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# Planning and Design of Rural Land Renovation in Arid Area of Northwest China——A Case Study of Lanjiabao, Shaanxi

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**Abstract** Taking Lanjiabao, Shaanxi as an example, the land renovation methods for areas with severe drought, water loss and soil erosion were discussed from the planning and design of land leveling, irrigation and drainage engineering, field road engineering, soil and water conservation and other aspects to fundamentally improve the production conditions of local agriculture, thereby effectively inhibiting soil erosion, reducing the impact of wind and sand, greatly enhancing the ability to withstand natural disasters, improving the natural productivity of farmland, and enhancing adjustment capacity. The planning and design of this case project can provide reference for land renovation activities in similar areas.

**Key words** Drought, Land renovation, Soil erosion, Land leveling

## 1 Introduction

Land renovation is the process of reorganizing and re-optimizing for land resources and their utilization, and is also a readjustment of land ownership. It is a complex system project[1-2]. Land renovation changes the spatial structure of land use and land cover through biological and engineering measures, and produces an impact on landscape diversity and spatial patterns. The type, structure and function of ecosystems also change[3-7]. According to the arable land supplement target specified in the *Outline of the National General Plan for Land Use* (2006 - 2020), land supplement by 2010 and 2020 will be no less than 630 000 and 1 820 000 ha. According to the requirement of *Interim Measures for the Administration of State-invested Land Development and Rearrangement Projects* (*2006 - 2020*) for newly-increased cultivated land ratio and the statistical analysis of *Typical Survey and Appraisal of Land Development and Rearrangement Projects* (*2006 - 2008*)[8-10], it is estimated that by 2020, approximately 5% of the total land area of China will be renovated based on the average newly-increased cultivated land ratio of 5%. With the overall advancement of land renovation work, people's understanding of land renovation is gradually deepening. In the new period, the new requirements for the land renovation have been proposed, transfering the focus from the amount of cultivated land to the quantity, quality and ecological protection of cultivated land. How to fully adapt to the local ecology and topography in the planning and design of land renovation, construct a corresponding land renovation planning and design technology system, maximize the protection and promotion of the local ecological environment and reduce soil and water loss while increasing the quantity and quality of arable land, especially in the ecologically fragile arid region of Northwest China is a scientific issue that urgently needs to be studied in land engineering applications.

Based on the planning and design concept of land renovation, combining the characteristics of the ecological environment in the arid region of Northwest China, the key points of the planning and design of rural land renovation were discussed in this paper with the land renovation project of Lanjiabao Village in Long County of Shaanxi Province as an example. Combining the local drought, water shortage and proneness to water and soil loss, the fields, waters, forests, roads and villages were renovated comprehensively to fundamentally improve the agricultural and environmental conditions in the region, thereby providing scientific basis for planning and design of land renovation and protection of landscape ecology.

## 2 Planning and design of land renovation

Land renovation planning and design plays a vital role in the implementation of land renovation. It is the key to safeguarding the success of land renovation. At present, more attention has been paid to the convenience of agricultural production and the amount of cultivated land in the planning and design of land renovation. However, the consideration of the construction and self-recovery of the ecosystem in the renovation area is not sufficient, causing a certain degree of impact on the ecological environment in the region after the renovation[11-12]. Therefore, land renovation should improve the efficiency of land use, and at the same time, the importance of soil and water conservation, surface water systems and vegetation in the renovation area should be also fully valued according to the actual situation of the area. In the planning and design of land renovation, the eco-planning design ideas can be introduced, strip-shaped ecological roads can be designed, and island structure of ecological significance can be retained. This is conducive to realizing the long-term goal of restoring quantity and quality of cultivated land and protecting the ecological environment

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in land renovation. This is also an effective way to promote the healthy and sustainable development of land renovation.

