

Rehabilitation of Agricultural Land and Ecosystems Around Dams Using Modern Agricultural Techniques

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Abstract. Dams serve a variety of purposes, including flood control, hydroelectric power generation, water storage and irrigation. However, dams can have negative impacts on surrounding natural ecosystems and the environment. Therefore, there is a need to weigh the relationship between the various functions of dams and their potential impacts on ecosystems in dam construction and management. This study analyzes the potential impacts of dam removal on water quality and soil through in-depth analysis. At the same time, this paper explores the role of modern agricultural technologies in promoting sustainable agriculture and proposes a comprehensive set of coping strategies. The paper concludes that in the study of water quality and soil issues, attention needs to be paid to water monitoring, soil protection and agronomic measures. However, in terms of resource inputs and economic costs, modern agricultural technologies require high initial investment and operating costs. In the exploration of sustainability and long-term effects, environmental impacts and long-term effects are at the center of attention. This paper emphasizes the indispensability of scientific planning and sustainable agricultural practices. The application of modern agricultural technologies are effective means to improve production efficiency, achieve environmental sustainability and promote agricultural sustainability. Ultimately, the importance of farmer training and economic viability needs to be emphasized in terms of community engagement and education.

Keywords: Dams; Sustainable agriculture; Modern agricultural technologies; Agronomic measures; Digital agriculture.

1. Introduction

Dams are barriers constructed on streams, rivers and estuaries. Dams can be used to prevent flooding, produce hydroelectric power, store water for food or irrigation, and commercial and industrial purposes. However, studies have shown that dams can have negative impacts on the surrounding natural ecosystems and environment. Floods can destroy fish egg beds and the reproduction of migratory fish is impeded by flooding. The distribution of water temperature, salinity and oxygen may change vertically as a result of the formation of the reservoir, leading to the destruction of the original ecosystem. In addition, irrigation return flows discharged under irrigation projects will lead to serious changes in water quality [1]. For example, the Three Gorges Dam in China, which is one of the largest three gorges dams in the world, will cause more damage than most dams due to ecosystem destruction, water quality impairment, and ecological structure displacement [2]. In addition, a study investigated that, according to data reported by the USGS Dam Removal Information Portal (DRIP), 1,654 dams were removed in the United States between 1968 and 2019 [3]. When dams are constructed, they cause problems such as the destruction of agricultural land downstream of dams and the destruction of ecosystems around dams because the river continuity is disrupted, leading to sediment deposition, which prevents fertile soil from entering downstream. Therefore, it is necessary to adopt sustainable development measures to cope with the problems of farmland replanting and ecosystem restoration caused by dams.

The limitations of traditional agricultural technologies are manifold, ranging from inefficient use of water resources, dependence on chemical fertilizers and pesticides, soil infertility and pests and diseases caused by monocropping, to relatively low levels of mechanization and unsustainable farming practices, all of which affect the efficiency, sustainability and adaptability of agriculture. These technologies are deficient in terms of water utilization, ecosystem balance, and efficient use of resources, while potentially negatively impacting the environment and ecosystems. Modern

agricultural technologies, emphasizing sustainability, precision agriculture, and eco-friendliness, achieve precise monitoring and management of farmland conditions. This is done with the help of remote sensing, drones, and advanced sensor technologies, aiming to increase the efficiency of agricultural production, reduce dependence on chemicals, and adapt to the challenges of the growing global population's demand for food. The purpose of utilizing modern agricultural techniques to replant farmland and restore and enhance ecosystems around dams is to protect and restore the ecosystems around dams that have been damaged by dam construction. By replanting farmland and applying modern agricultural techniques, soil quality and vegetation cover can be improved, and ecosystems can be restored and stabilized. In addition to this, abandoned or unused land resources can be utilized more effectively, increasing land productivity and providing new development space for agriculture. Through modern irrigation techniques and water resource management, it is possible to reduce the demand for water resources, avoid over-pumping of groundwater, and protect water bodies and water resources around dams. The application of modern agricultural technology can help improve the productivity of farmland and crop yields, promote the sustainable development of local agriculture, and enhance farmers' incomes. It promotes the application of modern agricultural technology in replanting and ecosystem restoration, promotes scientific research and technological innovation, and provides a demonstration for solving agricultural and ecological problems.

