Evaluation on the Influencing Factors of Agricultural Land Productivity in Huang - Huai Plain, China

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Abstract Taking Huang - Huai Plain as an example, evaluation index system is established from four aspects, including the resources condition, the social and economic condition, the agricultural science and technology condition, and the disaster resistant and sustainable production condition. Correlation coefficient method and expert consultation method are used to determine the weight of evaluation index. After the standardization of extreme value, weighted sum method and multiple regression method are adopted to evaluate the influencing factors of agricultural land productivity in Huang - Huai Plain, China. Evaluation result shows that agricultural science and technology condition has a lower contribution rate to the productivity of Huang - Huai Plain than that to Henan Province. Resources condition has a higher contribution rate to the productivity of Huang - Huai Plain than that to Henan Province. Both the social and economic condition and the disaster control and sustainable production condition show relatively small contribution rate to the productivity of Huang - Huai Plain. It can be concluded that the main factors affecting the productivity of Huang - Huai Plain are the backward agricultural science and technology level, the poor farmland quality and the farmland infrastructure. Based on this, relevant suggestions are put forward to improve the farmland productivity of Huang - Huai Plain.

Key words Huang - Huai Plain, Agricultural land productivity, Influencing factor, Evaluation index system, China

The work of productivity accounting of agricultural land has been finished in China, including the total grain production in all provinces, autonomous regions and municipalities[1]. It has obtained the comprehensive production capacities of agricultural land in different regions and the spatial variation law of productivity of farmland. However, the influencing factors of productivity and how to improve productivity have not yet studied, and the major influencing factors of agricultural land productivity have not been found out. Therefore, the Ministry of Land and Resources deploys the task of studying on production influencing factors based on the accounting work of agricultural land productivity. Henan Province is the largest agricultural province and the biggest grain production province in China. Since Huang - Huai Plain is the main producing region of agricultural products in Henan Province, we select Huang - Huai Plain as the research region to study on the main factors affecting the farmland productivity, to find out the factors restricting the enhancement of farmland productivity in this region at present, to offer scientific basis for the agricultural production development trend in research region, and to provide references for the productivity construction in the core grain region in Henan Province, China.

1 Data source, evaluation index and model establishment

1.1 Data source Data are from the 2007 *Henan Survey Yearbook*, the 2007 *Henan Statistical Yearbook*, the 2000 population census data of Henan Province, the 2007 statistical yearbook of different cities, and the realizable total productivity from the result of the agricultural land throughput calculation product.

1.2 Establishment of evaluation index According to the comprehensive, operational, concise and comparable principles, a comprehensive evaluation index system with four layers (total target layer, sub-target layer, factor layer and specific factor layer) is constructed based on the relevant research achievements of domestic and foreign scholars[2-6]. Table 1 reports that the total target layer is the regional agricultural land productivity; sub-target layer includes resource condition, socio-economic condition, agricultural technology condition, and disaster control and sustainable production condition. Factor layer consists of input, land resource, water resource, and farmland capital construction level. And specific factor layer is obtained through investigation. Through the sensitivity test, the remaining specific factors are all the sensitive factors to the productivity.

1.3 Construction of model

1.3.1 Standardization treatment of evaluation index. In order to eliminate the differences in units and data orders between productivity and influencing factor. Standardization of extreme value is carried out before modeling. The equation is

$$y_{ij} = \frac{x_{ij}}{\max(x_j)},$$

where y_{ij} is the standardized index value of the ith sample of factor j, x_{ij} is the original value of the ith sample of factor j, $\max(x_j)$ is the maximum of factor j.

1.3.2 Action mode of evaluation index on productivity. Since not all the indices have linear effect on productivity, action mode of index on productivity needs to be determined before modeling. And index with non-linear action mode needs corresponding treatment. According to the determination coefficient of regression model between factor and productivity, action

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mode of productivity is determined by contrastive analysis method. Result shows that grain multiple cropping index, fertilizer input, total power of agricultural machinery, pesticide application, and agricultural employee have the logarithm action mode on productivity. And the effective irrigation area has an index action mode on productivity. The rest have linear action mode.

Table 1 Evaluation index system of the influencing factors of farmland productivity in Huang – Huai Plain

Total target layer	Sub-target layer	Factor layer	Specific factor layer
Regional agricultural land productivity	Resource condition	Land resource	Average utilizable grade of farmland, grain sowing area, ratio of grain crops to industrial crops
		Water resource	Total water resources
		Climatic resource	Grain cropping index
	Socio-economic condition	Input	Chemical fertilizer consumption, agricultural machinery gross power, pesticide use, agricultural working population
		Grain production level	Unit grain yield
	Agricultural technology condition	Scientific and technological quality of labor force	Proportion of labor force graduated from junior high school
		Agricultural technology level	Three items of expenditure on agricultural science and technology
	Disaster control and sustainable production condition	Farmland capital construction level	Effective irrigation area

