The Cause Analysis of China Agricultural Information Efficiency in Different Provinces

—Based on the comparison of the 31 provinces and autonomous regions

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Abstract—The government wants to achieve the goal put forward in the eighteenth Congress of the Chinese Communist Party. It needs to improve efficiency. Therefore, the efficiency of agricultural information is particularly important for a large agricultural country like China in the information age. Through constructing agricultural input and output efficiency evaluation index system and using Data Envelopment Analysis, the article analyzed the Agricultural Information Efficiency in China's 31 provinces and autonomous regions. As the result, we found that the agricultural information efficiency of 11 provinces and autonomous regions does not reach optimal efficiency. So the paper explored the sensitive of various input and output indicators in these cities. Finally, this paper gives some policy advice from a objective perspective to improve the agricultural information efficiency.

Keywords- Agricultural Information Efficiency; DEA; Indicator System; Efficiency sensitivity

I. INTRODUCTION

Report of the eighteenth Congress of the Chinese Communist Party proposed that our country will build a moderately prosperous society and realize GDP and urban and rural incomes will be more double than 2010 until the year 2020.In order to achieve the target, the productivity is critical, that is to say, the problem of productivity efficiency is the core issue of economic and social development of our country in the next decade or even two decades. Similarly, the problem of efficiency is also the core issue of agricultural development of our country. Many scholars' study shows that information has a pivotal significance in promoting the development of rural areas and agriculture. Li Youzhu and others have done some corresponding studies on agricultural Information technology investment and the contribution rate of agricultural output in 2012; [1]Yu Shumin has studied the impact of agricultural information on agricultural TFP in 2011. [2]Guo Qingran has studied the strategy that agricultural information promotes agricultural industrialization in 2008[3] and also Zhang Hong has studied the influence agricultural information has on agricultural economic growth [4] and so on.

From the above papers, we can learn that agricultural Information plays an important role in improving the efficiency of agricultural production, but there is a lack of research about it. The improvement of the agricultural information efficiency helps to make full use of agricultural information resources and raise the level of the development of agricultural information at a low cost.

Therefore, the paper has evaluated the agricultural information efficiency by constructing evaluation index and using the statistic data of 31 provinces and autonomous regions through our country. And this paper analyzes the motivation of agricultural information efficiency difference forms in various provinces and autonomous regions and sensitivity of each agent.

In this paper, the structure arrangement is as follows: Section 2 is literature review; Section 3 has given the research methods and the corresponding index system; Section 4 is using DEA method to deal with data and explaining and analyzing the statistical results; the last is coming to the conclusion and putting forward the outlook.

II. LITERATURE REVIEW

Agricultural information is the important component of national economic information and is of great significance to promote China's agricultural information and realize agricultural modernization and the comprehensive construction well-off society. [5]Agricultural information efficiency decides the ability to use factors of agricultural information and the effect of it. While the research that most domestic scholars have done in recent years mainly focus on the current development of agricultural information, the existing problems, the improving measures and the effect of agricultural information and so on. Such as Cao Junjie (2007) analyzed 4 prominent problems in the agricultural information of our country and put forward 5 practical agricultural information construction measures; [6]Liu Jinai (2009) point out three main status, five problems and six countermeasures; [7]Long Bing, Du Tongqing (2012) analyzed the role of agricultural information in our country's modernization and point out that agricultural information is the important content and inevitable choice of agricultural modernization. [8]However, recent research on agricultural information in overseas refers only to its system, approaches, degree and circumstance and so on. Nuray Kizilaslan (2006) mentioned the benefit agricultural information has on farmers in his paper by studying the agricultural information system in Turkey. [9]Adebambo Adewale Oduwole , Chichi Nancy Okorie (2010) analyzed farmers in Abeokuta, Ogun State developed agricultural

information through electronic, print media, the village square commence, religion and the market.[10]William Mokotjo,Trywell Kalusopa(2010) obtained the degree of agricultural information service through investigating 300 farmers in Lesotho.[11] L.O. Aina（2012）indicated that the information environment related to agricultural stakeholders in Botswana. [12]It is rare to see the research on agricultural information efficiency. In this paper, it regard the provincial differences of agricultural information as the starting point, using the method of DEA (Data Envelopment Analysis), combining the presented agricultural information input and output index, parsing the data of 31 provinces, cities and autonomous regions, and conclude that all provinces and autonomous regions in China agricultural information efficiency ranking and analyze the causes of the differences, for low efficiency area and optimization of agricultural information inputs used to provide the direction of improvement.

