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Cultivated Land-Use Benefit Evaluation and Obstacle Factor Identification: Empirical Evidence from Northern Hubei, China

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Abstract: The benefit of cultivated land use is an essential indicator for measuring the optimal allocation of cultivated land resources and the high-quality development of agriculture. Taking Shiyan City, Xiangyang City, and Suizhou City in Northern Hubei as the research objects, this paper presents an evaluation index system for cultivated land use efficiency from the perspectives of ecology, economy, and society. The entropy TOPSIS method and the obstacle degree model were applied to estimate the cultivated land use efficiency and identify obstacle factors in the three study areas from 2010 to 2020, and the results were as follows. (1) The comprehensive benefit level of cultivated land utilization in Northern Hubei showed an upward trend, and the individual benefit levels of cultivated land utilization in different cities were significantly different. Xiangyang City had outstanding economic performance, Shiyan City had the fastest growth rate of ecological benefits, and various benefits of Suizhou City were "steady". (2) The fluctuation ranges of the obstacle factors for cultivated land use were relatively large in the Northern Hubei region. From 2010 to 2016, the effective irrigation index, land-averaged fertilizer input level, agricultural input–output ratio, and per capita income of farmers were the main factors restricting the improvement of cultivated land utilization efficiency in Northern Hubei. During 2017–2020, the per capita pesticide input level, per capita grain output, forest coverage rate, land output rate, and agricultural mechanization efficiency became the main obstacles restricting the improvement of cultivated land-use efficiency. (3) All cities of Northern Hubei should take measures according to local conditions, implement specific policies to address the restrictive factors of cultivated land use, improve the level of cultivated land-use benefit in the region, and promote the coordination and unity of the economic, ecological, and social benefits of cultivated land use.

Keywords: Northern Hubei; cultivated land use; benefit evaluation; obstacle factor analysis

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1. Introduction

Cultivated land resources are a non-renewable natural resource and an important agricultural production factor, representing the material basis for the survival and development of human society. From the perspective of physical form, the cultivated land resource system belongs to the natural resource system, which is mainly composed of paddy fields, dry land, vegetable fields, etc., and includes basic natural elements such as soil, geological landforms, climate, and hydrology within a certain time and space range. From the perspective of functional form, due to human activities such as the development, utilization, and protection of cultivated land resources and their impact results, the cultivated land resource system is endowed with economic and social attributes in a complete sense. For example, individuals obtain production and living materials through various inputs to arable land, resulting in economic functions; the cultivated land also has social functions by guaranteeing national or regional food security and maintaining social stability. In addition, the cultivated land system has ecological functions, such as adjusting the climate, purifying the environment, maintaining biodiversity, and providing leisure space. Therefore, it becomes a complex ecosystem formed by the intertwining, mutual influence, interaction, and interdependence of many complex factors, such as economy, society, and ecological environment. Cultivated land is defined as a "nature–economy–society" complex ecosystem that includes the material cycle and energy transportation [1]. The "benefit of cultivated land use" is the general term for the direct and indirect effects produced by the actual utilization of the ecosystem services of cultivated land by human society, including economic benefits, ecological benefits, and social benefits [2]. Because the ecological and social benefits of cultivated land use are placed in the public domain, with strong externalities and public goods attributes, the ecological and social benefits of cultivated land cannot be included in the benefits of cultivated land use [3]. In this way, under the land-use mechanism that ignores the ecological and social benefits of cultivated land, the comparative benefits of cultivated land use are low, the willingness of cultivated land owners and operators to protect cultivated land is reduced, and the potential driving force for the non-agriculturalization of cultivated land under comparative benefits is generated. At the same time, the conversion of cultivated land to non-agricultural land, such as construction land, industrial and commercial residential lands, etc., leads to short-term fiscal revenue based on land lease fees and brings long-term stable and lasting tax revenue [4]. In recent years, with the acceleration of urbanization, industrialization, and marketization in China, the non-agriculturalization of cultivated land has become more serious, leading not only to a large reduction in cultivated land resources, the low utilization efficiency of cultivated land, the serious ecological environment pollution of cultivated land, and other problems, but also affects China's food security [5,6]. In January 2017, the Central Committee of the Communist Party of China issued the document "Opinions on Strengthening the Protection of Cultivated Land and Improving the Balance of Occupation and Compensation", emphasizing "strengthening the three-in-one protection of cultivated land quantity, quality and ecology" to achieve "the coordinated development of cultivated land protection and the construction of economical society and ecological civilization". In January 2019, the Central Committee of the Communist Party of China put forward, in the document titled "Several Opinions on Adhering to Prioritizing the Development of Agriculture and Rural Areas and Doing a Good Job in 'Three Rurals'", the following instruction: "Do not relax and do a good job in grain production, mainly promote the storage of grain in the land and the storage of grain in technology, and ensure that 16.5 The sown area of 100 million mu of grain fields. Strictly abide by the red line of 1.8 billion mu of arable land, and fully implement the permanent basic farmland protection system". It can be seen from relevant policy documents in China that the protection and rational utilization of cultivated land resources is the key to ensuring the basic status of agriculture. Only on the basis of ensuring the sustainable utilization of cultivated land resources can we stabilize food production and maintain national security and social security. Therefore, the question of how to efficiently and rationally utilize cultivated land resources and maximize the benefits of cultivated land utilization has far-reaching practical significance for solving the contradiction between humans and lands in China and promoting the coordinated development of cultivated land resource utilization and human society, the economy, and the ecological environment.

Hubei Province is abbreviated as "E", and it spans the two major water systems of the Yangtze River and the Han River. It is located in the central part of the country and north of Dongting Lake, in the middle reaches of the Yangtze River. As of 2019, the total arable land area of Hubei Province was 4.7686 million hectares, the total population had reached 59.27 million, and the per capita arable land area was only 0.08 hectares per person, which was lower than the national average. The limited amount of cultivated land resources serves multiple purposes, such as ensuring regional food security, maintaining regional ecological protection, and coordinating urban and rural development. Grain production in Hubei Province occupies a vital position in the national economy of China, and it is known as the “land of fish and rice”. Hubei Province has continuous high mountains and extensive hills, and the mountainous regions account for nearly 70% of the province’s area, forming a pattern of “seven mountains, one water and two fields”. The distribution of arable land resources is uneven. Approximately 70% of the arable land is concentrated in the Jianghan Plain, the Yangtze River Plain in Eastern Hubei, the hilly area in Central Hubei, and the northern hilly area, and the remaining arable land is scattered across the mountainous valleys and intermountain basins in Western Hubei.

The cultivated land area in Northern Hubei is approximately 1.196 million hectares, accounting for 23% of the total cultivated land in Hubei Province. The soil in this area is mainly yellow-brown soil, with deep soil layers and high natural fertility, suitable for the growth of various crops. The dry land within the cultivated land area is approximately 2.5 times that of paddy fields. It is the main wheat-producing area in Hubei Province. At the same time, the site is more mountainous and less flat, and the reserve resources of cultivated land are scarce, making it challenging to develop and organize. With the economic and social development of Northern Hubei, the arrival of the peak in population and urbanization, and the promotion of the “Rise of the Central Region” strategy, the demand for construction land has continued to increase, and the contradictions between land supply and demand and between human and land are becoming increasingly acute. At the same time, due to the strong demand for food and agricultural products, agricultural production has to rely on intensive farming and the application of a large number of chemical fertilizers and pesticides to ensure output, which, to a certain extent, destroys the original orderly operation of the cultivated land resource system, resulting in soil degradation, environmental pollution, and other ecological and environmental problems. Thus, the northern Hubei region is challenged by a more prominent contradiction between “cultivated land protection, economic construction, and ecological improvement”. Against this background, it is crucial to carry out a comprehensive evaluation and research on the utilization efficiency of cultivated land in the Northern Hubei region, to identify the development balance point for the agricultural economy, society, and ecology in the area, and thoroughly implement the basic requirements for sustainable development.