In summary, this paper aims to explore how to protect the ecosystem. It is mainly analyzed from the perspective of the feasibility of using modern agricultural technology. The research will contribute to ecological conservation and community sustainability. This work aims to protect ecosystems, promote farmland replanting and sustainable agricultural development, reduce environmental impacts, and has the far-reaching significance that contributes to ecological environmental protection and community sustainability.

2. Research Progress at Home and Abroad

2.1. Development of Modern Agricultural Technology

Modern agricultural technologies include many aspects such as self-driving tractors, crop sensors, VRT. In addition, there are many systems consisting of modern technologies such as monitoring and controlling crop irrigation systems through smartphones, monitoring crop irrigation systems through smartphones, recording field conditions through GPS, biotechnology and ultrasound technology for livestock [4].

Studies are using applied model simulations and statistical data analysis to assess the ecological, hydrological, agricultural and economic impacts of ERP and SWCP in different climatic zones. Ecological restoration projects (ERP) can reverse ecosystem degradation, but in some cases, environmental constraints make it difficult to realize the expected benefits [5].

2.2. Agricultural Land Re-plowing

Farmland rehabilitation is the process of reclaiming and cultivating abandoned or barren farmland again. This agricultural practice aims to restore the productivity of the land, increase the effectiveness of its utilization, and improve the ecological environment of the farmland.

Farmland recultivation is regarded as a key agricultural strategy that focuses on sustainable land management, enhancing farmland productivity, improving the ecological environment and promoting sustainable agricultural development. Firstly, through the implementation of soil conservation and improvement measures, such as scientific crop rotation and the application of organic fertilizers. Secondly, water resource management should ensure effectiveness, including scientific irrigation systems and water utilization efficiency enhancement, as well as strengthening the ability to combat droughts and floods, to guarantee the sustainable use of water resources on farmland. Through farmland replanting, ecosystem restoration can also be promoted, including the regeneration of vegetation and the restoration of wildlife habitats, to establish an ecological balance and maintain the ecosystems around farmland.

On the other hand, scientific and technological innovation is another important direction, introducing modern agricultural technologies such as precision agriculture and remote sensing to improve the precision and efficiency of farmland management. Agricultural diversification should also be considered to improve soil resistance, mitigate the risk of pests and diseases, and enhance the resilience of farmland through the introduction of different types of crops, crop rotation, and intercropping.

The potential of thornless cacti for land restoration, inexpensive and erosion-prone control, and rational utilization of marginal lands. In the Mediterranean basin, especially in the Mediterranean islands and North Africa, cactus plantations and hedgerows cover about one million hectares. And unlike other subtropical regions, cacti have not become invasive pests in the region [6].

It has been shown that fertilizers are preferred to compensate for fertility losses and complex and radical machines are used to improve agricultural efficiency [7].

2.3. Ecosystem Restoration

The goal of ecological restoration is to transform ecosystems to their pre-disturbance state in terms of ecosystem structure, function, and composition [8].

A meta-analysis of 89 restoration assessments across a range of ecosystem types globally showed that ecological restoration increased biodiversity and ecosystem service provision by 44% and 25%, respectively. However, both remain less valuable in restored reference ecosystems than in intact reference ecosystems [9]. Therefore, ecosystem restoration remains a hot topic of discussion. It has also been shown that the development of river restoration techniques is currently showing the following trends: 1) the scale of ecological restoration is increasing; 2) ecological restoration measures need to satisfy multiple objectives; and 3) the management of water environments is changing from water quality management to aquatic ecosystem management [10].

