A study of the coordinated development of informatization and agricultural modernization in central China

Qing Wang and Chen Li

School of Management, Anhui Jianzhu University, Hefei, Anhui, China

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ABSTRACT

Agricultural modernization is an important part of national modernization. Informatization is the inevitable trend of economic and social development. Now informatization is no longer just a way to realize agricultural modernization, but as a new type of productivity, becomes one of the core elements of agricultural modernization, is the only way for the construction of agricultural modernization with Chinese characteristics. This paper calculates the development level of the informatization and agricultural modernization in central region in China, and the synergy degree of them. At last, based on the results of this study and real situations, some suggestions are put forward accordingly.

Keywords: Informatization; Agricultural modernization; Synergy degree; Central region

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INTRODUCTION

With the rapid development of the global information, developed countries are taking information industry as their core industry. Under this background, informatization is not only the essential condition and the important means of promoting the progress of agricultural science and technology, but also an important part of the construction of agricultural modernization. In November 2012, the report of the Eighteenth National Congress of the CPC changed the synchronous development of industrialization, urbanization and agricultural modernization to the synchronous development of industrialization, informatization, urbanization and agricultural modernization, highlighting the prominent status of informatization. In March 2013, the vice premier of the State Council, Wang Yang pointed out that, informatization represented the commanding heights of the modern agricultural civilization.

At present, informatization has become a new driving force for economic growth. Simultaneously, the level of informatization has been an important symbol of measuring the level of modernization of a country. As a part of the national modernization, agricultural modernization should't be the victim of "digital divide". Informatization should't be a new performance gap between the urban and the rural. Therefore, promoting their coordinated development is a key means to narrow the gap between the urban and the rural, which can achieve the integration of the urban and the rural. This paper constructs the evaluation index system based on system theory, and determines the weight of each index based on the entropy weight. Finally it defines the equation about the synergy degree based on the benefit theory and balance theory. Then scientific and effective calculation of the synergy degree can provide quantitative and scientific basis for the study on the synchronous and harmonious development, which can improve the accuracy and scientific of government decision-making.

2. Entropy weight and synergy degree
In an evaluation problem that has m evaluated objects and n criteria for each object, using the extreme value method to standardize original data.

$$x_{ij} = a_{ij}/\max(a_{ij}) \text{ or } x_{ij} = \min(a_{ij})/a_{ij} \quad i=1,2,\cdots,n; j=1,2,\cdots,m. \tag{1}$$

Where x_{ij} indicates the normalized eigenvalue of the jth bid with regarding to the ith criterion.

2.1 Defining the entropy weight

Entropy is the degree of orderly system, which is used to represent the degree of homogeneity of any kind of energy in spatial distribution. The more homogeneous energy distribution, the greater the entropy is. The ith criterion's entropy is defined as follows.

$$e_i = -t\sum_{j=1}^{m} g_{ij} \ln g_{ij}. \tag{2}$$

Where $g_{ij} = x_{ij}/\sum_{j=1}^{m} x_{ij}, t = 1/\ln m$.

In this evaluation problem, the ith criterion's entropy weight is defined as follows.

$$w_i = (1-e_i)/(n - \sum_{i=1}^{n} e_i), 0 \le w_i \le 1, \sum_{i=1}^{n} w_i = 1. \tag{3}$$

The entropy weight represents the degree of the criterion providing useful information from the viewpoint of information theory. Entropy weights of indices are determined by the contrast intensity of the object's performance ratings with respect to each criterion.

