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The Impact of Digital Inclusive Finance on Agricultural Green Total Factor Productivity: A Study Based on China's Provinces

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Abstract: Digital inclusive finance is key to China's agriculture and low-carbon economics. The panel data for China's 30 provinces were chosen from 2011 to 2019. An SBM GML model was applied in the thesis to measure agricultural green total factor productivity (GTFP), and to determine how Digital Inclusive Finance would affect agricultural GTFP a two-way fixed effect model was created. This study found that, from 2011 to 2019, the advancement of Digital Inclusive Finance could effectively enhance and drive the continuous increase of agricultural GTFP in China. Specifically, agricultural GTFP is increased by 0.288% as a result of every 1% rise in the Digital Inclusive Finance index; Digital Inclusive Finance helps agricultural green technologies advance and become more effective. According to a mechanism test, Digital Inclusive Finance increases agricultural GTFP growth by improving green technology innovation. Further analysis shows that the development of agricultural GTFP is significantly related to the depth and digitalization of Digital Inclusive Finance, but not in terms of its breadth. The above findings provide new ideas and empirical evidence for revealing the connection among Digital Inclusive Finance and agricultural GTFP and, on this basis, designing and improving relevant policies.

Keywords: digital inclusive finance; agricultural green total factor productivity; green technology innovation; fixed effect

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1. Introduction

The paradox of equivalence between economic development and environment protection is a major and inevitable challenge for the world. In past years, natural capital has long been sacrificed for the pursuit of rapid global economic growth, leading to serious environmental challenges such as overexploitation of energy resources, global warming, land degradation, and water and air pollution [1]. Greenhouse gas emissions are an important causal factor affecting global climate change and threatening the natural environment. The 2020 Emissions Gap Report, declared by the United Nations Environment Programme, illustrates that in 2019, the global carbon dioxide emissions had reached a record high at 59.1 billion tons in total, up 6.87% from 2018. In response to global warming, countries have committed to reduce carbon emissions and a "timetable" was set [2]. The United Nations Intergovernmental Panel on Climate Change (IPCC) has indicated in its Special Report about Climate Change and Land Use that food security could be strongly affected by abnormal light intensity, climate temperature, and precipitation patterns brought by climate change, for example, climate change can seriously hinder crop pollination and cause a chain ecological disaster response; undoubtedly, this would greatly affect food production and quality around the world. Agriculture is one of the largest origins of carbon emissions, followed by industry, and the total amount of greenhouse gases emitted from agricultural land account for 30% of the total global anthropogenic greenhouse gas

emissions. This proportion is even increasing; thus, it is urgent to reduce agricultural greenhouse gas emissions.

Therefore, from the view of sustainability, the traditional extensive growth method relying on high energy consumption and high resource investment is not conductive to humans' future; the green economic development concept, on the other hand, is a promising option for a higher quality economic development in the world [3,4]. More and more countries have begun to place emphasis on green economic development [5,6] since the OECD first proposed this concept in 2011. The key to green economic development lies in ways of boosting the development green total factor productivity (hereinafter referred to as "GTFP") [7,8]. Green total factor productivity is not equivalent to total factor productivity; the former one places a higher value on how to implement the concept of green development, take environmental factors into consideration, and examine the advancement of environmental quality while improving the productivity of inputs and outputs and, thus, the green total factor productivity has long been considered as the core means for countries to realize innovation-driven and green development strategies in the pursuit of mutual economic development as well as environmental protection. It not only helps to reduce the consumption of energy and decrease the carbon emissions through the improvement of new techniques and the greening of products, but also achieves sustainable growth of output, which is of paramount importance to break through the pressure on resources and the environment faced by countries in general and to achieve high-quality economic development.

China is a traditional agricultural production country, and agricultural carbon emissions makes up 24% of China's overall carbon emissions. With the strategies of "carbon peak" and "carbon neutralization" being proposed in the United Nations, China has also accelerated its research on low-carbon emission reduction techniques, which aim to boost the sustainable advancement of China's agricultural industry and expedite the pace of upgrading modern green agriculture industry. Promoting green growth in agriculture, with GTFP as the core element, is an inevitable choice to facilitate the production quality, productivity and effect in Chinese agriculture, and is of paramount importance to promote rural revitalization and achieve sustainable agricultural development. In this context, promoting GTFP in agriculture is a paramount method to break the dilemma of resource and environmental constraints in Chinese agriculture.

However, China's agriculture has been facing severe financial exclusion or suppression for a long time [9]; financial institutions tend to choose higher income customers in credit allocation, and the majority of low-income and middle-income farmers are excluded from formal financial services [10]. Digital Inclusive Finance enables those customers in need to access modern agricultural production equipment through financial support, which is an important factor in influencing the comprehensive division efficiency of agricultural land, labor and other production factors, and is an important support for accomplishing the higher quality of agricultural development and green growth [11]. Therefore, the way that Digital Inclusive Finance affects agricultural GTFP and clarifies the driving factors and transmission mechanism behind it is an important theoretical and practical issue that researchers should solve in this field.

Digital Inclusive Finance contains three meanings, namely "digital", "inclusive" and "finance" [12]. By June 2020, the coverage of 4G signal in rural China had exceeded 98%, and the population of rural residents who used Internet had mounted up 285 million, which provided a great base for the implementation of Digital Inclusive Finance. Compared with traditional financial business, inclusive finance covers a wider range, alleviates the credit constraints for rural, small and micro entrepreneurship, and meanwhile increases the income of poor farmers [13]. The long tail effect of Digital Inclusive Finance can expand the accessible channels to financial services, reduce transaction costs, and effectively help people break through the "financial threshold" [14]. Meanwhile, Digital Inclusive Finance can improve capital flow allocation and industrial structure optimization [15]. Not only does the advancement of Digital Inclusive Finance improve the digitalization process

of traditional finance in underdeveloped areas, but it also improves the service quality and efficiency of financial institutions, promotes the regional economy's higher quality development [16], and can effectively increase regional innovation output [17].

Some researchers have laid their attention on how Digital Inclusive Finance boosts the growth TFP; however, their research focuses are mainly on China's regional economy, non-agricultural sector and other aspects [18]. The existing literature pays less attention to the influence of Digital Inclusive Finance on China's agricultural GTFP. Consequently, the marginal contribution of the research lies in, firstly, further expanding Digital Inclusive Finance's research field to agricultural green growth efficiency, which is mainly characterized by agricultural GTFP, where GTFP is used to characterize the ability of China's green development in agriculture, which is helpful to show the total influence of Digital Inclusive Finance on agricultural green growth, by decomposing the GTFP into two sub-indexes: agricultural green technology progress, and technical efficiency improvement.