2. Literature Review

2.1. Research on the Sustainable Use of Cultivated Land

Research on the sustainable utilization of cultivated land resources is developed on the basis of sustainable agricultural research. Since Gro Harlem Brundtland first proposed the concept of “sustainable development” in the “World Development and Environment Committee” in 1987, research on sustainable agricultural development has gradually attracted widespread attention in society. The American Agricultural Society (ASA) defines sustainable agriculture as ensuring and improving environmental quality during its long-term development and evolution, consolidating the resource base on which agriculture depends, providing basic food and fiber for human beings, and ensuring an economically viable and feasible system so as to improve the quality of life of farmers and society as a whole [7]. The sustainable utilization of arable land resources is the material basis of sustainable agricultural development and a fundamental guarantee for environmental protection. In 1993, the Food and Agriculture Organization of the United Nations (FAO) promulgated the “Sustainable Land Use Evaluation Outline”, which defined the conditions of sustainable land use. Sustainable land management is the integration of technology, policy, social and economic principles, and environmental considerations. It relies on integrated activities to simultaneously achieve, maintain, or enhance products and services (productivity), reduce production risks (security), conserve natural resource potential and prevent soil degradation (conservation), and be economically viable (feasibility) and socially acceptable (acceptability) [8]. Herdt and Steiner [9] also pointed out that the capacity for sustainable development of the agricultural system should be measured and described via three aspects: economic benefits, social benefits, and ecological benefits. An evaluation index system for sustainable land use based on nature, economy, and society has been gradually established. In addition, some scholars have further discussed the evaluation and methods of land quality indicators for the sustainable use of cultivated land based on the economic and social conditions, resource and environmental characteristics, and land-use development prospects of the study area [10]. Dumanski and Preris [11] refined the evaluation factors for land quality in evaluating the sustainable use of cultivated land into soil erosion, soil fertility declination, forest land degradation, etc. Gameday et al. selected five evaluation indicators of productivity, safety, protection, feasibility, and acceptability to discuss the level of sustainable land-use management at the Canadian farm level [12]. J. Kostowicki suggested that the sustainable use of cultivated land is the most critical part of sustainable agricultural development and summarized the world's agriculture into six first-level types, 25 s-level types, and 93 third-level types. Finally, the sustainable utilization of cultivated land resources in different regional types was analyzed and evaluated [13]. Clem Tide suggested that the economic factors in sustainable land use are difficult to determine because the economic viability of an agricultural production system depends on many factors, one of which is the natural quality of the land [14]. Experts and scholars from various countries generally believe that the evaluation indicators of the sustainable utilization of cultivated land should include three categories: environmental and technical indicators, economic indicators, and social indicators [15].

2.2. Research on the Evaluation of Cultivated Land-Use Benefits

Western countries were the first to evaluate cultivated land utilization benefits. As a scarce resource, land-use efficiency is the primary research issue for land scientists. The theories of land supply and demand, land rent theory, and the law of diminishing returns put forward by western scholars laid a solid theoretical foundation for the evaluation of cultivated land utilization benefits. In 1930, Cornell University in the United States proposed a classification standard for the economic benefits of land use [16]. Subsequently, Alonso conducted a particular research study on the economic benefits of land in the city and found that the economic benefits of land in different geographical locations are various; then, the concept of location balance was proposed [17]. In 1961, the United States, the United Kingdom, Australia, Canada, and other countries successively developed a comprehensive land evaluation system—Land Capacity Classification (LCC). LCC is widely used in qualitative analysis to evaluate the potential productivity of land in many countries.

There are not many studies on the evaluation of the social benefits of land use around the world. Still, the evaluation research of social benefits in other fields has laid a particular practical foundation for evaluating the social benefits of land use. The assessment of social benefits originated from the review of industrial projects and can be divided into two categories: a narrow sense and a broad sense. The little definition of social benefit evaluation is based on economics, and it closely combines income distribution and economic growth and observes the impact of industrial projects on society [18]. The assessment of social benefits in a broad sense pays more attention to the non-economic nature of "development" and the unequal degree of distribution of benefits brought about by "development" [19]. In 1981, the U.S. Department of Agriculture's Natural Resources Conservation Service developed the Land Assessment and Site Assessment (LESA) system, which began to take social factors into account in land-use assessments. When individuals use land, they always seek the maximum pure benefit. When personal benefits and social interests are not always consistent, to achieve the established social goals, the government should limit this through economic leverage, as well as administrative and legislative means [20]. Laird [21] analyzed the social benefits of land development and utilization in terms of infrastructure changes, land property rights changes, and the impact on urban development. Crecente et al. [22] conducted an empirical study on the relationship between land development and utilization and rural population change in Galicia, Spain. They concluded that land development and consolidation could help to prevent rural population loss.

The evaluation of the ecological benefits of land use has become a popular research topic in recent years, and the theory of the service function value of the land ecosystem is the theoretical basis for evaluating the ecological benefits of land use. Daily GC defines ecosystem service functions as "the conditions and processes provided by natural ecosystems and their processes that can satisfy and maintain human survival needs" [23]. Land-use change is the main factor that changes the provision of these services by ecosystems. When food supply services increase sharply, this may change other service functions, such as loss of animal and plant habitats, land nutrient loss, pest damage, etc. [24]. Mostafa Emadi et al. [25] analyzed the soil composition of different land-use conditions before and after the forest and pasture tillage in the northern highlands of Iran. They found that tillage reduced the carbohydrate concentration of the former forest and the former pasture by 23.6% and 20.6%, respectively, and the soil nutrients significantly decreased. Meraj A [26] found that the conversion of primary forests at the foot of the mountains in the Eastern Himalayas of India to seasonal cultivation (upland rice and vegetables) leads to a higher degradation of soil carbon forms and overall soil health. It is proposed that the promotion of agroforestry based on legumes and woody fruits (mango/citrus/guava) in the highlands can reduce soil carbon degradation while ensuring the sustainable development of agro-ecosystems in the Himalayas of India. Since the 1990s, most scholars have essentially reached a consensus on the generalization and understanding of the conditions of sustainable land use and comprehensive benefits to achieving the best utilization.

2.3. Comparative Analysis of Evaluation Methods

At present, there are many types of methods related to land-use benefit evaluation, including the cost–benefit method [27], TOPSIS method [28], AHP [29], comprehensive index method [30], system model method [31], principal component analysis method [32], etc. From the perspective of the structure of the evaluation process, a complete evaluation study mainly includes five parts: index system construction, evaluation standard determination, data processing, index weight assignment, and evaluation method selection. Among them, selecting a reasonable and applicable evaluation method is essential to ensure the validity of the evaluation results. Regarding the existing research methods, most of them use a single evaluation technique, and a few involve the integrated evaluation of two ways. However, the comprehensive review of cultivated land-use benefits has the characteristics of complexity and uncertainty, and it is difficult to comprehensively evaluate the whole system with a single evaluation method. For example, some have higher requirements for sample size (such as factor analysis and principal component analysis); meanwhile, some evaluations are more subjective (such as the cost–benefit method), so it is necessary to improve and integrate evaluation methods. The integrated evaluation method is an improved comprehensive evaluation method that addresses the shortcomings of a single evaluation method and combines the advantages of various forms. Based on the hierarchical characteristics of the evaluation index system of regional cultivated land-use benefit, to reduce the subjectivity in the evaluation process and solve the problem of judgment matrix construction and consistency in practical applications, this paper adopts the entropy weight method and the TOPSIS model integrated evaluation method. This can more accurately analyze the level of cultivated land-use benefit in different regions. To summarize, this study takes the Northern Hubei region as the research object; constructs a scientific and reasonable economic–social–ecological comprehensive benefit evaluation index system; adopts the entropy weight TOPSIS model to quantitatively evaluate the economic, social, and ecological benefits of cultivated land use in the Northern Hubei region; and identifies obstacles. The degree model is used to diagnose the critical obstacle factors. We then put forward corresponding improvement suggestions to promote the coordinated development of the economy, society, and the ecological environment in the main agricultural producing areas in Northern Hubei and provide some reference value for the overall planning of regional development and the efficient utilization of cultivated land resources.

