

Evaluation of Ecological Benefits of High-Standard Farmland Construction and Analysis of Regional Differences between the East and the West

—Based on the Study of Jintang County in Sichuan Province and Yongtai County in Fujian Province

Yuqing Feng, Xiaotian Li*, Xiaoping Zhou

School of Government
Beijing Normal University
Beijing, China

* Corresponding author, lixtbnu@126.com

Abstract—High-standard farmland construction is an important strategy for China to maintain food security and social stability. However, a series of engineering measures used in the construction of high-standard farmland will cause ecological disturbances as well as ecological and environmental problems, so it is necessary to evaluate its ecological benefits, thus offering references to maintain the ecological security of high-standard farmland construction and promote sustainable development. Based on the ecosystem service value theory, this work used individual service evaluation methods to evaluate the ecological benefits of typical high-standard farmland construction projects in eastern and western China and analyze the reasons. Then, it analyzed regional differences and proposed targeted policy recommendations accordingly. The results show that the ecological service value of typical high-standard farmland construction projects in the eastern and western regions has increased significantly, indicating that the project has effectively improved regional ecological services while optimizing agricultural land production functions. At the same time, changes of ecological service value caused by high-standard farmland construction will also have regional disparity due to differences in soil quality, agricultural structure, and agricultural development models. In the future, different regulation measures should be selected in accordance with regional conditions to reduce negative ecological disturbance effect of the regulation process and improve ecological efficiency.

Keywords—High-standard farmland construction; Jintang County; Yongtai County; Individual service evaluation

I. INTRODUCTION

China is a country with a large population, and food security has an important impact on maintaining social stability and the long-term stability of the country. The report of the 19th National Congress of the Communist Party of China stated that "the issue of agriculture, rural areas, and farmers should always be addressed as the top priority", and "ensuring national food security and firmly holding the Chinese people's rice bowls in their own hands". High-standard farmland construction, as a special form of farmland improvement, plays a fundamental role in ensuring grain production and stabilizing high-quality farmland.

However, the construction of high-standard farmland will not only improve the grain production capacity, but also bring a series of ecological environmental problems, such as soil consolidation or water pollution [1]. After the 1970s, the issue of ecological civilization and sustainable development has received widespread attention, and academic circles have also carried out research on many aspects in terms of ecological awareness and ecological economy. Farmland is a special ecosystem formed by artificial control on the basis of nature. The protection of its ecological benefits is getting more and more attention, and foreign scholars have gradually incorporated ecological benefits into the evaluation system of farmland improvement benefits. In recent years, it is crucial to scientifically and accurately evaluate the ecological benefits of the whole process of the high-standard farmland construction in China. In addition, it is also significant to explore reasonable optimization methods and management methods to ensure the sustainable development and ecological security of high-standard farmland while fully stimulating the production potential of farmland.

"High-standard farmland" is a concept put forward by China, which refers to farmland with centralized contiguous land, complete facilities, agricultural power facilities, fertile soil, good ecology, and strong disaster resistance. These cultivated lands, designated as permanent basic farmland, are suitable for modern agricultural production and operation, with high and stable yields despite drought or excessive rain. Similar academic research abroad has mainly focused on the protection of high-quality cultivated land. Based on standards such as area and drainage facilities, the United States classifies cultivated lands as basic agricultural land, special agricultural land, local important agricultural land and state important agricultural land, which are used and protected in different levels [2]. In the agricultural land consolidation in Japan, the scattered and fragmented cultivated land has been transformed into concentrated contiguous land by means of land-use right replacement, which is convenient for large-scale and mechanized production [3]; The Netherlands eliminates finely divided arable land through land consolidation and reorganization, and attaches importance to agricultural

infrastructure construction to improve land quality [4]. Compared with developed countries, the problem of shortage of grain and low efficiency of cultivated land is more serious in China, and the demand for the construction and protection of high-quality arable land is particularly urgent. In this case, China started to build high-standard farmland in 2011, and it has achieved certain results so far. The steady increase in the area of high-standard basic farmland has promoted the development of China's agricultural economy and promoted the transformation of agricultural growth. However, in the process of high-standard farmland construction, due to the lack of unified construction standards, there are also a series of problems, including ignorance of the region suitability, emphasis on area over quality, and ecological damage.

