

Theoretical Basis and Level Evaluation of Tobacco Planting and Green Agriculture: a Case Study in Henan Province, China

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Objectives: As an important and traditional cash crop, tobacco plays an important role in promoting economic development. With the attention of the government, scholars and people from all walks of life to environmental protection, modern agriculture needs to be transformed. Under the current multiple pressures of resources, market, economy and other factors, how to find a high-efficiency, product safety, resource saving, environment-friendly agricultural modernization road is very important for the development of modern agriculture. Of course, tobacco planting is no exception. In view of this, this paper took China's Henan Province as an example to study its agricultural green development level and influenced factors from two angles at home and abroad. The results were showed as follows. Firstly, the green development of agriculture in Henan Province was still at the lower middle level in China. Secondly, there were some problems in the green development of agriculture in China's Henan Province. Finally, the green development of agriculture in Henan Province needs to promote the construction of laws and regulations and supervision system, increase the investment in agricultural human capital, accelerate the innovation of agricultural green science and technology, optimize industrial development and strengthen infrastructure construction according to local conditions. Further, based on the development experience of green agriculture, on the one hand, it can provide a good green agricultural production environment for the development of tobacco industry. On the other hand, it is conducive to inspire and promote the transformation and development of all links of tobacco planting, threshing and redrying, cigarette manufacturing, monopoly circulation and retail circulation, highlighting the characteristics of greening, technology, economy, health and safety.

Key words: green agriculture; entropy method; tobacco planting; environment friendly

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Lucid waters and lush mountains are invaluable assets. Environmental protection has always been the focus of the government, scholars and people from all walks of life. Although economic development is important, how to balance the relationship between economic development and environmental protection should not be underestimated. China is a country with a large population, but also an agricultural country. At the same time, China is also a large tobacco production and marketing country. With the continuous improvement of China's development concept, the implementation of agricultural supply side structural reform, and the improvement and reform of the corresponding management mechanism and system, China's agricultural production has achieved great development. However, under the current multiple pressures of resources, market, economy and other factors, how to find a high-efficiency, product safety, resource saving, environment-friendly agricultural modernization road is very important for the development of modern agriculture, in particular, specific industries, such as tobacco industry.

In fact, green development is imperative. The development of green agriculture could provide a green basis for tobacco planting, such as environmental protection concept, green planting technology, management and supervision mechanism. With the development of economy and technology, human beings are no longer subject to nature. At present, human beings try to transform, utilize and even dominate nature. However, the natural feedback makes people realize the importance of environmental protection. In addition, Green development of agriculture is also a hot issue for scholars all over the world. Specifically speaking, the main body of Chinese research has gradually changed from "agricultural sustainable development" to "agricultural green development", mainly focusing on product technology, development policy and method evaluation of agricultural green development; while the main body research in other countries always focused on "sustainable agriculture", mainly focusing on quantitative evaluation, driving analysis and

management system of agricultural sustainable development¹.

For example, in the related research of Chinese scholars on green agriculture, some scholars focused on the necessity²⁻³, development status and problems⁴ of green agriculture development, some scholars focused on green agricultural products⁵, green agricultural technology⁶, green water resources⁷, green mechanization⁸, etc., and some scholars studied the behavior and willingness of farmers⁹, enterprises¹⁰ and other innovative subjects participating in the development of green agriculture. In addition, some scholars were willing to carry out research on a certain region¹¹ to quantify the development level and regional differences of green agriculture¹².

In the related research of foreign scholars, some scholars combined with their own research fields to carry out research on sustainable agriculture from the perspectives of biochar¹³, nanofertilizer¹⁴, plant growth promoting rhizobacteria¹⁵, constraint based innovations¹⁶, green finance¹⁷, and green agricultural products¹⁸, some scholars had carried out empirical research on the development of green agriculture in a certain region¹⁹⁻²¹, and some scholars focused on the corresponding management mechanism, such as from the perspective of different regulation regions²² and organic grain cropping systems²³.

As for the related research of tobacco and tobacco planting, scholars focused on Planting technology and production technology²⁴, tobacco regulation²⁵, tobacco and health²⁶, tobacco product and its impact²⁷. However, it can not be ignored that there were relatively few studies on tobacco greening, although tobacco production has shown the demand and trend of greening.

The previous studies have drawn some important conclusions in promoting the development of modern agriculture. At the same time, the existing researches also laid a solid foundation for the development of our study. However, limited by the differences between the specific cultural environment and the natural environment in the region, the existing relevant studies mostly focus on the research of the development status of green agriculture, and there were relatively few quantitative studies, and the measurement of the development level of green

agriculture in the specific region was also relatively small.

In addition, as far as the research object, Henan Province is known as China's big granary, the development of agriculture in Henan Province is related to China's agricultural development and social stability. With the gradual implementation and deepening of the concept of green development, Henan Province has gradually improved its own level of green development. Of course, adhering to sustainable development and environmental protection also make the development of green agriculture an inevitable choice.

In fact, in the past, the "black agriculture" management mode, which highly depended on large-scale agricultural machinery, chemical fertilizer and pesticide, consumed a lot of non renewable energy, and caused soil loss, air pollution and water pollution. However, the development of green agriculture can fundamentally solve the above problems. Green agriculture, which is mainly based on "green environment", "green technology" and "green products", makes chemical agriculture and "black agriculture" which rely on fertilizer and pesticide excessively to ecological agriculture and green agriculture which mainly rely on the internal mechanism of biology. Developing green agriculture is a new requirement to adapt to the development of the world, and it is also an inevitable choice of agriculture in the development of the society.