3. Study Region and Data

3.1. Study Region

The Northern Hubei region is located in the northern part of Hubei Province, China, including Shiyan City, Xiangyang City, and Suizhou City (Figure 1). It is adjacent to the four provinces of Henan, Shaanxi, Chongqing, and Sichuan. It is an important transportation node in the central region of the country, and its economically strategic position is very prominent. The Northern Hubei region covers an area of 56,311 square kilometers, accounting for 30% of the total area of Hubei Province. Shiyan City is located at 109°43′–111°58′ east longitude, 31°50′–33°27′ north latitude, and is located in the Qinba Mountains area. The hinterland has more mountains and less land, and the mountainous area accounts for 73.6% of the total land area. It is a typical mountain city, and arable land resources are scarce. The city's existing arable land accounts for 10.6% of the total land area, and the per capita arable land area is only 1.1 mu. Sloping cultivated land accounts for more than 30% of the city's entire cultivated land, and there are many constraints on agricultural development. In 2020, Shiyan City achieved a regional GDP of 191.51 billion yuan and a per capita GDP of 56,400 yuan. Xiangyang City is located in the upper reaches of the Han River, between 110°45′–113°05′ east longitude and 31°14′–32°37′ north latitude, with a total land area of 19,724 square kilometers, accounting for 10.6% of the province's area, and 1.5 acres of arable land. Xiangyang City has a belt of hills, endless hills, and ridges. It is rich in land resources with a wide range of suitability and a large proportion of arable land that is concentrated and contiguous. It is a substantial production base for agricultural products in the country. Six counties (cities, districts) are listed as the primary grain-producing areas in Hubei Province, of which summer grains are among the top ten high-quality grains in the country. One of the high-yielding crops, sesame represents one of the three major producing areas in the country. The total economic output value is second only to Wuhan City, ranking second in the province. In 2020, the city's GDP reached 460.2 billion yuan, and the per capita GDP was approximately 81,000 yuan. Suizhou City is located at the intersection of the Yangtze River Basin and the Huai River Basin, spanning 112°43′~114°07′ east longitude and 31°19′~32°26′ north latitude. Suizhou has a long history of land development and utilization and a high degree of land utilization. The city's arable land area is 219,829.46 hectares (1.31 mu per capita), accounting for 22.86% of the total land area. In 2020, the city's real GDP reached 109.7 billion yuan, and the per capita GDP was approximately 49,400 yuan.

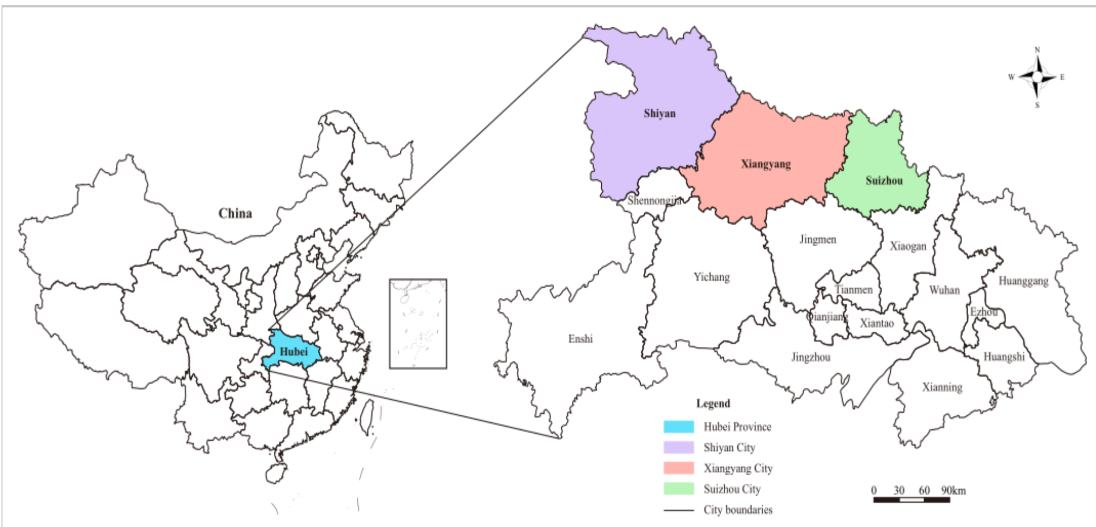

Figure 1. The study area covers parts of Hubei Province in China. Colored areas show the studied cities.

3.2. Data Sources

The original data of cultivated land resources in Northern Hubei in this article are all derived from the “Shiyan Statistical Yearbook” (2010–2021), “Xiangyang Statistical Yearbook” (2010–2021), “Suizhou Statistical Yearbook” (2010–2021), Bulletin of the primary data of the third national land survey of Hubei Province (2021), Hubei Rural Statistical Yearbook (2010–2021), and Hubei Province Natural Resources Comprehensive Statistical Annual Report (2010–2020); all the indicators involved in the evaluation method are calculated from raw data.

4. Evaluation Index System

4.1. Analysis of the Influencing Factors of Cultivated Land-Use Benefit

As a natural resource, cultivated land itself is closely related to the natural ecological environment. Interactions with natural resources such as climate, water sources, and biology affect the output results of cultivated land utilization. Different regions and different times have other effects, so natural factors are an important aspect involving the benefit of cultivated land use. Simultaneously, as a production activity in human society, agriculture is inevitably constrained by the development of society. The unique economic systems of different countries (community)—that is, the relationship between consumers and producers—are other, which will adjust agricultural production from the supply and demand ports of farm products. The level of human socio-economic and technological development determines the degree of agrarian modernization; the evolution of human consumption levels will also impact the types of farm products and agricultural production methods. These human social attributes will affect the utilization of cultivated land through agricultural production, bringing about changes in the benefits of cultivated land use. Therefore, the selected factors and indicators should be linked and interact with each other to jointly influence and determine the degree of cultivated land-use benefit.

4.2. Construction of Indicator System

Combining the literature research and the actual situation of cultivated land utilization in the study area, this study constructs the evaluation index system for cultivated land utilization benefits based on three aspects: ecological benefits, economic benefits, and social benefits. Four ecological benefit indicators, namely the effective irrigation index, land-averaged fertilizer input level, land-averaged pesticide input level, and forest coverage rate, were selected to reflect the impact of the farmland ecosystem’s life system support function on soil, water sources, the environment, etc., through the interaction of social and ecological factors. Four economic indicators, including the land output rate, per capita agricultural output value, per capita grain output, and agrarian input–output ratio, were selected to represent the economic benefits of the material results of human activities acting on the production of cultivated land. Agricultural labor productivity, agricultural mechanization level, agricultural mechanization efficiency, and the per capita income of farmers are four social benefit indicators that reflect the macro impact and results of the service function of the cultivated land ecosystem on the development of human society (productivity, income, etc.). Considering the availability of data, a total of 12 indicators were selected from three aspects—ecological benefits, economic benefits, and social benefits—as the basis to construct the evaluation index system of the cultivated land-use effect (Table 1).

Table 1. Cultivated land-use benefit evaluation index system.

