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Evaluation of Green Development Level of Mianyang Agriculture, Based on the Entropy Weight Method

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Abstract: Achieving the "dual carbon" objective is contingent upon the ecological development of agriculture. As the only Science and Technology City in China, evaluating the level of green agricultural development in Mianyang during the 13th Five-Year Plan is of considerable practical importance. Using the entropy weight comprehensive evaluation method, this paper determines the level of green agricultural development in Mianyang by selecting panel data from 2016 to 2020 for Mianyang and its counties (cities and districts) and constructing 15 agricultural green development evaluation indicators from three levels: socioeconomic, scientific and technological progress, and resources and environment. The results indicate that the overall level of green agricultural development in the city of Mianyang is satisfactory, and that the level of green development increased each year from 2016 to 2020, with clear differences in the level of green agricultural development between counties (cities and districts) and numerous factors influencing the development of green agriculture. On this basis, it is proposed that local conditions-specific green agricultural development policies be formulated and implemented in accordance with local conditions to promote the ecological and high-quality development of agriculture by capitalizing on the benefits of a science and technology city, and to assist in achieving the "dual carbon" objective.

Keywords: green development of agriculture; evaluation system; entropy weight comprehensive evaluation method; city of Mianyang

Citation: Chen, C.; Zhang, H. Evaluation of Green Development Level of Mianyang Agriculture, Based on the Entropy Weight Method. *Sustainability* **2023**, *15*, 7589. https://doi.org/10.3390/su15097589

Academic Editors: KuoRay Mao, Shuqin Jin and Zhen Zhong

Received: 30 March 2023
Revised: 29 April 2023
Accepted: 3 May 2023
Published: 5 May 2023

1. Introduction

Agriculture represents a paradigm transformation in the conception of agricultural growth. Adhering to the promotion of green agricultural development is not only essential for optimizing the structure of agricultural production and achieving high-quality agricultural development, but it is also the best example of the coordinated development of people and the ecological environment and the application of the "two mountains" concept. The Party Central Committee and the State Council prioritize the sustainable development of agriculture. In 2015, the Ministry of Agriculture published "On the Implementation of the Fight Against Agricultural Surface Pollution", proposing to achieve total agricultural water control, fertilizer, pesticide use reduction, livestock and poultry manure, crop straw, and agricultural film basic resource utilization of the "one control, two reduction, three basic" objective tasks. It commenced the management of agricultural surface source contamination. The 2016, the Central Document No. 1 highlighted the need to strengthen resource protection and ecological restoration, as well as promote green agricultural development. Since then, each year's No. 1 document of the central government has highlighted the green development of agriculture and enumerated germane work requirements and promotion measures. National and provincial departments conducted the first annual evaluation of the implementation of ecological civilization construction and green development by lower-level administrations in 2016. The Chinese government declared solemnly to the international community that the objective of "double carbon" is to reach carbon peak in 2030 and carbon neutrality in 2060. Various cities are currently vigorously implementing green development and endeavoring to reach this objective. Mianyang is the second largest city in Sichuan, and its landforms and resources for agricultural green development are highly representative. By evaluating the level of agricultural green development, identifying development gaps and extant problems, and then implementing targeted measures to increase the level of agricultural green development, carbon emissions can be reduced and the "dual carbon" objective can be realized. The Mianyang Municipal Government has issued several plans, including the "Fertile Mianyang" Modern Eco-Cycle Agriculture Development Plan (2016–2030) and the "Mianyang Innovative System Mechanism to Promote Green Agricultural Development Implementation Plan. The degree of ecological development in Mianyang has consistently increased as a consequence of the implementation of pertinent policies. The "Thirteenth Five-Year Plan for Promoting Agricultural and Rural Modernization" of Mianyang proposed in 2022 that, in order to achieve sustainable development, the concept that "lucid waters and lush mountains are invaluable assets" must be rigorously implemented. To enhance the overall quality and competitiveness of agriculture, we must vigorously promote low-carbon and environmentally friendly production and living patterns and construct a flawless green ecological security system. The green development of agriculture is predicated on the preservation of an outstanding ecological environment. It emphasizes the combination of agricultural production and environmental protection, as well as the combination of rational development and efficient use of agricultural resources. The scientific measurement of the level of green agricultural development can assist in identifying green agricultural development's limitations. The government can then implement precise policies to expedite the development of agriculture in a sustainable and high-quality manner.

2. Literature Review

Local academics' current research on green growth in agriculture focuses on four aspects. One example is the concept of sustainable agricultural expansion. Green development in agriculture is the process of pursuing sustainable development while respecting the environment and employing a variety of cutting-edge technologies [1]. Green agriculture is essentially a high-quality sustainable development model of agriculture [2]. Green agriculture is a new kind of agricultural development practiced by merging the principles of ecological balance, circular development, and green living on a system of sustainable agricultural development techniques [3]. Second, it is an investigation into the route of green growth in agriculture. Yu proposed path options such as leading the direction of agricultural green development with innovative concepts, consolidating the foundation of agricultural green development with water and soil protection [4]. To drive energy transformation in the twin-city economic cycle of Chengdu and Chongqing, Liu proposed transformation paths such as twin-city collaboration, carbon emissions exchange, technical innovation, and industrial cluster planning to promote energy transformation in the twin-city economic cycle of Chengdu and Chongqing. Third, the evolutionary characteristics and causes of agricultural green growth are studied [5]. Chen classified rural green growth in the Chengdu–Chongqing region into three sorts based on geographical and chronological evolutionary qualities and influencing variables: whole advancement development, special leading development, and unique delaying development [6]. The Chengdu–Chongqing region's cities' comprehensive level of industrial green transformation was expanding, but the discrepancy between regions was widening, and regional center cities had a higher comprehensive growth level than others [7]. Communities in the Chengdu–Chongqing twin-city economic circle demonstrated four types of evolutionary trajectories: rising, U-shaped, inverted U-shaped, and interval fluctuation [8]. Fourth is the research on the creation of a farming green development assessment indicator system. The author could mention that previous studies have used different indicators to assess agriculture development, such as resource utilization efficiency [9,10], environment use [11], and others [12–17].

In terms of research methods, it mainly includes comprehensive evaluation method [18,19], entropy value method [16,19–22], nonparametric data envelopment analysis [23], and coupled coordination model [24]. Using the entropy weighted TOPSIS model and the SBM bad model [25], the development indicators of IAT [26]. The level and structure of the absorption of funds from the CAP underwent analysis [27], the Gini coefficient was combined with hesitant fuzzy multiple attribute decision making to investigate the topic of agricultural green development methods [28]. Using an endogenous switching regression (ESR)model and linking a global ACE database to a global multi-regional input-output (MRIO) model [29,30]. Developing an assessment index system and two case studies that provides economic, social, and environmental advantages, as well as scientifically examining the function and mechanism of digital economy development on high-quality agricultural growth [31,32]. Using the SBM-DDF-Linebarger method to measure China's agricultural green total factor productivity (AGTFP) and agricultural labor surplus [33]. Logistic regression, data envelopment analysis and propensity score matching were used to analyze the data [34]. Taking into account the long-term importance of green water usage, carbon emissions, and fixed asset investment in agricultural output, an unanticipated dynamic SBM-DEA model was developed [35]. DID models and comparative studies were employed [36]. To effectively measure agricultural carbon emission efficiency in the Yangtze River Delta, an ultra-efficient relaxation-based measurement (SBM) model with unexpected outputs was used [37]. Scholars have performed research from the national, provincial, or a localized development region, depending on the scope of the study.