However, what is the level of agricultural green development in Henan Province? Is it compatible with the overall development level of Henan Province? Is it suitable for the future agricultural development trend? Can it provide green environment and experience for tobacco planting, output, circulation and other links?

These problems are practical problems that we should consider in developing green agriculture and tobacco planting. Furthermore, under the dual constraints of environment and resources, whether the green development of agriculture in Henan Province can break through the bottleneck, break through the land use efficiency, backward

economic resources, rapid population growth, environmental damage and other obstacles? It is also very important for Henan Province to play the role of the central agricultural development province in the context of promoting the supply side structural reform in China. Therefore, it is of great practical significance to study the green development of agriculture and tobacco planting in Henan Province, which is conducive to promoting the green development of agriculture in Henan Province and radiating its driving effect.

In view of this, based on the background of the development of Chinese green agriculture, firstly, we analyzed the connotation of green agricultural development and the related theoretical basis. Secondly, this paper constructed the index system of agricultural green development in Henan Province from four aspects, such as, environment-friendly, resource saving, output efficiency and life security. And then, we measured the level of agriculture green development and analyzed the influencing factors. Finally, combining with the research conclusion, Suggestions were put forward to promote the green development of agriculture in Henan Province. Lay a green and environmental protection foundation for tobacco planting from the perspective of large-scale agricultural greening.

THEORETICAL BASIS

the Connotation of Agricultural Green Development

As we known, China has a large population. It is a miracle in the world that the problem of food and clothing for 1.4 billion people can be solved. At present, China's economic development has entered a new normal and new period. The reform of the agricultural supply side is deepening, and the supporting role of agricultural science and technology in agricultural production is becoming increasingly prominent. A multi-subject collaborative innovation mode appears in agricultural science and technology. However, agricultural production is still faced with many difficulties and constraints mentioned above. Based on this, new ideas and connotation of agricultural green development had been instilled and proposed.

(1) The basic characteristic of agricultural green development is to attach importance to resource conservation. For a long time, China's agriculture had high resource consumption, high cost, high overdraft

of resources, excessive land development, and poor awareness of resource conservation. In order to promote the green development of agriculture, it is necessary to rely on the improvement of the quality of workers and the innovation of science and technology to improve the land output rate, labor production rate, and resource conservation rate, so as to realize the cost saving and efficiency increasing and income saving of agriculture.

(2) The inherent attribute of agricultural green development is to pay attention to environmental friendliness. The development of agriculture and the friendliness of the environment are in harmony. As we known, paddy fields are constructed wetlands, vegetable gardens are constructed green spaces, and forest gardens are constructed hot gardens, all of which are the “lungs of ecology”. In recent years, with the rapid development of agriculture, there are also problems in the development of ecological environment. To promote the green development of agriculture, it is necessary to vigorously promote green production technology, so as to speed up the governance of prominent problems in the agricultural environment, so as to re-display the nature of green agriculture.

(3) The fundamental requirement of agricultural green development is to pay attention to ecological conservation. Landscape, forest, farmland and lake are a community of life. For a long time, China’s agricultural production mode is relatively extensive, and the structure of agricultural ecosystem is gradually unbalanced and its function is also degenerating. At this time, to promote the green development of agriculture is to accelerate the construction of ecological agriculture, and cultivate sustainable and recyclable development mode, so that agriculture will gradually become the ecological support of beautiful China.

(4) The important goal of agricultural green development is to attach importance to product quality. We should place more emphasis on the supply of green and high-quality agricultural products. Nowadays, in terms of the supply of agricultural products, the number of high-quality brands is relatively small, which does not meet the requirements of the rapid upgrading of the consumption structure of urban and rural residents. To promote the green development of

agriculture is to increase the quality of agricultural products. The supply of safe and characteristic agricultural products can promote the transformation of the supply of agricultural products from mainly meeting the demand of “quantity” to paying more attention to the demand of “quality”.

Construction Principles of the Index System

In order to make the index system scientific and standardized, the following principles should be followed when constructing the index system.

(1) the scientific principle. That is, it should not only be based on its own law of agricultural green development, but also objectively and truly reflect the agricultural green development level of Henan Province and other major grain producing provinces.

(2) the principle of feasibility. The data required for the indicators are available from the official statistical yearbook, official department websites, announcements, or survey data. The data can be obtained, which is helpful to provide convenience for the quantification of the follow-up agricultural green development level.

(3) the comprehensive principle. That is, the index system should not only reflect the characteristics and current situation of the main grain producing areas in the period of agricultural green transformation, but also reflect their development trend.

(4) the principle of pertinence. That is, the index system should be able to reflect the main essential characteristics of the agricultural system of the main grain producing areas as an organic whole.

Two Mountain Theory

In August 2005, “clear waters and green mountains are mountains of gold and silver” had been put forward. After continuous development, “two mountain theory” was formed. “We need both clear waters and green mountains, and golden and silver mountains. It's better to have clear water and green hills than golden and silver mountains, and clear water and green hills are golden and silver mountains”, which provides principles and directions for agricultural green development, and points out the path for the transformation of agricultural development mode. It is an important theoretical guidance for promoting agricultural green development in the new era, and also the theoretical basis for constructing the evaluation index system of agricultural green development.

The theory of “two mountains” requires that saving resources and protecting environment should be

integrated into the whole process of agricultural green development. Therefore, the evaluation of agricultural green development must be based on the “two mountain theory”. It should not only save resources, reduce the application intensity of pesticides and chemical fertilizers and the use intensity of agricultural film, but also take into account the quantity and quality of output, increase the supply of green agricultural products, and then improve farmers' income and protect their lives.

