. For example, through cooperation with international scientific research institutions and enterprises, joint research and development of arable land quality improvement technology should be carried out. By participating in international academic conferences and exchange activities, we can learn the latest progress and trend of international arable land quality improvement technology and improve China's international competitiveness in this field.

5. Summary

Farmland quality improvement technology is an important means to ensure food security and sustainable agricultural development. At present, China has made some progress in farmland quality improvement technology, but there are still problems such as insufficient capital investment, poor technology adaptability, and insufficient management and policy support. In the future, we should strengthen research and development of new technologies, optimize and integrate existing technologies, promote intelligent and informatized development of technologies, strengthen policy and management innovation, and carry out international cooperation and exchanges, so as to provide strong technical support for China's farmland quality improvement.

Acknowledgements

This paper was funded by the Research project of Shaanxi Provincial Land Engineering Construction Group in China (DJNY-ZD-2023-4, DINY2024-30).

ISSN: 2710-0588

References

[1] Ministry of Agriculture and Rural Development. Report on China's Agricultural and Rural Development in 2023 [M]. Beijing: China Agricultural Press, 2023.

[2] Cropland Quality Monitoring and Protection Centre of the Ministry of Agriculture and Rural . Multifaceted efforts to manage degraded arable land. China Economic Net 2024-11-19.

[3] DING W., SONG D., ZHOU W. Dominant factors driving the farmland quality in China and strategies for improvement, Journal of Plant Nutrition and Fertiliser, 2024, 30(8): 1580-1594.

[4] Ministry of Natural Resources. Main data bulletin of the third national land surveyEB/OL. (2021−08−26). https://m.mnr.gov.cn/dt/ywbb/202108/t20210826_2678340.html.

[5] Qu X., Ren Y., Wang H., Zhang J., Xie Y. Report on 30-year changes in key soil quality characteristics in China, Agricultural Comprehensive Development in China, 2020, 5, 25-26.

[6] Lu Y., Liao Y., Nie J., Zhou x., Xie J., Yang Z., Wu H. Status of Red Soil Acidification and its Amelioration Technologies in South China. Hunan Agricultural Sciences, 2015, 3: 148-151.