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Evaluation of the Ecosystem Services Value of Agricultural Industrial Parks under the Background of Tianfu Granary Construction - A Case Study of the Daoming and Longxing Districts in Chongzhou City

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Abstract. In the new era, China faces two major challenges of food security and ecological protection. The agricultural industrial parks constructed in the process of developing the Tianfu Granary play a significant role in China's food supply and ecological security as a special type of farmland ecosystem. Accurately calculating the value of ecosystem services in agricultural industrial parks is of great importance for achieving sustainable agricultural development and comprehensively realizing rural revitalization. This paper takes the Daoming and Longxing Agricultural Industrial Parks in Chongzhou City as the research subjects, constructs an evaluation index system for ecosystem service value, and assesses and calculates the supply, support, regulation, and cultural services of the agricultural industrial parks. The research findings show that the total value of ecosystem services reaches 260.64 million yuan, which is 4.65 times the value of the agricultural products supplied, and its significant ecosystem service value cannot be ignored. Among the ecosystem service values of the park, the cultural service value is the highest, followed by the social security service value. Based on the above conclusions, this paper discusses how to achieve high-standard construction of agricultural industrial parks, providing a scientific basis for the government and policymakers to make correct decisions in the rational use of resources, reduce and avoid short-term economic behaviors that damage ecosystem service functions, and promote sustainable agricultural development.

Keywords: Agricultural Industrial Park; Ecosystem Service Functions; Value Assessment; Construction of Tianfu Granary.

1. Introduction

Entering the new era, China is faced with two major issues of the times: food security and ecological protection. General Secretary Xi Jinping put forward the important instruction of "building a higher level of 'Tianfu Granary' in the new era" during his inspection and research in Sichuan in June 2022. Subsequently, the Chengdu Municipal Party Committee and the municipal government office issued the "Implementation Plan for Building a Higher Level 'Tianfu Granary' in Chengdu Area". As a special artificial-controlled farmland ecosystem formed on the natural basis, agricultural industrial parks play a significant role in China's food supply and ecological security, while also having important social security functions. On the one hand, it solves the survival and employment problems of a large number of rural residents; on the other hand, agricultural industrial parks produce a large amount of agricultural products during their operation, providing important guarantees for China's food security. However, for a long time, the value of the product services of farmland has been far more emphasized than its ecological service value, which has caused serious ecological damage in the process of agricultural modernization.

The construction of the "Tianfu Granary" is a major decision concerning the overall national economic construction and development determined by the central government. Meanwhile, the ecological and social security value of the agricultural industrial parks created in the construction of the Tianfu Granary cannot be ignored. The multifunctionality of agricultural industrial parks must be emphasized, and their service value needs to be comprehensively calculated, rather than focusing solely on the supply service value. The valuation of ecosystem services means assessing the benefit value of ecosystem services, which can play an important role in the process of protection planning and ecosystem-based management decision-making, providing reliable references and bases for formulating ecological protection plans and management systems. On the other hand, it is conducive to maintaining regional ecological health, promoting harmonious coexistence between humans and nature, and the sustainable development of human society (Fisher B et al., 2009).[1]

2. Literature Review

Costanza et al. (1997)[2] conducted the first global assessment of ecosystem service values, initiating public attention to the value of ecosystems. As an economic concept (Song Luping, 2024)[3], agricultural industrial parks are essentially semi-natural and semi-artificial agricultural ecosystems, which, in addition to providing agricultural products, play a significant role in ensuring and regulating ecosystem service values that should not be overlooked (Chen Yuanquan and Gao Xingwang, 2009)[4].In recent years, research on the evaluation of the value of farmland ecosystem services in our country has gradually become rich. Ouyang Zhiyun and others (1999)[5] were the first to carry out research on terrestrial ecosystem services and their ecological economic value in our country, and for the first time evaluated the service functions of China's terrestrial ecosystem from six aspects: organic matter production, CO_2 fixation, O_2 release, degradation of important pollutants, water conservation, and soil protection, and introduced some new ideas for subsequent ecological value research. Subsequently, Xie Gaodi and others (2003)[6] conducted a questionnaire survey of more than 700 ecologists in the country based on Costanza's evaluation model and proposed the "China Ecosystem Service Value Equivalent Factor Table". Up to now, environmental economic accounting is an important new field both internationally and domestically, especially the accounting of ecosystem service value, which aims to evaluate the support and well-being provided by natural ecosystems for human survival and development (Ouyang Z Y et al.,2020)[7], and is considered to have the potential to solve sustainability issues (Bai Y et al.,2018)[8].