III. METHODOLOGY AND INDICATOR SYSTEM

A. Methodology

DEA (Data Envelopment Analysis) method is an effective method for multi-input and multi-output system which make the relative efficiency evaluation. It not only calculates the efficiency of the production units and can analyze the reasons for the different efficiency. Regional agricultural information efficiency evaluation is a multi-input and multi-output the same type of system evaluation. Therefore this paper adopted the method to evaluate agricultural information efficiency of 31 provinces and autonomous regions with DEA and analyze theMaintaining the Integrity of the Specifications difference motivation.

This paper adopts CCR model to study efficiency of agricultural information in 31 provinces and autonomous regions studied. The CCR model is given as follow (1):

$$\begin{cases} \max h_{j_0} = \dfrac{\sum_{r=1}^{s} u_r y_{rj_0}}{\sum_{i=1}^{m} v_i x_{ij_0}} \\ s.t. \dfrac{\sum_{r=1}^{s} u_r y_{rj}}{v_i x_{ij}} \le 1,\ j = 1,2,\ldots,n \\ u \ge 0, v \ge o \end{cases} \tag{1}$$

The above plan is a fractional programming model, using Charnes-Cooper transformation:

$$t = \frac{1}{v^t x_0}, w = tv, u = tu$$

$$\mathrm{t} = \frac{1}{v^t x_0}, \quad w^t x_0 = 1$$

lt can be turned into the following linear programming model P:

$$(P)\begin{cases} \max h_{j_0} = u^T y_0 \\ s.t. w^T x_j - u^T y_j \ge 0,\ j = 1,2,\ldots,n \\ w^T x_0 = 1 \\ w \ge 0, u \ge 0 \end{cases}$$

Using dual planning theory and further introduction of slack and surplus variables above fractional programming can be transformed into a linear programming problem, as formula (2) shown:

$$\begin{cases} \min \theta \\ s.t. \sum_{j=1}^{n} \lambda_j x_j + s^+ = \theta x_0 \\ \sum_{j=1}^{n} \lambda_j y_j - s^- = \theta y_0 \\ \lambda_j \ge 0,\ j = 1,2,\ldots,n \\ s^+ \ge 0, s^- \ge 0 \end{cases} \tag{2}$$

If $\theta^* = 1, s^{*+} = 0, s^{*-} = 0$, the decision-making unit j_0 is DEA valid. The economic activities are both the best of technology effectively and scale efficiently; If $\theta^* = 1$ and at least one of the input or output is greater than 0, the unit j_0 is weak DEA valid. If $\theta^* < 1$, the unit j_0 is not DEA valid. The economic activities are neither the best of technology effectively nor scale efficiently.

B. Indicator system

Agricultural information with quantify measure first began in Machlup (Macluph) and Borat (Porat), while China's agricultural information construction began in the early 1990s. It is clear measure of agricultural information for research lagged behind and because China's agriculture has a high dispersion, variety, small-scale, family-run and non-standard features. As a result, there are some difficulties in selecting indicators, and data availability is also limited. So far, the presence of agriculture information measurement indicators has big different with different scholars, as shown in Table 1.

TABLE1 SCHOLARS HAVE BUILT EVALUATION INDEX SYSTEM OF AGRICULTURAL INFORMATION

No	Author	Document	Indicators Classification
1	Zhou Hong（2001）	Research on agricultural information questions[14]	Three levels and four categories
2	Xu Aiping.et（2004）	Research on agricultural information measurement index system [15]	8 level indicators and a series of secondary indicators
3	Wang Zhengyu（2005）	The development of Chinese agricultural	20 indicators in six categories

		information and empirical research [16]	
4	Sheng Qifeng（2005）	Agricultural information construction and evaluation research [17]	6 level indicators and 18 secondary indicators
5	Lu Anxinag, etc（2006）	Research on the development of rural information index system [18]	20 indicators in six aspects
6	Chen Zhen, Cao Dianli（2007）	Agricultural information evaluation research based on principal component analysis [19]	4 level indicators and 18 secondary indicators
7	Lu Lina（2007）	The structure building of agricultural information measurement index system [20]	21 indicators in six categories
8	Liu Shihong.etc（2008）	China's rural information evaluation method research [21]	6 level indicators and 25 secondary indicators
9	Xin Liyuan.etc（2008）	Shallow of Tianjin agricultural information construction of evaluation index system [22]	5 level indicators, 20 secondary indicators
10	Yang Cheng, Jiang Zhihua（2009）	The rural information evaluation index system construction in our country [23]	Five elements indicators and 28 constitute indicators
11	Deng Peijun, Chen Yizhi（2010）	Agricultural information and the rural economy growth correlation studies [24]	Four areas, 13 specific indicators
12	Lu Lina, Yu Fengcheng.etc（2010）	Agricultural information level measure theory and application research of our country [25]	6 large elements and 20 indicators

Reference to the above scholars constructed the index system of agricultural information, taking into account the degree of difficulty index data obtained. This article selected input indicators from the infrastructure, talent and resources and output indicators from farmers and social perspectives. Finally, we selected nine input indicators and four output indicators totally.