2. Literature Review

As reported by neoclassical economic growth theory, the continuous increase of factor inputs and productivity are the fundamental drivers for long-term economic growth; that is, TFP is a qualitative contribution and comprehensive reflection on the role of technological progress in economic growth [19]. However, the TFP has the shortcoming of neglecting the resource and environmental factors in the measurement process, while the GTFP takes the resource and environmental factors into account and can show the real performance of economic development. TFP is the remaining portion of total output growth after deducting labor, capital and other intermediate inputs. According to the theme of the thesis, the agricultural GTFP includes unexpected outputs such as greenhouse gas emissions and pollution of agriculture, considers the environmental costs in agricultural economic growth, and can fully reflect the comprehensive strength and development potential of regional agricultural economic development.

The characteristics (small amount, short cycle and decentralization) of rural finance make it hard for the traditional financial services to match the demand in rural areas, resulting in an adverse selection of products, lagging development of industries, slow increase of farmers' income and other problems, many of which, however, can be solved by Digital Inclusive Finance in terms of digital technology and digital economy. Recently, some scholars have found that Digital Inclusive Finance is able to reduce farmers' intermediate expenses, enhance farmers' financing willingness, raise farmers' risk identification ability [20], and bridge the income differences and regional differences between city and countryside districts [21]. Ji and Wang [22] further pointed out that, for Digital Inclusive Finance, only coverage can significantly reduce the income difference between city and countryside districts, while the impact of depth and digitalization is not significant. In addition, Digital Inclusive Finance is also helpful when promoting the consumption upgrading of rural populations [23], creating a great financial ecological environment in rural areas, and adjusting the rural industrial structure [24,25]. Digital Inclusive Finance emerges as a financial institute mode realized by digital technology [26], and GTFP is a new concept of economic growth which pursues the social productivity improvement and environment protection at the same time [27]. Next, this paper will develop a research project on how Digital Inclusive Finance influences agricultural GTFP, and will discuss the operation mechanism of Digital Inclusive Finance in agricultural green development support.

Compared with general agricultural production activities, green agricultural production activities are long-term, high-risk, and more vulnerable to the uncertainty of the external environment. All these make the financing of green agricultural production activities more difficult. Unlike traditional financial institutions, Digital Inclusive Finance has alleviated the shortage of green credit to some extent and allocated resources in a more reasonable way due to its characteristics of openness, equality, collaboration and sharing. Research on digital finance has contributed to substantial improvements in the

availability and convenience of financial services, which is helpful to boost the development of inclusive finance in China, especially for remote districts and underdeveloped regions.

Digital Inclusive Finance can effectively reduce the marginal expenses of obtaining green credit for long tail populations, such as farmers and the less well off, by expanding its service coverage, customer group and the application of technology. Furthermore, the capillary-like service channel driven by big data technology penetrates into the vast number of dispersed farmers, can achieve a more accurate portrait of farmers' financing characteristics, and can efficiently match supply and demand of green credit funds [28]. Firstly, digital financial inclusion affects GTFP through agricultural scale operation. The increasing proportion of green credit in agriculture can effectively transfer and disperse the risk of agricultural scale operation and, driven by profit maximization, the economically rational farmers will expand the scale of operation by participating in land transfer or reclaiming wasteland. Specifically: firstly, the large-scale agricultural operation has realized the intensification of influencing the output of agriculture production and reduced the input of agricultural chemicals per unit area; secondly, the large-scale agricultural operation helps to enhance the productivity of agricultural mechanization and reduce the input of agricultural machinery power and energy. In addition, Digital Inclusive Finance promotes the structure of agricultural cultivation, which in turn affects GTFP. According to previous reports, green credit is one of the most important agricultural policies and one of its main objectives is to maintain China's food security. Guided by Digital Inclusive Finance, more agricultural operators will choose to grow food crops, which will help to improve the GTFP. Specifically: firstly, compared with cash crops, food crops are less affected by pests and disaster, and their dependence on agrochemicals in the production process is relatively lower. Secondly, food crops are more dependent on water resources, and the implementation of water-saving irrigation technology in this area is most effective. Therefore, with the development of water-saving irrigation technology, growing food crops is more conducive to reducing the waste of water in agricultural production. Thirdly, it has been documented that food crops are less erosive to the soil than cash crops [29]; therefore, increasing the proportion of food crops will help reduce the loss of soil organic matter and, thus, achieve healthy and continuous development in agriculture.

Digital Inclusive Finance causes a slowdown impact on environmental pollution in agriculture. Agricultural production and operation activities are usually accompanied by environmental pollution, the degree of which mainly depends on the operation of sustainable ecological technology, the environmental awareness of agricultural producers and operators, the allocation of production resources and the implementation of the government's environmental regulation. Against the background that green consumption has become the dominant factor and the government has gradually strengthened regulations on agricultural environment, in addition to the yield, operation and profitability condition, the greenness of output will also be an important consideration for agricultural producers and operators to obtain financing through Digital Inclusive Finance. So as to obtain the support of Digital Inclusive Finance, agricultural production and operation subjects will inevitably place great emphasis on the green orientation of their production and operation activities, and Digital Inclusive Finance supplies funds to them to strengthen green technology investment. Furthermore, Digital Inclusive Finance and the optimal allocation of agricultural land and labor forces promote comprehensive agricultural resource utilization and aid in the transition from the traditional extensive growth model to an intensive growth model. Inclusive financial development has contributed to indirect development in knowledge and technology of agricultural operators and has also improved the comprehensive quality of agricultural producers and operators, and also contributed to the cultivation of their understanding of environmental protection. Generally speaking, the green guidance of digital inclusive financial investment, the financing support for clean technology in agricultural production and the spillover effect of green environmental protection awareness all contribute to the reduction of the "undesirable output" of environmental pollution in

agricultural production. According to the referred statement of theory, this thesis puts forward the following assumptions:

Hypothesis 1 (H1). *Digital Inclusive Finance has significantly improved agricultural GTFP.*

In terms of agricultural production, carbon emissions mainly come from the combustion of agricultural waste, the utilization of machines in agriculture, and the production and application of pesticides, fertilizers and agricultural film, as well as carbon dioxide and other carbon containing harmful substances emitted in the process of agricultural generation, such as farmland irrigation and farmland ploughing.