3. Analysis of Dam Removal and Sustainable Agricultural Development

3.1. Legacy of Dam Removal

Water quality and soil problems that may result from dam removal. Dam construction may impact water quality in the surrounding area, affecting irrigation water and agroecosystems. Timely monitoring and management are necessary to ensure agricultural and ecosystem sustainability. In addition, soil erosion problems that may occur after dam removal require agronomic measures, such as soil protection, to prevent soil erosion caused by water flow and other factors and to accommodate the application of modern agricultural technologies. For example, the dam removal project in Yellowstone National Park in the United States illustrates the effectiveness of vegetation restoration and soil conservation in preventing streambank erosion and promoting ecosystem restoration. In summary, the importance of comprehensive monitoring, management and adoption of effective protection and improvement strategies after dam removal is needed to ensure the sustainability of agriculture and ecosystems after dam removal.

3.1.1. Water Quality Issues and Improvement

Dam construction may bring about peripheral water quality problems, triggered by potential sources of pollution, that adversely affect irrigation water quality and agroecosystems, affecting the sustainability of agriculture and ecosystems. Therefore, water monitoring and management is necessary to address potential water quality problems promptly to ensure the health of the aquatic environment. Dam removal may lead to water quality problems involving potential sources of pollution to neighboring waters, adversely affecting irrigation water quality and farmland ecosystems, and threatening the sustainability of agriculture and ecosystems. To solve the problem, control of industrial discharges, urban sewage and agricultural activities should be strengthened to reduce the impact of pollution sources on water bodies. In addition, ecological restoration means, such as vegetation restoration and wetland construction, should be used to promote the natural purification

of water and improve the quality of water bodies. National and local governments need to collaborate in formulating and enforcing strict environmental protection regulations and strengthening the regulation of waters to ensure that water quality continues to improve. These measures will help maintain the sustainability of the watershed environment.

3.1.2. Soil Protection and Improvement

After dam removal, soil may cause erosion problems due to water flow and other factors. Effective soil protection measures are necessary to ensure the sustainability of agricultural land. In addition, soil improvement may be required to accommodate the application of modern agricultural techniques and to prevent soil quality problems from limiting the productivity of farmland. In the United States, the dam removal project in Yellowstone National Park aims to restore the natural flow of the river and to prevent riverbank erosion through vegetation restoration and soil protection, thus contributing to the restoration of the surrounding ecosystem.

3.2. Resource Inputs and Economic Costs

3.2.1. High Initial Investment

The introduction of modern agricultural technologies may require high initial investments, including the purchase of equipment, seeds and training costs. This may constitute a disproportionate burden for some farmers, especially for small-scale and poor area farmers. Solutions need to be sought, for example in the form of government subsidies or cooperatives, to reduce the financial pressure on farmers. In India, some agricultural cooperatives have been able to obtain low-interest loans for modern agricultural technologies through partnerships with the government and NGOs to help farmers cope more easily with the high initial investment.

3.2.2. Operating Costs

In addition to the initial investment, maintenance, energy and other operating costs may make the technology unaffordable for some farmers, limiting the sustainability of the technology. Consideration could be given to promoting energy efficiency and the use of renewable energy, as well as providing technical support to reduce operating costs.

There are already some farming communities that have introduced solar irrigation systems to reduce operating costs and improve the sustainability of agriculture through solar power.

3.3. Sustainability and Long-term Effects

3.3.1. Environmental Impacts

The introduction of modern agricultural technologies may lead to some environmental problems such as soil quality degradation and water resource pollution, posing a threat to the sustainability of agriculture. Effective environmental protection measures need to be implemented to minimize negative impacts and ensure that agricultural activities do not cause irreversible damage to the surrounding environment. In Australia, where the sustainability of agroecosystems is affected by climate change, some farmers have mitigated the risk of water resource pollution and improved the sustainability of their farming systems by introducing water-saving irrigation techniques and organic farming methods.