Cultivated Land-Use Benefit Evaluation Index System			
First-Level Indicators	**Secondary-Level Indicators**	**Indicator Properties**	**Indicator Code**
Ecological benefit	Effective irrigation index	+	E11
	Average fertilizer input level	-	E12
	Average pesticide input level	-	E13
	Forest cover rate	+	E14
Economic benefit	Land productivity	+	E_{15}
	Per capita agricultural output	+	E_{16}
	Per capita food production	+	E_{17}
	Agricultural input–output ratio	+	E_{18}
Social benefit	Agricultural labor productivity	+	E_{19}
	Level of agricultural mechanization	+	E_{20}
	Agricultural mechanization efficiency	+	E_{21}
	Per capita income of farmers	+	E_{22}

5. Research Methods

5.1. Entropy Weight TOPSIS Model

The TOPSIS method, also known as the approximation ideal solution sorting method, was proposed by Hwang. C.L and Yoon. K.S in 1981. It is a compelling analysis method to make decisions based on more indicators and goals and is often used to accurately reflect the gaps between different evaluation schemes. This evaluation method can make full use of the original data of the research content, explore the distance of the "ideal solution" of the evaluation object, and obtain the closeness value through calculation combined with the actual situation of the positive ideal solution and the negative ideal solution. The TOPSIS method can satisfy the higher requirements for sample quality and the strict distribution constraints of the evaluation index data set and can obtain significant differences between evaluation objects [33]. However, the weight assignment of the traditional TOPSIS method often relies on the opinions given by experts to determine the weight distribution, which has intense subjectivity and is influenced by human factors. The weight assignment has a significant impact on the later research conclusions. The entropy method (EM) is an objective weighting method. By introducing the concept of "entropy", the weight is determined by analyzing the usefulness of the information in decision-making problems based on actual data. According to entropy theory, the smaller the entropy of the information contained, the smaller the uncertainty, the higher the usefulness of the information, and vice versa. In the multi-criteria decision-making problem, the greater the variability of the index, the higher the value of the information provided, and the greater the weight [34]. Therefore, the entropy method is a scientific and objective method for determining the consequences of indicators; it has high stability and can effectively reduce the influence of subjective factors in evaluation. To ensure the rationality and scientificity of the research, this study combines the entropy method with the TOPSIS method to evaluate and analyze the benefits of cultivated land use. The specific research steps are as follows.

(1) Calculation of indicator weights

Step 1: Standardize the original data according to Formulas (1) and (2).
Positive indicators:

$$x_{ij} = \frac{X_{ij} - \min(X_{ij})}{\max(X_{ij}) - \min(X_{ij})} \tag{1}$$

Negative indicators:

$$x_{ij} = \frac{\max(X_{ij}) - X_{ij}}{\max(X_{ij}) - \min(X_{ij})} \tag{2}$$

In Formulas (1) and (2), X_{ij} refers to the actual value of the jth evaluation index of the ith evaluated object, x_{ij} refers to the normalized value of the jth evaluation index of the ith evaluated object, $\max(X_{ij})$ refers to all the maximum values of the jth evaluation index of the evaluation object, and $\min(X_{ij})$ refers to the minimum values of the jth evaluation index of all the evaluated things in a particular year.

Step 2: Calculate the entropy value; the calculation formula is as follows:

$$f_{ij} = \frac{x_{ij}}{\sum\limits_{i=1}^{n} x_{ij}} \tag{3}$$

In Formula (3), f_{ij} represents the feature proportion of each standard value, and n represents the number of evaluated objects.

$$h_j = -\frac{\sum\limits_{i=1}^{n} f_{ij} \ln f_{ij}}{\ln n} \tag{4}$$

In Formula (4), h_j represents the entropy value of the jth index.

$$w_j = \frac{1 - h_j}{m - \sum\limits_{j=1}^{m} h_j} \tag{5}$$

In Formula (5), w_j represents the weight of the jth indicator, and m represents the number of evaluation indicators.

(2) Constructing a Weighted Evaluation Matrix

Combining the standard matrix x with the index weight w_j, the weighted matrix is obtained as follows:

$$Y = \begin{Bmatrix} x_{11}w_1 & \cdots & x_{1n}w_n \\ \cdots & & \cdots \\ x_{m1}w_1 & \cdots & x_{mn}w_n \end{Bmatrix} = \begin{Bmatrix} y_{11} & \cdots & y_{1n} \\ \cdots & & \cdots \\ y_{m1} & \cdots & y_{mn} \end{Bmatrix} \tag{6}$$

(3) Calculate distance

After confirming the positive and negative ideal solution values, calculate the distance between the positive and negative perfect solutions. The calculation formula is as follows:

$$D_j^+ = \sqrt{\sum_{j=1}^{m} \left(y_{ij} - y_j^+\right)^2} \tag{7}$$

$$D_j^- = \sqrt{\sum_{j=1}^{m} \left(y_{ij} - y_j^-\right)^2} \tag{8}$$

In Formulas (7) and (8), D_j^+ and D_j^- represent the distance between the evaluated object and the positive and negative ideal solutions, respectively; y_{ij} represents the corresponding value of the jth index of the ith evaluated object in the decision matrix Y; y_j^+ represents the maximum value of the jth index; and y_j^- represents the minimum value of the jth index.

(4) Confirm closeness degree (C)

The closeness degree (C) refers to the closeness of the evaluation object to the optimal solution. The larger the value of C, the closer it is to the optimal solution—that is, the closer the cultivated land-use effect is to the optimal level—and the utilization is in a disordered state. When the C value is 1, the benefit level of cultivated land utilization is the highest, and the land utilization is in the optimal condition. The degree of closeness C_i is divided into four grades, which represent the level of cultivated land-use benefit (Table 2). The formula for calculating closeness is as follows:

$$C_i = \frac{D_i{}^-}{D_i{}^+ + D_i{}^-} \quad (9)$$

Table 2. Cultivated land-use benefit evaluation criteria.

Closeness Degree	Benefit Level
0~0.30	Poor level
0.31~0.60	Moderate level
0.61~0.80	Good level
0.81~1.00	High level

5.2. Obstacle Degree Model

Identifying the influencing factors that hinder the efficient use of cultivated land in different regions is the premise of an in-depth understanding of the changing laws of cultivated land-use benefits in the different areas. The management department provides a decision-making reference and formulates more targeted adaptive management measures. Therefore, this study uses the obstacle degree model to calculate the impact of each evaluation index on the improvement of cultivated land-use efficiency in Northern Hubei. The measure's calculation is based on the factor contribution, index deviation, and obstacle, which are the three indicators used to analyze the results. They are defined as follows: (1) factor contribution (W_j) is the contribution of a single factor to the overall goal, expressed by the weight of a single factor; (2) index deviation (I_j) refers to the gap between the single factor index and the system development goal, which is set as the difference between the standardized value of the single index and 100%; and (3) obstacle degree (O_j) is the degree of influence of a single index on the improvement of cultivated land-use benefits. It is calculated as follows:

$$I_{ij} = 1 - x_{ij} \quad (10)$$

In Formula (10), I_{ij} represents the index deviation degree, which indicates the gap between the single index and the optimal target value—that is, the difference between the standardized value x_{ij} of the single index and 100%.

$$O_{ij} = \frac{I_{ij} w_j}{\sum\limits_{j=1}^{n} I_{ij} w_j} \times 100\% \quad (11)$$

In Formula (11), O_{ij} represents the obstacle degree of the jth evaluation index of the ith evaluated object, and w_j represents the weight value of the jth index.

6. Results

6.1. Comprehensive Benefit Comparison

Through Formulas (1)–(9), the weights w_i (W_1 represents the weight of Shiyan City; W_2 represents the weight of Xiangyang City; W_3 represents the weight of Suizhou City) of each index of the comprehensive benefit of cultivated land use in the three regions of Northern Hubei from 2010 to 2020 (Table 3), and the value of the closeness degree of comprehensive benefit C (Table 4), were calculated. It can be seen that the benefit of cultivated land use in Northern Hubei is on the rise as a whole. From 2010 to 2020, the closeness degree increased from 0.332 to 0.682, increasing by 1.1 times. The level of cultivated land-use benefit in Northern Hubei has changed from an intermediate state to a good state, and the overall benefit level has shown a trend of steady development. Regarding the specific conditions of each region, the level of farmland utilization efficiency in Shiyan has experienced a development process of "intermediate–poor–intermediate–

good"; Xiangyang has experienced a development process of "poor–intermediate–good" development; and Suizhou has continued to maintain an intermediate level of development. From the perspective of spatial evolution, in 2010, the regions ranked from high to low were as follows: Suizhou (0.443), Shiyan (0.366), and Xiangyang (0.188). In 2020, from high to low, they were ranked as follows: Xiangyang (0.769), Shiyan City (0.716), and Suizhou City (0.56). It can be seen that the spatial difference in cultivated land utilization benefits between the three regions is noticeable. Xiangyang has the highest comprehensive benefit level of cultivated land utilization and the fastest development. Shiyan's development speed is second only to Xiangyang and Suizhou. The growth of Suizhou is relatively slow.