The core idea of GTFP is to reduce environmental pollution and improve the utilization of resources. By optimizing production processes and technologies, especially pollution control and resource recycling, enterprises and farmers in rural areas have improved green technical efficiency, and their expenditure on resource and energy consumption will be reduced, promoting the saving of energy and reduction of carbon emissions, thus contributing to the improvement of GTFP. China's overall scientific and technological level is not high, and the unbalanced development of various regions is still very prominent. Correspondingly, the weak capital support for agricultural science and technology and the low level of technological creativity directly forces most farmers to rely too much on chemical products to increase agricultural production, which leads to the high consumption of chemical products and causes the low use of resources in the procedure of agricultural production in China. Agricultural ecological degradation and environmental pollution are the key factors which limit the sustainable development of agriculture in China [30]. In addition, it has been shown that the transformation of new techniques is beneficial to developing countries in reducing the utilization of energy and promoting sustainable development in economics and agriculture [31]. For example, the use of biogas production technology (BPT) and other green technologies can significantly reduce the consumption of fossil energy in rural areas, consequently reducing the pollutants and carbon dioxide from fossil energy combustion [32].

The study indicates that Digital Inclusive Finance can support the innovative activities of rural green technology [33]. Digital Inclusive Finance can lower the access limits and transaction expenses of rural innovation traders, encourage rural enterprises and farmers to actively promote new green technologies and processes, and create an endogenous power source and an external environment to improve the efficiency of rural green production [34]. Compared with traditional finance, rural Digital Inclusive Finance can satisfy the scattered and small-scale financial support of small and medium sized enterprises and individuals [35], and provide relatively low-cost financial support for farmers to carry out green technology innovation. Digital technology helps boost the development of financial services such as the Internet and big data. Rural Digital Inclusive Finance can break through the spatial constraints of financial services, provide more credit facilities and suitable products for rural residents, and help them conduct rapid risk assessments of rural financial entities, thus enabling rural residents to obtain financing as soon as possible [36,37]; all these mention above can significantly reduce the financing costs of rural residents, actively encouraging them to carry out green technology innovation and research with high investment costs, and producing green agricultural products that meet public demands, all of which may contribute to reversing the situation in which most farmers rely too heavily on chemical products to increase agricultural yield and solve the problems of high chemical product consumption, low resource utilization efficiency, ecological degradation, and environmental pollution in the agricultural production process in China [38]. Therefore, digital financial inclusion can stimulate farmers' awareness of innovation and assist agricultural techniques transformation and development. The improvement of green technology innovation will improve unit production efficiency and effectively reduce environmental pollution caused by its output, thus promoting the improvement of agricultural GTFP and

helping sustainable agricultural development. According to the referred illustrations, this thesis puts forward another assumption:

Hypothesis 2 (H2). *Digital Inclusive Finance promotes the level of agricultural GTFP by the means of promoting green technology innovation.*

3. Model Design and Data Description

3.1. Model Design

Generally, there are three kinds of model estimation methods that can be adopted to analyze the panel data: mixed regression model estimation, random effect model estimation, and fixed effect model estimation. So as to choose the most effective research model for study, the data used in this paper were tested by F test, LM Test and Hausman test. First, an F test was carried out. The preliminary assumptions of the F test are to select the mixed regression model. As shown in Table 1, the statistical value of F is 8.22, and the preliminary assumptions of the F test are greatly turned down at the key level of 1%, showing that the function of fixed effect is to process the data. Subsequently, the LM Test was carried out, and outcomes of the LM test, which uses the chibar2, indicated that the preliminary assumptions of the LM Test (mixed regression model ought to be selected) was greatly turned down at the 1% level; that is, the random effect model ought to be selected.

Table 1. Model selection test.

Test Method	Statistical Indicators	Statistics	*p*-Value	Outcome
F test	F (29, 225)	8.22	0.0000	Reject mixed region, choose fixed effect model
LM Test	Chibar2 (01)	277.96	0.0000	Reject mixed region model and choose random effect model
Hausman test	Chi2 (8)	18.07	0.0000	Reject random effect model, choose fixed effect model

Finally, the Hausman test was conducted to confirm whether the random effect model or the fixed effect model should be chosen for data research. The former assumption of the Hausman test was "no individual fixed effect", and the *p*-value of the test result was 0.0207. At the key level of 5%, the original hypothesis was rejected, i.e., there was an individual fixed effect, so the fixed effect model ought to be chosen for the next study. The specific formula for regression analysis by a two-way fixed effect model is as follows:

$$\mathrm{GTFP}_{it} = \alpha_0 + \beta_1 DIF_{it} + \gamma\,\mathrm{Control}_{it} + \delta_i + \mu_i + \varepsilon_{it} \quad (1)$$

where GTFP_{it} means the I province's agricultural GTFP in year t; DIF_{it} means I province's digital inclusive financial index in year t; $\mathrm{Control}_{it}$ are control variables; and δ_i, μ_i, and μ_i represent individual effect, time effect and random error, respectively.

This thesis reaches a conclusion from the intermediate role measure approach of Wen Zhonglin et al. [39] to measure the transmission role of the transformation of technology in the process of agricultural GTFP enhancing by Digital Inclusive Finance. On the basis of Equation (1), the subsequent model is established to measure the effect of Digital Inclusive Finance on the transformation of technology:

$$M_{it} = \alpha + \beta_2 DIF_{it} + \gamma\,\mathrm{Control}_{it} + \varepsilon_i + \mu_{it} \quad (2)$$

In Equation (2), M represents the intermediary variable of green technology innovation. When β_1 is positive, indicating that Digital Inclusive Finance is helpful to alleviate and improve the transformation of technology, it will restrain green technology innovation. In

this paper, the following model is constructed, which is based on Digital Inclusive Finance and Green Technology Innovation and Agricultural GTFP.

$$\mathrm{GTFP}_{it} = \alpha + \beta_3 DIF_{it} + \beta_4 M_{it} + \gamma\,\mathrm{Control}_{it} + \varepsilon_i + \mu_{it} \tag{3}$$

If, when β_2 in Equation (2) is significantly positive, β_4 in Equation (3) is also significant, it indicates that Digital Inclusive Finance's influence on agricultural GTFP can be achieved by promoting green technology innovation.

3.2. Index Design

For the traditional measurement of agricultural TFP in China, the desired/expected outputs under factor inputs are always the main consideration; however, those undesired/unexpected outputs are not taken into account in the analytical framework. In contrast, green TFP incorporates the undesired output of pollutant emissions into the growth accounting framework, which can better portray the true level of economic development quality compared with TFP in the traditional sense.