1.3.3 Establishment of the productivity influencing factor evaluation model for agricultural land. The index in specific factor layer has different influencing modes on productivity. Considering the generality of model, evaluation model is established by hierarchical modeling method. First, obtain the weighted sum of data at specific factor layer and calculate the data at factor layer. Second, obtain the weighted sum at factor layer and calculate the index at target layer. Third, carry out multiple regression on the data at sub-target layer and the data at productivity sample point data, and simulate productivity. The weighted sum method is a modeling method for both the first and second layers. Therefore, determination method of weight is the key to the modeling. In order to objectively reflect the relative important degree of index to productivity, Preliminary value of weight is determined by correlation coefficient, that is, the value of correlation coefficient between index and productivity. Greater correlation coefficient leads to higher weight, and *vice versa*. Due to the complexity of agricultural production, it is difficult to reflect the real importance degree of index only by the value correlation coefficient. Therefore, preliminary value of weight determined by correlation coefficient should be revised by experts. But the weight after revision is not the final weight. And adjustments time after time are needed according to the simulation efficiencies of models.

2 Result and analysis

2.1 Evaluation on the influencing factors of productivity of agricultural land According to the evaluation model, influencing factors of productivity are evaluated in both Henan Province and Huang – Huai Plain. Table 2 reports the result of evaluation.

2.2 Analysis of the evaluation result Evaluation result shows that indices at sub-target layer have different contribution rates to the two regions. Among them, agricultural science and technology condition and resource condition have the most significant difference in the contribution rates of the two regions. Agricultural science and technology condition has a contribution rate of 26% to the productivity of Huang – Huai Plain and a contribution rate of 29% to Henan Province, a difference of 3 percentage points. And the average contribution rate of agricultural science and technology to productivity in China is 48%[7], indicating that the contribution rate of Huang – Huai Plain is a little lower compared with the contribution rate of Henan Province and the average level of China, which restricts the enhancement of productivity. Meanwhile, the difference of 22 percentage points between the average level of China and the Huang – Huai Plain indicates that there is still a more room to improve the contribution rate of agricultural science and technology in Huang – Huai Plain. Restricted by the ecological protection, urban expansion and other factors, the most effective way to improve the regional productivity is to enhance the contribution rate of agricultural science and technology to productivity. Contribution rate of resource condition to Huang – Huai Plain is 3 percentage points more than that to Henan Province, showing that the farmland quality, water resource and natural resource conditions are superior to those of Henan Province. Among the resource condition, contribution rate of land resource has the largest increase, from 0.41 to 0.44. And among the land resources, contribution rate of farmland quality increases from 0.23 to 0.28, an increase of 5 percentage points, which is the greatest. This shows that the Huang – Huai Plain with relatively good farmland quality has played a larger role in the status exertion of regional productivity.

Disaster control and sustainable condition has small difference with social and economic condition in the contribution rates of productivity in Henan Province and Huang – Huai Plain, which are both within 1 percentage point. This reflects that the current conditions of these two factors have little differences in the two regions, and the contribution rates of these two indices to productivity are a little lower. Thus, the agricultural infrastructure and the farmland management level are relatively low.

In a word, main factors affecting the grain productivity in Huang – Huai Plain at present are the low quality of farmland, the low level of farmland infrastructure, and the insufficient contribution of agricultural scientific and technological level to productivity.

Table 2 Evaluation result of productivity influencing factors in both Huang – Huai Plain and Henan Province

Item	Name of index	Contribution rate//%		Item	Name of index	Contribution rate//%	
		Whole province	Typical area			Whole province	Typical area
Specific factor layer	Sown area of grain	0.48	0.52	Factor layer	Land resource	0.41	0.44
	Farmland quality	0.23	0.28		Water resource	0.28	0.27
	Ratio of grain crop to cash crop	0.29	0.20		Climate resource	0.31	0.29
	Total water resource	1	1		Input	0.56	0.47
	Multiple cropping index of grain	1	1		Level of food production	0.44	0.53
	Fertilizer input	0.28	0.26		Scientific and technological quality of labor force	0.68	0.6
	Total power of agricultural machinery	0.26	0.31		Scientific and technological level of agriculture	0.32	0.4
	Pesticide application	0.2	0.18		Basic construction level of farmland	1	1
	Agricultural employee	0.26	0.25	Sub-target layer	Resource condition	0.36	0.39
	Unit area grain yield	1	1		Social and economic condition	0.14	0.13
	Proportion of agricultural population graduated from middle school or above	1	1		Condition of agricultural technology	0.29	0.26
	Three items of expenditure on agricultural science and technology	1	1		Disaster control and sustainable condition	0.21	0.22
	Effective irrigation area	1	1				

3 Major measures to improve the farmland productivity in Huang – Huai Plain

3.1 Strengthening the farmland protection Firstly, stabilize the area of farmland; establish strict protection mechanism for farmland. Secondly, strengthen the protection and improvement of farmland quality; actively promote the farmland consolidation and the quality construction of standardized farmland; minimize the water and soil loss caused by land slide and debris flow; realize the quantity and quality balance of total amount of farmland; implement the " Project of Soil Fertility Increase" ; control the impact of soil pollution and farmland ecological problems on farmland quality. Finally, establish a long-term mechanism for farmland quality protection; realize the routine and institutionalized monitoring of farmland quality; enhance the construction and management levels of farmland quality; and effectively inhibit the decline of farmland quality.