Table 3. Index weights of Shiyan City, Xiangyang City, and Suizhou City.

Index	W_1	W_2	W_3
Effective irrigation index	0.07	0.07	0.09
Average fertilizer input level	0.12	0.13	0.11
Average pesticide input level	0.09	0.11	0.11
Forest cover rate	0.07	0.08	0.13
Land productivity	0.06	0.08	0.08
Per capita agricultural output	0.06	0.05	0.04
Per capita food production	0.12	0.07	0.05
Agricultural input–output ratio	0.14	0.15	0.13
Agricultural labor productivity	0.06	0.05	0.05
Level of agricultural mechanization	0.06	0.05	0.05
Agricultural mechanization efficiency	0.06	0.08	0.08
Per capita income of farmers	0.09	0.08	0.07

Table 4. The proximity of the comprehensive benefits of Shiyan City, Xiangyang City, and Suizhou City.

Year	The Proximity of Shiyan City	The Proximity of Xiangyang City	The Proximity of Suizhou City
2010	0.366	0.188	0.443
2011	0.282	0.254	0.462
2012	0.365	0.383	0.479
2013	0.448	0.418	0.493
2014	0.483	0.441	0.5
2015	0.502	0.478	0.503
2016	0.5	0.485	0.523
2017	0.578	0.621	0.522
2018	0.655	0.651	0.528
2019	0.673	0.669	0.532
2020	0.716	0.769	0.56

6.2. Analysis of Each Benefit Level

6.2.1. Eco-Efficiency Comparison

From 2010 to 2020, the ecological benefits of cultivated land use in all regions of Northern Hubei showed an increasing trend (Figure 2). The growth of Shiyan presents a "V" shape, and the ecological benefit level of cultivated land utilization can be divided into three stages. The first one is the descending stage (2010–2011): it decreased from 0.31 to 0.19, with a decrease of 38.7%. The second one is the slow-rising stage (2012–2016), with an average annual growth rate of only 9.15%. The third stage is the rapid growth stage (2017–2020), wherein the average annual growth rate reached 23.2%, rising from 0.65 to 1 from 2017 to 2020, with an increase of 53.8%. At the end of 2018, Shiyan City was awarded the national practice and innovation base of "Lucid waters and lush mountains are invaluable assets". The proportion of ecological counties and cities reached 100%, and the forest coverage rate reached 73.29%, much higher than the national average. In 2020, the ecological benefits of cultivated land utilization in Shiyan City reached a high-quality level, and the evaluation index was the highest among the three regions. Xiangyang has shown a steady upward trend, rising from 0.22 to 0.86 during 2010–2020, with an increase of 2.9 times, and the overall growth rate is relatively high. Xiangyang has the largest cultivated land area among the three regions, and the region has excellent natural conditions, a high economic development level, relatively advanced agricultural technology, and a significant increase in the ecological benefits of cultivated land utilization. The growth of Suizhou is relatively slow. From 2010 to 2020, the growth rate was 0, and the change was horizontal. The land development and utilization in Suizhou took place relatively early, and the degree of land utilization was relatively high. In 2010, the closeness degree of the ecological benefit of cultivated land utilization reached 0.51, which is at the intermediate level. With the development of urbanization and industrialization, the demand for non-agricultural land has increased, and the phenomenon of "hollow villages" and "barren land" has become increasingly severe, restricting the further improvement of the ecological benefits of cultivated land utilization in Suizhou.

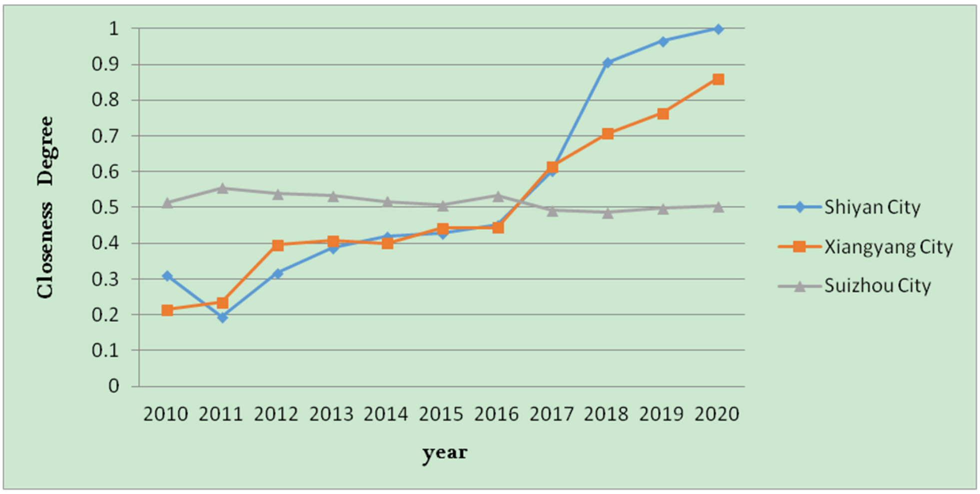

Figure 2. The closeness degree of the ecological benefits of cultivated land use in three study areas during 2010–2020.

6.2.2. Comparison of Economic Benefits

From 2010 to 2020, the economic benefits of cultivated land utilization fluctuated and appeared to present a volatile upward trend in the three study areas, with specific differences in different regions (Figure 3). Shiyan City showed a "W"-shaped change trend, and it was in a declining stage from 2010 to 2012. In 2014, it showed a slow-rising trend, with an increase of only 3.17%; from 2015 to 2016, there was a downward trend, indicating that the development level of Shiyan's agricultural economy was poor and prone to rebound; from 2017 to 2020, it resumed the upward trend, with an increase of 10.39%. Xiangyang has shown a meandering growth trend, rising from 2010 to 2017, benefiting from the rapid economic development and unique natural conditions of Xiangyang. From 2018 to 2019, there was a slight decrease of 4.41%, and the upward trend resumed in 2020. Suizhou showed a continuously rising trend, increasing from 0.239 to 0.688 during 2010–2020, an increase of 1.88 times.

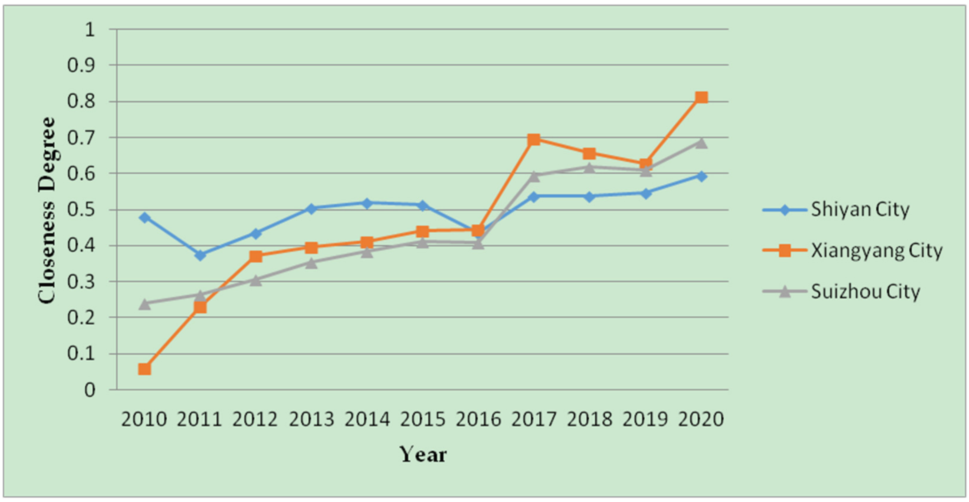

Figure 3. The closeness degree of the economic benefits of cultivated land use in three study areas during 2010–2020.