## 3 Case study

**3.1 Overview of study area** This article takes the land renovation project of Lanjiabao Village in Long County of Shaanxi Province as a case. The study area is located in Lanjiabao Village of Hebei Township that is in the northeast of Long County (106°59′10″ – 107°01′49″ E, 34°57′32″ – 34°58′41″ N). The land is collectively owned. The study area is located between the Guanshan Mountain and Qianshan Mountain in the western part of the Weibei Plateau. Long County is located in the middle of Qianhe Valley. The overall terrain is high in the northwest and low in the southeast. The terrain is complex with overlapped mountains and numerous gullies and slopes. The topography of the study area is composed of valleys and slopes. The area of land to be renovated is about 78.3 ha. The topography of the study area before renovation was shown in Fig. 1.

**Fig. 1 Topography of study area before renovation**

Wind erosion in the study area is severe. Due to lack of coverage of the underlying surface, loose sand particles are prone to erosion under the influence of wind. Sand particles complete the erosion process by blowing, jumping and accumulating. Wind erosion causes the sand dunes to move and the topsoil denuded, resulting in a decline in land fertility, and even destroys the land, erodes seeds and overturns crops, leading to a reduction in production and income. Soil erosion is one of the major natural disasters in the study area. The average annual precipitation is 600.1 mm, and its spatial and temporal distribution is uneven. There is little rain in winter and spring, accounting for about 17.93% – 23.37% of the annual precipitation; while there is much rain in summer and autumn, accounting for about 76.27% – 82.07% of the annual precipitation. The distribution of rainfall in each month is also uneven. Most of it is concentrated in the flood season, accounting for 65.41% – 72.98% of the annual precipitation. Most of the rains are heavy rains, with limited effective rainfall. The groundwater resources have not been effectively used. Drought and water shortage have become the main limiting factors for the development of local land use and agricultural production. The groundwater aquifer is the Quaternary and Upper Tertiary upper Holocene – Pleistocene alluvial gravel aquifer with strong water permeability, thickness of 5 – 10 m, groundwater depth of 1.7 – 8.0 m, permeability coefficient of 54 – 118 m/d and maximum water inflow of 1 083 – 1 658 $m^3$/d. The main sources of recharge include infiltrate recharge of atmospheric precipitation and lateral recharge of Qianhe River and Beihe River. After investigation and analysis of exploration data, the irrigation system and proportion of crops in the study area were adjusted, the irrigation methods were planned scientifically, and underground freshwater resources were exploited and utilized rationally to meet the needs of local crop irrigation.

**3.2 Planning and design of land renovation** Land renovation has distinct regional nature. The study area is located in the northwestern arid region. According to the natural conditions in the study area, the focus of land renovation in Lanjiabao is to solve the problems of crushing of land plots due to complex terrain, water shortage and water and soil erosion. During the planning of the project, the design should focus on new terrace construction, field leveling, water resources guaranteeing, water facilities construction and road construction.

**3.2.1** Planning and design of land leveling engineering. As the land to be renovated in the study area is mainly desert slope, it is planned to be renovated into bench terraces in accordance with local conditions. Thus, the use of land resources will be maximized, and soil erosion on barren slopes will be relieved. At the same time, according to the nature, resources and socio-economic conditions of the study area, the layout of land use in the study area is determined as follows: the other existing grasslands will be developed into irrigated lands; the cultivated land in the study area is mainly used for growing crops such as maize and wheat; slope renovation will be carried out through construction of bench terraces to control soil erosion; and basic farmland will be constructed. From the cross section, horizontal field is formed by the triangular area of the excavation area and the triangular area of the fill area. The principles of land leveling planning and design are as follows: (i) the elevation of field plots can be determined reasonably based on topographic conditions to minimize the amount of land leveling work; (ii) the elevation within each leveling unit is unified. The specific requirements for the bench terraces are as follows: (i) each field plot is viewed as one leveling unit; (ii) the width of the terraces is not less than 6 m, the length of the field is about 300 m, the field is flat, the height difference is controlled within ± 5 cm, and the plot descends along the contour line by 1/800 – 1/1 000. According to this calculation, the height of the field ridges is designed to be about 3 m, and it can be locally increased to 4 m according to the topography. The angle of slope of the field ridges is 45° – 60°. Through renovation, other grasslands in the study area can be developed into irrigated land, thus increasing the arable land by 88.699 1 ha, which newly-increase cultivated land ratio of 95.00%. The use of barren slopes is maximized as much as possible.