On the basis of “two mountains theory”, sustainable development theory and circular economy theory are also essential. Only by integrating the existing resources, meeting the requirements of ecological development, meeting the needs of contemporary people, and leaving enough resources for future generations, can the ecosystem develop for a long time. Similarly, the green development of agriculture needs the theory of “two mountains” to balance the ecological problems of environmental protection, and the theory of sustainable development and circular economy to ensure the sustainable, green and healthy development of modern agriculture.

Determination of Index System

Based on the research purpose and the availability of data, we mainly constructed the index system of agricultural green development in Henan Province from four aspects. Such as, resource conservation, environment friendly, output efficiency and living security, as shown in Table 1.

(1) Indicators of resource conservation. Resource conservation is the basic feature of green agricultural development. It emphasizes the utilization rate of cultivated land, water resources, agricultural machinery and power resources and the improvement of labor productivity, especially the utilization rate of cultivated land and water resources, because the area of cultivated land and the amount of water resources are the important factors affecting the yield of agricultural products. In this paper, three specific indexes of effective irrigation area, soil erosion control area and total power of agricultural machinery were selected to evaluate the resource conservation status of agricultural green development in major grain-producing areas.

(2) Environmental friendly indicators. The nature of environmental friendliness is the harmony and unity of agricultural development and resource and environmental protection, as well as the harmony and unity of the quantity and quality benefits of agricultural development, which emphasizes the protection of the resource base of agricultural production. Based on the characteristics of agricultural production, the environmental friendliness of agricultural green development was quantified by selecting four indexes, including the amount of plastic film, agricultural diesel oil, pesticide and agricultural chemical fertilizer, in order to improve the level of agricultural green development from the perspectives of pesticide, chemical fertilizer and agricultural film.

(3) Output efficiency index. Output efficiency is the direct goal of agricultural green development. This indicator requires both quantity and quality of output, that is, the trend of agricultural development is not only to pursue the quantity benefit of agriculture, but

Table 1
Index System of Agricultural Green Development in Henan Province

Index	Classification
Resource conservation	Effective irrigation area
	Soil erosion control area
	Total power of agricultural machinery
Environment friendly	Usage of plastic film
	Consumption of agricultural diesel oil
	Pesticide usage
	Net amount of agricultural chemical fertilizer
Output efficiency	Grain yield per unit area
	Grain output per capita
Living security	Per capita net income of farmers

Note.

The specific data and units of the above indicators were showed in the attached tables.

to gradually develop to high quality, relying on quality and green agriculture to solve the contradiction between people's increasing demand for high quality and safe agricultural products and the insufficient supply of agricultural production. Therefore, two indexes of grain yield per unit area and grain yield per capita were selected to evaluate the quantity, quality and efficiency of agricultural green output in major grain-producing areas.

(4) Indicators of living security. The green development of agriculture is not only to meet people's demand for high-quality and safe agricultural products, but also to meet the demand for food and clothing and the improvement of material living standards. If farmers' income can be increased and their happy life can be guaranteed through green agricultural development, farmers will be more active in participating in green agricultural development. Therefore, we chose farmers' per capita net income to reflect the life security index of green agricultural development in Henan Province.

METHODS

Data sources

The indicators and the original data in this paper were from the "China Rural Statistical Yearbook" and "Henan Statistical Yearbook" from 2009 to 2018, as well as the official data published by the National Bureau of statistics. Considering the principle of timeliness and feasibility of data, the source data was the data of the latest ten years given by the National Bureau of statistics. Although some data could be traced back to 2019 or 2020, the data was less scientific, so it was not used.

Research methods

Entropy method has the characteristics of weakening subjective factors and fully highlighting the advantages of fuzzy comprehensive evaluation, so it is widely used in evaluation models, and the method is relatively mature. The entropy evaluation model of this paper was as follows,

(1) Setting indicators. There were 13 provinces, 10 years and 10 indicators in entropy method. In vertical comparison, M was the year, while in horizontal comparison, M was the province.

(2) Data non negative processing. Because there was no negative data in this paper, there was no need for non negative processing, and because this paper used the ratio of a certain index to the total of the same index, there was no need for standardized processing.

(3) Determine the proportion of each index. Where $j = 1, 2, \dots, m$, $i = 1, 2, \dots, n$, j was the attribute and i was the scheme.

$$P_{ij} = X_{ij} / \sum_{i=1}^n X_{ij} \quad (1)$$

(4) Calculating the entropy of the index. Where k is a constant and $K = 1$,

$$e_j = -k \times \sum_{i=1}^n P_{ij} \log (P_{ij}) \quad (2)$$

(5) Calculating the weight value of each index. Where $g = 1 - e$, the larger g was, the more important the index was.

$$W_j = g_j / \sum_{j=1}^m g_j \quad (3)$$

(6) Calculating the score of each index.

$$S_i = \sum_{j=1}^m W_j \times P_{ij} \quad (4)$$

Measures

Development level of green agriculture in Henan Province

Based on the above entropy method calculation model and formula 1-4, we calculated the agricultural green development index of Henan Province, and the results were shown in table 2.

Table 2 showed the ranking of four dimensions of green agriculture development in Henan from 2009 to 2018. In particular, according to the relationship between each sub-index and the level of agricultural green development, it is generally believed that the lower the four sub-indexes of environmental friendly factors, the better the level of agricultural green development; the higher the ranking of other factors, the more conducive to the green development of agriculture.