3.2 Accelerating the scientific and technological progress and improving the scientific and technological popularization Firstly, government should increase the investment in agricultural science and technology, make better use of the scientific research capacity of universities and scientific research institutions, and offer necessary material preconditions for the release of scientific research capacity by capital injection. Secondly, private enterprises are allowed to enter into the field of applied agricultural science and technology; and a diversified agricultural research system led by government should be established in order to promote the transfer of scientific research. Finally, accelerate the subsidy and incentive mechanism for agricultural technology promotion, government should fully mobilize the subjective initiative of scientific research institutions and peasant collectives, improve the conversion mechanism of agricultural science and technology, and eliminate the disjunction between the innovation and application of agricultural science and technology, so that science and technology will realize the timely and effective use in the actual agricultural production, and will be turned into the practical agricultural productivity.

3.3 Improving agricultural infrastructure Improving agricultural infrastructure can reduce the adverse effect of insufficient supply of water resources, make the limited water resources play a more effective role, and improve the utilization efficiency of water resources. Strengthening the agricultural infrastructure construction should fully mobilize the enthusiasm of both government and individual. Firstly, speed up the legalized process of the standardization and institutionalization of major agricultural support policies. Secondly, the investment priority of farmland infrastructure construction should be transferred into small and medium irrigation and road construction. Thirdly, a series of policies should be developed as soon as possible in order to make individual farmers investment more in irrigation and water conservancy facilities.

4 Conclusion and discussion

Based on the accounting results of farmland productivity, evaluation index system of productivity influencing factors is established, and empirical study on the influencing factors of farmland productivity in Huang – Huai Plain is carried out. The main factors affecting the productivity of local farmland at present are obtained, which are the low farmland quality, the low level of farmland infrastructure, and the insufficient contribution of agricultural scientific and technological level to productivity. Therefore, corresponding measures should be adopted to improve the farmland productivity. And there are still some problems. For instance, the comprehensiveness and rationality of

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(2) Relatively low income of farmers from farmland transfer. Sample shows that the farmland transfer contracts before the year 2005 are mainly in the pricing form of a fixed number of currency and some of the contracts have a time limit over 30 years. The long time limit and unscientific pricing mode have restricted farmer's benefit sharing from land value increment. Meanwhile, there is an irrational phenomenon in some townships. The transfer mode is land share, but farmers can not enjoy the allocation of profits and only receive dividends at a fixed number of currency or grain. Therefore, farmers should bear the management risk but can neither participate in the decision-making of company, nor share the operation benefits of the company.

(3) Quality decline of farmland and difficult full reclamation in transfer period. Scale management of farmland leads to the change of a large amount of farmland into agricultural non-cultivated land. And naturally, some will be used for the construction for productive purposes. After the time limit of transfer or meeting operation problems, it may be difficult for farmers to returning the land into farmland, which threatens the long-term interests of land.

4 Countermeasures and suggestions

4.1 Using a unified contract; improving the record and supervisory system A unified contract can ensure the complete articles and complete procedures in every transfer contract. We should improve the organization, standardize the behavior of farmland transfer, strengthen the standardization and legalization of farmland transfer contract, establish a perfect recording system of contract, and form professionals and specialized agencies[1]. At the same time, we should also set up specialized identification institutions for farmland transfer contract in townships, implement relevant polices to avoid the contract invalidation and contract breaking.

4.2 Innovating farmland transfer mode Farmers can select grain as a payment mode, which has the function of ensuring the basic needs. And an increasing payment year by year in proportion or payment according to the growth rate of CPI should be adopted when possible. We should innovate a transfer mode, try to implement the plan of "housing land for housing, contract land for social security"[2], adopt new modes to make farmers enjoy more benefits, such as establishing rural land cooperative with land management right as the share[3], strengthen the training and education for grass-roots cadres and farmers' representatives, make sure that farmers understand the contents of transfer modes, clarify the rights and obligations, and eliminate the inequality in the contract.

4.3 Paying attention to the use of farmland transfer; improving related security systems Contract signature should conform to the rules formulated by the state, that is, land after transfer should be used as agricultural land. Specialized agency is sent to monitor the use situation of farmland after transfer, to detect the quality of farmland regularly, to ensure the capacity of agricultural land reclamation, to guarantee the red line of farmland area, and to safeguard the long-term interests of farmers. At the same time, we should establish a specialized protection regime for farmers' land rights action, improve the rural social security system, and offer better external conditions for land transfer.

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the index system selected still need further verification, because there are many factors affecting the farmland productivity. Besides, this research only evaluates the influencing factors of regional total yield, but neglects the influencing factors of unit yield. Therefore, differences between total yield and unit yield also need further research.

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