DEA has significant advantages in measuring TFP. Considering that this method does not need to make assumptions about the specific form of the production function, it can effectively avoid the impact of artificial subjective setting in the function on the estimation results.

In the current economic accounting system of China, the GDP indicator neither truly reflects the cost of preventing environmental pollution, nor addresses the cost of depletion and depreciation of natural resource stocks and the loss of environmental degradation. However, in the GTFP indicator, the deduction of losses due to environmental pollution and the deduction of costs paid for this purpose are deducted in the accounting: ecological inputs and the corresponding ecological outputs should be included in the accounting.

1. Explained variable. The explained variable is agricultural green TFP (GTFP).

Referring to the research of Tone (2001) [40], this paper incorporated unexpected output by choosing the SBM super efficiency model to calculate the agricultural GTFP of 30 sample cities of China since 2011 to 2019, excluding Tibet, Hong Kong, Macao and Taiwan, and obtained the corresponding indicators. The model is built as follows:

If k-th determined unit (J = 1, 2, … , n) has an input variable, an expected output variable and an unexpected output vector, respectively, and at the same time the matrix is defined as $X = [x_1, x_2, \ldots x_n] \in R^m \times n$, $Y^g = \left[y_1^g, \ldots y_n^g\right] \in R^{S_1} \times n$, for the decision-making unit K to be measured, the following formula is given:

$$\begin{aligned} min\rho = & \frac{1 + \frac{1}{m}\sum_{i=1}^{m} \frac{S_i^-}{x_{ik}}}{1 - \frac{1}{S_1+S_2}\left(\sum_{r=1}^{S_1} S_r^g / y_{rk}^g + \sum_{r=1}^{S_2} S_t^b / y_{tk}^b\right)} \\ & S.t. \sum_{j=1,j\neq k}^{n} x_{ij}\lambda_j - s_i^- \leq x_{ik} \\ & \sum_{j=1,j\neq k}^{n} y_{rj}\lambda_j + s_r^g \geq y_{rk}^g \\ & \sum_{j=1,j\neq k}^{n} y_{rj}\lambda_j - s_t^b \leq y_{tk}^b \\ & \lambda \geq 0,\ s^g \geq 0,\ s^b \geq 0,\ s^- \geq 0 \end{aligned} \tag{4}$$

Here, λ is the weight variable and s_i^-, s_r^g, s_t^b are the slack variables. $\frac{1}{m}\sum_{i=1}^{m} \frac{s_i^-}{x_{ik}}$ represents the average invalidity degree of input, $\frac{1}{s_1+s_2}\left(\sum_{r=1}^{s_1} s_r^g / y_{rk}^g + \sum_{t=1}^{s_2} s_t^b / y_{tk}^b\right)$ represents the average invalidity degree of output. ρ is the determined units' productivity value and can be greater than 1, so effective decision-making units can be distinguished. Using Equation (4), the efficiency level of each unit evaluated in terms of technology circumstances can be calculated, but the productivity of technology under this condition is still under investigation, and cannot directly reflect the role of efficient range in manufacturing agriculture and

advancement. So as to provide no feasible solution for linear programming, referring to Oh [41], the GML index is defined as:

$$GML^{t,t+1}\left(x^{t+1}, y^{t+1}, b^{t+1}; x^t,\ y^t,\ b^t\right) = \frac{1 + D_G^T\left(x^t, y^t, b^t\right)}{1 + D_G^T\left(x^{t+1},\ y^{t+1}, b^{t+1}\right)} \tag{5}$$

If $GML^{t,\ t+1}$ is less than 1, the results indicate that the expected output is depleted, the unexpected output is increased, and the GTFP level of agriculture is lower than before, but it indicates that the GTFP is increasing.

In detail, the GTFP input and output variables are selected as follows:

(1) Input variables. Input indicators consist of land input, labor input, machinery input and fertilizer input. Specific variables include the extra benefits input of the primary industry, the population of employees in the primary industry (10,000 people), the agricultural sowing area (1000 hectares), the effective irrigation area (1000 hectares), the agricultural mechanization rate (kilowatts), the use of plastic film (10,000 tons), the application of agricultural fertilizer (10,000 tons), the total agricultural carbon emissions (10,000 tons), and carbon sequestration of agricultural production (10,000 tons); the above data are based on the provincial statistical yearbooks of the National Bureau of statistics of China.

(2) Output variables. The expected output variable of agriculture is the overall output benefits of agriculture, forestry and so on (CNY 100 million).

The GTFP includes the impact of environmental pollution, and environmental factors need to be considered in the output. All kinds of pollution in agricultural production can be measured using carbon emissions, so carbon emissions are selected as the undesired output [42]. The unexpected output of agriculture is greatly indicated in greenhouse gas emissions of agriculture, which are influenced by six elements in the agricultural production process, such as fertilizer, pesticide, irrigation, etc. Therefore, this paper uses agricultural carbon emissions as a proxy variable for the unexpected output. The equation is as follows: $E = \sum E_i = \sum T_i \cdot \delta_i$. In the equation, E is the overall carbon emission from agriculture, E_i is the greenhouse gas emissions resulted from i carbon source (unit: million tons), and δ_i is the greenhouse gas emission factor of i carbon source.

2. Main explanatory variables. The main explanatory variable is Digital Inclusive Finance. Based on the Peking University Digital Finance Research Institute [43], this paper builds China's Digital Inclusive Finance index system from three perspectives, using depth and digitalization, and finally using the Digital Inclusive Finance development index to test China's Digital Inclusive Finance development. The measurement index covers a wide range and has strong authority in China.
3. Control variables. Referring to the relevant literature [44,45], this thesis chooses the subsequent control vectors: the education level (EDU) of rural populations, which is characterized by the extent of education received per capita in rural areas; the disaster rate (Disaster), measured by the proportion of the influenced districts to the overall sown districts of agriculture products in each region; the urbanization rate (urban), characterized by the ratio of non-agriculture residents in the overall population of the regional districts at the end of the year; the agricultural development level (agri), presented by the proportion of added value of primary industry in local GDP; financial development (finance), as measured by the ratio of local deposit and loan balances to regional GDP; openness (openness), as measured by the proportion of total regional imports and exports to regional GDP.
4. Mediating variables. Green Patent is the intermediary variable of this paper. Existing studies mainly use green patent output, R&D investment and other measurement methods to test the level of the transformation of sustainable technology in provinces. From the perspective of green patent output, and referring to the practice of the relevant literature [46], this thesis makes use of patent operations of technology in each province as a measure of transformation of sustainable technology in each province.