The scientific evaluation of ecological benefits is the basis for determining the degree of ecological damage and the basis for subsequent ecological restoration and optimization. Relevant studies on ecological benefit assessment have been extensively carried out in areas such as forest land, grassland, and urban green space. In terms of research methods, quantitative evaluation methods such as ecosystem service function value method, energy value analysis method and index system method are usually adopted. It can be seen that ecological benefit evaluation is a research hotspot in academia, and the evaluation methods are rich and diverse.

As for the benefit evaluation of basic farmland, foreign scholars focus on the evaluation of ecological landscape and environmental protection on farmland use [5]. They explored a variety of ecological disturbance effect evaluation methods, and analyzed the ecological disturbance effect mechanism of each element. In terms of evaluation method, the relative assessment method was mainly used in the early stage; in the later stage, a variety of quantitative evaluation methods, such as ecosystem service value method and energy value analysis method, and multidisciplinary methods, such as landscape ecology, geography and soil science, are adopted [6]. In terms of evaluation factors, it mainly involves soil, water resources and water environment, vegetation and related ecological processes, biodiversity, atmosphere and related ecological processes and landscape patterns [7]. In the past, most Chinese scholars analyzed the construction effectiveness from the aspect of the economic and social benefits of high-standard farmland construction. In recent years, research on ecological benefits has gradually increased, mainly involving the mechanism, assessment methods and evaluation methods of ecological disturbance effects of high-standard farmland construction. On the spatial scale, it involves three levels of national, regional, and county. On the time scale, the static disturbance effect of the state before and after the remediation is mainly statically evaluated [8], offering some references to this work. On this basis, this work selected high-standard farmland construction projects on the county scale in the east and west of China, compared and analyzed regional differences, and finally proposed optimal policy recommendations in a targeted manner. The objectives of this study are as follows: first, using the individual service evaluation method to evaluate the ecological benefits of high-standard farmland construction projects and analyze the reasons based on the ecosystem service value theory; second,

analyzing regional differences by comparing the changes in ecological benefits of different high-standard farmlands in the west and east; third, proposing targeted policy recommendations based on the differences in high-standard farmland ecological benefits in different regions.

II. RESEARCH AREAS, METHODS AND DATA SOURCES

A. Research areas

In this research, typical high-standard farmland construction projects were selected in Jintang County, Sichuan Province in the west and Yongtai County, Fujian Province in the east.

Jintang County is a suburban county under the jurisdiction of Chengdu, which is located in the northeast of Chengdu, with east longitude between $104^{\circ} 20' 37''$ and $104^{\circ} 52' 56''$, and north latitude between $30^{\circ} 29' 10''$ and $30^{\circ} 57' 41''$. The county borders two major fold belts in the middle and west of the basin. The eastern edge of the Chengdu Plain, the western edge of the central Sichuan hills, and the middle part of the Longquan Mountains from northeast to southwest, lying across the middle of the county, together form a terrain that gradually decreases from the northwest to the southeast. Lands used in Jintang County are mainly cultivated land and forestland. Since 2001, construction land and forestland have increased significantly, while cultivated land, grassland, water and other land have decreased. Jintang County is a key development area of the economic zone of Chengdu Plain. It has a natural geographical location and rich land resources. It is in a subtropical monsoon climate zone, with a mild climate, four distinct seasons, and abundant rainfall.

Yongtai County is a suburban county under the jurisdiction of Fuzhou, located in the eastern part of Fujian Province, with a longitude between $118^{\circ} 23'$ and $119^{\circ} 12'$, and a latitude between $25^{\circ} 39'$ and $26^{\circ} 05'$. The project area involves Xi'an, Hongyang and Sanjie, which are located in the middle and low mountainous area on the south slope of the branch vein of Gaogai Mountain (1128m above sea level) in the northeastern part of the Daiyun Mountains in the middle of Fujian. The geomorphology type belongs to mountain narrow valley or depression, so the terrain within the territory undulates, gully drop is large, the current is fast-flowing, the surface drainage is rapid, and the underground water level is low. The soil physical and chemical properties of Yongtai County are good and the soil fertility is high.

B. Research methods

This work selects the individual service evaluation method and refers to the common environmental value evaluation methods summarized by Zhou Xiaoping (Table 1) [9], and then it calculates the monetary value of various ecosystem services.