TABLE2 THE INPUT INDICATORS OF AGRICULTURAL INFORMATION EFFICIENCY EVALUATION

Level Indicators	Secondary Indicators	Source	Indicators Code
Agricultural Information Infrastructure	Number of TV every hundred rural	Yearbook of Rural Household Survey	x_1
	Number of computer every hundred rural	Yearbook of Rural Household Survey	x_2
	Number of telephone every hundred rural	Yearbook of Rural Household Survey	x_3
Agricultural information professionals	The proportion of primary industry in personnel employment	China Statistical Yearbook、China Agricultural Development Report	x_4
	Number of every hundred high school education or more	Statistical Yearbook of the provinces about the rural economy、China Agricultural Development Report	x_5
Agricultural Information Resources	Long-distance fiber optic coverage ratio	China Statistical Yearbook Information	x_6
	Agricultural investment accounted for the proportion of investment areas	Yearbook of Rural Household Survey、China Statistical Yearbook Technology	x_7
	Amount of agriculture-related websites in Millions of people	CNNIC Statistics	x_8
	Rural per capita reserves of agricultural books	China Yearbook published	x_9

TABLE3 THE OUTPUT INDICATORS OF AGRICULTURAL INFORMATION EFFICIENCY EVALUATION

Level Indicators	Secondary Indicators	Source	Indicator Code
Farmer Output	Per capita net income of rural residents	China Agricultural Statistics Yearbook	y_1
	Farmers per capita food production	China Agricultural Statistics Yearbook	y_2
Social output	Per capita amount of Posts and Telecommunications	China Statistical Yearbook Information	y_3
	The proportion of agricultural added value in total output value	China Agricultural Statistics Yearbook	y_4

IV. DATA ANALYSIS

A. *The initial data analysis*

It is concluded in this paper that the optimal point envelope of the output/input ratio to determine the efficient frontier by using the CCR-O model of DEA and choosing 9 input indicators and 4 output indicators. Obviously, the decision unit deviating farther from the efficient frontier is lower relatively, while those closer is higher.

Through DEA software processing of input and output data of 31 provinces, cities and autonomous regions in our country, we calculate their efficiency and the result is shown in Fig.1. The efficiency of decision making for 1 unit constitutes the efficient frontier. The Fig.1 shows cities in the efficient frontier are Beijing, Shanghai, Tianjin, Neimenggu, Jilin, Heilongjiang, Jiangsu, Zhejiang, Anhui, Jiangxi, Hubei, Hunan, Guangxi, Guangdong, Hainan, Chongqing, Sichuan, Guizhou, Xizang, Xinjiang and other 20 provinces and cities autonomous region; in the second level is Shandong, Liaoning, Hebei, Henan, Fujian, etc. Efficiency of Shanxi's agricultural information is the lowest, the value is 0.6612.

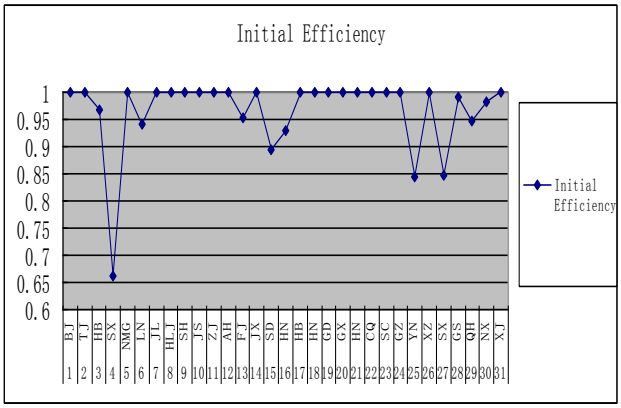

Figure 1. Initial Efficiency

From Fig.1, we can see that agricultural information efficiency in 11 provinces, cities, and autonomous regions is non DEA effective.