Considering that the amount of technology patent operations in most provinces is zero, and there is a right bias distribution, this paper makes use of patent operations of technology plus one to measure the natural number. The specific idea of developing provincial green technology innovation indicators in this paper is to compare the obtained international green invention patent number with the World Intellectual Property Organization's (WIPO) "green list of international patent classification" in order to gain the number of green invention patent applications in each province, in order to develop relevant indicators to characterize the transformation of sustainable technology in each province.

3.3. Data Sources and Descriptive Statistics

1. Data sources. There are inter-regional differences in economic development and pollution levels among Chinese regions, and the typical phenomenon of uncoordinated regional development persists. Provinces are the key carrier of economic development in regional districts, and the frontier of constructing ecological civilization. Using Chinese provinces as research samples is conducive to achieving joint improvement of economic and environmental achievements in regional districts. The study sample is the data of 30 provinces in China from 2011 to 2019 (not including Hong Kong, Macao, Taiwan and Tibet, for the time, being due to the availability of data), totaling 270 samples. The data on Chinese provinces from 2011 to 2019 selected in this paper are mainly taken from the China Statistical Yearbook, the China Land and Resources Statistical Yearbook, and the China Rural Statistical Yearbook.

So as to reduce the gap between data, and utilize the calculation of follow-up regression and the display of regression coefficient, a logarithm was applied to Patent, the horizontal variable (non-ratio variable). Due to the large difference between the inclusive financial index, its three-dimensional variables and other variables, the inclusive financial index and three-dimensional data divided by 100 are used as the sample raw data. Moreover, the data from Chinese intellectual property websites are manually integrated and matched to construct a green patent database at a provincial level, which makes the information involving Digital Inclusive Finance and green technology innovation more abundant and feasible, thus making up for the shortage of information in the existing single database and making the estimation of large samples more efficient.

2. Descriptive statistics. The important vectors and definitions used in this thesis are indicated in Table 2, and the descriptive statistics of these vectors are indicated in Table 3:

Table 2. Definition of main variables.

Variable Name	Variable Definition
GTFP	Green total factor productivity
TC	Agricultural green technology progress
EC	Efficiency of agricultural green technology
Dif	Digital Inclusive Finance index
Coverage	Digital inclusive financial coverage_ Breadth
Usage	Digital Inclusive Finance usage_ Depth
Dig_Level	Digital Inclusive Finance digitization_ Level
Patent	Number of green patent applications
Edu	Education level of rural residents (per capita education years in rural areas)
Disaster	Disaster rate (affected area/total sown area of crops)
Urban	Urbanization level (non-agricultural population/total regional population)
Agri	Agricultural development level (added value of primary industry/regional GDP)
Finance	Financial development level (balance of deposits and loans/regional GDP)
Open	Openness (total import and export/regional GDP)

Table 3. Descriptive statistics of main variables.

Variable	OBS	Mean	STD. Dev	Min	Max
GTFP	270	0.932	0.137	0.471	1.239
TC	270	1.025	0.0542	0.768	1.177
BC	270	0.909	0.129	0.562	1.268
Dif	270	2.034	0.916	0.183	4.103
Coverage	270	1.836	0.902	0.0196	3.847
Usage	270	1.980	0.914	0.0676	4.399
Dig_Level	270	2.784	1.180	0.0758	4.622
Lnpatent	270	8.137	1.593	3.434	11.40
Edu	270	7.801	0.612	5.923	9.844
Disaster	270	0.158	0.115	0.00592	0.619
Urban	270	0.575	0.120	0.350	0.896
Agri	270	0.0973	0.0512	0.00272	0.261

4. Model Empirical Results and Analysis

4.1. Data Sources and Descriptive Statistics

Pearson correlation is an approach to test the level of relationship between two vectors, the value of which fall between −1 and −1. A value of 1 shows that the variable is utterly positive, 0 means unrelated, and −1 shows utterly negative. The relationship between two variables is often tested by the coefficient. The coefficient matrix symbolizes a based standard to measure the relationship between variables, and the outcome depends on the regression. As indicated in Table 4, the measured outcomes of correlation show that the correlation coefficient between dependent variables, independent variables, and control variables is relatively significant, which proves that there is a correlation between variables. Among them, the core explanatory variable's co-efficacy of the digital inclusive financial index to agricultural green total factor productivity is 0.183, representing a significantly positive value at the 1% level, in line with theoretical expectations.

Table 4. Correlation coefficient matrix.

Variable	GTFP	Dif	Coverage	Usage	Dig_Level	Lnpatent	Edu
GTFP	1.000						
Dif	0.183 ***	1.000					
Coverage	0.192 ***	0.992 ***	1.000				
Usage	0.279 ***	0.957 ***	0.938 ***	1.000			
Dig_Level	−0.008	0.898 ***	0.864 ***	0.768 ***	1.000		
Lnpatent	0.561 ***	0.566 ***	0.571 ***	0.647 ***	0.336 ***	1.000	
Edu	0.414 ***	0.335 ***	0.357 ***	0.359 ***	0.185 ***	0.528 ***	1.000
Disaster	−0.271 ***	−0.330 ***	−0.330 ***	−0.356 ***	−0.232 ***	−0.451 ***	−0.194 ***
Urban	0.566 ***	0.409 ***	0.447 ***	0.447 ***	0.182 ***	0.633 ***	0.618 ***
Agri	−0.284 ***	−0.287 ***	−0.323 ***	−0.323 ***	−0.093	−0.598 ***	−0.367 ***
Finance	0.143 **	0.384 ***	0.420 ***	0.374 ***	0.236 ***	0.318 ***	0.353 ***
Open	0.479 ***	0.094	0.132 **	0.174 ***	−0.130 **	0.593 ***	0.464 ***
Variable	**GTFP**	**Dif**	**Coverage**	**Usage**		**Dig_Level**	
Disaster	1.000						
Urban	−0.199 ***	1.000					
Agri	0.162 ***	−0.739 ***	1.000				
Finance	−0.050	0.579 ***	−0.426 ***	1.000			
Open	−0.204	0.772 ***	−0.604 ***	0.593 ***		1.000	

** $p < 0.05$, *** $p < 0.01$.

4.2. Multicollinearity Test

In order to eliminate the interference of multicollinearity, the variance inflation factor (VIF) was used for the test. Generally, if the VIF value is greater than 10, it indicates that there is serious multicollinearity; if the VIF value is lower than 10, there is no relationship

between variables. As shown in Table 5, each variable's VIF value is lower than 10, which proves that the results are reliable and no relationship exists between variables, which can be followed according to the following exploratory analysis.