**3.2.2** Planning and design of irrigation and drainage engineering. According to the analysis of the balance of supply and demand of water resources, it was found that the water supply in the region mainly depends on the local surface water supply to meet the demand for water. According to the cultivated area, irrigation method, and crop irrigation system in the region, surface water is used as the water source. In addition, pumping stations are constructed, that is, a pump room is built at the water source. The

main form of power supply is to connect village wires or built transformers. The water is transported to the reservoirs in the study area through water transfer pipes. The pipes take water from the reservoirs, and the water flow is controlled by the outlet valve. The pipes are basically arranged along the short site of the field. The pipes are connected to the branch pipes at the vertical direction at an interval of a certain distance. Gate valve is used to divert water in two directions, and each gate valve is equipped with a valve well. Brach pipes are laid parallel to the planting direction of crops. Water piles are connected to the branch pipes every 50 cm and the water piles are above the ground. For larger plots, the number of water piles can be increased approximately every 0.20 – 0.33 ha or 50 cm. For smaller plots, one water pile can be equipped to every two plots. A drain valve is installed at the end of the branch pipe so as to drain excess water in the pipe. In addition, drainage wells are constructed.

**3.2.3** Planning and design of field road engineering. Roads are an essential project in land renovation projects. The layout of road projects should fully consider coordinating with nearby residential areas and roads within the area to facilitate production and meet transportation needs. According to the actual situation in Lanjiabao Village, in accordance with the principle of facilitating residents' travel and farming, and improving the level of agricultural mechanization, the main roads, field roads and production roads are designed separately to form a traffic network in the study area that the roads inside and outside the study area are connected and the residential areas and labor fields are connected, thereby facilitating field operations and the transportation of agricultural resources. The main roads in the study area are responsible for connecting the entire study area. Field roads are branch roads of the main roads, and they go to the field or connect with the village, facilitating agricultural transportation and farming. In addition to connecting main roads or field roads, production roads should also extend toward the sloping fields to ensure that small-scale machinery can go to anywhere of each bench terrace. Thus, the cultivation and farming in the study area will become convenient and quick. In addition, bridges are designed at the junction of the roads and trenches to ensure that cultivation in the entire study area is convenient, fast and efficient. According to the design, the access rate of the field roads will reach 95%.

**3.2.4** Planning and design of water and soil conservation. Due to topography and climatic conditions, soil erosion is serious in the study area. In the planning and design of land renovation for barren slopes, it is necessary to protect the ecological environment as the main prerequisite and strengthen water and soil conservation and eco-environmental planning to minimize water and soil loss in the study area. In view of the loose sand grains that are prone to erosion and serious erosion of the top soil in the study area, the designing and planting of farmland shelterbelts and the construction of windbreaks and sand fixations can be carried out in the region to reduce the blowing and migration of sand grains and reduce the erosion of surface soil. On the other hand, the soil to be renovated can be reconstructed using the organic reconstruction technology to optimize the physical and chemical properties of the soil and increase the content of organic matter and nutrients in the soil. By building a soil erosion protection system, the coverage of the underlying surface will be increased, thus effectively curbing the occurrence and development of soil erosion and weakening and even eliminating the restrictions of soil and water loss to land use. The comprehensive land renovation design plan for the study area was shown in Fig. 2, and Fig. 3 showed the aerial photography of the study area after land renovation.