6.2.3. Comparison of Social Benefits

As shown in Figure 4, from 2010 to 2020, the social benefits of cultivated land utilization in Northern Hubei showed a severe upward trend. The three regions showed a trend of rising, then falling, and then rising. From the perspective of the regional social and economic development level, through the implementation of China's targeted poverty alleviation policy in Northern Hubei, poverty-stricken counties and cities have been lifted out of poverty one after another, and the per capita income level of farmers has been significantly improved, showing a significant upward trend from 2010 to 2016. In 2017, the rural revitalization strategy was introduced. The question of how to effectively connect the two policies is a critical issue. Therefore, 2017 represents an inflection point that determined the future direction of China's agricultural transformation. In the process of change, there was, inevitably, a replacement of the old with the new, resulting in a brief decline in 2016–2017. From 2017 to 2020, there was an upward trend again. China is now in the stage of rapid urbanization and industrialization. It is facing pressures such as urban–rural integration, increased regional infrastructure construction, and the promotion of new socialist rural construction, which trigger changes in the land-use model. As the Northern Hubei region is in the stage of economic transformation, the social benefits of cultivated land use show a development trend of rising first and then falling.

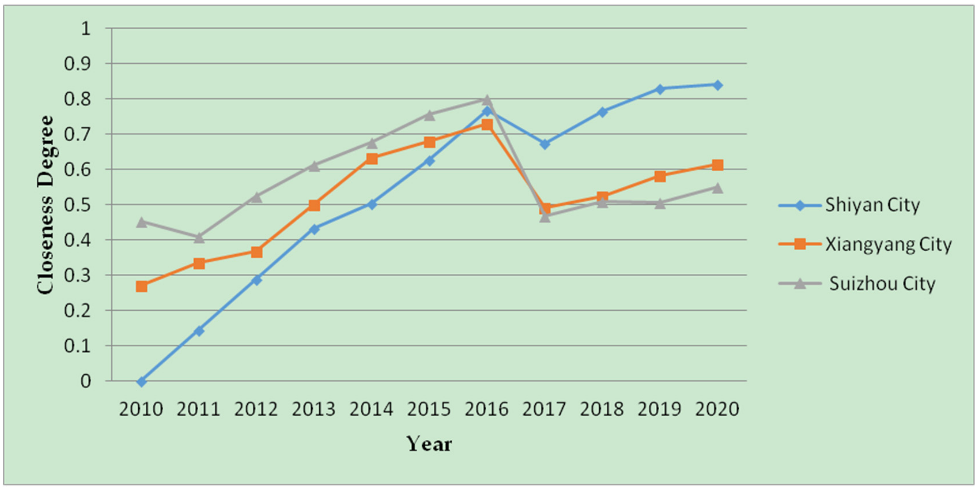

Figure 4. The closeness degree of the social benefits of cultivated land use in three study areas during 2010–2020.

6.3. Identification of Obstacle Factors

According to Formulas (10) and (11), the obstacle degrees of cultivated land-use benefits in Shiyan City, Xiangyang City, and Suizhou City were calculated (Table 5).

Table 5. Obstacle degree of each indicator in Shiyan City, Xiangyang City, and Suizhou City during 2010–2020.

Index	Year / City	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
E_{11}	Shiyan	0.0797	0.0752	0.1013	0.1273	0.1294	0.1424	0.1439	0.0641	0.0301	0.0107	0.0000
	Xiangyang	0.0714	0.0923	0.1176	0.1387	0.1577	0.1661	0.1635	0.0696	0.0377	0.0015	0.0000
	Suizhou	0.1301	0.1295	0.1482	0.1680	0.1951	0.2261	0.2227	0.0154	0.0079	0.0023	0.0000
E_{12}	Shiyan	0.1092	0.1560	0.1766	0.1562	0.1499	0.1660	0.1650	0.0560	0.0343	0.0126	0.0000
	Xiangyang	0.1458	0.1622	0.2094	0.2130	0.2351	0.2348	0.2355	0.0683	0.0466	0.0251	0.0000
	Suizhou	0.1810	0.1694	0.1828	0.2039	0.2198	0.2466	0.2303	0.0167	0.0104	0.0035	0.0000
E_{13}	Shiyan	0.0261	0.0595	0.1124	0.0903	0.1014	0.1024	0.1042	0.2137	0.0310	0.0235	0.0000
	Xiangyang	0.0491	0.0355	0.0251	0.0215	0.0277	0.0000	0.0203	0.2868	0.2595	0.2675	0.3044
	Suizhou	0.0167	0.0000	0.0206	0.0259	0.0236	0.0228	0.0258	0.1794	0.2261	0.2177	0.2569
E_{14}	Shiyan	0.1012	0.0798	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Xiangyang	0.0960	0.1112	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Suizhou	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2503	0.2603	0.2649	0.3244
E_{15}	Shiyan	0.0880	0.0676	0.0565	0.0461	0.0324	0.0226	0.0000	0.1147	0.1653	0.1756	0.2156
	Xiangyang	0.0905	0.0746	0.0470	0.0337	0.0234	0.0154	0.0000	0.1697	0.1709	0.1667	0.2464
	Suizhou	0.0943	0.0849	0.0671	0.0448	0.0378	0.0083	0.0000	0.1570	0.1579	0.1504	0.1655
E_{16}	Shiyan	0.0840	0.0642	0.0551	0.0451	0.0353	0.0288	0.0070	0.0519	0.0673	0.0499	0.0000
	Xiangyang	0.0543	0.0524	0.0523	0.0534	0.0546	0.0586	0.0524	0.0486	0.0474	0.0414	0.0000
	Suizhou	0.0731	0.0677	0.0632	0.0525	0.0500	0.0360	0.0334	0.0451	0.0419	0.0326	0.0000
E_{17}	Shiyan	0.0000	0.0434	0.0343	0.0213	0.0134	0.0191	0.1171	0.2772	0.4261	0.5302	0.6143
	Xiangyang	0.0713	0.0531	0.0000	0.0071	0.0074	0.0070	0.0375	0.0424	0.1308	0.2225	0.0292
	Suizhou	0.0193	0.0226	0.0301	0.0199	0.0093	0.0000	0.0371	0.0786	0.0554	0.0991	0.0374
E_{18}	Shiyan	0.1344	0.1496	0.1743	0.2195	0.2536	0.2954	0.3510	0.0000	0.0016	0.0022	0.0029
	Xiangyang	0.1749	0.1759	0.2577	0.2837	0.3084	0.3264	0.3230	0.0000	0.0009	0.0008	0.0011
	Suizhou	0.2007	0.2204	0.2355	0.2781	0.2809	0.3306	0.3484	0.0026	0.0030	0.0030	0.0000
E_{19}	Shiyan	0.0820	0.0589	0.0473	0.0181	0.0273	0.0214	0.0000	0.0507	0.0518	0.0333	0.0173
	Xiangyang	0.0570	0.0492	0.0507	0.0501	0.0400	0.0399	0.0291	0.0353	0.0333	0.0240	0.0000
	Suizhou	0.0902	0.0847	0.0660	0.0458	0.0463	0.0093	0.0045	0.0381	0.0338	0.0205	0.0000
E_{20}	Shiyan	0.0883	0.0663	0.0668	0.0649	0.0707	0.0765	0.0250	0.0619	0.0555	0.0224	0.0000
	Xiangyang	0.0524	0.0451	0.0353	0.0332	0.0359	0.0414	0.0320	0.0291	0.0298	0.0226	0.0000
	Suizhou	0.0827	0.0715	0.0635	0.0408	0.0461	0.0124	0.0000	0.0484	0.0462	0.0324	0.0056
E_{21}	Shiyan	0.0881	0.0701	0.0680	0.0790	0.0742	0.0230	0.0000	0.0403	0.0726	0.0912	0.1499
	Xiangyang	0.0450	0.0463	0.0578	0.0342	0.0000	0.0126	0.0284	0.2027	0.1785	0.2037	0.4189
	Suizhou	0.0000	0.0399	0.0152	0.0146	0.0122	0.0367	0.0375	0.1365	0.1386	0.1735	0.2034
E_{22}	Shiyan	0.1190	0.1093	0.1073	0.1322	0.1126	0.1024	0.0869	0.0696	0.0644	0.0483	0.0000
	Xiangyang	0.0923	0.1023	0.1471	0.1314	0.1097	0.0978	0.0786	0.0475	0.0647	0.0245	0.0000
	Suizhou	0.1118	0.1096	0.1076	0.1058	0.0788	0.0712	0.0604	0.0319	0.0183	0.0000	0.0069