At the current stage, research on agricultural industrial parks in our country mostly remains at the theoretical level, discussing how to construct a sound modern agricultural industrial park (Liu Xuxiang, 2023)[9]; how to enhance the competitiveness of national modern agricultural industrial parks (Cui Yongwei, 2021)[10]; factors to consider in the construction of agricultural industrial parks (Zhang Min, 2011)[11], and empirical aspects such as the evaluation of the agglomeration effect of agricultural industrial parks (Zhao Haiyan et al., 2024)[12] and the impact on county-level economic growth (Qiao Han et al., 2023)[13]. There is little involvement in the assessment and accounting of the value of agricultural industrial parks, and no evaluation and recognition of the value of ecosystem services in agricultural industrial parks have been found. Based on this, this study selects the Daoming and Longxing districts of the Chongzhou demonstration area of the national grain production functional zones as the research subjects, analyzes and calculates the value of ecosystem services in agricultural industrial parks, and quantifies the actual value of their ecological assets.

3. Regional Overview

The Daoming and Longxing districts' grain and oil industrial park is located in the southwest of Chongzhou City, China, geographically situated between 103°33′~103°43′ east longitude and 30° 31′~30°43′ north latitude, belonging to the subtropical humid monsoon climate of the Sichuan Basin. The area experiences distinct seasons, with short spring and autumn, long winter and summer, abundant rainfall, less sunshine, and a longer frost-free period. The annual average temperature is 15.9°C, with an average annual sunshine duration of 1161.5 hours, an average annual rainfall of 1012.4 millimeters, and both rainy days and rainfall are higher in summer and lower in winter. The topography includes mountains, hills, and plains. In the prime irrigation area of Dujiangyan, natural water bodies and several artificial irrigation canals run from north to south, rich in water resources, with a well-developed irrigation network and good natural ecological resources.

The study area is dominated by rice, oilseed rape, wheat, and corn as the main crops. In 2022, the total sown area for grain and oil crops in the region was 35,584 mu, of which: rice was sown on 18,042 mu, wheat on 5,909 mu; corn on 1,896 mu, and oilseed rape on 9,737 mu. In terms of infrastructure construction, in 2022, the two towns completed the "seven networks" of field network, canal network, road network,sightseeing network, service network, information network, and facility land network, with high-standard farmland accounting for 74.49% of the cultivated land area in the park. With the rapid development of technology, the grain and oil industrial park has adopted a series of high-tech equipment to aid in park construction, with a mechanized farming level of 98% in the park in 2022, and the level of mechanized sowing (harvesting) of grain crops reaching 82.5%.

From the perspectives of geographical resources, ecological conditions, and industrial foundations, the area has a good foundation and development conditions for constructing a high-quality grain and oil industrial park. It is the most characteristic premium grain and oil production area with the Sichuan style, known as the "Granary of Western Sichuan," and it has been designated as a national new grain production functional zone and an important agricultural product (oilseed) protection area. In addition, the industrial park also has a positive impact on food security and the stability of grain prices. In recent years, the area has focused on food security and increasing farmers' incomes, with the core of promoting technology innovation as the driving force, and has achieved breakthroughs by innovatively constructing the "agricultural co-management system," initially forming a sustainable and healthy development trend for the grain and oil industry.

4. Research Methodology

4.1. Data Sources

The data used in this paper come from "China Statistical Yearbook 2023," "Chengdu Statistical Yearbook 2023," "Chongzhou Statistical Yearbook 2023," "Master Plan for the Construction of Modern Agricultural Park for the Integration of Grain, Economic, and Tourism Development in the Northern Part of Chongzhou City," "Jintang County Shu Mo Grain Storage Project Implementation Plan (New)," and field research data. Various indicators required for the calculation process are referenced from different literature. To eliminate the impact of factors such as the time value of money, the data on price calculation in this paper are all selected based on the 2022 benchmark prices.