Existing studies in the literature have examined the level of green agricultural development in great detail from a variety of vantage points and employing a wide range of methodologies. Fewer studies have been conducted on counties (cities and districts) than on large regions, such as the entire country and the national ecological civilization experimental zones. Achieving the national goal of "dual carbon" relies significantly on the development of sustainable agriculture in counties. Therefore, research in this discipline is both necessary and mandatory. This study constructs an index system to evaluate the level of green agricultural development in the city of Mianyang and its counties (cities and districts) by addressing the problems of severe agricultural surface source pollution, prominent contradiction between agricultural production and resource environmental protection, and inadequate scientific and technological vitality for agricultural development. Then, this paper employs the entropy weighted comprehensive evaluation method to assess the level of green agricultural development in counties and to provide development recommendations so as to serve as a benchmark for the assessment of the level of green and low-carbon development in other counties.

3. Research Methodology and Data Sources

3.1. Research Methodology

The majority of methods for determining weights can be classified as either subjective or objective. The subjective assignment method determines the weights according to the evaluator's subjective perspective on the importance of each index, and the fraudulently assigned weights lack any objective scientific basis. The entropy weighting method, on the other hand, determines the weight objectively based on the information provided by each evaluation index, utilizing the discrete character of the data to derive more objective weights. Comprehensive evaluation is a method that employs statistical indicators to make a precise and exhaustive evaluation or judgment on the object of evaluation, as well as to determine the order and classify the rank. Using the exhaustive evaluation method based on entropy weight, this paper evaluates and analyzes the level of green agricultural development in Mianyang from 2016 to 2020.

The specific steps are as follows:

Step 1. The evaluation indices are set. Let the index measure be a_{ij}, where: i denotes the ith evaluation object, i.e., year i or region i, and j denotes the jth evaluation index.

Step 2. The normalization of indicators. In order to eliminate the influence of the scale between different indicators, each indicator is normalized using the relative deviation value method. Let $a_j^{max} = {}_i^{max}a_{ij}$, $a_j^{min} = {}_i^{min}a_{ij}$, which denote the maximum and minimum values of the jth indicator, respectively, and the normalized indicator measure is b_{ij}.

Positive indicator: $b_{ij} = \frac{a_{ij} - a_j^{min}}{a_j^{max} - a_j^{min}}$ Negative indicator: $b_{ij} = \frac{a_j^{max} - a_{ij}}{a_j^{max} - a_j^{min}}$.

Step 3. The output entropy of the jth indicator is calculated: $E_j = -(\ln(m))^{-1}\sum_{i=1}^{m} P_{ij}\ln(P_{ij})$, where, $P_{ij} = \frac{b_{ij}}{\sum_{i=1}^{m} b_{ij}}$.

Step 4. Calculate the variability of the jth indicator: $D_j = 1 - E_j$.

Step 5. Calculate the objective weights of the jth indicator: $\theta_j = \frac{D_{ij}}{\sum_{j=1}^{n} D_{ij}}$.

Step 6. Calculate the comprehensive score of the agricultural green development level of Mianyang and each county and district: $Z_j = \sum_j^n \theta_j b_{ij}$.

3.2. Construction of Indicator System

This study has established the first-level indicators in three dimensions, namely, socioeconomic, scientific, and technological progress, and resources and environment, by adhering to the principles of scientificity, operability, and quantifiability in constructing the evaluation index system. The existing research results have been referred to in this process. This study selected 15 secondary indicators that align with the characteristics of green agricultural development in Mianyang. The selection process considered General Secretary Xi Jinping's instructions on the twin-city economic circle in Chengdu and Chongqing regions, Mianyang's positioning in these regions, and the strategic deployment of Sichuan Province's "one stem, multiple branches, five regions and synergy" approach. Additionally, the study accounted for the impact of the construction of Mianyang, a Science and Technology City, on green agricultural development. Please refer to Table 1 for further information.

Table 1. Agricultural green development evaluation index system.

Tier 1 Indicators	Tier 2 Indicators	Unit	Indicator Meaning	Direction of Action
Socioeconomic	Economic development level	ten-thousand CNY CNY/person	Gross regional product/total population	Positive
	Per capita disposable income of farmers	ten-thousand CNY CNY/person	Disposable income of farmers/number of rural population	Positive
	Labor productivity	ten-thousand CNY CNY/person	Total output value of agriculture, forestry, animal husbandry and fishery industry/employees in primary industry	Positive
	Land productivity	ten-thousand CNY CNY/hm^2	Total output value of agriculture, forestry, animal husbandry and fishery/area of agricultural land	Positive
Tier 1 Indicators	**Tier 2 Indicators**	**Unit**	**Indicator Meaning**	**Direction of Action**
Technological Progress	Effective irrigated area of arable land per capita	hm^2/person	Effective irrigated area of arable land/number of rural population	Positive

Table 1. *Cont.*

	Machine cultivation area per capita	hm^2/person	Area of mechanized farming/number of rural population	Positive
	Total power of agricultural machinery per capita	kW/person	Total power of agricultural machinery/rural population	Positive
Resource Environment	Energy saving and environmental protection expenditure per capita	ten-thousand CNY CNY/person	Energy saving and environmental protection expenditure/total population	Positive
	Cultivated land replanting index	–	Crop sowing area/cultivated land area	Negative
	Agricultural diesel use intensity	ton/hm^2	Amount of agricultural diesel used/crop sown area	Negative
	Fertilizer application intensity	ton/hm^2	Fertilizer application amount/crop sowing area	Negative
	Pesticide application intensity	ton/hm^2	Pesticide application amount/crop sowing area	Negative
	Intensity of agricultural film application	ton/hm^2	Amount of agricultural film applied/crop sown area	Negative
	Energy consumption per unit of GDP	ton of standard coal/ten-thousands CNY CNY	Total energy consumption/regional GDP	Negative
	Electricity consumption per unit GDP	ten-thousands CNY kWh/RMB	Total electricity consumption/regional GDP	Negative

3.2.1. Socioeconomic Indicators

Socioeconomic indicators serve as primary metrics for evaluating the extent to which agriculture has achieved sustainable and environmentally conscious growth. The assessment of economic development and potential can be facilitated by examining indicators that reflect the scale, speed, and level of local agricultural green development. The per capita discretionary income of farmers can offer a comprehensive understanding of the living standards of rural inhabitants, along with their level of social and economic development. The phenomenon of urbanization has resulted in a dearth of agricultural labor and a suboptimal level of production efficiency. To a certain extent, it has influenced the development of sustainable agricultural practices. Enhancing the productivity of farm workers is imperative for the sustainable development of agriculture. The measure of land productivity pertains to the capacity of agricultural land to yield crops.

3.2.2. Science and Technology Progress Indicators

The rapid advancement of digital agriculture has led to the increased integration of technology in agricultural practices, such as rural farming and arable land irrigation. The extent of irrigated arable land can serve as an indicator of the level of development and utilization of water resources in a given region, as well as the state of rural water conservancy infrastructure. As such, the per capita effective irrigated area of arable land is commonly employed as a metric to gauge the degree of scientific and technological advancement in this domain. The utilization of agricultural machinery plays a crucial role in the dissemination and implementation of sophisticated agricultural green technology. The extent of contemporary agricultural green development can be gauged by the degree of agricultural mechanization. Consequently, the per capita area of machine cultivation and the per capita total power of agricultural machinery are utilized as indicators to represent the level of regional agricultural green technological advancement.