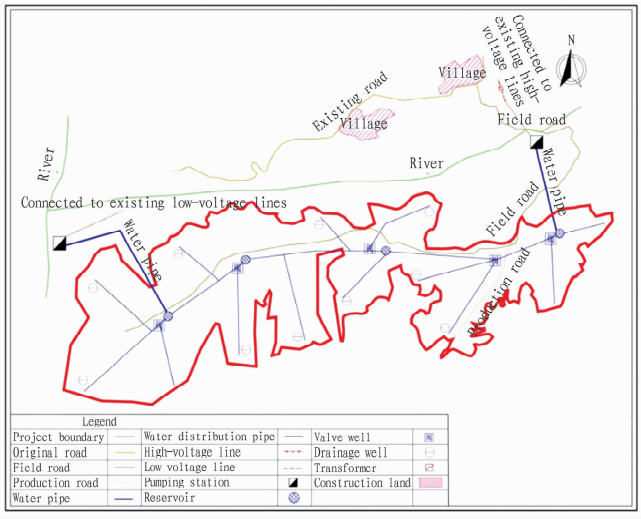


**Fig. 2 Design plan for land renovation in Lanjiabao**

**Fig. 3 Aerial photograph of Lanjiabao Village after land renovation**

## 4 Conclusions

Land renovation in China started relatively late, and it has only been nearly 20 years since it was formally proposed and launched on a large scale. In view of the status of land renovation and the existing problems in the process of implementation, focusing on the continuous improvement of land quality and the long-term strategic goal of ecological environmental protection[13] and adopting land renovation planning and design ideals according to the soil structure and ecological environment of the area is the development trend of land renovation in the future and is also an effective way to promote land renovation's focus transforming from the amount of cultivated land to the quality of cultivated land. Based on the concept of land renovation planning and design in the northwestern arid region, an empirical research was conducted in this article combined with the actual case. Through land leveling, construction of

farmland water conservancy, power facilities, roads and forest network and comprehensive adjustment of fields, waters, forests, roads and villages in the study area, infrastructure facilities such as field irrigation and drainage engineering and field roads have been further improved, and the agricultural production conditions have been fundamentally improved so that soil erosion is effectively suppressed, the impact of sand wind is reduced, the ability to resist natural disasters is greatly enhanced, the natural productivity of farmland is increased, and the ability of adjust reservoir is enhanced. In short, environmental protection benefits are significant. The planning and design methods of this case project can provide reference for land renovation activities in similar areas.

## References


[1] WANG J, YU L, LUO M, *et al.* Review on progress in land consolidation[J]. Areal Research and Development,2002,22(2):8 – 11. (in Chinese).

[2] PASAKARNIS G,MALIENE V. Towards sustainable rural development in Central and Eastern Europe: Applying land consolidation[J]. Land Use Policy,2010,27(2): 545 – 549.

[3] BONFANTI P,FREGONESE A,SIGURA M. Landscape analysis in areas affected by land consolidation[J]. Landscape and Urban Planning,1997, 37(6): 91 – 98.

[4] YU GM, LU D, LIN XW, *et al.* On the assessment methodology of natural ecological compensation for land consolidation planning[J]. Ecology and Environment,2008,17(4):1702 – 1706. (in Chinese).

[5] GU XK, CHEN BM. Method and application of landscape ecological evaluation of land consolidation: A case of land consolidation project in Jianghan Plain[J]. China Land Science,2008,22(12):58 – 62. (in Chinese).

[6] ZHAO GS, JIA WT, LIU XL. Construction of ecological engineerings of farmland landscape for land consolidation[J]. Transactions of the Chinese Society of Agricultural Engineering,2007,23(11): 114 – 119. (in Chinese).

[7] ZHANG ZF. Estimation of gains and losses of ecosystem services value with land consolidation[J]. Transactions of the Chinese Society of Agricultural Engineering,2008,24(9):69 – 72. (in Chinese).

[8] GAO XJ, YUN WJ, WANG L, *et al.* Typical investigation and evaluation of land development and consolidation projects (2006)[M]. Beijing: China Land Press,2006. (in Chinese).

[9] GAO XJ, YUN WJ, WANG L, *et al.* Typical investigation and evaluation of land development and consolidation projects (2007)[M]. Beijing: Geological Publishing House,2007. (in Chinese).