As can be seen from Figure 5, the main obstacle factors of cultivated land-use efficiency were E_{12} (land-averaged fertilizer input level), E_{18} (agricultural input–output ratio), E_{11} (effective irrigation index), and E_{22} (farmers' per capita income) from 2010 to 2016 in Shiyan. Because Shiyan City has many mountains and hills, scattered plots, poor soil, low farmland quality, low land yield, and complex development, there is a high capital investment demand, low agricultural input–output ratio, low level of agricultural economic growth, and low per capita income of farmers, resulting in common comprehensive benefits of cultivated land use. From 2017 to 2020, E_{15} (land output rate), E_{17} (per capita grain output), and E_{21} (agricultural mechanization efficiency) showed a continuously increasing trend, indicating that the three indicators restricted the improvement in the comprehensive benefits of cultivated land utilization in Shiyan. With the implementation of policies such as returning farmland to forests and afforestation on sloping land, the ecological benefits of cultivated land use in Shiyan have significantly improved. Still, the level of economic and social benefits has improved slowly, and the constraints on the full use of cultivated land are still relatively obvious.

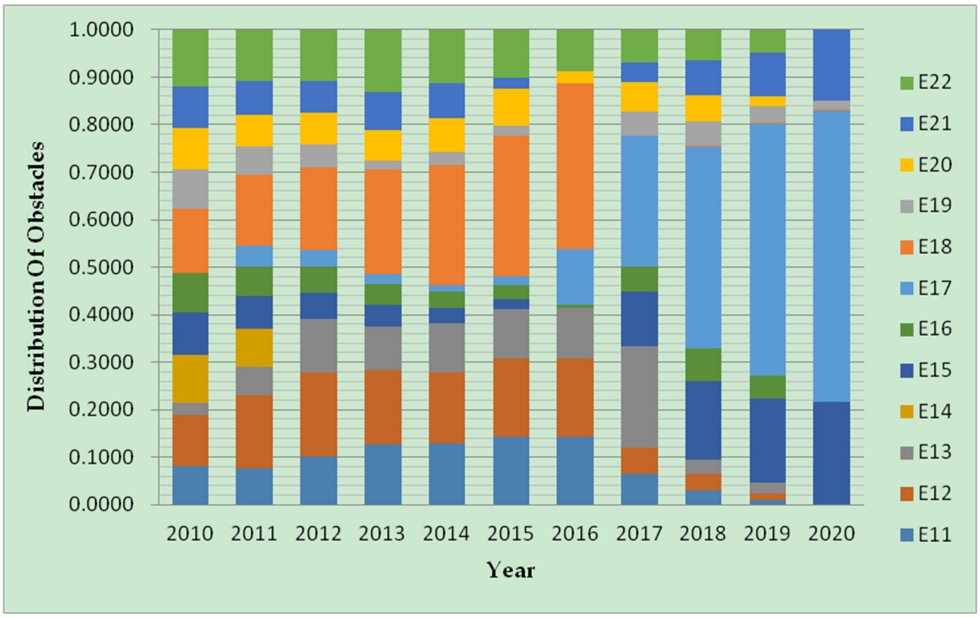

Figure 5. Distribution of obstacles to improving cultivated land-use benefits in Shiyan City.

From 2010 to 2016, E_{11} (effective irrigation index), E_{12} (land-averaged fertilizer input level), E_{18} (agricultural input–output ratio), and E_{22} (farmers' per capita income) were the main obstacles restricting the improvement of cultivated land use in Xiangyang (Figure 6); the land-averaged fertilizer input level and the agricultural input–output ratio had the most substantial impacts as obstacles. After 2017, the constraint level of these two obstacle factors dropped significantly. As a result of the significant increase in Xiangyang's investment in basic farmland construction, land consolidation and reclamation, and agricultural technology, the constraints have been alleviated. From 2018 to 2020, E_{13} (pesticide input level per land), E_{15} (land output rate), and E_{21} (agricultural mechanization efficiency) showed a rapidly rising trend. These were the main obstacles to the utilization of cultivated land in Xiangyang at this stage.

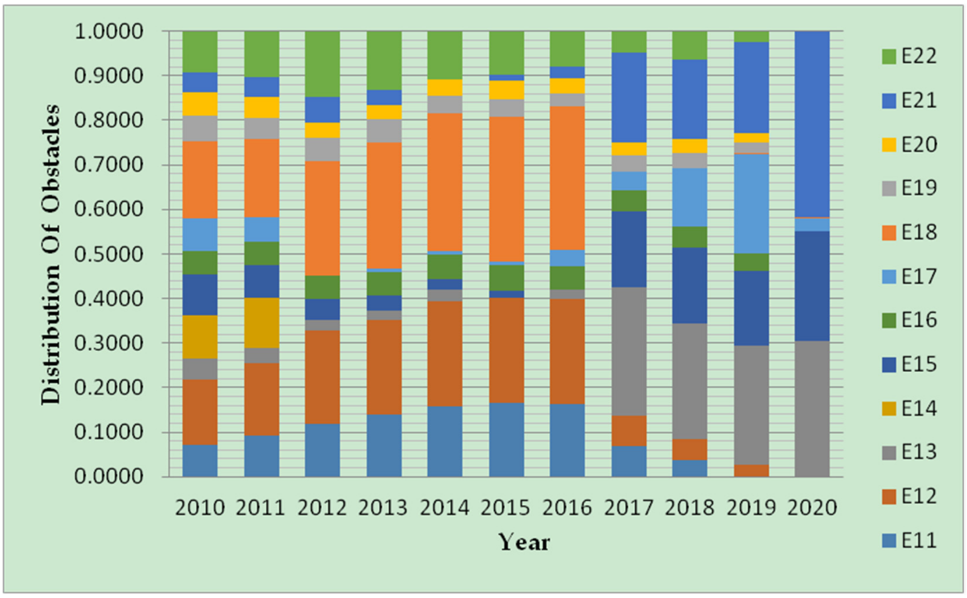

Figure 6. Distribution of obstacles to improving cultivated land-use benefits in Xiangyang City.

From 2010 to 2016, E_{11} (effective irrigation index), E_{12} (land-averaged fertilizer input level), and E_{18} (agricultural input–output ratio) showed a rising trend (Figure 7), indicating that the effective irrigation index, land-averaged fertilizer input level, and agricultural input–output ratio are the main obstacles restricting the improvement of cultivated land utilization efficiency in Suizhou. From 2017 to 2020, the main challenges to cultivated land utilization in Suizhou changed to four indicators: E_{13} (pesticide input level per land), E_{14} (forest coverage rate), E_{15} (land output rate), and E_{21} (agricultural mechanization efficiency). However, the future conditions may not be the critical factor limiting the improvement in cultivated land utilization efficiency in Suizhou.