3.2.3. Resource and Environmental Indicators

The concept of green agriculture development involves the integration of agricultural development, rational utilization of agricultural resources, and environmental protection measures by production operators. The aim is to minimize the negative impact of agricultural activities on the environment and resources, and to establish a harmonious coexistence between humans and nature. The financial backing for endeavors related to environmental management is derived from expenses allocated towards energy conservation and safeguarding the environment. The per capita expenses allocated towards energy conservation and environmental preservation serve as a measure of the extent to which localities are engaged in managing their energy and environmental resources. Enhancing the regeneration index has the potential to significantly improve crop productivity. In the event that the regeneration index surpasses a certain threshold, the cultivation of arable land may result in ecological and environmental strain as a result of the extensive application of chemical fertilizers, pesticides, and compost. This practice is not conducive to the sustainable development of land. As a result, the cropland regeneration index exhibits negative values with respect to both resource and environmental indicators. The correlation between the utilization of diesel fuel in the agricultural sector and the energy consumption of agricultural production is evident. The reduction of diesel fuel is the sole approach to mitigate pollutant emissions and foster environmentally sustainable agricultural practices. Agricultural surface source pollution is a notable contributor to environmental degradation. This type of pollution primarily encompasses pesticide pollution, fertilizer pollution, and agricultural film pollution. The evaluation of Mianyang's agricultural green development focuses on three indicators: fertilizer application intensity, pesticide application intensity, and agricultural film application intensity. The aim is to reduce the usage of these resources and improve the environmental friendliness of the agricultural practices. The metric of energy consumption per unit of GDP serves as an indicator of both energy and electricity consumption rates, as well as the efficacy of energy conservation and consumption reduction measures. The statement elucidates the correlation between the economic development of a particular region and its corresponding energy and electricity consumption levels. Agricultural development's dependence on energy and electricity is inversely proportional to the sustainability of such development, as higher electricity consumption per unit of GDP indicates a greater reliance on energy resources.

3.3. Data Sources

The data sources for the index system were obtained from various official publications, including the China Statistical Yearbook, the China Rural Statistical Yearbook, the Sichuan Statistical Yearbook, the Mianyang Statistical Yearbook, the official website of the Mianyang Municipal Bureau of Agriculture and Rural Development, the Mianyang Ecological Environment Status Bulletin, and the statistical yearbooks of each county, city, and district in Mianyang. This was done to ensure the reliability, authority, and accessibility of the data.

4. Empirical Analysis

4.1. Descriptive Analysis of Sample and Variables

Over the period of 2016 to 2020, the city of Mianyang has experienced a gradual increase in its socio-economic status, as have the individual counties, cities, and districts within its jurisdiction. However, there exists a significant disparity in the level of economic development among these administrative divisions. Over the past five years, Fucheng District has exhibited the most substantial economic expansion, as evidenced by the successive increases in per capita incomes of CNY 92,100, CNY 105,900, CNY 116,700, CNY 136,800, and CNY 142,200. Over the past five years, Santai County has exhibited the least amount of economic development, with per capita incomes of CNY 15,400, CNY 17,300, CNY 19,100, CNY 27,300, and CNY 29,600, respectively. Over the course of the past five years, there has been a consistent rise in the per capita disposable income of farmers. Notably, the farmers residing in Fucheng District have experienced the highest per capita disposable income within this time frame. Youxian District and Jiangyou City rank second highest in comparison, whereas Pingwu County holds the lowest position. The per capita disposable incomes of farmers residing in Santai County, Yanting County, Zitong County, Beichuan County, and Pingwu County were observed to be lower than the average per capita disposable income in Mianyang. The labor productivity of the counties, cities, and districts in Mianyang has exhibited considerable fluctuations over the last five years, but with a general upward trajectory. Specifically, the figures indicate that the labor productivity was CNY 31,500 per person in 2016, CNY 57,100 per person in 2017, CNY 60,600 per person in 2018, declined to CNY 59,400 per person in 2019, and then increased to CNY 82,300 per person in 2020. From 2016 to 2019, Fucheng District exhibited the highest labor productivity, as evidenced by the figures of CNY 57,700 per person, CNY 105,100 per person, CNY 111,300 per person, and CNY 116,300 per person, respectively. Between 2016 and 2019, Pingwu County exhibited the lowest levels of labor productivity, with figures of CNY 16,400 per capita, CNY 29,900 per capita, CNY 31,700 per capita, and CNY 32,100 per capita, respectively. According to the data for the year 2020, Zitong County is projected to exhibit the highest labor productivity, with an estimated value of CNY 131,200 per person. Conversely, Youxian District is expected to demonstrate the lowest labor productivity, with an estimated value of CNY 53,600 per individual. Between 2016 and 2020, it was observed that Fucheng District exhibited the highest annual land productivity, whereas Pingwu County demonstrated to be the lowest.

In terms of scientific and technological progress, in 2016–2020, Youxian District had the greatest per capita effective irrigated arable land at 0.09 hm^2/person, 0.1 hm^2/person, 0.1 hm^2/person, and 0.11 hm^2/person. Beichuan County's 0.01 hm^2/person per capita was the lowest. In 2016, the greatest per capita machine farming area was in Anzhou District and Jiangyou City with 0.14 hm^2/person; from 2017 to 2020, the largest was in Youxian District with 0.14 hm^2/person, 0.17 hm^2 per person, 0.20 hm^2/person, and 0.23 hm^2/person. Beichuan County's annual averages over the last five years were 0.01 hm^2/person, 0.04 hm^2/person, 0.04 hm^2/person, 0.06 hm^2/person, and 0.07 hm^2/person. The largest counties in terms of agricultural machinery power per capita are all located in Fucheng District. In Beichuan County, the lowest rates in 2016, 2017, and 2020 are 0.49 kW/person, 0.53 kW/person, and 0.57 kW/person, respectively. The per capita electricity consumption in Santai County was recorded as 0.49 kW/person and 0.36 kW/person for the years 2018 and 2019, respectively. Based on the available data pertaining to the utilization of agricultural machinery, it can be inferred that Fucheng District and Youxian District exhibit the most significant levels of mechanization among all the counties. Santai County and Beichuan County exhibit comparatively lower levels of agricultural technology in comparison to the remaining counties.

With regards to the resource environment, the development of agricultural resources and the environment in the city of Mianyang has been analyzed. The average per capita expenditure on energy conservation and environmental preservation is CNY 0.0160. Over the course of the past five years, Fucheng District has exhibited the highest index for the replanting of arable land, with values of 2.74, 1.93, 1.96, 1.99, and 1.99, respectively. Anzhou District, Pingwu County in 2016, and Pingwu County from 2018 to 2020, have been identified as the counties with the lowest population growth rates, with recorded figures of 2.13, 1.14, and 1.13, respectively. Typically, there is a slight variation in the index for replanting arable land across different counties. The Anzhou District comprises the two counties that exhibit the least agricultural diesel intensity. In 2017, Jiangyou City held the highest county status; however, in subsequent years, Zitong County surpassed it as the top county. Over the past half-decade, Yanting County has exhibited the highest degree of fertilizer application intensity among all counties. Yet, it demonstrates a declining tendency, with values of 0.528 t/hm^2, 0.511 t/hm^2, 0.484 t/hm^2, 0.468 t/hm^2, and 0.452 t/hm^2, correspondingly. At 0.147 t/hm^2, 0.182 t/hm^2, 0.184 t/hm^2, 0.182 t/hm^2, and 0.182 t/hm^2, Pingwu County has the lowest fertilizer application intensity of all years. Jiangyou County has the greatest pesticide application density, with 0.014 t/hm^2, followed by 0.014 t/hm^2, 0.014 t/hm^2, 0.013 t/hm^2, and 0.012 t/hm^2. Pingwu County has the lowest pesticide application density, with 0.001 t/hm^2. Fucheng District exhibited the highest degree of agricultural film application intensity among all the counties. In 2018, the application rate of agricultural film was 0.022 tons per hectare of land. In the subsequent years of 2016, 2017, 2019, and 2020, the application rate remained consistent at 0.023 tons per hectare of land. Pingwu County exhibits the least intensity of agricultural film application, with a rate of 0.002 t/hm^2. Anzhou District exhibited the highest energy consumption per unit GDP in both 2016 and 2017, with values of 0.520 t standard coal/ten-thousand CNY and 0.488 t standard coal/ten-thousand CNY, respectively. Jiangyou City exhibited the highest energy consumption per unit GDP between 2018 and 2020, with values of 0.444 t standard coal/ten-thousand CNY and 0.461 t standard coal/ten-thousand CNY, respectively. Jiangyou City exhibited the highest energy consumption per unit GDP between 2018 and 2020, with a value of 0.444 t standard coal/ten-thousand CNY. Yanting County exhibited the lowest energy consumption per unit of GDP between 2016 and 2018, with a recorded figure of 0.009 tons of standard coal per CNY in each of the three years. In 2018, the county's energy consumption per unit of GDP slightly increased to 0.011 tons of standard coal per CNY. In 2019, Zitong County and Youxian District exhibited the lowest standard coal/CNY ratio, amounting to 0.025 tons. According to data from 2020, Zitong County had the lowest rate of standard coal consumption per CNY, with a value of 0.023 tons. Between 2016 and 2020, Anzhou District exhibited the highest electricity consumption per unit GDP, with values of 800 kWh/CNY, 820 kWh/CNY, 580 kWh/CNY, 550 kWh/CNY, and 560 kWh/CNY, respectively. The counties exhibiting the least electricity consumption per unit of GDP are Yanting County, with respective values of 40 kWh/ten-thousand CNY, 30 kWh/ten-thousand CNY, 30 kWh/ten-thousand CNY, 40 kWh/ten-thousand CNY, and 50 kWh/ten-thousand CNY.