3.3.2. Long-term Impacts

Some technologies may bring benefits in the short term but may lead to problems in the long term, such as soil degradation and ecosystem destruction. Therefore, there is a need to ensure that introduced technologies have positive and sustainable impacts on farmland and ecosystems in the long term through scientific planning and monitoring. Continued agricultural development has led to large-scale land degradation. By adopting sustainable agricultural practices, such as crop rotation and revegetation, farmers have succeeded in improving soil quality and increasing the long-term productivity of farmland.

4. Prospects and Introduction of Modern Agricultural Technologies

4.1. Modernized Irrigation Technology

After the dam removal, the adoption of modern agricultural technologies becomes a crucial initiative to achieve sustainable agricultural development. It is imperative to introduce advanced irrigation systems, including but not limited to drip and sprinkler irrigation technologies. The use of these highly efficient systems will maximize the use of limited water resources, increase irrigation efficiency, and minimize water wastage. This strategic measure is intended to address the potential reduction in water resources associated with dam removal and to ensure that agricultural production is optimized in a water-limited environment. The introduction of advanced irrigation technologies not only improves the efficiency of water use but also helps to ensure that crops are grown in the right moisture conditions. Through effective irrigation, farmers can better plan and manage their water sources to achieve stability and sustainability in their agricultural systems. This is not only critical for the continuity of agricultural production but also has far-reaching implications for the restoration and preservation of agro-ecosystems.

4.2. Precision Agriculture Technology

The widespread popularization of precision agriculture technology, including the application of satellite navigation and sensor technology, and the precise management of farmland are key initiatives to promote sustainable agricultural development. The core goal of this technology is to realize the precise management of farmland, including precise fertilizer application, precise irrigation and targeted plant protection. Through scientific data collection and analysis, precision agriculture technology effectively improves the productivity of farmland while reducing the use of pesticides and fertilizers, making a positive contribution to environmental protection and sustainable agricultural development.

The application of satellite navigation technology enables farmers to accurately locate various areas of farmland to understand soil conditions and crop growth. Paired with sensor technology, these data can be monitored and recorded in real time, providing a scientific basis for farmland management. In practice, farmers can achieve accurate fertilizer application, precise irrigation, and targeted plant protection according to specific needs and conditions. This not only improves crop yields and quality, but also reduces the overuse of agrochemicals and has a positive impact on environmental health. The widespread diffusion of precision agriculture technologies not only offers significant advantages in terms of increased production efficiency but also plays a positive role in terms of environmental protection and agricultural sustainability. By reducing the overuse of pesticides and fertilizers, this technology helps reduce the burden of agriculture on the ecosystem and mitigates the risk of contamination of soil and water resources.

4.3. Intelligent Agricultural Technology

The introduction of intelligent and automated equipment, such as drones and smart farm machinery, is an important means of enhancing the efficiency of agricultural production. The application of these advanced technologies in agriculture aims to monitor and manage farmland, as well as optimize the planting and harvesting process, thereby reducing farmers' labor intensity. Through drone technology, farmers can quickly and comprehensively access real-time information about their farmland, including soil quality, vegetation conditions, and pest and disease conditions. This provides strong support for scientific decision-making and makes farmland management more precise and efficient. At the same time, the use of intelligent farm machinery has automated the planting and harvesting process, reducing farmers' physical labor and increasing production efficiency.

The introduction of these intelligent and automated equipment not only simplifies the agricultural production process but also improves the accuracy and efficiency of production. Through real-time monitoring and automated operations, the management and operation process of farmland has become

more scientific, making agricultural production more sustainable. This has positively contributed to the modernization of agriculture and the improvement of farmers' production conditions.

4.4. Digital Agriculture

The active promotion of digital agriculture is a key initiative to provide comprehensive decision support for agricultural production through information technology and big data analysis. This digital transformation empowers farmers to manage scientifically, enabling them to respond more flexibly and precisely to changing environmental factors such as climate change and pests and diseases. By accessing and analyzing big data in real-time, farmers can gain a deeper understanding of farm conditions so they can more effectively plan their planting, manage their crops and respond to varying weather conditions.