Table 5. Multicollinearity test.

Variable	Vif	1/VIF
Urban	5.61	0.178258
Open	5.44	0.183736
Lnpatent	4.05	0.246675
Dif	3.12	0.320786
Agri	2.62	0.381293
Finance	2.40	0.417476
Edu	1.84	0.543648
Disaster	1.33	
Mean Vif	3.30	

4.3. Benchmark Regression Results

According to Formula (1), which was developed using panel data from Chinese provinces from 2011 to 2019, inclusive finance has an impact on agricultural GTFP, which is empirically investigated using a two-way fixed effect model. The outcomes are indicated in Table 6.

Table 6. Impact test of Digital Inclusive Finance on agricultural GTFP.

	(1)	(2)	(3)
	GTF	TC	EC
Dif	0.288 ***	0.137 **	0.146 **
	(3.60)	(2.10)	(2.26)
Edu	0.007	−0.021	0.035
	(0.24)	(−0.97)	(1.60)
Disaster	−0.175 ***	−0.080 **	−0.117 ***
	(−3.69)	(−2.06)	(−3.05)
Urban	0.356 *	0.058	0.324 **
	(1.82)	(0.36)	(2.05)
Agri	0.551	0.363	0.341
	(1.18)	(0.96)	(0.91)
Finance	0.011	0.008	0.003
	(0.57)	(0.55)	(0.17)
Open	0.029	0.035	−0.002
	(0.48)	(0.71)	(−0.04)
_Cons	0.336	0.991 ***	0.260
	(0.92)	(3.32)	(0.88)
N	270.000	270.000	270.000
R2	0.779	0.054	0.836
F	22.522	1.352	32.239

T Statistics in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

As shown in Table 6, based on the basic settings of model (1), Digital Inclusive Finance has a great influence on agricultural total factor productivity, which is investigated through a multiple regression fixed effect model. The number of coefficients of the core explanatory variable, Digital Inclusive Finance (DIF), is 0.288, and it is positively important at the 1% level, showing that, under the control of other variables, Digital Inclusive Finance contributes to a good effect on agricultural GTFP. For every 1 percentage point growth in Digital Inclusive Finance, the agricultural GTFP increased by 0.0866 percentage points. Digital Inclusive Finance is conducive to agricultural GTFP, which to some extent indicates

that Digital Inclusive Finance strengthens the continuous advancement in countryside districts, has a positive incentive impact on agricultural green total factor productivity, and can promote agriculture to better cater to the green environmental protection orientation of external stakeholders to revitalize rural areas, so as to achieve sustainable development based on green ecology. Therefore, the hypothesis of this paper is supported by empirical results. In addition, because green total factor productivity is also able to be separated into two aspects (agricultural green technology progress and agricultural green technology efficiency), the results of models (2) and (3) indicate that the core explanatory variable Digital Inclusive Finance is significantly positive for agricultural sustainable techniques advancement and agricultural sustainable technology efficiency, which lies at the level of 5%, which shows that Digital Inclusive Finance has effectively promoted the improvement of agricultural green technology progress. It also improves the efficiency of agricultural green technology. The possible reasons are as follows: first, digitally inclusive finance helps agricultural enterprises and farmers alleviate the pressure of agricultural capital. Since China has developed a series of transformational and positively implemented diplomatic policies, China's implementation of the unbalanced approach of the development of "urban and industrial priority" has led to the net inflow of agricultural financial resources to urban non-agricultural sectors. However, Digital Inclusive Finance's advancement has positively alleviated the "financial restraint" faced by agriculture for a long time, and provided effective financial support for agricultural manufacturing and applications entities to update agricultural production and operation technology.

The regression results of the control variables show that the coefficient of education level (EDU) of rural residents is 0.007, a good relationship but not significant, indicating to a certain extent that the popularization of people receiving education is conducive to farmers recognizing the importance of green development. The regression coefficient of disaster rate is −0.175, which is obvious at 1% level, showing there exists a worse relationship between agricultural natural calamity and sustainable development. Agriculture has natural properties, and all kinds of production factors and desirable outputs will be affected by natural disasters, which will significantly weaken the agricultural GTFP. The coefficient of the urbanization ratio (urban) is 0.356, and is greatly obvious at the 10% level, indicating that urbanization rate is helpful to the advancement of agricultural GTFP, which may be because the development of cities and towns drives the development of surrounding rural areas, and cities and towns have high-quality human capital with "knowledge spillover effect", thus promoting the green development of agriculture. The coefficient of agricultural development level (agri) is 0.551, which shows that agriculture's higher quality advancement contributes to boosting the green increase of agriculture. The value of the coefficient of the financial development level (finance) is 0.011, which shows to a certain extent that the advancement of the overall level of financial services also causes a great impact on agricultural GTFP. The regression coefficient of the opening up is 0.029, positive but not significant, indicating to a certain extent that the improvement of opening up has brought advanced technology and imitation learning effect to Chinese farmers, promoting the progress of agricultural technology and the advancement of the productivity of technology, and is conducive to the improvement of agricultural GTFP.

4.4. Robustness Test

The robustness test mainly uses two methods to re-estimate the main effect model by randomly deleting 10% of the samples and replacing the dependent variable (agricultural GTFP) calculation method to SBM-ML. According to the perspectives of Pastor et al. [47], under the basic framework of global reference data envelopment analysis, comprehensively considering the unexpected output super efficiency model (SBM) and Malmquist

productivity index, the agricultural GTFP of 30 provinces in China are calculated as in the following equation:

$$min\rho = \frac{1 - \frac{1}{n}\sum_{i=1}^{n}\frac{S_i^-}{x_{i0}}}{1 + \frac{1}{m_1+m_2}\left(\sum_{r=1}^{m_1}\frac{S_r^a}{y_{r_0}^a} + \sum_{r=1}^{m_2}\frac{S_r^b}{y_{r_0}}\right)} \quad (6)$$

$$s.t.\begin{Bmatrix} x_0 = X\lambda + S^- \\ y_0^a = Y^a\lambda - S^a \\ y_0^b = Y^b\lambda + S^b \\ S^- \geq 0,\ S^a \geq 0,\ S^b \geq 0,\ \lambda \geq 0 \end{Bmatrix}$$

In Equation (6), ρ represents the efficiency value of decision-making unit; n, m_1 and m_2 are the value of inputs, desired output and undesired output, respectively; a and b are the distinguishing symbols between desired output and undesired output; i and r are the lower bounds of the summation symbol; S^-, S^a, and S^b represent input slash variables, expected output slash variables, and unexpected output slash variables, respectively; X, Y^a, and Y^b represent input matrix, desired output matrix, and undesired output matrix, respectively; x_0 and y_0^a and y_0^b show the input variable, desired output variable, and undesired output variable in a particular determined unit; λ represents the weight vector.