4.2. Construction of Indicator System

Drawing on the research experience of predecessors related to the evaluation of ecosystem service value, such as Hu Xiaoyan et al. (2023)[14], and combining the characteristics of the research object, Chongzhou Grain and Oil Industrial Park, the evaluation system of ecosystem services in agricultural industrial parks is summarized into four categories: supply services, social security services, supporting services, and cultural services, as shown in the following table:

Table 1. Evaluation System of Ecosystem Service Value

First level indicator	Secondary indicators	Index connotation	Evaluation method
Supply services	Supply of agricultural products	Direct utilization of supplied products: crops such as rice, wheat, rapeseed, and other crops Renewable energy mainly refers to field straw, excluding agricultural and sideline products.	Market Value Method
Social Security Services	Ensuring employment	Residents in the park earn economic income by planting crops in farmland, which is equivalent to ensuring employment for the surrounding labor force and promoting social stability	Alternative cost method
	Ensuring food security	Agricultural industrial parks produce sufficient quantities of food to meet people's demand for food consumption, thereby ensuring stable food prices and social stability	Market Value Method
Adjustment service	Soil conservation	Industrial park farmland reduces the erosive force of precipitation on soil through plant layers, litter layers, and root systems, thereby reducing soil erosion and avoiding sedimentation	Alternative cost method
	Carbon fixation and oxygen release	Crops absorb carbon dioxide from the atmosphere through photosynthesis, release oxygen, synthesize organic matter, and maintain their balance in the atmosphere	Alternative cost method Carbon tax approach
	Air purification	The ecosystem effectively purifies the air and improves air quality by purifying, filtering, and decomposing pollutants in the air, such as sulfur dioxide, nitrogen oxides, dust, etc	Market Value Method
	Conserve water sources	The ecosystem intercepts precipitation and stores water through the plant layer, litter layer, root system, and soil layer, effectively conserving soil moisture, regulating surface runoff, and replenishing groundwater.	Market Value Method
Cultural services	Leisure tourism	The landscape of agricultural industrial parks can attract tourists to experience, relax, study, and take care of themselves	Travel Expense Method

4.3. Evaluation Method

4.3.1. Supply Services

$$PV = PV_1 + PV_2 = \sum_{i=1}^{m} Q_i \cdot P_i + \sum_{i=1}^{m} Q_i \times \eta_i \times \lambda_i \times P_j$$

Where PV, PV_1, PV_2 represents the supply service value of the industrial park ecosystem, the value of agricultural products, and the value of renewable energy, respectively; P_i is the market price of the ith agricultural product; Q_i is the output of the ith agricultural product; m is the number of types of agricultural products; η_i is the collection coefficient of the straw of the ith type of crops; λ_i is the grass-grain ratio of the straw of the ith type of crops, P_j is the straw price, which is 180 yuan /t.

Based on the actual planting conditions of the Chongzhou Grain and Oil Industrial Park, the article selects four types of crops: rice, wheat, corn, and oilseed rape for the calculation of supply service value. According to the visit to the Chongzhou Grain Bureau, the purchase prices of rice, wheat, corn, and oilseed rape at the end of 2022 were 2763 yuan/ton, 3232 yuan/ton, 3173 yuan/ton, and 6826 yuan/ton, respectively; the per-unit yield of crops was 540.00 kg/mu, 311.94 kg/mu, 385.07 kg/mu, and 313.02 kg/mu, respectively. The value accounting of agricultural products is shown in Table 2. Rice, wheat, and corn were selected for the calculation of renewable energy value, with straw collection coefficients of 0.78, 0.76, and 0.95 (Cao Xingjin, 2013)[15]; the straw-grain ratio of the crops was 0.97, 1.03, 1.37 (Cao Xingjin, 2013)[15]. The value accounting of renewable energy is shown in Table 3.