According to the analysis of Table 2, the level of agricultural green development in Henan Province had a good development momentum in research years, among which the output efficiency and living security had reached the highest level in research period, and the other indicators had also been ranked relatively high in 2018. Such as, the effective irrigation area,

agricultural diesel use amount and pesticide use amount. However, the area of soil er

Table 2
The Ranking of Influencing Factors of Agricultural Green Development in Henan Province

Year	Effective irrigation area	Soil erosion control area	Total power of agricultural machinery	Consumption of plastic film	Consumption of agricultural diesel oil	Pesticide usage	Net amount of agricultural chemical fertilizer	Grain yield per unit area	Grain output per capita	Net income per capita
2018	1	5	6	7	10	10	6	1	1	1
2017	2	6	8	5	7	9	3	2	4	2
2016	3	7	9	3	4	6	2	4	3	3
2015	4	8	1	4	2	3	1	3	2	4
2014	7	9	2	2	1	2	4	7	5	7
2013	10	10	3	1	3	1	5	6	6	10
2012	5	1	4	6	5	5	7	5	7	5
2011	6	4	5	8	6	3	8	8	8	6
2010	8	3	7	9	8	7	9	10	9	8
2009	9	2	10	10	9	8	10	9	10	9

Note.

The specific raw data and units of the above indicators were showed in the attached tables.

erosion control, total power of agricultural machinery, plastic film usage amount and the

Agricultural green development level in major grain producing areas in China

Besides Henan Province, China's major grain producing areas include Hebei Province, Liaoning Province, Heilongjiang Province, Jilin Province, Inner Mongolia, Jiangsu Province, Jiangxi Province, Anhui Province, Shandong Province, Hubei Province, Hunan Province and Sichuan Province. According to the formula and model above, we calculated the green agriculture development level of 13 major grain producing areas in China, as shown in table 3. In particular, in order to keep the research cycle consistent, and considering the availability and integrity of data, we only calculated the green agriculture development factors of 13 major grain producing areas in 2018.

According to the analysis of table 3, compared with other major grain producing areas, in terms of resource saving index, except for the index of soil erosion control area, Henan Province has a good performance in agricultural green development, with the effective irrigation area and the total power of agricultural machinery ranking second.

refraction amount of agricultural chemical fertilizer application were in the medium level.

In terms of environmental friendly indicators, except for the use of agricultural diesel ranked fifth, which was generally at the lower level, the other indicators ranked relatively low, which showed that there was still a lot of room for improvement in the environmental friendly aspect of agricultural green development in Henan Province. In terms of living security, that is, per capita net income, the ranking was also relatively backward. In the aspect of output efficiency, the agricultural green development of Henan Province was in the middle level, and the corresponding per capita grain output and grain yield per unit area were in the fourth and sixth place respectively.

Analysis

Combined with the calculation of quantitative analysis, in order to maintain the consistency of research and analysis paradigm, this section will deeply discuss the level and causes of agricultural green development in Henan Province from the vertical and horizontal perspectives.

Vertical analysis

(1) Level of resource conservation

Table 3
The Ranking of Agricultural Green Development Factors in 13 Major Grain Producing Areas in China (2018)

Province	Effective irrigation area	Soil erosion control area	Total power of agricultural machinery	Consumption of plastic film	Consumption of agricultural diesel oil	Pesticide usage	Net amount of agricultural chemical fertilizer	Grain yield per unit area	Grain output per capita	Net income per capita
Hebei	5	5	3	6	1	9	3	9	8	11
Inner Mongolia	7	1	10	8	6	13	11	13	2	13
Liaoning	13	6	13	4	10	10	12	5	7	4
Jilin	12	11	11	12	8	12	10	2	3	9
Heilongjiang	1	7	6	10	3	7	7	12	1	8
Jiangsu	6	13	7	5	4	8	6	1	11	1
Anhui	4	12	4	7	7	5	4	11	5	7
Jiangxi	11	4	12	13	13	6	13	7	10	5
Shandong	3	8	1	1	2	1	2	4	6	2
Henan	2	9	2	2	5	3	1	6	4	12
Hubei	10	3	9	11	9	4	5	8	9	3
Hunan	8	10	5	9	12	2	8	3	12	6
Sichuan	9	2	8	3	11	11	9	10	13	10

Note.

The specific raw data and units of the above indicators were showed in the attached tables.

According to the index system mentioned above, the level of resource conservation was mainly reflected by three sub-indexes: effective irrigation area, soil erosion control area and total power of

agricultural machinery, and the three indicators were all positive indicators.

In terms of effective irrigation area, the effective irrigation area has been rising since 2009. In 2013, Henan Province has poor effect on effective

irrigation area, ranking only 10th. However, it has grown rapidly after 2013, and the growth status has been relatively stable until 2015. This was mainly due to the fact that Henan Province has increased 6.1 million mu of high-efficiency agricultural water-saving irrigation area for further promoting the construction of agricultural water-saving projects since 2012. The effective utilization coefficient of agricultural irrigation water has been constantly improving, which has steadily improved since 2013 in Henan Province.

In terms of soil and water loss control area, soil and water loss control has always been the focus of agricultural development in Henan Province. Since 2013, the management of water loss and soil erosion control area had been increasing, but in general, the control amount of soil and water loss area in Henan Province in recent years was not as good as that from 2009 to 2012. On the one hand, it may be because the control area of soil and water loss was relatively large in the initial stage. On the other hand, it may be that there were relatively more land rivers with low control difficulty. With the completion of the governance of the less difficult, the speed has gradually decreased. In recent years, affected by the national policy and the improvement of control technology, the speed of soil erosion control in Henan Province has been gradually accelerated.