2.2 Calculating the development level of each subsystem

Using the linear weighted method to calculate the development level of each subsystem.

$$A = \sum_{i=1}^{n} x_{ij} w_i. \tag{4}$$

2.3 Calculating the synergy degree

Coordinated development is the strength of interactive coupling and mutual promotion of internal system elements. According to the synergy theory and efficiency theory, the coordinated development can be used to obtain the maximum comprehensive benefit. Generally, the product of elements' benefits represents the composite benefit. The weighted sum of multiple composite benefits represents comprehensive benefit. The synergism of informatization and agricultural modernization is pursuing the maximum composite benefits based on comprehensive benefit maximization. The comprehensive benefit is the sum of subsystems' development level, the composite benefit is the product of their development level, which is adopted to build the following equation.

$$C = AB/(\frac{A+B}{2})^2. \tag{5}$$

Where C is the synergy degree of A and B, A is informatization's development level, B is agricultural modernization's development level. C is in [0, 1], when C is more close to l, the system's synergy degree is higher, and vice versa. When C=0, the system's synergy degree is minimum and the system is chaos collapse. The synergy degree can be divided into two categories: coordination and offset, including 7 levels. Level 1 $C \in [0.9,1.0]$ means that the system is high coordination, level 2 $C \in [0.8,0.89]$ means that the system is good coordination, level 3 $C \in [0.7,0.79]$ means that the system is intermediate coordinate, level 4 $C \in [0.6,0.69]$ means that the system is primary coordination, level 5 $C \in [0.5,0.59]$ means that the system is barely coordination, level 6 $C \in [0.4,0.49]$ means that the system is on the verge of disorder, level 7 $C \in [0,0.39]$ means that the system is disorder.

3. Empirical study

3.1 Present situation of informatization and agricultural modernization in central region

There is no unified evaluation criteria about the coordinated development of informatization and agricultural modernization.This paper makes reference to IDI and the existing index system , considering the availability of data, and then establishes the index systems.

3.1.1 Present situation of informatization in central region

In recent years, China has been one of the fastest growing global informationization. Simultaneously, central regional informatization construction keeps on developing at a rapid speed. The informatization level of central region is not high in the Chinese overall ranking. The gap among six provinces is obvious. The main reason is that from 1980s to 1990s, the development of central region had a "collapse". In this century, the development modes for accelerating of the six provinces in central are different.

Tab.1 The index system of development level of informatization in central region

Factor layer	Index layer	Jiangxi	Henan	Shanxi	Hubei	Anhui	Hunan
Infrastructure index	TV Ownership（Set/one hundred households）	107	106	109	110	112	96
	Mobile telephone Ownership（Set/one hundred households）	206.71	200.20	188.39	204.35	202.61	198.22
	Fixed telephone Ownership（Set/one hundred households）	60.34	51.98	70.54	59.32	74.57	57.48
Application of consumption index	Computer Ownership（Set/one hundred households）	78.17	74.41	74.07	81.91	79.57	74.77
	Per capita information consumption（Yuan RMB/person）	586.04	605.09	660.08	609.90	797.67	662.23
Knowledge support index	Proportion of information industry practitioners（%）	1.11	0.71	1.22	0.94	1.03	1.25
	Number of college students per ten thousand people（person）	177	171	164	232	170	162
Development effect index	GDP per capita（Yuan RMB per capita）	28800	31499	33628	38572	28792	33480
	Proportion of information industry's R&D expenditure（%）	0.46	0.22	0.40	0.55	0.47	0.41

（*Source:Chinese statistical yearbook 2013 and statistical yearbooks of provinces 2013*）

3.1.2 Present situation of agriculture modernization in central region

According to the Statistical Yearbooks, in 2010 the total area of arable land in central region was 47,917.90 thousand hectares, the crop acreage was 28214.8 thousand hectares, the total number of mechanical power was 13.1 kilowatts per square meter.