Table 2. Value Accounting of Agricultural Products

crops	Per unit yield (kg/acre)	Unit Price (Yuan/ton)	Sowing surface (mu)	Total value (Ten thousand yuan)
rice	540.00	2763	18042	2691.90
wheat	311.94	3232	5909	595.74
corn	385.07	3173	1896	231.66
rapeseed	313.02	6826	9737	2080.48

Table 3. Value of Renewable Energy

crops	total output (ton)	collection coefficient	The ratio of grass to grain	Straw price (yuan/ton)	Total value (Ten thousand yuan)
rice	9742.68	0.78	0.97		132.68
wheat	1843.25	0.76	1.03	180	25.97
corn	730.09	0.95	1.37		17.10

4.3.2. Social Security Services

4.3.2.1 Employment Security

$$V_{eg} = N_{eg} \cdot C_{ml}$$

4.3.2.2 Ensuring Food Security

$$V_{fs} = (N - N_0) \cdot P_f \cdot E_f$$

In terms of ensuring employment, V_{eg} represents the value of employment security for the ecosystem; N_{eg} represents the sown area of grain and oil crops in the industrial park; C_{ml} represents the average salary required for workers to maintain each mu of the park on a daily basis.

According to the survey and interviews with the responsible personnel of the park, the current park implements mechanized production, with labor mainly responsible for the management tasks related to mechanized farming. The average labor cost per mu is 200 yuan. With an area of 35,584 mu of grain and oil crops in the park, the value of employment security is 7.1168 million yuan.

In terms of ensuring food security, V_{fs} represents the value of the farmland ecosystem in ensuring national food security; N represents the actual grain yield per mu of cultivated land; N_0 represents the average yield of secure grain per mu; P_f represents the price of grain; E_f represents the price elasticity of grain.

From the "Comprehensive Development Plan for the Modern Agricultural Park in the Northern Part of Chongzhou City" it can be concluded that the grain yield per mu is 470kg/ mu, the average safe grain yield per mu is = (per capita safe grain consumption * total national population / national grain sown area). According to the basic standards proposed by the Food and Agriculture Organization of the United Nations, the per capita safe grain consumption should reach 400 kilograms. According to the "China Statistical Yearbook 2023", China's population in 2022 was 1.41175 billion people, and the total sown area reached 16,991 thousand hectares. The calculation shows that China's average safe grain yield per mu is 221.57 kg/mu. The average grain price is 3056 yuan/ton. The grain price elasticity adopts the research results of Wang Wentao's "Grain Supply and Demand Tight Balance under the Open Economy", and it is concluded that the grain supply price elasticity from 1979 to 2015 is 0.1221. The calculated value of ensuring food security is 5832.24 million yuan.

4.3.3. Regulatory Value

4.3.3.1 Soil Conservation

$$V = V_{S1} + V_{S2}$$

$$V_{S1} = \frac{A_i * B_i}{10000 * L * D}$$

$$V_{S2} = A \sum C_j P_j \quad (j=N,P,K)$$

Where V represents the value of maintaining soil, V_{S1} represents the value of reducing land abandonment, V_{S2} represents the value of maintaining soil nutrients; A_i represents the reduction in soil erosion; D is the average soil density; L is the thickness of the soil layer; B_i represents the annual average income of the park; A is the amount of soil maintained; C_j is the content of the jth type of nutrient in the soil; P_j is the market price of the jth type of nutrient.

The average soil erosion modulus in these areas is 348.06t/($km^2 \cdot a$), and the annual soil erosion amount is 71742.13t/a (Liu Bintao et al., 2016)[16]; the average soil density is 2.65mg/m3; the average thickness of the soil layer (cultivated land) is greater than or equal to 50cm; the annual average income of the park is considered as the value of agricultural product supply, which is 55,999,700 yuan; therefore, the value of reducing land abandonment is 302.92 yuan. The average contents of organic matter, total nitrogen, available phosphorus, and available potassium in the cultivated soil of Chongzhou City are 29.61g/kg, 1.88g/kg, 18.09mg/kg and 56.90mg/kg (Sun Juan et al., 2020)[17], thus the proportion of nitrogen, phosphorus, and potassium is taken as 0.19%, 0.0019%, 0.0057%, D_i for the market price of the i type of nutrient, N, P, K are respectively 17142.86, 15989.34, 4400 yuan /t (Zhang Feixue, 2022)[18]; therefore, the value of maintaining soil nutrients is 134,300 yuan.