4.2. Data Standardization Analysis and Weighting

There is a significant difference in value between each assessment indication. The normalization of each indicator and objective establishment of its weight based on the information provided by the entropy weighting technique's assessment indicators is necessary to mitigate the influence of indicator magnitudes. Table 2 presents the weights assigned to different indicators for agricultural green development statistics in Mianyang and its constituent counties, cities, and districts, over the period spanning from 2016 to 2020. Table A1 in Appendix A provides a comprehensive record of the standardized data list pertaining to the city of Mianyang between 2016 and 2020.

Table 2. Weights for green development of agriculture in city of Mianyang, 2016–2020.

Tier 1 Indicators	Weights	Tier 2 Indicators	Weights
Socioeconomic	0.3215	Economic development level	0.1511
		Per capita disposable income of farmers	0.0476
		Labor productivity	0.0610
		Land productivity	0.0618
Technological Progress	0.1711	Effective irrigated area of arable land per capita	0.0681
		Area under machine cultivation per capita	0.0342
		Total power of agricultural machinery per capita	0.0688
Resources Environment	0.5074	Per capita expenditure on energy conservation and environmental protection	0.1531
		Cultivated land replanting index	0.0339
		Agricultural diesel use intensity	0.0617
		Fertilizer application intensity	0.0493
		Pesticide application intensity	0.0480
		Agricultural film application intensity	0.0806
		Energy consumption per unit of GDP	0.0505
		Electricity consumption per unit of GDP	0.0303

4.3. Comprehensive Evaluation Analysis of Indicators

The utilization of the entropy weighting methodology is employed to ascertain the comprehensive scores of Tier 1 indicators of Agricultural Green Development Level for every county (city and district) located within Mianyang city, spanning the time period of 2016 to 2020 (as demonstrated in Table 3). Based on the Tier 1 indicators, there has been a consistent increase in the comprehensive assessment value of agricultural green development over the past five years. Additionally, the comprehensive development level has demonstrated a year-on-year improvement. From 2016 to 2020, it can be observed that environment and resource indicators exhibit superior performance compared to other indicators. The impact of the resource and environmental ratio on the sustainable development of agriculture in the city of Mianyang is evident. In 2017, the CPC Sichuan Provincial Committee and the provincial administration released two documents titled "Evaluation and Assessment Measures for the Building of Ecological Civilization in Sichuan Province" and "Green Development Indicator System of Sichuan Province". The green development of each city was evaluated within the state. The most environmentally sustainable development within the province was located in Mianyang. The resource utilization index of the aforementioned entity is 84.44, which is the highest among its counterparts in the province. The results of the assessment are in line with this statement, indicating the reliability of the assessment's approach and its precise outcomes. The results of Tier 2 indicators of Agricultural Green Development in Mianyang from 2016 to 2020 are presented in Table 4. This is done with the aim of conducting a more comprehensive analysis of the practical significance of the scores of Tier 1 indicators.

Table 3. Comprehensive evaluation value of Tier 1 indicators of agricultural green development in city of Mianyang, 2016–2020.

Year	Socioeconomic	Technology Progress	Resources Environment	Comprehensive Evaluation Value	Order
2016	0.5320	0.6382	2.1241	3.2943	5
2017	0.8077	0.7039	2.4008	3.9178	4
2018	0.9311	0.7328	2.4972	4.1610	3
2019	1.0982	0.8118	2.6347	4.5447	2
2020	1.3939	0.8889	2.6327	4.9155	1

Table 4. Comprehensive evaluation value of Tier 2 indicators of agricultural green development in city of Mianyang, 2016–2020.

Tier 1 Indicators	Tier 2 Indicators	2016	2017	2018	2019	2020
Socioeconomic	Economic development level	0.2003	0.2569	0.3044	0.4266	0.4628
	Per capita disposable income of farmers	0.1097	0.1538	0.2020	0.2599	0.3150
	Labor productivity	0.0847	0.2242	0.2430	0.2409	0.3678
	Land productivity	0.1373	0.1727	0.1816	0.1708	0.2483
Technological Progress	Effective irrigated area of arable land per capita	0.3098	0.3258	0.3409	0.3458	0.3758
	Machine cultivation area per capita	0.1177	0.1514	0.1756	0.1963	0.2200
	Total power of agricultural machinery per capita	0.2107	0.2321	0.2163	0.2698	0.2931
Resource Environment	Energy saving and environmental protection expenditure per capita	0.2868	0.3428	0.3272	0.4140	0.3505
	Cultivated land replanting index	0.0778	0.2547	0.2535	0.2506	0.2476
	Agricultural diesel use intensity	0.3284	0.3271	0.3264	0.3321	0.3369
	Fertilizer application intensity	0.2447	0.2607	0.2720	0.2930	0.3175
	Pesticide application intensity	0.2447	0.2514	0.2597	0.2753	0.2915
	Intensity of agricultural film application	0.4233	0.4249	0.4782	0.4834	0.5104
	Energy consumption per unit of GDP	0.3303	0.3443	0.3674	0.3701	0.3646
	Electricity consumption per unit GDP	0.1881	0.1950	0.2127	0.2161	0.2137
Comprehensive evaluation value		3.2943	3.9178	4.1610	4.5447	4.9155

In 2016, the arable land replanting indicator received the lowest evaluation rating. This can be attributed to the application of fertilizers, pesticides, mulch, and other pollutants to arable land. The agricultural industry has prioritized economic efficiency over environmental concerns, resulting in increased ecological and environmental pressure. This approach is not conducive to sustainable land use. Since 2017, there has been a significant increase and stabilization in the score of the index for replanting arable land. The lowest score was obtained by the per capita area farmed by machines in 2017 and 2018. As scientific and technological advancements have progressed, mechanization has increasingly been utilized in agricultural production, resulting in a linear growth in the overall power rating of agricultural machinery per individual. Overall, the data indicates a positive trend of improvement. The land production sector experienced a slight decline this year, as compared to the preceding two years, resulting in the lowest score. The data exhibits an upward trend in the year 2020, accompanied by a generally fluctuating pattern. In 2020, the power usage per unit of GDP attained the lowest score. Despite maintaining a relatively stable score over the course of the previous five years, this particular indicator remains below average in comparison to other indicators. The data indicates a significant dependence on energy and power in the pursuit of agricultural progress, a circumstance that poses a challenge to the promotion of eco-friendly agricultural development. The trend of assessment scores for each Tier 2 indicator in the city of Mianyang displays a consistent upward trajectory overall. Furthermore, the score for agricultural film application intensity has reached its highest point in the past five years. Based on the relevant data, it can be inferred that Mianyang's agricultural sector has exhibited a positive shift towards environmental sustainability in the year 2020. Specifically, there has been a decrease in the utilization of pesticides and chemical fertilizers, while the quality of agricultural surface sources has shown consistent improvement. The total utilization rates of straw, livestock dung, and agricultural film were 97%, 97.99%, and 87.62%, respectively. The rate of equipment support for manure treatment systems in large-scale farms has attained a perfect score of 100%. In comparison to other metrics, the growth rate of economic development levels is frequently observed to be substantial. The economic development level score growth rate in the city of Mianyang has decreased in comparison to the previous year, and per capita expenditure on energy saving and environmental protection has also witnessed a significant decline. This can be attributed to the intricate development scenario, especially in the year 2020, when the outbreak of the COVID-19 pandemic had a substantial impact. The remaining indicators demonstrate comparatively subdued patterns of fluctuation and less pronounced shifts.