Tab.2 The status of development level of agricultural modernization in central region

Objective layer	Factor layer	Index layer	Jiangxi	Henan	Shanxi	Hubei	Anhui	Hunan
Agro-economic modernization	Supplies and equipment	Per ha arable land mechanical power（KW/ ha）	2.19	8.98	7.54	10.70	4.95	3.66
		Effective irrigation rate(%)	66.06	64.98	32.66	73.05	84.78	82.54
		Per ha arable land Chemical fertilizer(Kg/ha)	49.79	84.99	28.25	105.56	78.79	72.46
	Science and technology investment	Proportion of science and technology personnel in agricultural practitioners(%)	6.84	5.82	5.73	7.22	4.97	7.63
		Proportion of junior high school and higher education in agricultural practitioners(%)	79	77	68	82	73	84
	Agricultural output levels and management	Agricultural labor productivity（Yuan RMB/person）	41955	39261	29839	42281	33159	35477
		Proportion of the Primary Industry (%)	11.90	13	5.70	13.10	13.20	14.10
		Proportion of the Primary Industry practitioners(%)	34.40	44.90	38.30	45.70	38.80	41.90
Agro-community modernization	Rural development	Farmers per capita net income（Yuan RMB）	7829.4	7524.9	6356.6	7851.7	7160.5	7440.2
		Engel's Coefficient of rural(%)	43.50	33.80	33.40	37.60	39.30	43.90
Agro-ecological modernization	Sustainable development level	Forest coverage(%)	58.32	20.16	14.12	31.14	27.53	44.76

(Source:Chinese statistical yearbook 2013 and statistical yearbooks of provinces 2013)

Tab.3 The standardized data of informatization in central region

Factor layer	Index layer	Jiangxi	Henan	Shanxi	Hubei	Anhui	Hunan
Infrastructure index	TV Ownership	0.955	0.946	0.973	0.982	1	0.982
	Mobile telephone Ownership	1	0.969	0.911	0.989	0.980	0.989
	Fixed telephone Ownership	0.809	0.697	0.946	0.795	1	0.795
Application of consumption index	Computer Ownership	0.954	0.908	0.904	1	0.971	1
	Per capita information consumption	0.735	0.759	0.828	0.765	1	0.765
Knowledge support index	Proportion of information industry practitioners	0.888	0.568	0.976	0.752	0.824	0.752
	Number of college students per ten thousand people	0.763	0.737	0.707	1	0.733	1
Development effect index	GDP per capita	0.747	0.817	0.872	1	0.746	1
	Proportion of information industry's R&D expenditure	0.836	0.4	0.727	1	0.855	1

Using entropy weight (Eq. 2-3) to calculate and obtain the weight of each index.

3.2 The development level of informatization and agricultural modernization
3.2.1 The development level of informatization in central region

According to the table1 and table2,the indicators are all positive indicators,and the datum in table1 are standardized

by Eq. 1, as shown in table 3.

Tab.4 The index weight of informatization subsystem

Factor layer	Index layer	w_i
Infrastructure index	TV Ownership	0.1118
	Mobile telephone Ownership	0.1119
	Fixed telephone Ownership	0.1112
Application of consumption index	Computer Ownership	0.1118
	Per capita information consumption	0.1114
Knowledge support index	Proportion of information industry practitioners	0.1104
	Number of college students per ten thousand people	0.1111
Development effect index	GDP per capita	0.1114
	Proportion of information industry's R&D expenditure	0.1090

Using Eq. 4 to obtain the informatization's development level in 2012, as shown in table 5:

Tab.5 The development level of informatization in central region

	Jiangxi	Henan	Shanxi	Hubei	Anhui	Hunan
Infrastructure index	0.3087	0.2917	0.3160	0.3089	0.3327	0.2888
Application of consumption index	0.1067	0.1016	0.1011	0.1118	0.1086	0.1021
Knowledge support index	0.2646	0.2291	0.2785	0.2793	0.2838	0.2805
Development effect index	0.1743	0.1346	0.1764	0.2204	0.1763	0.1779
Level of development of informatization	0.8544	0.7569	0.8719	0.9204	0.9014	0.8493

According to table 5, in the development level of the central region's informatization, Hubei is the highest, followed by Anhui and Shanxi, Hunan and Henan are weak. As a whole, the central region is in the stage of development, and its overall level is not high. There is lager room for development in technology application and infrastructure.