TABLE I. EVALUATION METHOD OF SINGLE SERVICE EVALUATION METHOD FOR ECOLOGICAL BENEFITS OF HIGH-STANDARD FARMLAND PROJECTS

Ecological services	Evaluation factors	Evaluation methods
Food production, raw material production	Production	Market value approach
Water supply	Canal water storage	Alternative engineering method
Gas regulation	Carbon fixation and oxygen production	Alternative engineering method
	Emission of greenhouse gases	Achievements reference method, market value method
Climate regulation	Climate regulation	Achievements reference method
Environment purification	Stagnant dust	Achievements reference method, alternative engineering method
Hydrological regulation	Water conservation	Alternative engineering method
Soil conservation	Soil and water conservation	Shadow price method
Nutrient cycle maintenance	Soil organic matter retention	Opportunity cost method
Biodiversity	Biodiversity	Results reference method
Aesthetic landscape	Landscape beauty	Expense method
		Achievements reference method

C. Data sources

The required data includes both statistical data and survey data. First, statistical data: the national average grain yield comes from the website of the National Bureau of Statistics, and the local average grain yield comes from Jintang County and Yongtai County Agricultural Statistics Annual Report; the average price of Chengdu and Fuzhou crops comes from the national grain and oil price monitoring website; the average precipitation of the country, Chengdu and Fuzhou comes from the 2016-2017 *China Statistical Yearbook*; the annual per capita income of Chengdu and Fuzhou cities comes from the 2017 *Chengdu Statistics Yearbook* and *Fuzhou Statistical Yearbook*; data on land use, effective soil layer thickness, and soil organic matter content before and after land remediation are provided by Chengdu and Jintang County Planning and Natural Resources Bureau and Jintang County Agriculture and Forestry Bureau. Second, survey Data: the field average annual water storage cost, multiple cropping index, local tourism costs and time data of high standard farmland construction project areas in Jintang County are obtained through field surveys.

TABLE II. ECOLOGICAL BENEFIT EVALUATION RESULTS OF HIGH-STANDARD FARMLAND PROJECTS

Ecological services	Evaluation factors	Result			
		Sanxing Town, Jintang County		Tong'an Town, Yongtai County	
		Total / 10 ⁵ Yuan	Unit area/10 ² Yuan(hm) ⁻²	Total /10 ⁵ Yuan	Unit area/10 ² Yuan(hm) ⁻²
Food production, raw material production	Production	1.5	3.0	0.024	0.29
Water supply	Canal water storage	0.012	0.024	0.79	9.54
Gas regulation	Carbon fixation and oxygen production	5.7	11.55	3.2	39
Climate regulation	Climate regulation	3.3	6.69	0.012	0.14
Environment purification	Stagnant dust	0.021	0.043	0.00004	0.00048

III. RESEARCH RESULTS

According to the classification of ecosystem services, the ecological benefits are evaluated, and the value of 4 primary ecosystem services and 11 secondary ecosystem services in two high-standard farmland construction projects is calculated. The ecological benefits of the high-standard farmland construction projects in Jintang County and Yongtai County are 3 million yuan and 430,000 yuan respectively (table 2), indicating that the ecological environment has been greatly improved after renovation.

The total increase in ecological service value of Jintang County's high-standard farmland construction projects is 30×10^5 RMB, the increase in unit area ecological service value is 6081 /hm²RMB. The value of various ecological services has increased, and the three types of ecological services with the largest increase in unit area are nutrient cycle maintenance (1824 yuan /hm²), aesthetic landscape (1236 yuan /hm²) and gas regulation (1155 yuan /hm²), by comparison, the type with the least increase in unit area is the water supply (2.4 yuan /hm²).

The total increase in ecological service value of Yongtai County's high-standard farmland construction project is 4.3×10^5 RMB, the increase in the value of ecological services per unit area is 5200 yuan /hm². Among them, the service unit area value of the aesthetic landscape reduces by 13 yuan /hm². The value of other ecological services has increased, and the three types of ecological services with the largest increase in unit area are in turn gas regulation (3900 yuan /hm²), water supply (954 yuan /hm²), and nutrient cycle maintenance (250 yuan /hm²), by comparison, the type with the least increase in unit area is environment purification (0.048 yuan /hm²).