In recent years, the city of Mianyang has consistently pursued a trajectory of high-quality growth that is underpinned by a commitment to green development. The decision-making process in Mianyang has prioritized both high-quality industrial growth and environmental preservation, resulting in an optimal outcome. The objective is to expedite the establishment of a contemporary industrial system with Mianyang characteristics, denoted as "686", and to vigorously cultivate emerging industries that exhibit promising market potential, substantial developmental opportunities, and minimal resource utilization. The term "withdraw" serves as a potent incentive to expedite the process of industrial transformation and upgrading, while also substantially elevating the standards for environmentally sustainable development. Additionally, it facilitates the prompt elimination of obsolete production capabilities.

In order to analyze the differences between regions, the combined scores of Tier 2 indicators of agricultural green development for each county (city and district) in Mianyang are shown in Table 5.

Table 5. Comprehensive evaluation value of Tier 2 indicators for green agricultural development in Mianyang.

Tier 1 Indicators	Tier 2 Indicators	Mianyang	Peicheng District	Youxian District	Anzhou District	Santai County
Socioeconomic	Economic development level	0.1776	0.6161	0.2282	0.1176	0.0378
	Per capita disposable income of farmers	0.1079	0.1725	0.1276	0.1213	0.0987
	Labor productivity	0.1111	0.2273	0.0862	0.1154	0.1064
	Land productivity	0.0829	0.2254	0.0959	0.0942	0.0791
	Socioeconomic indicators score	0.4795	1.2413	0.5379	0.4485	0.3219
Technological Progress	Effective irrigated area of arable land per capita	0.1770	0.2388	0.3043	0.2197	0.1670
	Machine cultivation area per capita	0.0855	0.0894	0.1220	0.1069	0.0677
	Total power of agricultural machinery per capita	0.1006	0.2465	0.1961	0.1505	0.0244
	Science and technology progress index score	0.3632	0.5746	0.6223	0.4771	0.2591
Resource Environment	Per capita expenditure on energy conservation and environmental protection	0.1415	0.0741	0.0828	0.1866	0.0334
	Cultivated land replanting index	0.1128	0.0653	0.1039	0.1036	0.1004
	Agricultural diesel use intensity	0.1486	0.1180	0.2764	0.3080	0.1202
	Fertilizer application intensity	0.1422	0.0464	0.0991	0.1755	0.1781
	Pesticide application intensity	0.1286	0.1069	0.1044	0.1296	0.1732
	Intensity of agricultural film application	0.1934	0.0126	0.2833	0.3532	0.0215
	Energy consumption per unit of gdp	0.1828	0.2239	0.2387	0.0700	0.2397
	Electricity consumption per unit gdp	0.1091	0.1251	0.1192	0.0304	0.1369
	Resource and environment index score	1.1589	0.7724	1.3079	1.3571	1.0034
	Overall score	2.0016	2.5883	2.4681	2.2827	1.5844
	Order	6	1	2	4	10
Tier 1 Indicators	**Tier 2 Indicators**	**Yanting County**	**Zitong County**	**Beichuan County**	**Pingwu County**	**Jiangyou City**
Socioeconomic	Economic development level	0.0501	0.0965	0.0627	0.0670	0.1974
	Per capita disposable income of farmers	0.0947	0.0972	0.0527	0.0423	0.1254
	Labor productivity	0.1254	0.1598	0.0845	0.0461	0.0985
	Land productivity	0.0755	0.0733	0.0869	0.0100	0.0876
	Socioeconomic indicators score	0.3458	0.4268	0.2868	0.1654	0.5089
Technological Progress	Effective irrigated area of arable land per capita	0.1378	0.2192	0.0056	0.0234	0.2053
	Machine cultivation area per capita	0.0852	0.1166	0.0269	0.0561	0.1047
	Total power of agricultural machinery per capita	0.1129	0.1395	0.0308	0.0534	0.1672
	Science and technology progress index score	0.3359	0.4754	0.0633	0.1330	0.4772
Resource Environment	Per capita expenditure on energy conservation and environmental protection	0.0765	0.1066	0.3464	0.5533	0.1199
	Cultivated land replanting index	0.1264	0.1078	0.0787	0.1445	0.1408
	Agricultural diesel use intensity	0.1795	0.0247	0.2187	0.2219	0.0350
	Fertilizer application intensity	0.0253	0.1991	0.1799	0.2292	0.1131
	Pesticide application intensity	0.0724	0.1404	0.2131	0.2390	0.0148
	Intensity of agricultural film application	0.2540	0.3221	0.3393	0.3993	0.1414
	Energy consumption per unit of gdp	0.2419	0.2379	0.0713	0.2354	0.0350
	Electricity consumption per unit gdp	0.1492	0.1322	0.0627	0.0935	0.0673
	Resource and environment index score	1.1254	1.2709	1.5102	2.1161	0.6674
	Overall score	1.8070	2.1730	1.8603	2.4145	1.6535
	Order	8	5	7	3	9

This study employed ArcGIS 18.0 to evaluate the strength of agricultural green growth in the city of Mianyang. The assessment score was categorized into four tiers, as illustrated in Figure 1. The intensity of the color was used to indicate the magnitude of the score, with darker shades representing higher scores. Fucheng District, Youxian District, and Pingwu County have been classified as belonging to the highest tier. The primary contributing factor to the highest overall score achieved by Fucheng District is largely attributed to the elevated performance of its socioeconomic indicators. The Fucheng District has emerged as a key driver of economic development in Mianyang, having capitalized on significant strategic opportunities in recent times, including the establishment of the twin-city economic circle within the Chengdu–Chongqing region. The objective is to become one of the four leading entities in Mianyang with regards to scientific and technological innovation, industrial development, urban construction, and improvement of people's livelihood. Additionally, the aim is to fully execute the "Three Thousand Project" and expedite the establishment of "four strong areas" in science and education, as well as within the entire area, industry, and openness. The district was designated as the province's economic development district with a strong county focus, as well as the province's service industry district with a strong emphasis on the implementation of rural revitalization plans. These designations have effectively stimulated economic and social development within the district. The districts of Youxian and Pingwu exhibit the highest aggregate assessment value with regards to resource and environmental indicators. Since the implementation of the "13th Five-Year Plan," the Youxian District has been thoroughly implementing the "four key strategies for district development." The entity in question has diligently implemented the novel development ideology, and emerged victorious in the endeavor to mitigate and manage pollution. The rectification and reform of feedback issues from central and provincial ecological environmental protection inspectors and "look-back" have been completed with a high standard and quality. The implementation of decisions and deployments pertaining to the construction of ecological civilization by the central, provincial, and municipal governments has been fully executed. The organization has demonstrated remarkable accomplishments in various domains of its operations, including effective management of environmental pollution, consistent enhancement of ecological standards, and the promotion of sustainable development. In recent years, Pingwu County has implemented initiatives aimed at the preservation and advancement of ecological resources in order to ensure their safety. The implementation of green development initiatives promotes a culture of environmental sustainability. The objectives and requirements of agricultural green development have brought about significant structural transformations in Youxian District and Pingwu County.