B. *Fractal dimension efficiency analysis*

The efficiency of various provinces, cities and autonomous regions on the two kinds of output indicators are shown in Fig.2.In Fig.2, the efficiency of farmers' output and social output in China's 31 provinces, cities and autonomous regions is divided into 4 parts by using two parallel and perpendicular lines.

As is shown in Fig.2, both farmer output and social output efficiency in Beijing, Shanghai, Tianjin and Jiangsu are higher, greater than 0.85; Hebei, Liaoning, Henan, Qinghai and other provinces have a lower farmers' produce efficiency but higher social output efficiency; Gansu, Guangxi and other provinces have a lower social output efficiency but higher farmers' output; Shanxi province in the two aspects of output efficiency is very low.

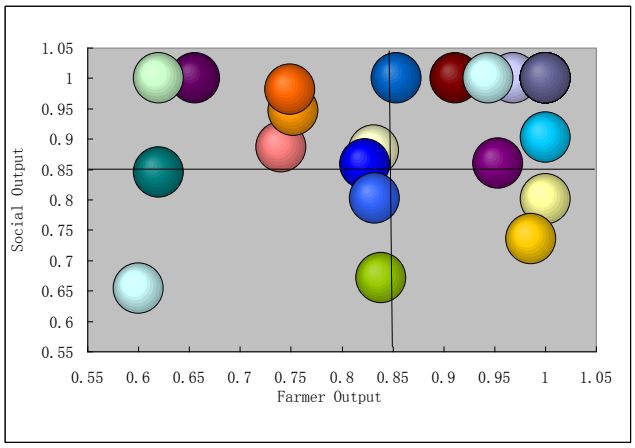

Figure 2. Interval efficiency

C. *Sensitivity Analysis*

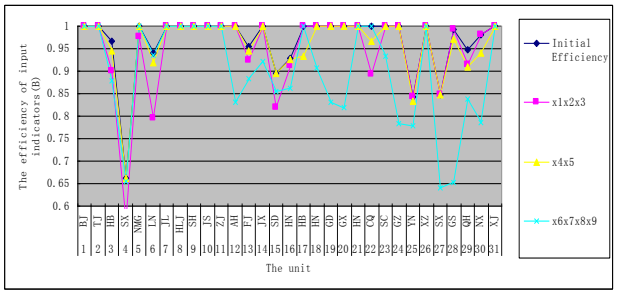

Figure 3. The efficiency of input indicators (B)

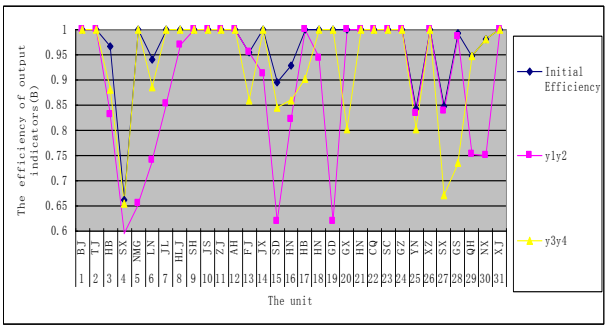

Figure 4. The efficiency of output indicators (B)

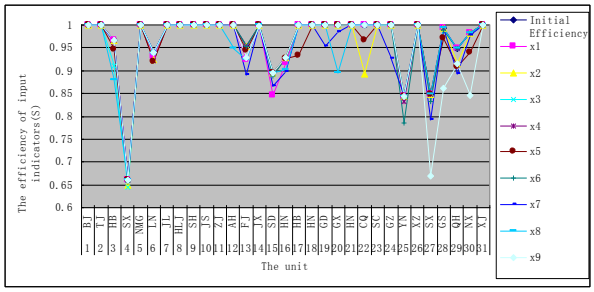

Figure 5. The efficiency of input indicators (S)

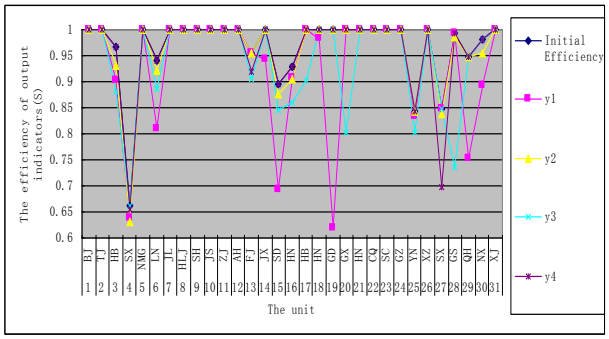

Figure 6. The efficiency of output indicators (S)

In this paper, the sensitivity analysis is divided into input index sensitivity and output index sensitivity analysis of two aspects, both of which are parsed according to both primary and secondary indicators.