As indicated in Table 7, without controlling the variables, by randomly deleting 10% of the samples and changing the dependent variable of the agricultural GTFP calculation method, models (1) and (3) have an obvious relationship at the level of 5% and 1%, respectively; with controlling the variables, the results of models (2) and (4) indicate that the values of the coefficient of Digital Inclusive Finance are 0.267 and 0.395, respectively, and both significantly promote agricultural GTFP at the 1% level, showing that the outcomes of this research are reliable. At the same time, the importance and indicators of the main variables keep steady, proving that the referred empirical outcomes are significantly reliable.

Table 7. Robustness test.

Variable	(1) GTF	(2) GTF	(3) GTF_Ml	(4) GTF_Ml
Dif	0.149 **	0.249 ***	0.267 ***	0.395 ***
	(1.99)	(2.87)	(5.49)	(7.12)
Edu		0.006		0.009
		(0.22)		(0.46)
Disaster		−0.186 ***		−0.078 **
		(−3.76)		(−2.38)
Urban		0.403 **		0.183
		(2.00)		(1.35)
Agri		0.595		0.496
		(1.13)		(1.54)
Finance		−0.000		0.030 **
		(−0.01)		(2.30)
Open		0.019		0.084 **
		(0.30)		(1.99)
_Cons	0.900 ***	0.422	1.294 ***	0.640 **
	(11.69)	(1.10)	(25.59)	(2.52)
Regional fixed effect	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
N	270	270	270	270
R-squared	0.763	0.780	0.934	0.938
F statistical	21.533	20.466	100.849	93.930

T statistics in parentheses: ** $p < 0.05$, *** $p < 0.01$.

5. Discussion

5.1. Mechanism Testing

As a first step, it is necessary to examine if inclusive digital finance can improve the transition to green technologies.

The test outcomes in column (3) of Table 8 indicate that the value of the coefficient of Digital Inclusive Finance has an obvious relationship and is significant at the 1% confidence level, indicating that Digital Inclusive Finance can significantly improve the level of green technology innovation. The second step is to join the agricultural GTFP for regression. Table 8 (4) tests the influence of Digital Inclusive Finance on sustainable techniques transformation, and it can be seen that the result has the same sign as that in column (3), indicating that green technology transformation plays an important intermediary role, indicating that green technology innovation is a necessary access point for Digital Inclusive Finance to have a significant influence on GTFP. The above results verify hypothesis H2. So as to effectively improve agricultural GTF, we must fully recognize the importance of Digital Inclusive Finance in influencing agricultural GTF through green technology innovation. As mentioned in the previous theory, Digital Inclusive Finance is able to make great contributions to green technology innovation, have a great influence on sustainable techniques transformation, and then promote GTFP. Meanwhile, green technology transformation helps to improve the performance of agricultural green growth. Through sustainable techniques and research on products, rural residents and enterprises produce differentiated high value-added products, enhance the market competitiveness of enterprises and products, gradually eliminate high energy consumption and high pollution enterprises, enhance the ratio of environmental industry in the industrial constructure, and then optimize TFP and increase its "green" proportion (GTFP). Meanwhile, sustainable techniques transformation helps for businesses to win government subsidies and other support, indirectly reduces production costs, and has a positive effect on GTFP.

Table 8. Mechanism test of Digital Inclusive Finance on agricultural GTFP.

Variable	(1) lnPatent	(2) GTFP	(3) lnPatent	(4) GTFP
DIF	0.481 **	0.123 *	0.786 ***	0.197 **
	(2.31)	(1.87)	(3.38)	(2.54)
lnPatent		0.125 ***		0.116 ***
		(6.08)		(5.36)
Edu			−0.038	0.011
			(-0.49)	(0.43)
Disaster			−0.456 ***	−0.122 ***
			(−3.30)	(−2.67)
Urban			0.721	0.272
			(1.27)	(1.47)
Agri			−2.370 *	0.826 *
			(−1.75)	(1.87)
Finance			0.038	0.006
			(0.69)	(0.36)
Open			0.435 **	−0.021
			(2.46)	(−0.37)
_Cons	9.319 ***	−0.292	8.126 ***	−0.607
	(43.14)	(−1.44)	(7.64)	(−1.57)
Regional fixed effect	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES
N	270	270	270	270
R-squared	0.985	0.797	0.986	0.803
F statistic	451.890	28.006	435.916	25.371

T statistics in parentheses t; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5.2. Dimensional Analysis of Digital Inclusive Finance

The preceding article analyzed the impact of the general index of digital inclusive financial development on agricultural GTFP, and the digital inclusive financial service

development input includes three perspectives: coverage, depth of utilization, and extent of digitalization. Moreover, the three dimensions have different emphases, so it is necessary to research the different dimensions of the digital inclusive financial development index, respectively, so as to specifically analyze the direction and degree of each dimension's influence on agricultural GTFP. As indicated in Table 9 (2), the regression coefficient of the coverage of Digital Inclusive Finance has a good relationship but is not obvious, showing that, to a certain extent, the increasing users of Alipay and other electronic accounts and the widening coverage of Digital Inclusive Finance are helpful to the improvement of agricultural GTFP, but the impact is not significant. The possible reason is that when some new farmers begin to use digital technology to develop agriculture, they concentrate on economic efficiency, which leads to the low efficiency of agricultural green technology, and thus the promotion of agricultural GTFP is not obvious. Increasing the coverage of Digital Inclusive Finance can reduce the threshold of the service of finance, improve the possibility of access to financial services for agricultural enterprises and farmers, and promote green agricultural growth. As shown in Table 9 model (4), the regression coefficient of the depth of use of Digital Inclusive Finance is 0.144 and is positively obvious at the 1% level, indicating that with the advancement of Digital Inclusive Finance in China, rich financial instruments and products can effectively meet market demand, and the practical utilization of digital inclusive financial services is expanding, which provides strong support for the demand side of funds, and can promote the change of agricultural structure, thus promoting agricultural GTFP. As indicated in Table 9 (6), the regression coefficient of dig_level is 0.069, showing that with the advancement of China's digitalization, the equality of financial services and even economic development has been improved, and particular groups such as small and micro enterprises and the less well-off can also enjoy the convenience brought by Digital Inclusive Finance. As a potential condition to improve inclusive finance, digital improvements can increase the availability of financial services without restricting the size of financial services based on geographic location.