According to the statistics of Henan Provincial Department of water resources, by the end of 2017, the province has controlled and controlled the soil erosion area of 40300 square kilometers, built 1.36 million small comprehensive reservoirs and soil conservation facilities, such as dams, Gufang, Shuijiao, etc., transformed more than 300000 mu of sloping farmland, and more than 60% of the whole soil erosion control area has been effectively controlled. At present, soil and water conservation in Henan Province pays attention to ecological construction, from the people's self-reliance and decentralized investment management to the local government's scale management, from the protection management to the ecological management, slope land turns into green terraces, barren mountains are covered with green clothes, and the overall control effect is relatively significant.

In terms of the total power of agricultural machinery, agricultural machinery is an important tool to carry out agricultural activities. The total

power of agricultural machinery can reflect the level of resource conservation. Since 2009, the total power of agricultural machinery in Henan Province has changed in "N" shape. From 2009 to 2015, the total power of agricultural machinery increased steadily, rising from the 10th place in 2009 to the first place in 2015. From 2015 to 2016, the index dropped from the first to the ninth. In 2016—2018, it steadily increased from 9th place in 2016 to 6th place in 2018. From the actual data of the total power of agricultural machinery, the difference between the 10th year in 2009 and the best year in 2015 was only 1892.24. In fact, the overall fluctuation trend did not mean the decline of production capacity. The possible reason was that, on the one hand, the old machinery and equipment that pollute the environment and consume too much energy were eliminated. On the other hand, the production of agricultural machinery was more standardized and intelligent. Although the total power was declining in stages, the actual production capacity has been improving.

On the whole, the three aspects of effective irrigation area, soil erosion control area and the total power of agricultural machinery summarize the achievements of green agricultural development in Henan Province in terms of resource conservation during the research period. Agricultural green development in Henan Province has made progress in resource conservation during the research period. The effective irrigated area ranked first in 2018, and the soil erosion control area improved despite the increasing difficulty in control. Although the total power of agricultural machinery fluctuated, it also continued to increase since 2016.

(2) Environmentally friendly level

As the above index system design, environmental friendliness mainly depends on the use of plastic film, agricultural diesel, pesticide and agricultural chemical fertilizer application of four indexes, all of which are negative indicators.

In terms of the amount of plastic film, the use of plastic film was on the rise. In 2009, the use of plastic film was 141354 tons, and in 2018, it increased to 152838 tons, with the highest point of 167794 tons in 2013. The study found that in 2013, the orchard area of Henan Province was 47719 thousand hectares, which was the highest in Henan in research period, and the melon and fruit area

was 309.75 thousand hectares, It was also relatively high in Henan Province in research period. These two factors had become important factors affecting the use of plastic film. With the continuous adjustment of agricultural development strategy in Henan Province, the use of plastic film will also be reduced. At the same time, with the development of science and technology, the research on degradable film has a considerable impact on the ground laying film.

In terms of agricultural diesel oil, agricultural diesel mainly refers to the diesel used for tractors and irrigation and drainage diesel engines. The consumption of agricultural diesel oil in Henan Province reached the lowest point in 2018, which was 1039200 tons. Taking 2014 as the node, the consumption of agricultural diesel oil continued to increase from 2019 to 2014, and achieved four consecutive drops from 2014 to 2018, among which the consumption of agricultural diesel oil reached the lowest level in a decade in 2018, According to the number of tractors and irrigation diesel engines in Henan Province, we found that in 2018, the number of large and medium tractors in Henan Province was 353481, which was in the middle position from 2009 to 2018, the number of small tractors was 3184500, which ranked ninth from 2009 to 2018, and the number of agricultural irrigation diesel engines had been declining from 2009 to 2018, The reason why the agricultural diesel oil in Henan Province reached the lowest level in 2018 was mainly due to the decrease in the number of small tractors and agricultural drainage and irrigation diesel engines.

In terms of pesticide use, the amount of pesticide use in Henan Province also reached the lowest level in 2018, only 113600 tons. From 2009 to 2013, the amount of pesticide use in Henan Province was unstable, but it was generally on the rise. From 2013 to 2018, the amount of pesticide use in Henan province gradually decreased, from the highest of 130100 tons in 2013 to 113600 tons. Although the use of pesticides in Henan Province reached the lowest level in 2018, the use of pesticides in Henan Province was still an important factor hindering the green development of agriculture in Henan Province. Moreover, the warm winter phenomenon caused by spring drought and autumn flood in Central China has promoted the occurrence of diseases and insect pests in Henan Province, so the management of

diseases and insect pests in Henan Province is urgent.

In terms of the net amount of agricultural chemical fertilizer, in 2018, the net amount of agricultural chemical fertilizer in Henan Province was 6.9279 million tons, ranking sixth. Since 2014, the net amount of agricultural chemical fertilizer has been improved and decreased year by year. However, from 2009 to 2014, the situation was very severe, and the intensity of agricultural chemical fertilizer application gradually increased, followed by the net amount of agricultural chemical fertilizer application gradually increased. In 2018, the net amount of agricultural chemical fertilizer application reached the highest in China, and the application of agricultural chemical fertilizer is also an important part of the agricultural green development road in Henan Province.

On the whole, Henan Province had achieved good results in environmental friendly efforts, and all factors had achieved good results in 2018. However, for the whole country, Henan Province was still lacking in environmental friendly aspects, ranking relatively low. Environmental friendly was a roadblock on the road of agricultural green development in Henan Province.