4.3.3.2 Carbon sequestration and oxygen release

$$V_{CO} = V_C + V_O$$

$$V_C = 1.62 * NPP * P_C * 27.27\%$$

$$\text{NPP} = \sum_{i=1}^{n} NPP_i = \sum_{i=1}^{n} y_i(1 - w_i)/f_i$$

$$V_O = 1.2 * NPP * P_O$$

The rice harvest index is 0.52, the wheat harvest index is 0.368, the corn harvest index is 0.441, and the oilseed harvest index is 0.26 (Xie Guanghui et al., 2011[19]; Zhang Fuchun and Zhu Zhihui, 1990[20]); the moisture content of rice is 14.0%, the moisture content of wheat is 13.0%, the moisture content of corn is 13.0%, and the moisture content of oilseed is 13.5% (Yuan Yuan et al., 2011[21]; Su Benying et al., 2010[22]), the primary net productivity is as shown in Table 4; the carbon trading price adopts the average price of China's carbon trading market in 2022, which is 56.07 yuan/ t, and the Swedish carbon tax of 137 US dollars/ t carbon, calculated at the average annual exchange rate midpoint of the Renminbi in 2022 by the People's Bank of China, which is 6.7261, that is, 921.476 yuan/t carbon, taking the average value of 488.77 yuan/t carbon; the price of industrial oxygen production is 400 yuan/ton (Zhang Feixue, 2022)[18]. The calculated total value of carbon sequestration is 6.9206 million yuan, and the total value of oxygen release is 15.3845 million yuan.

Table 4. Primary Net Productivity of Crop Plants

grain crops	total output (ton)	Moisture content (%)	harvest index	NPP(t/a)
rice	9742.68	14%	0.52	16112.89
Wheat	1843.25	13%	0.368	4357.68
Corn	730.09	13%	0.441	1440.31
rape	3047.88	13.5%	0.26	10140.06

4.3.3.3 Air Purification

$$V_d = (\frac{Q_S}{Y_S} + \frac{Q_N}{Y_N} + \frac{Q_{PM}}{Y_{PM}}) \times S \times C_{ap} \times X_a$$

Where Vd represents the value of air purification function; QS, QN, QPM represents the average flux of the farmland ecosystem absorbing SO_2, NOx and adsorbing dust (t·hm−2·a−1), respectively 45, 33.31, 1500kg/(hm2·a− (Hu Xiaoyan et al., 2023)[14];YS, YN, YPM represents the SO_2, NOx and dust pollution equivalent values (kg), respectively 0.95, 0.95, 1kg (Hu Xiaoyan et al., 2023); S represents the area of cultivated land in the park; Cap represents the tax amount per pollution equivalent of taxable air pollutants, both being 1.2 yuan; Xa represents the unit conversion coefficient, with the calculated value of air purification being 45,100 yuan.

4.3.3.4 Water Conservation

$$V_w = (R_0 - R) * \lambda * P_w$$

Where V_w represents the value of water conservation; R_0 represents the total annual precipitation; R represents the total annual runoff; λ represents the percentage of the area of crops sown to the total area; P_w represents the water price.

The total annual precipitation in Chongzhou City in 2022 was 984.5mm, with an area of 1089km^2, hence the total annual precipitation volume is $1.07*10^9 m^3$. In addition to precipitation, the total runoff of rivers in Chongzhou City in 2022 was $1.57*10^9 m^3$,λ, with a coefficient of 0.19, and the water price was taken as the non-residential water price in Chengdu City in 2022 3.03 yuan /m^3, using proportional conversion, the value of water conservation was calculated as -6.2724 million yuan.

4.3.4. Cultural Services

4.3.4.1 Leisure Tourism

$$CV = TC * TN$$

Where CV represents the cultural service value of the agricultural industrial park ecosystem; TC is the average consumption of visitors to the agricultural industrial park (including transportation and accommodation); TN is the total number of visitors received by the agricultural industrial park.

Visitor consumption mainly includes: homestays, 120-300 yuan/person, averaging about 210 yuan/person-time; catering, 50-100 yuan, averaging about 75 yuan/person-time;耕读 education averaging about 90 yuan/person-time, i.e., TC is 375 yuan/person; the park receives 323,300 visitors annually. From this, the cultural service value of the park can be calculated as 121.2375 million yuan.