The districts of Anzhou and Zitong are classified as second-tier regions, with complete assessment values of 2.2827 and 2.1730, respectively. These regions exhibit lower scores for socioeconomic indicators, while displaying higher scores for resource and environmental indicators. Anzhou District and Zitong County have faced significant challenges in ensuring a robust social welfare system in light of various complex domestic and international factors. These include the aging population, the COVID-19 pandemic, a challenging economic landscape, and sluggish fiscal revenue growth. In comparison to other nations, the socioeconomic indicators are comparatively unfavorable. However, it can be observed that Anzhou District and Zitong County have achieved greater success in preserving resources while promoting agricultural growth, resulting in a higher score for this particular indicator.

Beichuan and Yanting counties are classified as third-tier regions, with an aggregate assessment score that falls within the range of 1.6536 to 1.8603. The metric evaluating progress in scientific and technical domains demonstrated the least favorable outcome, whereas the metric assessing resources and environment exhibited the most favorable result. The Qiang Autonomous County located in Beichuan is characterized as an ethnic zone, which has resulted in economic underdevelopment, severe poverty, and economic backwardness. Simultaneously, it is noteworthy that Beichuan County exhibits the least developed science and technology advancement index in comparison to all other counties, cities, and districts within the Mianyang region. In recent times, Beichuan has vigorously executed the "green rising" strategy, leveraging the benefits of being a nationally significant ecological functional area and prioritizing the development of ecological civilization. The county of Yanting is actively implementing the ecological civilization thought of Xi Jinping, with a particular focus on the theme of "industrial salt, green first." The county is making full use of its ecological advantages and green wealth to consolidate and further develop the results of its ecological construction efforts, resource value, and environmental indicators, with the aim of improving its overall score.

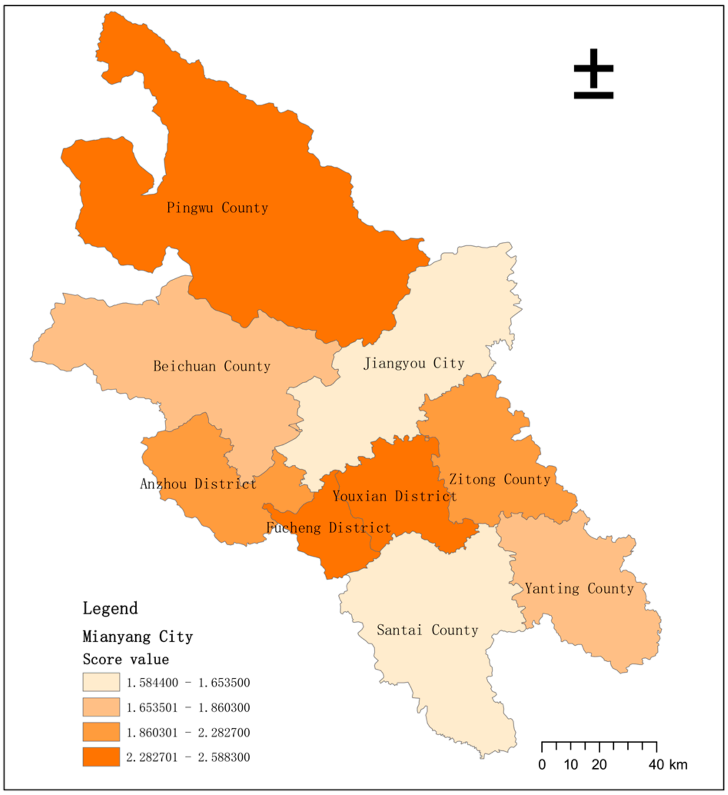

Figure 1. Comprehensive evaluation of agricultural green development in city of Mianyang, 2016–2020.

The overall strength of fourth-echelon agricultural green development in the city of Jiangyou and Santai County is considered to be weak. The primary cause is their inability to gain a competitive advantage over other counties, which can be attributed to their subpar performance on environmental and resource-related metrics. The economy of Jiangyou holds considerable importance in the broader context of Mianyang. However, the city's performance in terms of agricultural green development is suboptimal, as it tends to prioritize industrial economic benefits over agricultural green growth. Santai County's indicators exhibit a low level across the board. In recent years, Mianyang has achieved some success in mitigating pollution in agricultural production through the implementation of measures that restrict the utilization of chemical fertilizers and pesticides. Notwithstanding efforts to develop high-yield agricultural methods and the excessive application of chemical fertilizers and pesticides, the issue of surface pollution in agriculture remains a pressing concern. Despite the lack of statistical significance, this outcome can be attributed to the premature adoption of intensive farming techniques aimed at maximizing crop yields. Mianyang, being the sole city in China that is dedicated to science and technology, has not adequately supported the advancement of agricultural science and technology for the purpose of promoting green development in agriculture. Furthermore, the implementation and dissemination of agricultural green technology in the region is not yet fully developed.

The utilization of scientific and technological innovation to attain agricultural cost savings and enhance efficiency and income has yielded an unsatisfactory outcome.

5. Conclusions and Recommendations

After conducting an assessment and research on the ecological development of agriculture in Mianyang, it has been determined that the region has made significant strides in implementing the "dual control" system of total energy consumption and intensity, optimizing energy structure, planning industrial layout, improving energy resource utilization efficiency, accelerating comprehensive green transformation of the economy and society, and promoting ecological civilization construction and high-quality development. Nonetheless, there exist certain limitations. The present study has yielded the subsequent conclusions and recommendations in relation to this matter.

5.1. Conclusions

(1) The agricultural green development score of Mianyang exhibited an average increase of 16.11% per year, rising from 3.29 in 2016 to 4.92 in 2020. The data indicates that Mianyang has made significant progress in the realm of green agricultural development within the last five years, resulting in a more pronounced impact of said development. The assessment value of Mianyang's green agricultural development has exhibited a linear increase trend post 2018, indicating a positive trajectory for its development;

(2) Upon examining the level of agricultural green development in each county, city, and district, it becomes evident that there exists an uneven distribution in this domain. The varying factors that impact high and low scores demonstrate unequal characteristics. The overall assessment score of Fucheng District surpasses that of Santai County by a factor of 1.63. The Fucheng District has demonstrated significantly higher scores in socioeconomic, scientific, and technical growth indicators compared to Santai County, despite the latter exhibiting excellent scores for resources and the environment. The pressing issue at hand is the need to promptly address the challenge of narrowing the disparities among counties, cities, and districts, while simultaneously augmenting Mianyang's overall capacity for the advancement of sustainable agriculture;

(3) The assets of Mianyang Science and Technology City are underutilized, resulting in a lack of vitality in the development of science and technology in the field of agricultural green development. Agricultural production methods often incorporate a scientific and technological aspect that exhibits an inverse relationship with the environmentally advantageous green impact. The scientific and technical index scores of Santai County, Pingwu County, and Beichuan County were found to be lower than the average Mianyang county. This suggests that the role of agricultural science and technology in promoting sustainable agricultural development in these areas is not significant.

5.2. Recommendations

(1) It is recommended to implement the "two mountains" framework and pursue the path of environmentally sustainable modern agriculture.

In order to effectively promote the green growth of agriculture in the city of Mianyang, it is imperative to successfully implement the "two mountains" concept and cultivate the intrinsic motivation of agricultural production operators to embrace environmentally sustainable agricultural practices. The progress of modern agriculture and its eco-friendly counterpart are inherently interconnected, and the trajectory of scientific and environmental progress is continuously pursued. Attain an optimal equilibrium between agricultural productivity and ecological preservation. Through the integration of agricultural science and technology investment, financial investment, and policy support, our focus is on prioritizing environmental quality, agricultural resource protection, and ecological restoration. Our collaborative endeavors aim to advance the establishment of contemporary agricultural green industrial and production management systems, enhance green industrial structures, and achieve the integrated development of three industries. These efforts are geared towards enhancing the modernization of agricultural and rural communities, and ultimately achieving the overarching objective of "dual carbon";

(2) Formulate and execute tailored agricultural policies for green development based on contextual factors.