[10] GAO XJ, YUN WJ, WANG L, *et al.* Typical investigation and evaluation of land development and consolidation projects (2008)[M]. Beijing: Geological Publishing House,2008. (in Chinese).

[11] ZHONG XB, YU GM, HE GS, *et al.* Carbon storage loss during land readjustment and optimization of ecological compensation[J]. Chinese Journal of Ecology,2006,25(3):303 – 308. (in Chinese).

[12] PULECKA A, KUPIDURA P. Landscape issues in Poland[J]. Gim International, 2008, 22(6): 14 – 15.

[13] LUO M, WANG J. A study on regional differences of land consolidation in China and suggestions[J]. Progress in Geography,2001,20(2):97 – 103. (in Chinese).


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[2] GAO ZM, PENG MC. The socialization service mode of agriculture in developed countries and the development thought of China's new agricultural service system[J]. World Agriculture,2012, 34(12):50 – 53. (in Chinese).

[3] YANG Y, WANG WS, LI M. Thoughts on the participation of supply and marketing cooperative system in agricultural social service[J]. Agricultural Outlook,2017,12(11):77 – 81. (in Chinese).

[4] LIU XH. The predicament of the development of family farm and the construction of agricultural socialization service system in China[J]. Studies on Mao Zedong and Deng Xiaoping Theories,2013, 20(10):31 – 35. (in Chinese).

[5] CAI JF. Countermeasures for establishing and improving China's agricultural socialization service system[J]. Fujian Tribune (The Humanities & Social Sciences Bimonthly),2005,25(10):21 – 25. (in Chinese).

[6] LI BK. The construction and development of agricultural socialization service system[J]. Management World,1999,15(1):195 – 202. (in Chinese).

[7] YANG HQ, ZHU QZ. Commentary on the organization construction of commercialized rural service system since the 60th anniversary of the founding of new China[J]. Journal of South China Agricultural University:Social Science Edition,2010,9(1):21 – 27. (in Chinese).


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## References


[1] AHTHUKORALA P C,WOO T W. Malaysia in the middle-income trap [J]. Paper Prepared for the Asia Economic Panel Meeting at Columbia University,2011(1): 24 – 25.

[2] GUAN LJ. The "middle-income trap" and China's economic development strategy[D]. Jilin: Jilin University, 2013. (in Chinese).

[3] CAI F. From demographic dividend to reform dividend[M]. Beijing:Social Sciences Academic Press(China),2014: 129. (in Chinese).

[4] CAI F. Avoid the "middle income trap"——Exploration on the sources of China's future growth[M]. Beijing:Social Sciences Academic Press (China), 2012: 132. (in Chinese).

[5] FANG H. Interest groups and the "middle-income trap" : A reflection on Latin America's model[J]. Reform of Economic System, 2011, 29(5) : 147 – 151. (in Chinese).

[6] CHEN CB. "Welfare catch-up" and "growth trap"[J]. Economic Review,2009, 30(4): 97 – 105. (in Chinese).

[7] FAN G, ZHANG XJ. "Welfare catch-up" and "growth trap" : lessons from Latin America[J]. Management World,2008, 24(9) : 12 – 24. (in Chinese).

[8] LI YP. Why chooses market economy——Reread smith again [J]. February,2012, 34(3) : 3 – 11. (in Chinese).

[9] ROSTOW. The orists of Economic Growt from David Hume to the Present [M]. CHEN CL, GU YC, WANG CG, *et al.* Hangzhou: Zhejiang University Press, 2016: 4s. (in Chinese).

[10] WU JL. Institution outweighs technology[M]. Beijing: China Development Publishing House,2004. (in Chinese).

[11] CAI F. To solve the riddle of China's economic development[M]. Beijing: China Social Sciences Press,2014: 187. (in Chinese).

[12] QIAN M. Political gains and losses in China's past dynasties[M]. Beijing: Sanlian Bookstore Press,2001: 59 – 67. (in Chinese).