Table 5. The value of ecosystem services in agricultural industrial parks

First level indicator	Secondary indicators	value (Ten thousand yuan)	value (Ten thousand yuan)
Supply services	Supply of agricultural products	5599.78	5775.53
	renewable energy	175.75	
Social Security Services	Ensuring employment	711.68	6543.92
	Ensuring food security	5832.24	
Adjustment service	Soil conservation	13.46	1621.24
	Carbon fixation and oxygen release	2230.51	
	Air purification	4.51	
	Conserve water sources	-627.24	
Cultural services	Leisure tourism	12123.75	12123.75

5. Conclusions and Recommendations

5.1. Conclusion

The evaluation results show that the agricultural industrial parks in the towns of Daoming and Longxing have significant economic value. The current evaluation indicators calculate the total value of ecosystem services in the agricultural industrial parks of Daoming and Longxing towns to be 260.64 million yuan, which is 4.65 times the value of the agricultural products supplied, and the value of their ecosystem services cannot be ignored. Among the values of ecosystem services, the cultural service value is the highest, followed by the social security service value. The reason for this can be found in the current Chongzhou modern agricultural industrial parks, which rely on the grain and oil industry, deeply explore resources such as rural farming, folk customs, and creative culture, highlight the development of leisure agriculture and rural tourism, and fully integrate and utilize the ecological resource advantages of the agricultural industrial parks to enhance the overall value of the industrial parks. The value displayed by social security services is closely related to the orientation of Daoming and Longxing towns to build a 1 million mu high-yield, stable, and efficient grain production base. The grain and oil industry in the park has made significant contributions to ensuring employment and national food security. The regulatory service has the smallest proportion in the value of ecosystem services, as shown in Table 5, the soil conservation and air purification value of the regulatory service is relatively low, the value of water conservation is negative, and the value contribution of carbon sequestration and oxygen release to regulatory services is the highest, accounting for 6.22% of the total value of ecosystem services, which is higher than the overall contribution of regulatory services. Based on the relevant information collected from Chongzhou, it can be inferred that this conclusion is significantly related to the geographical location, hydrology, and climatic conditions of Chongzhou. Since the agricultural industrial parks in Daoming and Longxing mainly plant rice and oilseed crops, especially rice, which requires a large amount of water resources, natural precipitation is difficult to meet the water demand for rice planting, and it is necessary to rely on the water resources of the prime irrigation area. This is why effective soil moisture conservation, surface runoff regulation, and groundwater replenishment cannot be achieved.

5.2. Recommendations

Based on the above conclusions, this paper provides the following insights and recommendations. We should fully recognize the ecological and economic value of agricultural industrial parks. In the planning process of high-standard farmland construction, the value of supplying agricultural products should not be considered in isolation; the important role of agricultural industrial parks in ecological protection, food security, cultural tourism, and other aspects should be fully understood. On the one hand, we should fully utilize the ecosystem service value of industrial parks, adhere to transformation and upgrading, and green development directions. According to the intensity of crops' functions such as carbon sequestration and oxygen production, we should change and optimize the agricultural planting structure, guiding park farmers to plant crops that can effectively increase carbon sinks; promote green organic production, implement high-quality grain and oil organic fertilizer substitution for chemical fertilizers, popularize the application of organic fertilizers, and increase the application of farm manure to improve the soil; strengthen the comprehensive utilization of waste plastic films, straw, and livestock and poultry manure to enhance the overall service level of the farmland ecosystem. On the other hand, we should play the leading role of the government, benchmark against the construction of "Tianfu Granary," strengthen fiscal support and ecological compensation systems, improve farmland productivity protection 补贴 policies, focus on green ecology, perfect the evaluation and assessment mechanism, ensure that the promotion work is implemented, achieve the construction of high-standard agricultural industrial parks, and build a higher-level Tianfu Granary in the new era.

Literature References

[1] Fisher B, Turner R K, Morling P. Defining and classifying ecosystem services for decision making[J]. Ecological economics, 2009, 68(3): 643-653.

[2] Costanza R, d' Arge R, de Groot R, et al. The value of the world's ecosystem services and natural capital [J]. Nature, 1997,387: 253-260.

[3] Song Luping. The Path and Experience of Modern Agricultural Parks Leading Rural Economic Development [J]. Agricultural Economics, 2024 (04): 13-16.