The level of agricultural green development in the counties, cities, and districts in the city of Mianyang is subject to variation, as are the factors that constrain such growth. These factors include endowment of resources, geographic location, level of economic development, and circumstances surrounding agricultural production. Consequently, it is imperative to devise and execute discrete agricultural green development tactics tailored to the specific regions based on their respective conditions. Beichuan County ought to prioritize the advancement of agricultural green technology development, while Pingwu County must endeavor to promote social and economic growth. The city of Jiangyou places significant emphasis on the advancement of resources and environmental protection. It offers increased support to regions that are lagging behind in three key areas: socioeconomic development, scientific and technological progress, and resource and environmental sustainability. This approach highlights the unique characteristics of agricultural green development;

(3) The strategy is to depend on advancements in science and technology, with a particular emphasis on the preservation of resources and the safeguarding of ecological environments.

Mianyang possesses a significant quantity of agricultural research institutions and scientific personnel. However, the progress of science and technology in promoting agricultural green development is sluggish, and its complete potential remains unrealized. The promotion of agricultural green development can be facilitated by relying on scientific and technical advancements. In order to translate scientific research discoveries into advantageous outcomes for agricultural green growth and tangible productivity, Mianyang must revamp its system and mechanisms for science and technology development. Additionally, it has the potential to enhance the vigor of scientific research subjects. Leveraging the strengths of Mianyang Science and Technology City, it is recommended that efforts be made to actively advance the development of green agricultural technology, enhance the utilization of agricultural machinery for cultivation and irrigation, facilitate the transformation and upgrading of agricultural mechanization, reinforce research and development as well as the promotion of agricultural equipment, enhance the agricultural technology promotion system, and expedite the dissemination of advanced and practical agricultural technology. The integration of government, industry, academia, research, and application can potentially enhance energy-saving and environmental protection expenditures, augment agricultural production efficiency, minimize agricultural surface pollution, decrease reliance on energy consumption in agricultural production, and actively advance the green development of agriculture.

Author Contributions: Conceptualization, C.C.; methodology, H.Z.; writing—original draft preparation, C.C. and H.Z.; writing—review and editing, C.C. and H.Z. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Natural Science Foundation of China (Project Numbers: 72003158).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Standardized data and weights for green development of agriculture in the city of Mianyang, 2016–2020.

Tier 1 Indicators	Weights	Tier 2 Indicators	Weights	Year	Mianyang City	Fucheng District	Youxian District	Anzhou District	Santai County
Socioeconomic	0.3215	Economic Development Level	0.1511	2020	0.3278	1.0000	0.4512	0.2295	0.1119
				2019	0.3027	0.9577	0.4218	0.2101	0.0939
				2018	0.2175	0.7991	0.2577	0.1385	0.0291
				2017	0.1835	0.7141	0.2196	0.1136	0.0147
				2016	0.1435	0.6053	0.1593	0.0857	0.0000
		Per capita disposable income of farmers	0.0476	2020	0.6790	1.0000	0.7778	0.7442	0.6305
				2019	0.5620	0.8567	0.6514	0.6229	0.5185
				2018	0.4401	0.7063	0.5201	0.4971	0.4022
				2017	0.3395	0.5856	0.4154	0.3900	0.3053
				2016	0.2463	0.4749	0.3158	0.2947	0.2167
		Labor productivity	0.0610	2020	0.5743	0.8976	0.3242	0.4997	0.5152
				2019	0.3744	0.8703	0.3483	0.3868	0.3651
				2018	0.3852	0.8265	0.3313	0.4381	0.3811
				2017	0.3549	0.7724	0.3045	0.4054	0.3515
				2016	0.1318	0.3603	0.1042	0.1620	0.1308
		Land productivity	0.0618	2020	0.3524	1.0000	0.3139	0.3558	0.2924
				2019	0.2527	0.6726	0.3330	0.2949	0.2557
				2018	0.2694	0.7367	0.3275	0.3474	0.2739
				2017	0.2562	0.7043	0.3124	0.3314	0.2609
				2016	0.2097	0.5307	0.2634	0.1926	0.1949
Technological Progress	0.1711	Effective irrigated area of arable land per capita	0.0681	2020	0.5499	0.9389	1.0000	0.6815	0.5035
				2019	0.5367	0.6744	0.9052	0.6723	0.5062
				2018	0.5223	0.6743	0.9006	0.6662	0.4906
				2017	0.5055	0.6409	0.8671	0.5665	0.4852
				2016	0.4847	0.5776	0.7949	0.6394	0.4663
		Area under machine cultivation per capita	0.0342	2020	0.6078	0.7888	1.0000	0.7167	0.4694
				2019	0.5671	0.5723	0.8429	0.6727	0.4557
				2018	0.5141	0.4853	0.7289	0.6494	0.4068
				2017	0.4451	0.4285	0.5711	0.5123	0.3653
				2016	0.3682	0.3397	0.4262	0.5780	0.2841

Table A1. *Cont.*

Tier 1 Indicators	Weights	Tier 2 Indicators	Weights	Year	Mianyang City	Fucheng District	Youxian District	Anzhou District	Santai County
		Total power of agricultural machinery per capita	0.0688	2020	0.3396	1.0000	0.6960	0.5017	0.1171
				2019	0.3206	0.6947	0.5974	0.4862	0.0000
				2018	0.2550	0.6789	0.5282	0.3782	0.0676
				2017	0.2865	0.6472	0.5566	0.3877	0.0926
				2016	0.2605	0.5613	0.4717	0.4333	0.0763
Resources Environment	0.5074	Per capita expenditure on energy conservation and environmental protection	0.1531	2020	0.2074	0.3121	0.2610	0.1122	0.0406
				2019	0.2430	0.0865	0.1608	0.4992	0.0406
				2018	0.1330	0.0000	0.0345	0.2378	0.0469
				2017	0.2127	0.0021	0.0453	0.2666	0.0889
				2016	0.1275	0.0829	0.0388	0.1025	0.0008
		Cultivated land replanting index	0.0339	2020	0.7594	0.4708	0.6909	0.6537	0.6930
				2019	0.7701	0.4652	0.6939	0.6606	0.6999
				2018	0.7770	0.4852	0.6963	0.6819	0.7003
				2017	0.7799	0.5052	0.6991	0.6835	0.7032
				2106	0.2412	0.0000	0.2859	0.3768	0.1656
		Agricultural diesel use intensity	0.0617	2020	0.4875	0.3988	0.8975	1.0000	0.3776
				2019	0.4825	0.4002	0.8982	0.9993	0.3793
				2018	0.4749	0.3710	0.8992	0.9971	0.3839
				2017	0.4765	0.3684	0.9001	0.9973	0.3851
				2016	0.4864	0.3734	0.8845	0.9986	0.4213
		Fertilizer application intensity	0.0493	2020	0.6521	0.3487	0.5517	0.7498	0.7887
				2019	0.6069	0.2526	0.4763	0.7266	0.7515
				2018	0.5673	0.1572	0.3930	0.6896	0.7135
				2017	0.5422	0.1214	0.3688	0.6865	0.6846
				2016	0.5179	0.0616	0.2217	0.7105	0.6766
		Pesticide application intensity	0.0480	2020	0.5852	0.5587	0.5747	0.5757	0.7529
				2019	0.5536	0.5051	0.4847	0.5363	0.7310
				2018	0.5244	0.4202	0.4113	0.5236	0.7158
				2017	0.5097	0.3806	0.3943	0.5206	0.7056
				2016	0.5041	0.3623	0.3091	0.5428	0.7018