First of all, analyze the sensitivity according to the primary index sensitivity and output index sensitivity, namely investigating the fluctuation of efficiency of various provinces, cities and autonomous regions from the investment of agricultural information structure, talents and resources and farmers' output benefits and social output benefits. If the difference between the efficiency of decision-making unit is the largest when other indicators remain the same after removing some indicators, this means that the index for decision-making unit is the most sensitive factors.

According to Fig.3, efficiency in Beijing, Jilin, Heilongjiang, Jiangsu, Zhejiang, Xizang and Xinjiang remains the same after removing any one input indicator, while in Fig.4, that the efficiency value has not changed is Beijing, Tianjin, Shanghai, Jiangsu, Zhejiang, Hainan, Chongqing, Sichuan, Guizhou, Tibet and Xinjiang after removing any one primary output indicator. Fig.3 tells us that the efficiency of Guizhou changes from 1 to 0.7835, making a difference of 0.2165 after removing the influence factor of agricultural information resources. That indicates that the agricultural information resources of Guizhou have the greatest effect on the agricultural information efficiency. Therefore, if you want to improve the agricultural information efficiency in Guizhou in terms of the index, you can achieve good results.

From Fig.4, we can see efficiency in Guangdong is the largest after removing farmers' output benefit index, being 0.3807, which indicates that Guangdong province must strengthen the farmers' output benefit if he wants to improve the agricultural information efficiency.

In addition, we can analysis the influence the 9 second input index and 4 second output index have on agricultural information efficiency. From Fig.5, we can that the television, computer and telephone have small effect on agricultural information efficiency, and the efficiency of the majority of decision-making units changes little or even remains unchanged. The efficiency difference of Shanxi province is the largest, being 0.1790 after removing per capita agricultural books inventory, suggesting that for Shanxi province, the per capita agricultural book capacity had the largest influence on its efficiency.

After removing the proportion of the added value of agriculture according to Fig.6, the largest difference of efficiency value in Gansu province is 0.2559, namely the sensitivity of agricultural information efficiency to the total value added of Shanxi province is the largest.

Through sensitive analysis, we can know clearly the most effective improvement direction of the provinces, cities and autonomous regions, which benefits for the optimal allocation of the elements of the agricultural information and reduces resource waste.

V. CONCLUSION AND OUTLOOK

A. *Conclusion*

The paper constructs the agricultural information evaluation efficiency index system and uses the method of DEA to analyze agricultural information efficiency in 31 provinces and autonomous regions in our country, then comes to the conclusion:

a) The efficiency of Beijing, Shanghai, Tianjin, Jiangsu, Zhejiang and other 20 provinces and municipalities autonomous regions is 1, which is in the efficient frontier. But efficiency of the rest 11 like Shandong, Liaoning, Henan, Hebei, Fujian is less than 1, among which Shanxi province is lowest. But there are small overall differences in our country's agricultural information efficiency.

b) The provinces and autonomous regions who is not in efficient frontier and has efficiency less than 1 indicate there exists improvement and room for promotion. First, we can use some reference set and weight compared with effective decision making unites to improve the information efficiency. Second, the efficiency will be divided into "four quadrants" according to the social output indicators and farm output. *H*ebei, iaoning and other provinces in the second quadrant which have high social output and lower farm output. Therefore, they should focus on strengthening elements in peasant household production in agricultural information. The decision unite in the forth quadrant has higher farm output and lower social output. So they need to increase the agricultural information production elements into social output. And both farmers output and social output in the third quadrant of Shanxi province are at a lower level, which shows that space has great progress in agricultural information in Shanxi province and it requires planning from the two aspects of farmers and social or conversion for elements in agricultural information; last, give specific guidance in the direction of agricultural information factors of production. For instance, the most sensitive factors that influence agricultural information efficiency of Guizhou is agricultural information resources, indicating that if Guizhou wants to improve efficiency, efforts in this aspect can make obvious progress mostly.

B. *Outlook*

Though it is not hard to find there are small differences overall in our country's agricultural information efficiency, there are limitations in choosing index of measuring input and output indicators of agricultural information efficiency. So errors may be obtained through the data. Hence in the future research we need to continually improve the measure indicators of the agricultural information efficiency in order to probe into the factors of agricultural

information efficiency from a deeper level and apply modern technology and the organic combination of various factors of production truly to improve the agricultural information efficiency.

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