In general, for the two project areas, except for the decrease in the aesthetic landscape value of Yongtai County, the value of various ecological services all increases, of which the increase in the value of maintaining nutrient cycling and gas regulation is large, and the increase in the value of other ecological services is different. In the project area of Jintang County, the unit area increment of individual ecological service values such as food and raw material production, climate regulation, environment purification, hydrological regulation, nutrient cycling maintenance, biodiversity and aesthetic landscape are higher than those of the Yongtai County project area; for the remaining individual ecological service values (water supply, gas regulation and soil conservation), the unit area increase is higher than that in the project area of Yongtai County.

Cont. to TABLE II.

Hydrological regulation	Water conservation	2.6	5.27	0.063	0.76
Soil conservation	Soil and water conservation	0.063	0.13	0.036	0.43
Nutrient cycle maintenance	Soil organic matter retention	9.0	18.24	0.21	2.5
Biodiversity	Biodiversity	1.7	3.45	0.0016	0.019
Aesthetic landscape	Agricultural tourism	6.1	12.36	-0.01113	-0.13
Total		30	60.81	4.3	52

IV. DISCUSSION

A. Reasons for changes in ecological service value

Based on the changes in the land use area of the project area, reasons for the changes in the value of ecological services can be analyzed. In general, after the implementation of the high-standard farmland construction projects in Jintang and Yongtai County, the area of cultivated land and rural roads increases and the area of farmland decreases, which has effectively expanded the scale of farmland ecosystem and improved the conditions of farmland infrastructure. Therefore, the total value of ecosystem services has increased, generating certain positive ecological benefits. The reasons for the changes in the value of various ecological services are analyzed separately:

In both project areas, the value of food production and raw material production in supply services increases, indicating that through the comprehensive improvement of the road, both projects effectively improve the quality of farmland and utilization efficiency, thereby increasing the value of supply services.

The main reason for the increase of regulation services in both project areas is that through the implementation of field consolidation, local leveling, and elimination of redundant ridges, the rehabilitated farmland can meet the planting needs of rice, fruits and vegetables, and economic forests, thereby playing the role of gas emission of diversified plants and the balance of atmospheric components, so as to effectively improve the gas and climate regulation value of the project area. Wetland ecosystems have the functions of regulating climate, conserving water sources, degrading pollutants and protecting biodiversity. Therefore, the increase in wetland area has effectively improved ecological services. At the same time, by constructing and improving water conservancy facilities such as diversion canals, drainage and irrigation canals, the project area has solved the problems of earth canal leakage and field water canal blockage, increasing the irrigation guarantee rate to more than 75%, which helps increase water supply, conserve water sources and regulate hydrological value.

The increase in the value of support services is mainly caused by the increase in the area of cultivated land. In the project area, digging, filling, and rationalizing the crop layout can ensure the flatness of the field, increase the thickness of the cultivated layer, and improve the soil quality, which helps soil conserve and maintain nutrient cycling, and increase biodiversity.

The value of aesthetic landscape in cultural services varies according to the characteristics of different project areas. Jintang County project areas improve the aesthetics of ecological landscapes through the construction of high-standard farmland, develop ecological tourism, and effectively increase the value of cultural services. However,

Yongtai County does not focus on the development of ecological tourism. Because of the reduction of pond water, the aesthetic value of the landscape is reduced, so the value of cultural service is slightly decreased.

From the above analysis, it is known that the two project areas have effectively increased ecological efficiency while increasing land use efficiency and potential by increasing the area of cultivated land and improving the quality of cultivated land. According to the characteristics of the ecosystem development, it can be predicted that project areas will maintain a relatively stable state for a long period of time, and its ecological service value will also tend to balance. However, in the long run, with the growth of grass, trees and other plants in the farmland ecosystem, the ecological service functions of the ecosystem such as gas regulation, climate regulation, hydrology regulation, soil conservation and biodiversity, the value of ecological service in the project area will increase in the future.