Table A1. *Cont.*

Tier 1 Indicators	Weights	Tier 2 Indicators	Weights	Year	Mianyang City	Fucheng District	Youxian District	Anzhou District	Santai County
		Agricultural film application intensity	0.0806	2020	0.5590	0.0203	0.7087	0.8819	0.1552
				2019	0.5123	0.0142	0.6905	0.8771	0.0840
				2018	0.4905	0.0522	0.7082	0.8707	0.0108
				2017	0.4186	0.0356	0.7189	0.8702	0.0000
				2016	0.4182	0.0339	0.6879	0.8810	0.0159
		Energy consumption per unit of GDP	0.0505	2020	0.7367	0.8717	0.9694	0.4024	0.9614
				2019	0.7493	0.8853	0.9692	0.4902	0.9530
				2018	0.7298	0.8889	0.9419	0.4296	0.9472
				2017	0.7158	0.9030	0.9239	0.0629	0.9423
				2016	0.6849	0.8812	0.9185	0.0000	0.9398
		Electricity consumption per unit of GDP	0.0303	2020	0.7310	0.7516	0.8533	0.3289	0.9308
				2019	0.7484	0.8056	0.8457	0.3440	0.9152
				2018	0.7465	0.8762	0.7708	0.3012	0.8900
				2017	0.7040	0.8627	0.7255	0.0000	0.8983
				2016	0.6749	0.8366	0.7421	0.0307	0.8876
Tier 1 Indicators	**Weights**	**Tier 2 Indicators**	**Weights**	**Year**	**Yanting County**	**Zitong County**	**Pingwu County**	**Beichuan County**	**Jiangyou City**
Socioeconomic	0.3215	Economic development level	0.1511	2020	0.1375	0.1960	0.1478	0.1399	0.3199
				2019	0.1156	0.1714	0.1290	0.1217	0.2979
				2018	0.0423	0.1143	0.0669	0.0789	0.2690
				2017	0.0267	0.0891	0.0469	0.0619	0.2288
				2016	0.0090	0.0672	0.0238	0.0404	0.1902
		Per capita disposable income of farmers	0.0476	2020	0.6103	0.6231	0.4185	0.3658	0.7673
				2019	0.5011	0.5128	0.3195	0.2713	0.6430
				2018	0.3859	0.3959	0.2133	0.1698	0.5126
				2017	0.2898	0.2989	0.1203	0.0803	0.4058
				2016	0.2023	0.2109	0.0354	0.0000	0.3060
		Labor productivity	0.0610	2020	0.7185	1.0000	0.6105	0.3661	0.5239
				2019	0.3766	0.4846	0.2611	0.1374	0.3438
				2018	0.4216	0.4922	0.2383	0.1339	0.3360
				2017	0.3892	0.4554	0.2172	0.1182	0.3072
				2016	0.1498	0.1882	0.0576	0.0000	0.1033

Table A1. *Cont.*

Tier 1 Indicators	Weights	Tier 2 Indicators	Weights	Year	Mianyang City	Fucheng District	Youxian District	Anzhou District	Santai County
		Land productivity	0.0618	2020	0.3522	0.4133	0.4823	0.0929	0.3592
				2019	0.2037	0.1934	0.2651	0.0250	0.2653
				2018	0.2387	0.2020	0.2473	0.0246	0.2680
				2017	0.2271	0.1906	0.2354	0.0192	0.2541
				2016	0.1995	0.1848	0.1751	0.0000	0.2691
Technological Progress	0.171	Effective irrigated area of arable land per capita	0.0681	2020	0.4407	0.6735	0.0234	0.0797	0.6268
				2019	0.4204	0.6533	0.0206	0.0761	0.6117
				2018	0.4081	0.6451	0.0195	0.0723	0.6061
				2017	0.4002	0.6388	0.0176	0.0677	0.5947
				2016	0.3538	0.6082	0.0000	0.0479	0.5757
		Area under machine cultivation per capita	0.0342	2020	0.6154	0.8837	0.2735	0.4334	0.6482
				2019	0.5743	0.8012	0.2391	0.4108	0.6071
				2018	0.4886	0.6752	0.1454	0.3714	0.6741
				2017	0.4642	0.5729	0.1281	0.3877	0.5549
				2016	0.3501	0.4794	0.0000	0.0384	0.5803
		Total power of agricultural machinery per capita	0.0688	2020	0.3195	0.4789	0.1076	0.1643	0.5345
				2019	0.5885	0.4498	0.0986	0.1699	0.5144
				2018	0.2375	0.3148	0.0887	0.1535	0.4403
				2017	0.2641	0.4116	0.0854	0.1515	0.4890
				2016	0.2313	0.3725	0.0674	0.1368	0.4506
Resources Environment	0.5074	Per capita expenditure on energy conservation and environmental protection	0.1531	2020	0.2152	0.1995	0.3693	0.4106	0.1601
				2019	0.2023	0.0675	0.4023	0.7232	0.2772
				2018	0.0529	0.0641	0.4784	1.0000	0.0883
				2017	0.0172	0.1986	0.3937	0.8582	0.1543
				2016	0.0117	0.1659	0.6185	0.6211	0.1027
		Cultivated land replanting index	0.0339	2020	0.8241	0.7037	0.5497	0.9983	0.9616
				2019	0.8477	0.7377	0.5535	0.9993	0.9666
				2018	0.8705	0.7406	0.5585	1.0000	0.9684
				2017	0.8735	0.7522	0.5558	0.9953	0.9672
				2016	0.3134	0.2449	0.1044	0.2718	0.2906

Table A1. *Cont.*

Tier 1 Indicators	Weights	Tier 2 Indicators	Weights	Year	Mianyang City	Fucheng District	Youxian District	Anzhou District	Santai County
		Agricultural diesel use intensity	0.0617	2020	0.5904	0.0985	0.7471	0.7011	0.1610
				2019	0.5929	0.0919	0.7109	0.7040	0.1227
				2018	0.5719	0.0960	0.6954	0.7044	0.0964
				2017	0.5715	0.1137	0.6988	0.7074	0.0823
				2016	0.5817	0.0000	0.6918	0.7787	0.1049
		Fertilizer application intensity	0.0493	2020	0.1981	0.8616	0.8245	0.9298	0.5404
				2019	0.1557	0.8269	0.7552	0.9092	0.4865
				2018	0.1149	0.8102	0.7258	0.9037	0.4453
				2017	0.0440	0.8084	0.7030	0.9098	0.4224
				2016	0.0000	0.7340	0.6431	1.0000	0.4012
		Pesticide application intensity	0.0480	2020	0.3393	0.6256	0.9244	0.9947	0.1384
				2019	0.3176	0.5995	0.9059	0.9947	0.1049
				2018	0.2796	0.5811	0.9008	0.9947	0.0570
				2017	0.2782	0.5840	0.8605	0.9929	0.0081
				2016	0.2933	0.5343	0.8470	1.0000	0.0000
		Agricultural film application intensity	0.0806	2020	0.9513	0.8013	0.8718	0.9917	0.3891
				2019	0.8132	0.7957	0.8524	0.9890	0.3670
				2018	0.8010	0.8052	0.8543	0.9864	0.3521
				2017	0.2815	0.8101	0.8320	0.9858	0.3173
				2016	0.3039	0.7834	0.7981	1.0000	0.3281
		Energy consumption per unit of GDP	0.0505	2020	0.8827	0.9720	0.3863	0.9407	0.0916
				2019	0.9094	0.9693	0.3425	0.9402	0.1155
				2018	0.9966	0.9333	0.3169	0.9345	0.1500
				2017	0.9987	0.9194	0.2238	0.9223	0.1999
				2016	1.0000	0.9139	0.1413	0.9205	0.1347
		Electricity consumption per unit of GDP	0.0303	2020	0.9731	0.9211	0.4355	0.6463	0.4885
				2019	0.9817	0.9130	0.4531	0.6421	0.4921
				2018	0.9957	0.8745	0.4524	0.6389	0.4816
				2017	1.0000	0.8343	0.4116	0.5789	0.4259
				2016	0.9803	0.8255	0.3181	0.5821	0.3366

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