(3) Output efficiency and living security level

The output efficiency mainly depends on grain yield per unit area and grain output per capita. What is more, we used per capita net income of farmers to measure the living security level, both of which are positive indicators.

In terms of Output efficiency level, as for grain yield per unit area, Henan Province had a good development momentum in the research period. The per unit grain yield rose from 5567.77 in 2009 to 6096.52 in 2018. However, on the ranking of agricultural green development level in Henan Province, the index showed an overall upward trend and fluctuating from time to time. In 2018, it reached the best level in the research period, ranking first. The order of grain yield per capita was similar to grain yield unit area. In 2018, it reached the highest level, but the growth was relatively stable. From 2009 to 2015, it increased year by year with a good momentum. From 2015 to 2017, it declined, but in 2018, it picked up in time and stabilized its output. In short, in terms of comprehensive output efficiency, Henan Province had made good progress in research years. The

grain output per unit area and per capita grain output had reached the highest in the past decade.

In terms of living security, agriculture in Henan Province had developed rapidly, and the per capita net income of farmers had generally shown an upward trend. There was a small fluctuation in 2016 and 2017, while the other years showed an increasing trend year by year. In 2018, it reached 12,719.18 yuan. However, restricted by the large population base of Henan Province, although it was increasing year by year, the development level was still in a particularly backward position in the whole country. Under the special environment of Henan Province, how to turn the large number of agricultural population into advantages had become an important link in the agricultural development of Henan Province.

Horizontal analysis

In order to further analyze the level of agricultural green development in Henan Province, we calculated the factor order of agricultural green development level of 13 major grain producing areas in China. We attempted to analyze the level of agricultural green development in Henan Province from a horizontal perspective on the basis of the previous vertical time series analysis. The specific results were shown in Table 3 above.

The level of agricultural green development in Henan Province was relatively low for other major grain producing areas in China. Comparative analysis of table 3, it showed that the level of agricultural green development in Henan Province was relatively advanced in terms of resource conservation, and performs better. However, in the aspect of environmental friendliness, Henan Province was relatively low, and in the aspect of output efficiency, it was in the middle position. Restricted by the situation of large population base in Henan Province, in the aspect of life security, that is, per capita net income, Henan Province was relatively low, ranking only 12.

Specifically, the environmental friendly factors were the most influential factors for the agricultural green development in Henan Province, among which the use of plastic film ranked second, the use of agricultural diesel ranked fifth, the use of pesticides ranked third, and the net amount of agricultural fertilizer ranked first. It is necessary to solve the environmental friendly problems of

agricultural green development. For example, Henan Province needed to constantly improve the green agriculture development policy mechanism to guide the development of green agriculture.

And then, In view of the factors affecting the development of green agriculture in Henan Province, we should improve the environment-friendly agriculture, such as choosing degradable agricultural film, standardizing the use of fertilizers and pesticides, and finally improving the use of tractors and irrigation machines. For the problems of living security, it was mainly due to the population base of Henan Province. In view of this, it was very important for Henan Province to solve the relationship between population and agriculture, and how to use the dividend of population for agricultural development.

RESULTS

The analysis showed that the level of agricultural green in Henan Province was on the rise with time fluctuation. From 2009 to 2010, the green development of agriculture in Henan Province was in a moderate range, and the environment of producing area was in a relatively good state. At this time, the green development level of agriculture in Henan Province was mainly driven by resource utilization and environmental factors of producing area. From 2011 to 2013, the level of agricultural green development in Henan Province was relatively poor.

At this time, the agricultural green development in Henan Province was in a disordered development stage. The agricultural resources in Henan Province were over invested, the environment of producing area was damaged, and the green atmosphere had not formed. Although the economic benefits had improved at this time, the level of green development was relatively poor. From 2014 to 2018, the green development of agriculture in Henan Province was in a stage of rapid development. The government was aware of the decline of green development of agriculture, and had taken effective measures to actively correct the problems of excessive investment of agricultural materials in green development of agriculture in Henan Province. At the same time, it had increased the environmental construction of the land and strengthened the cultivation of green atmosphere, So as to promote the rapid improvement of green development level.

From the analysis of influencing factors, the use of plastic agricultural film, the use of agricultural diesel oil, the amount of pesticide and the amount of pure agricultural fertilizer were all the factors that had a great influence on the green development of agriculture. Effective irrigation area, soil erosion control area and total power of agricultural machinery also had a positive impact on agricultural green development in Henan Province. In the future, Henan Province should continue to maintain a good momentum of development, be down-to-earth, analyze the main influencing factors, seize the development opportunities of the times, combine the willingness of agricultural employees with the development of the country, actively learn the measures of areas with higher green development level, make contributions to Henan Province according to local conditions, and grasp the main focus, Let the level of agricultural green development in Henan Province be improved.

DISCUSSIONS

Based on the previous calculation and analysis, we found that there were some problems of agricultural green development in Henan Province. Such as, not optimistic environment friendly situation, insufficient technical support for green production, low economic efficiency of agricultural development. So we put forward countermeasures and suggestions.

Firstly, we should improve the mechanism of policies and regulations. Such as, the government departments of Henan Province could issue relevant laws and regulations to promote the green development of agriculture as soon as possible, and realize the transformation of relevant laws and regulations from scratch. We should try to standardize the green development of agriculture in Henan Province to save the cost of green development of agriculture. Of course, it could not be ignored that standardization should be combined with the principle of applicability and pay attention to the regional characteristics of agriculture. At the same time, we should strengthen environmental protection and supervision.