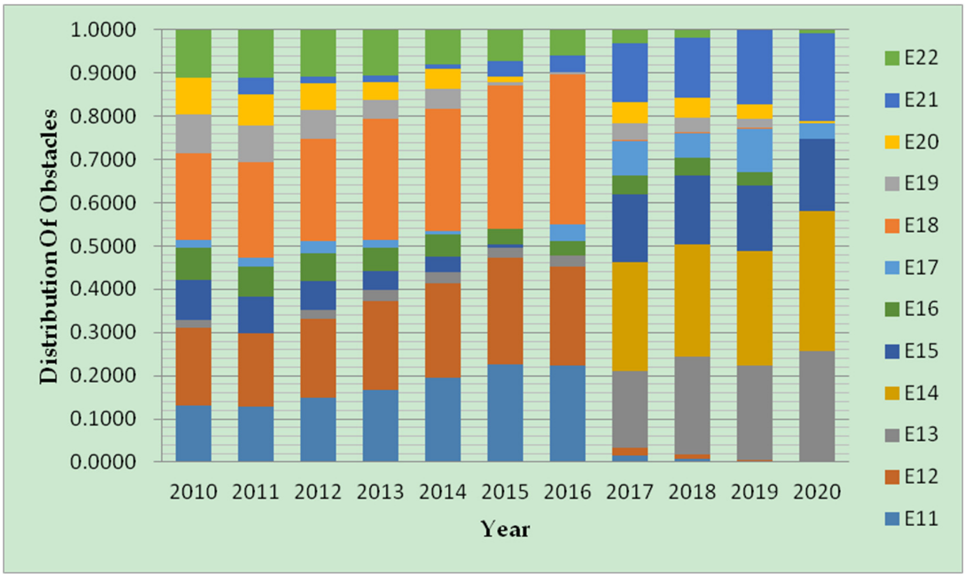

Figure 7. Distribution of obstacles to improving cultivated land-use benefits in Suizhou City.

7. Discussion

From the analysis results, the comprehensive benefits of cultivated land utilization in the three regions of Northern Hubei showed a good growth trend, with noticeable spatial differences between regions. The cultivated land area of Xiangyang is the largest among the three parts, and the site has superior light, heat, and hot soil conditions and high natural productivity across the land. Moreover, Xiangyang is the second largest city in Hubei Province, with a high level of economic development, and can fully use the quality of labor and the level of agricultural science and technology. Therefore, the overall benefit of cultivated land utilization in Xiangyang is better than that in the other two regions. Affected by the topography of the region, Shiyan City has barren sloping farmland, soil erosion, and rocky desertification [35]. The difficulty of farmland restoration and reclamation limits the full use of farmland resources, and many restrictive factors affect the improvement of farmland utilization benefits. The economic development and natural conditions of Suizhou are good, the benefit level of cultivated land utilization is relatively stable, the modern agricultural industry structure has begun to take shape, and there is strong potential for development in the future. Regarding the evaluation results of individual benefits, the ecological benefits, economic benefits, and social benefits of cultivated land utilization in various regions have shown a development trend of increasing and decreasing, and the coordination is poor. The average pesticide input level, per capita grain output, forest coverage rate, land output rate, and agricultural mechanization efficiency are the key factors hindering the improvement of cultivated land utilization efficiency in Northern Hubei. The primary task is the sustainable utilization of cultivated land in the region. Hubei is designated as one of the leading grain-producing areas in China. Therefore, in the context of rapid economic development, food security is still a significant challenge for Hubei. The stronger the externality of cultivated land protection, the stronger the guarantee of ecological environment construction and food security in each region; however, the protection of cultivated land means increased government responsibility [4]. This requires governments to fully consider the synergies and trade-offs between ecosystems [36]. It is necessary to plan the land scientifically and rationally, promote the coordination between social and economic development and environmental protection, and realize the effective use of land resources and the sustainable development of society and economy [37]. At the same time, the effective irrigation index, land-averaged fertilizer input level, agricultural input–output ratio, and farmers' per capita income have generally shown a downward trend in hindering the efficiency of cultivated land use in Northern Hubei. However, it is still necessary to continue to strengthen critical work in these areas. For example, most of the Northern Hubei area is dry land with poor water storage capacity and is vulnerable to drought. The development of water-saving irrigation and increasing the effective irrigation area of farmland are continuously implemented [35].

Due to the complex evaluation process of cultivated land-use benefits, the limited availability of data, and the quantification of indicators, there is no absolute standard and unified measurement framework in existing research. Because of the defects of the TOPSIS model, when there are few evaluation schemes, the optimal and worst plans are often unrepresentative, which will have a particular impact on the evaluation results [38]. In this paper, the TOPSIS model and the entropy weight method are integrated for evaluation, which significantly reduces the evaluation error, but the study still has certain limitations. Using the entropy weight method to determine the index weight can ensure the objectivity and accuracy of the results. Still, this depends heavily on the sample, which may lead to distortion, making the evaluation stability relatively poor. For example, farmers may only value additional economic benefits, and it is difficult for them to understand the urgent need for organic agriculture [39]. In this case, further integration or comparative analysis with other evaluation methods is required. Some scholars [40,41] selected seven typical evaluation models or methods, namely, principal component analysis, AHP, grey relational analysis, the improved order relationship, fuzzy comprehensive evaluation, a BP neural network, and the support vector machine (SVM) model, to conduct a method comparison study of the sustainable utilization of water resources in nine districts and cities in Fujian Province. As far as the research content and research objects are concerned, in future research, the index system will be further expanded, the research methods will be improved, and the sustainable efficiency of cultivated land use in Northern Hubei will be further explored to put forward practical and constructive suggestions for the sustainable development of agriculture in Northern Hubei.

8. Conclusions

This study takes Shiyan City, Xiangyang City, and Suizhou City in Northern Hubei as the research objects. It selects 12 effect evaluation indicators from the three levels of economy, society, and ecology. According to the standardized values and weights of the evaluation indicators, this study adopts the entropy weight TOPSIS model to quantitatively evaluate the economic, social, ecological, and comprehensive benefits of cultivated land utilization in Northern Hubei and conducts a comparative analysis. By constructing an obstacle degree model, the obstacle factors of cultivated land-use benefits in each region were deduced and identified. Based on scientific and rational requirements, targeted solutions are given for the obstacle factors and, finally, the following conclusions are drawn.

Firstly, there are significant differences in the single benefit of cultivated land utilization in Shiyan City, Xiangyang City, and Suizhou City. Xiangyang has the most outstanding economic performance, and Shiyan has the highest growth rate of ecological benefits among the three areas. Suizhou is known for its stability, and various benefits have developed steadily. The overall benefits of the three regions show a steady upward trend.

Secondly, from the perspective of the scale of agricultural development in the three regions, Xiangyang City is the highest, followed by Suizhou City, and Shiyan City is the lowest. The utilization efficiency of cultivated land in the three areas has shown an upward trend, which reflects, to a certain extent, that the investment in agricultural production in Northern Hubei is increasing year by year. The daily operations of cultivated land, such as fertilizer and irrigation, are scientifically planned, to ensure the sustainable development of cultivated land utilization and efficient cultivated land production, making a more outstanding contribution.

Finally, judging from the influence degree of each obstacle factor on the improvement in cultivated land-use benefit, the fluctuation ranges of the cultivated land-use obstacle factors are relatively large in Northern Hubei. From 2010 to 2016, the effective irrigation index, land-averaged fertilizer input level, agricultural input–output ratio, and per capita income of farmers were the main factors restricting the improvement of cultivated land utilization efficiency in Northern Hubei. From 2017 to 2020, the per capita pesticide input level, per capita grain output, forest coverage rate, land output rate, and agricultural mechanization efficiency became the main obstacles restricting the improvement of cultivated land-use efficiency in Northern Hubei. All evaluation indicators of cultivated land utilization must be actively taken into consideration, the "longboard" should be continuously developed, and the "short board" should be weakened, to maximize the level of cultivated land utilization efficiency.

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