B. Reasons for regional differences

Comparing the difference in the value of ecological services after the implementation of high-standard farmland construction projects in Jintang County and Yongtai County, it can be seen that the ecological service value in Jintang County after farmland improvement is higher than that in Yongtai County. That is because on the one hand, the area of the project area in Jintang County is about 7 times that of Yongtai County, so it is easier to form scale effects during the process of land remediation and ecological restoration, which is conducive to the formation of a stable ecosystem; on the other hand, from the specific assessment factors, the evaluation results of most factors in Jintang County are higher than those in Yongtai County, especially the soil organic matter retention and agricultural tourism. In terms of soil organic matter retention, most of soil in Jintang County is purple soil, which is rich in mineral nutrients and high in fertility but low in organic matter. Soil fertility decreases during long-term cultivation, and nitrogen and phosphorus in the soil are easily lost when the slope is large and the rainfall intensity is high. In the construction process of high-standard farmland, with the application of a series of remediation methods such as scientific fertilization and field leveling, the retention capability of soil organic matter will be significantly enhanced. In terms of agricultural tourism, Jintang county has gradually formed a modern urban agriculture characterized by vegetable planting, flower planting, fruit tree cultivation, agricultural products processing park and beautiful countryside, which is conducive to tourism activities such as agricultural sightseeing and participatory experiences. However, Yongtai County's agriculture is mainly based on the cultivation of grain and specialty agricultural products, but pays insufficient attention to agricultural concern.

C. Policy recommendations

In the future construction of high-standard farmland projects, it is necessary to comprehensively consider the social, economic and ecological benefits of the project to ensure the increase in the value of various ecological service functions. In particular, it is necessary to pay attention to improving the positive promotion effect of project implementation on the value of regional landscape patterns, and fully consider the impact of the project on regional landscape richness, landscape diversity and landscape aesthetics.

In the process of high-standard farmland construction, the western region represented by Jintang County should pay more attention to the positive effects brought by water, soil and biodiversity. It should strengthen water and soil conservation work, and give full play to the scale effect of agricultural land consolidation and form a more stable ecosystem. The eastern region represented by Yongtai County needs to improve the overall ecological service value of high-standard farmland construction. In particular, it should learn from Jintang County's mature experience in agricultural tourism.

V. SUMMARY

From the evaluation results, the value of ecological services in the two pilot areas has significantly improved, indicating that high-standard farmland construction projects can improve the regional ecological functions while promoting the function of agricultural land production. However, at the same time, the ecological service value of high-standard farmland construction also has regional differences due to differences in soil quality, agricultural structure and agricultural development model. From the perspective of future development, the construction of high-standard farmland is the focus of land remediation, and the importance of ecology has become more prominent with the development

of society and improved concepts. Therefore, in the future, it is necessary to select differentiated remediation measures based on regional conditions, reduce the negative ecological disturbance effects of the remediation process, and strive to improve ecological benefits.

REFERENCES

- [1] Ye Y, Wu C, Huang H. Influence of Farmland Consolidation Engineering on Farmland Ecology and Its Model Design of Eco-environmental Care[J]. Transactions of the Chinese Society of Agricultural Engineering, 2001, 17(5): 167-71.
- [2] Ward R M. The US Farmland Protection Policy Act: Another case of benign neglect[J]. Land Use Policy, 1991, 8(1): 63-8.
- [3] Ishii A. The Methods to Consolidate Scattered Tenanted Lots into Large Rice Paddy Lots by the Land Consolidation Projects in Japan[J]. Paddy & Water Environment, 2005, 3(4): 225-33.
- [4] Yang Fan Reinen. Land Consolidation and Agricultural Development in the Netherlands[J]. China Land, 2017, (5): 43-4.
- [5] VDramstad W E, Olson J D, Forman R T T. Landscape Ecology Principles in Landscape Architecture and Land-use Planning[M]. Harvard University Graduate School of Design, 1996.
- [6] Bonfanti P, Fregonese A, Sigura M. Landscape Analysis in Areas Affected by Land Consolidation[J]. Landscape & Urban Planning, 1997, 37(1-2): 91-8.
- [7] Dudzińska M, Kocur-Bera K. Land Consolidation as the Driving Force Behind Ecological and Economic Development of Rural Areas[J]. 2014.
- [8] Wang Ailing, Liu Wenpeng, Ji Guangwei, Li Ying. Evaluation of Ecological Value of Cultivated Land in Low Mountain and Hilly Land Management Area of Shandong[J]. Journal of Agricultural Engineering, 2013, (S1): 244-50.
- [9] Zhou Xiaoping, Feng Yuqing, Luo Wei, Jia Wentao, Yang Jian, Li Hongju. Comparison of Two Evaluation Methods of Ecosystem Services Value: A Case Study of Land Remediation Project in Sanxing Township, Jintang County, Sichuan Province[J]. Acta Ecological Science, 2020, 40 (5).