[4] Chen Yuanquan, Gao Fengsheng. Overall evaluation of ecological service value of farmland in major grain producing areas in China [J]. China Agricultural Resources and Zoning, 2009, 30 (01): 33-39.

[5] Ouyang Zhiyun, Wang Xiaoke, Miao Hong Preliminary study on the service functions and ecological economic value of terrestrial ecosystems in China [J]. Chinese Journal of Ecology, 1999,19 (5): 607-613.

[6] Xie Gaodi, Lu Chunxia, Leng Yunfa, et al. Valuation of Ecological Assets in the Qinghai Tibet Plateau [J]. Journal of Natural Resources, 2003, 18 (2): 189-196.

[7] Ouyang Z Y, Song C S, Zheng H, et al. Using gross ecosystem product (GEP) to value nature in decision making [J]. Proceedings of the National Academy of Sciences of the United States of America (PNAS), 2020, 117(25): 14593-14601.

[8] Bai Y, Wong C P, Jiang B, et al. Developing China's ecological redline policy using ecosystem services assessments for land use planning [J]. Nature Communications, 2018(9): 1-13.

[9] Liu Xuxiang. Building high-quality and efficient modern agricultural industrial parks [J]. Jiangsu Rural Economy, 2023 (06): 68.

[10] Cui Yongwei. Research on the Competitiveness of National Modern Agricultural Industrial Parks [J]. Agricultural Economics, 2021 (02): 16-18.

[11] Zhang Min. Research on Theory and Practice of Agricultural Industrial Park Planning [D]. Northwest A&F University, 2011.

[12] Zhao Haiyan, Zhu Mengyao, Ma Zheng et al. Study on the Agglomeration Effect of Modern Agricultural Industrial Parks: An Empirical Analysis Based on 8 Residential Areas in Beijing [J/OL]. China Agricultural Resources and Zoning: 1-16 [2400-03-20].

[13] Qiao Han, Liu Aolong, Qiu Kexin. Agricultural Industry Agglomeration and County Economic Growth: Evidence from the Quasi Natural Experiment of Establishing Modern Agricultural Industrial Parks in Henan Province. Business Economics and Management, 2023 (11): 87-100.

[14] Hu Xiaoyan, Yu Fawen, Xu Xiangbo et al. Valuation of Agricultural Ecosystem Services: Construction and Application of Indicator System [J]. Ecological Economics, 2023, 39 (04): 111-121.

[15] Cao Xingjin Multi functional Value Assessment of Farmland Ecosystem [D]. Nanjing Agricultural University, 2013.

[16] Liu Bintao, Song Chunfeng, Tao Heping. Quantitative Evaluation of Soil Erosion in Chengdu City [J]. Journal of Changjiang Academy of Sciences, 2016, 33 (09): 40-47.

[17] Sun Juan, Zhong Wenting, Xie Lihong, et al. Spatial variation characteristics of soil nutrients in cultivated land in Chongzhou City [J]. Sichuan Agricultural Science and Technology, 2020 (02): 46-48.

[18] Zhang Feixue Assessment of Ecosystem Service Value for Ecological Enhancement of Farmland in Danjiangkou Reservoir Area [D]. Northeast Agricultural University, 2022.

[19] Xie Guanghui, Han Dongqian, Wang Xiaoyu et al. Harvest Index and Straw Coefficient of Grain/Non Grain Field Crops in China [J]. Journal of China Agricultural University, 2011, 16 (01): 1-8.

[20] Zhang Fuchun, Zhu Zhihui. Harvest Index of Chinese Crops [J]. Chinese Journal of Agricultural Sciences, 1990 (02): 83-87.

[21] Yuan Yuan, Liu Jintong, Jin Zhanzhong. Comprehensive evaluation of positive and negative effects of agricultural ecosystem services in Luancheng County [J]. Journal of Ecology, 2011, 30 (12): 2809-2814.

[22] Su Benying, Zhang Lu, Chen Shengbin et al. Study on the Spatiotemporal Pattern and Influencing Factors of Regional Farmland Ecosystem Productivity: A Case Study of Shandong Province [J]. Journal of Ecological Environment, 2010,19 (09): 2036-2041.