Secondly, we would increase investment in agricultural human capital. As the primary industry, agriculture has economic function, social function and ecological function. The most important social and economic function is to provide employment

opportunities for a large number of labor force. The production and development of modern agriculture can provide high-quality agricultural products, maintain farmers' life, and lay the foundation for the reserve and economy of the secondary and tertiary industries. Compared with the development of secondary and tertiary industries, the employment labor cost of modern agriculture is relatively low, the contribution is larger, and the advantages are obvious. To speed up the development of modern agriculture, we should increase the employment quantity of modern agricultural labor force in various forms, levels and channels, and expand the employment space of labor force.

Thirdly, we should accelerate the innovation of agricultural green science and technology. We should increase policy support and strength for modern agricultural intelligent technology and innovation, and improve investment in modern agricultural intelligent production technology and total factor agricultural comprehensive productivity. We can give policy support to vigorously develop the equipment and technology of intelligent agriculture and breeding, the intelligent production equipment and management technology of modern agriculture, intelligent water-saving, low-carbon and energy-saving machinery and equipment.

Fourthly, we would optimize industrial development according to local conditions. Many cities and regions in Henan Province had gradually formed a part of standardized agricultural industrial clusters with origin and local cultural characteristics from their own environmental needs. At present, in order to meet the requirements of the national, provincial, municipal and county levels for the standardization of agricultural bases, Henan Province had constructed a number of 581 standardized agricultural demonstration bases and agricultural projects, including 69 national standardized demonstration agricultural bases, 183 provincial standardized demonstration agricultural bases and 329 municipal and county standardized demonstration agricultural bases.

Fifthly, we should strengthen the construction of agricultural infrastructure. One of the important goals and tasks of the modernization of agricultural infrastructure was to accelerate the modernization of modern agricultural production infrastructure, which focused on the construction of water

conservancy and the circulation network of agricultural products. We should further increase the investment in agriculture, accelerate the pace of agricultural infrastructure modernization, and improve the comprehensive production capacity of modern agriculture as soon as possible, so as to better achieve and improve the long-term weak situation of modern agricultural infrastructure. At present, we should start from three aspects: water conservancy, agricultural mechanization and agricultural forecast information system.

Finally, we should change the concept of consumption and development and strengthen the publicity of agricultural green production and green consumption concept, guide consumers to develop green consumption concept, and guide consumers' green consumption behavior in combination with agricultural green tourism and leisure functions. Such as, we can formulate and implement the overall plan for agricultural green production and development in urban areas, focus on the construction and development of a number of green tourism and leisure industries as well as urban ecological planting and breeding industries, and actively develop a number of new urban ecological agriculture suitable for agricultural development in urban areas at the edge of cities, such as Taihang Mountain, Funiu Mountain, Dabie Mountains and the nearby Yellow River beach, and other areas actively build and develop green agriculture and tourism in urban areas, and build large-scale tourism areas.

Further, although there were few studies on tobacco green planting, based on the above research method, result and the suggestion to development experience of green agriculture, we could promote the development of tobacco green planting from the theoretical level. on the one hand, the above research could provide a good green agricultural production environment for the development of tobacco industry. On the other hand, it is conducive to inspire and promote the transformation and development of all links of tobacco planting, threshing and redrying, cigarette manufacturing, monopoly circulation and retail circulation, highlighting the characteristics of greening, technology, economy, health and safety.

Study Innovations and Limitations

There were some innovations in the research perspective. Taking Henan Province as an example, this paper made a regional study to analyze the development level and influencing factors of green agriculture from a micro perspective. Based on the background of the development of Chinese green agriculture, firstly, we analyzed the connotation of green agricultural development and the related theory. Secondly, this paper constructed the index system of agricultural green development in Henan Province from four aspects, such as, environment-friendly, resource saving, output efficiency and life security. And then, we measured the level of agriculture green development and analyzed the influencing factors. Finally, combining with the research conclusion, Suggestions were put forward to promote the green development of agriculture in Henan Province. As for the research methods, we expanded the application field of research methods from the application of research methods, reflecting the application innovation of research methods. We tried to promote the tobacco green planting based on the green level of modern agriculture.

However, we also had some shortcomings, such as research methods and data. In terms of research methods, compared with other evaluation methods, the entropy method has obvious advantages. However, due to the subjectivity of the index system, the entropy method based on the index system may affect the effect and accuracy of the application of research methods. In the future, we will strive to explore more suitable research methods on the basis of continuously improving the index system. In terms of data, subject to the timeliness and availability of data updates, and considering the impact of COVID-19, our field research has received certain restrictions. In the future, we will continue to update the research data, conduct field research, and conduct in-depth research on China's agricultural green development from a more micro perspective. In particular, we would apply the whole research paradigm to the green development of tobacco planting, rather than taking the green development of agriculture as the environmental guidance and constraint.

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Author Contributions

Chen Qiqi made substantial contributions to the conception and design of the study, acquisition of data and the analysis and interpretation of the data, and gave some constructive suggestions to modify and improve the article. Wang Jianghua modified the language expression of some views. Su Yufeng collected data, participated in empirical research. All the authors gave final approved of the version to be published.

Author Declaration

This research is not funded by any organization related to tobacco production.

Conflicts of Interest

The authors declare no conflict of interest.

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Rural Statistical Yearbook” and “Henan Statistical Yearbook” from 2009 to 2018, as well as the official data published by the National Bureau of statistics. Considering the principle of timeliness and feasibility of data, the source data was the data of the latest ten years given by the National Bureau of statistics. Although some data could be traced back to 2019 and 2020, the data was less scientific, so it was not used.