Table 9. Dimensional test of Digital Inclusive Finance on agricultural GTFP.

Variable	(1) GTFP	(2) GTFP	(3) GTFP	(4) GTFP	(5) GTFP	(6) GTFP
Coverage	0.137	0.097				
	(1.36)	(0.88)				
Usage			0.087 **	0.144 ***		
			(2.19)	(3.31)		
Dig_level					0.044 *	0.069 ***
					(1.90)	(2.70)
Edu		0.000		0.009		0.008
		(0.01)		(0.34)		(0.28)
Disaster		−0.160 ***		−0.185 ***		−0.174 ***
		(−3.27)		(−3.85)		(−3.62)
Urban		0.181		0.327 *		0.343 *
		(0.92)		(1.67)		(1.71)
Agri		0.332		0.387		0.265
		(0.68)		(0.84)		(0.57)
Finance		−0.005		0.000		0.007
		(−0.28)		(0.00)		(0.37)
Open		−0.012		0.033		−0.005
		(−0.20)		(0.54)		(−0.08)
_Cons	0.905 ***	0.875 **	0.958 ***	0.535	1.031 ***	0.655 *
	(8.17)	(2.52)	(19.35)	(1.54)	(37.53)	(1.90)
Regional fixed effect	YES	YES	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES	YES	YES
N	270	270	270	270	270	270
R-squared	0.760	0.767	0.763	0.777	0.762	0.773
F statistic	23.399	21.106	23.771	22.286	23.623	21.865

T statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Generally speaking, in addition to increasing R&D investment in digital technology, attention should also be paid to ways of guiding small and micro enterprises and farmers to embark on the road of green agriculture.

6. Conclusions and Policy Recommendations

6.1. Conclusions

In this paper, GTFP of 30 provinces in China (excluding Tibet, Hong Kong, Macau and Taiwan) from 2011 to 2019 are measured systematically, and the impact of Digital Inclusive Finance and its sub-indices on agricultural GTFP are empirically tested. The paper further discusses the intermediary function of sustainable techniques transformation in the above impact. This paper draws the following conclusions: firstly, Digital Inclusive Finance promotes agricultural GTFP through driving the improvement of agricultural green technology and enhancing the productivity of agricultural sustainable techniques; secondly, Digital Inclusive Finance promotes the degree of agricultural GTFP by promoting green technology innovation; finally, the advancement of agricultural GTFP is significantly related to the depth and digitalization of Digital Inclusive Finance, but not to the breadth of coverage.

6.2. Policy Recommendations

China is actively promoting the viewpoint of sustainable development and the rural revitalization strategy. So as to speed up the integration of Digital Inclusive Finance and agricultural sustainable development, improve the market-oriented green technology innovation system, and promote high-quality development, according to the overall survey findings, this thesis puts forward the subsequent policy advice for agricultural GTFP improvement:

1. Government supervision. First, to promote the constructure of financial science and technology, digital technology should be used as a necessary tool to promote green development. For example, regulatory sandboxes should be established to support green financial technology. Regulatory sandboxes can encourage innovative use of block chain technology, establish project pools for the underlying assets of the securitization products of green bonds and green asset, and disclose project risks and environmental benefits to investors in real time, in order to deplete the expenses of third-party authentication, improve the efficiency of bond issuance and enhance information transparency. Second, the level of local environmental protection should be improved. Regulators should, further, give full play to the responsibilities of management departments to integrate and share the enterprise and public information such as the environmental penalty information, enterprise pollutant discharge license information, green project feasibility study report, credit data and other information into an unified information sharing platform. Finally, the problems of untimely data updating should be solved and the traceability of data by standardizing and labeling those data that have been integrated and shared should be realized.
2. Financial institution. First, the credit products that focus more on green projects should be explored and developed, so as to effectively alleviate dilemmas such as the high green credit threshold to obtain loans for the scale of small and medium-sized companies and farmers, thus promoting green investment by enterprises and farmers. Second, banks should use digital technology as a necessary tool to promote green agricultural development. For the first time, digital technology could be used to mine data value, systematically integrate, analyze and continuously accumulate green data, establish a green intelligent marketing database, and make great contributions to the significance of green data; next, digital technology can be leveraged to power the applications and services of green business. For example, using artificial intelligence, machine learning and other technologies to develop the intelligent identification tools to improve the efficiency and quality of green credit business; and using big data technology to update risk control methods, help green enterprise financing, effectively

supervise the use of funds, reduce the default rate, and enhance the overall green level of the industrial chain.

3. For rural enterprises and farmers. First, enterprises can use the assistance of Digital Inclusive Finance to promote the green identification ability of investment projects, enhance the internal control and management level of environmental risks, reduce energy consumption and innovation costs, and promote the level of agricultural GTFP. Second, farmers should enlarge a financing scale for green credit and actively fulfill environmental protection commitments. Under the goal of "carbon peak and carbon neutralization", domestic banks have increased their investment in agricultural green credit; farmers should actively apply for green credit and green bonds, fulfill environmental protection commitments, and support green agricultural development projects so as to help green transformation and agriculture upgrading.
4. Green technology level. Boost the application of various green techniques in rural areas to reduce the expenses of fossil resource. Firstly, rural China, with reference to other developing countries, can introduce techniques such as biogas production technology (BPT) and other green technologies to carry out a large number of technological innovation activities to deplete the cost of fossil resource significantly in rural areas and lower the pollution and carbon emissions to the environment. The government gives certain financial subsidies to rural households to encourage them to use green technologies [48]. Secondly, with the guidance of the government, remote districts promote cleaner energy consumption for manufacturing in agriculture and deplete the dependence of agricultural production processes on fossil energy. Biomass energy is the only renewable carbon source, or a clean energy source, with natural energy storage characteristics, but it is also an energy source that can achieve long time and space energy storage and conversion [49]. China should actively develop renewable energy in rural areas to achieve sustainable ecological development in the real line, exploring the reduction and alternative supporting technologies of chemical fertilizers, pesticides, and agricultural films, such as replacing chemical fertilizers by having manure, compost, and straw return to the field, replacing chemical pesticides with biological pesticides and biological pest control, and replacing non-degradable agricultural films with degradable agricultural films.

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