The advantage of digital agriculture is not only in providing decision support but also in promoting stability and resilience in agricultural systems. Farmers can make precise resource management, such as water use and soil conservation, based on detailed data to maximize the productivity of their farmland. In addition, digital agriculture provides learning and training opportunities for agricultural practitioners, enabling them to better master advanced agricultural technologies and management methods, thereby continuously improving agricultural production.

In addition, the promotion of digital agriculture will inject new vitality into the agricultural sector, improve the intelligence of agricultural systems and make them more responsive to the needs of contemporary society. Through more scientific management and decision-making, digital agriculture is expected to provide farmers with more sustainable agricultural production methods and promote the development of the agricultural system in the direction of greater health, efficiency and sustainability.

Overall, the application of modern agricultural technologies after dam removal can improve agricultural production efficiency and reduce resource use while protecting the ecological environment and promoting sustainable agricultural development. The government, agricultural organizations and farmers should work together to promote the widespread application of these technologies in actual production.

5. Cost Budget

5.1. Engineering Survey and Design Costs

Engineering investigation and design are key stages in a dam removal program to ensure that removal methods, impact assessments and safety considerations are in place. Investigation costs include geological investigations and topographical surveys to provide the geological and topographical information required for the removal design. Structural assessment costs cover the assessment of the dam structure by a professional engineer and the testing and analysis of construction materials. The environmental impact assessment costs cover ecological surveys and water and soil testing to ensure that the removal process meets environmental standards. Safety assessment costs cover safety expert consultation and contingency plan preparation to ensure that the removal process meets relevant safety standards. Design costs cover the design of the demolition program and the preparation of engineering drawings to provide the necessary technical and environmental foundation for smooth construction.

5.2. Labor Costs

Engineer compensation is an integral part of a dam removal project and covers professionals such as structural engineers and civil engineers whose experience and skills are critical to the success of the project. Technician costs include geologists, ecologists, etc., who provide critical expertise in surveying, assessment, and monitoring during the removal process, and play a vital role in supporting project implementation. Labor compensation covers the large number of laborers required for the demolition work, including porters, machine operators, etc. This component reflects the cost of

human resources and has a significant impact on the overall project budget. Training costs may include the costs required to provide special skills or training to team members. This helps to ensure that the team has the necessary skills to improve efficiency and safety. Additional costs such as meals at the workplace, transportation allowances, etc., need to be considered in the labor cost in addition to the base salary. Considering these cost details in detail will help to accurately forecast and manage the overall dam removal project budget and ensure that there is no shortage of human resources during implementation.

5.3. Legal and Licensing

Legal counsel costs are a necessary expense in a dam removal project and include advice from legal professionals to ensure that the removal plan meets relevant regulations and compliance standards. Government permitting costs related to obtaining government permits and approvals required for dam removal, including application fees, approval fees, and other costs required to work with government agencies. Environmental Impact Assessment (EIA) costs involve an EIA that meets regulatory requirements to assess the potential impacts of removal on the surrounding environment and may involve costs of working with environmental consultants. Public participation costs may involve the process of interacting with the public, including public notices, meeting organization, and preparation of materials to ensure that public input is adequately considered in the demolition plan. Regulatory compliance costs involve ensuring that the demolition process complies with local regulations and environmental standards, including costs for document preparation, regulatory agency review, etc. By considering these costs in detail, it is possible to ensure that the project is legally compliant and to budget ahead to avoid potential legal issues.