We mainly constructed the index system of agricultural green development in Henan Province from four aspects. Such as, resource conservation including effective irrigation area, soil erosion control area and total power of agricultural machinery, environment friendly consisting of usage of plastic film, consumption of agricultural diesel oil, pesticide usage and net amount of agricultural chemical fertilizer, output efficiency containing grain yield per unit area and grain output per capita, and living security measuring by per capita net income of farmers.

In terms of vertical analysis, the research time was from 2009 to 2018, and in terms of horizontal analysis, it was based on the comparative analysis of 13 major grain producing areas in China. Among them, the original data of the key data tables were shown in Table 1, Table 2, Table 3 and Table 4.

The Attached Tables

As mentioned above, the indicators and the original data in this paper were from the “China

Table 1
The Source Data of Resource Saving Factors in Henan Province from 2009 to 2018

Year	Effective irrigation area (1000 ha)	Soil erosion control area (1000 ha)	Total power of agricultural machinery (10000 kw)
2018	5288.69	3778.27	10204.46
2017	5273.63	3672.95	10038.32
2016	5242.92	3600.81	9854.96
2015	5210.64	3559.76	11710.08
2014	5101.15	3441.74	11476.81
2013	4969.11	3236.74	11149.96
2012	5205.63	4510.86	10872.73
2011	5150.44	4412.59	10515.79
2010	5080.96	4428.70	10195.89
2009	5033.03	4449.38	9817.84

Note.

The original data were from the “China Rural Statistical Yearbook” and “Henan Statistical Yearbook” from 2009 to 2018.

Table 2
The Source Data of Environmental Friendly Factors in Henan Province from 2009 to 2018

Year	Consumption of plastic film (10000 tons)	Consumption of agricultural diesel oil (10000 tons)	Pesticide usage (10000 tons)	Net amount of agricultural chemical fertilizer (10000 tons)
2018	15.2838	103.92	11.36	692.79
2017	15.7298	108.84	12.07	706.70
2016	16.3149	112.44	12.71	715.03
2015	16.2001	114.70	12.87	716.09
2014	16.3477	115.95	12.99	705.75
2013	16.7794	113.43	13.01	696.37
2012	15.5169	112.25	12.83	684.43
2011	15.1616	111.07	12.87	673.71
2010	14.6979	107.92	12.49	655.15
2009	14.1354	104.17	12.14	628.67

Note.

The original data were from the “China Rural Statistical Yearbook” and “Henan Statistical Yearbook” from 2009 to 2018.

Table 3
The Source Data of Output Efficiency and Living Security Factors in Henan Province from 2009 to 2018

Year	output efficiency		living security
	Grain yield per unit area (kg / ha)	Grain output per capita (kg)	per capita net income of farmers (yuan)
2018	6096.52	693.90	12719.18
2017	5977.25	683.49	11657.12
2016	5791.68	683.57	11697.00
2015	5815.24	684.10	10853.00
2014	5604.03	650.81	9350.00
2013	5631.07	640.18	8969.11
2012	5652.73	627.69	7524.90
2011	5597.12	610.69	6604.00
2010	5566.79	590.92	5523.70
2009	5567.77	582.24	4807.00

Note.

The original data were from the “China Rural Statistical Yearbook” and “Henan Statistical Yearbook” from 2009 to 2018.

Table 4
The Key Factors of Green Agriculture in Major Grain Producing Areas in China (2018)

Province	Effective irrigation area (1000 ha)	Soil erosion control area (1000 ha)	Total power of agricultural machinery (10000 kw)	Consumption of plastic film (10000 tons)	Consumption of agricultural diesel oil (10000 tons)	Pesticide usage (10000 tons)	Net amount of agricultural chemical fertilizer (10000 tons)	Grain yield per unit area (kg/ha)	Grain output per capita (kg)	Net income per capita (yuan)
Hebei	4492.33	5532.54	7706.2	10.9833	217.56	6.15	312.4	5659.95	490.96	12881
Inner Mongolia	3196.52	14088.57	3663.66	9.3969	79.20	2.96	222.67	5233.23	1403.63	12661
Liaoning	1619.33	5394.54	2243.72	11.7975	62.37	5.51	145.02	6292.84	502.39	14656
Jilin	1893.05	2385.81	3466	5.6216	67.34	5.10	228.3	6487.36	1340.25	13748
Heilongjiang	6119.57	4895.44	6084.65	7.7431	147.42	7.42	245.64	5281.07	1985.40	13804
Jiangsu	4179.83	930.24	5017.71	11.6064	109.36	6.96	292.45	6684.31	455.26	20845
Anhui	4538.29	1989.18	6543.81	9.7828	75.50	9.42	311.8	5477.13	637.13	13996
Jiangxi	2032.02	5917.85	2381.97	5.2218	30.93	7.72	123.2	5866.97	472.64	14460
Shandong	5235.99	4142.96	10415.22	27.6935	147.47	12.99	420.35	6329.10	530.55	15118
Henan	5288.69	3778.27	10204.46	15.2838	103.92	11.36	692.79	6096.52	693.9	12719
Hubei	2931.90	6134.72	4424.61	6.3554	65.10	10.33	295.82	5858.19	480.49	14978
Hunan	3164.00	3745.54	6338.57	8.5397	44.56	11.42	242.61	6366.81	439.41	14093
Sichuan	2932.54	9961.84	4603.88	12.0186	46.91	5.13	235.21	5576.03	419.84	13331

Note.

The original data were from the “China Rural Statistical Yearbook” and “Henan Statistical Yearbook” from 2009 to 2018.