5.4. Machinery, Equipment and Tools for Modernized Agriculture

The cost of modernized irrigation technology includes the cost of equipment acquisition, installation and maintenance for the introduction of drip and sprinkler irrigation technology to efficiently utilize water resources, improve irrigation efficiency and reduce water wastage. Precision agriculture technology costs consider equipment acquisition and maintenance costs for satellite navigation and sensor technologies to achieve precise management of farmland, reduce pesticide and fertilizer use, and promote sustainable agricultural development. Smart agriculture technology costs cover equipment acquisition, training and maintenance costs for the introduction of drones and smart farm machines aimed at monitoring and managing farmland, automating planting and harvesting, and improving agricultural production efficiency. Digital agriculture costs include the introduction of information technology and big data analytics tools, covering the costs of equipment acquisition, training and data analytics tools to provide decision support to farmers and promote scientific management. The comprehensive cost budget considers the combined costs of the above modernized agricultural technologies, including acquisition, maintenance, training, and many other aspects, to ensure the wide application of these technologies, promote sustainable agricultural development, and improve production efficiency.

5.5. Waste Disposal

After dam removal, waste disposal involves costs in several areas. Soil treatment costs include cleanup, screening, and possible remediation work, which includes the selection of soil treatment processes, equipment rental or purchase, and associated labor costs. Rock disposal costs consider treatment methods such as crushing, grinding, or sorting, and include the rental or acquisition of rock disposal equipment, as well as the labor and energy costs required to perform the treatment work. Concrete treatment costs include crushing, recycling, or other treatment methods, considering treatment process selection, equipment rental or acquisition, and operation and maintenance costs. Waste transportation costs include the cost of transporting treated waste to a designated site, including the rental or acquisition of vehicles, fuel costs, and associated labor costs. In addition, waste disposal requires compliance with environmental regulations and standards, resulting in environmental

compliance costs for working with environmental consultants, document preparation, and regulatory agency compliance reviews. By considering these waste disposal aspects in detail, a comprehensive understanding of the cost structure of waste management is ensured so that waste can be handled safely and environmentally and accurately budgeted for in the overall project costs.

5.6. Environmental Monitoring and Remediation

After dam removal, environmental monitoring and restoration costs include monitoring of the surrounding environment to ensure that there are no negative impacts on the atmosphere, water bodies, and soil. In addition, ecological restoration costs aim to prevent permanent damage to the surrounding ecosystems, including revegetation, protection of wildlife habitats, and measures to protect endangered species. Waterbody remediation costs may cover water quality testing, ecosystem restoration, and waterbody engineering projects. Soil remediation costs consider dealing with soil changes caused by demolition and include soil testing, amendment, and remediation projects. Sustainability compliance costs ensure that environmental work complies with sustainability principles, including working with experts, developing sustainability plans, and conducting training. By considering these aspects of costs in detail, it is possible to ensure that environmental management following dam removal is comprehensive, sustainable and accurately budgeted for in the overall project costs.

6. Conclusion

This study delves into the strong links between dam removal and sustainable agricultural development and proposes a comprehensive set of countermeasures. First, the study focuses on the water quality and soil issues that may arise from dam removal and clarifies the urgency of conducting water monitoring, implementing soil protection, and adopting agronomic measures. Specifically, the remarkable effectiveness of vegetation restoration and soil protection in preventing soil erosion is emphasized by citing the example of the Yellowstone National Park Dam Removal Project in the United States. At the level of resource inputs and economic costs, the study highlights the expensive initial investment and operating costs required for modern agricultural technologies, identifying solutions such as government subsidies, cooperative forms, and the application of renewable energy. Environmental impacts and long-term effects take center stage in the discussion of sustainability and long-term effects, emphasizing the indispensability of scientific planning, monitoring, and sustainable agricultural practices. In terms of making recommendations, the study discusses in depth the application of modern irrigation technologies, precision farming technologies, smart farming technologies and digital agriculture, emphasizing their positive role in improving production efficiency, environmental protection and promoting agricultural sustainability. In terms of cost budgeting, a detailed list of six key elements involved in dam removal projects is presented, including the costs of engineering surveys, labor, machinery and equipment, waste disposal, environmental monitoring and legal permits. Finally, in terms of community participation and education, the study highlights the importance of farmer training and economic viability and proposes effective training programs and community participation mechanisms to achieve these goals. The assessment of economic viability was also emphasized to ensure return on investment and project sustainability.

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