3.2.2 The development level of agricultural modernization in central region
According to the table 2, the indicators include nine positive indicators and two negative indicators(Proportion of the Primary Industry practitioners and Engel's Coefficient of rural). The datum in table 2 are standardized by Eq. 1, as shown in table 6:

Tab.6 The standardized data of agricultural modernization in central region

Objective layer	Factor layer	Index layer	Jiangxi	Henan	Shanxi	Hubei	Anhui	Hunan
Agro-economic modernization	Supplies and equipment	Per ha arable land mechanical power	0.2047	0.8393	0.7047	1	0.4626	0.3421
		Effective irrigation rate	0.0078	0.0077	0.0039	0.8616	1	0.0097
		Per ha arable land Chemical fertilizer	0.4717	0.8051	0.2676	1	0.7464	0.6864
	Science and technology investment	Proportion of science and technology personnel in agricultural practitioners	0.8965	0.7628	0.7510	0.9463	0.6514	1
		Proportion of junior high school and higher education in agricultural practitioners	0.9405	0.9167	0.8095	0.9762	0.8690	1
	Agricultural output levels and management	Agricultural labor productivity	0.9923	0.9286	0.7057	1	0.7843	0.8391
		Proportion of the Primary Industry	0.4790	0.4385	1	0.4351	0.4318	0.4043
		Proportion of the Primary Industry practitioners	0.7527	0.9825	0.8381	1	0.8490	0.9168
Agro-community modernization	Rural development	Farmers per capita net income	0.9972	0.9584	0.8096	1	0.9120	0.9476
		Engel's Coefficient of rural	0.7678	0.9882	1	0.8883	0.8499	0.7608
Agro-ecological modernization	Sustainable development level	Forest coverage	1	0.3457	0.2421	0.5340	0.4721	0.7675

Using entropy weight (Eq. 2-3) to calculate and obtain the weight of each index.

According to table 8, the materials and equipment of Hubei is the best. Agricultural output and management level of Shanxi is better than others. Agricultural and social development in Henan, Shanxi, Anhui are better. The highest level of sustainable development in Jiangxi means there is great potential for development. Overall, the development level of agricultural modernization in Hubei is the highest. While the level of agricultural modernization in the central region as a whole is not high, it's still in the development stage.

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Tab.7 The The index weight of agricultural modernization subsystem

Objective layer	Factor layer	Index layer	权重
Agro-economic modernization	Supplies and equipment	Per ha arable land mechanical power	0.2762
		Effective irrigation rate	0.0869
		Per ha arable land Chemical fertilizer	0.1629
	Science and technology investment	Proportion of science and technology personnel in agricultural practitioners	0.0253
		Proportion of junior high school and higher education in agricultural practitioners	0.0058
	Agricultural output levels and management	Agricultural labor productivity	0.0182
		Proportion of the Primary Industry	0.1546
		Proportion of the Primary Industry practitioners	0.0111
Agro-community modernization	Rural development	Farmers per capita net income	0.0057
		Engel's Coefficient of rural	0.0136
Agro-ecological modernization	Sustainable development level	Forest coverage	0.2397

By using Eq. 4, we obtain the development level of agricultural modernization in 2012, and results are listed in table 8.

Tab.8 The development level of agricultural modernization in central region

	Jiangxi	Henan	Shanxi	Hubei	Anhui	Hunan
Supplies and equipment	0.2011	0.4296	0.2717	0.5140	0.3363	0.2909
Science and technology investment	0.0281	0.0246	0.0237	0.0296	0.0215	0.0311
Agricultural output levels and management	0.1005	0.0956	0.1767	0.0966	0.0905	0.0879
Rural development	0.0161	0.0189	0.0182	0.0178	0.0168	0.0157
Level of sustainable agricultural development	0.2397	0.0829	0.0580	0.1280	0.1132	0.1840
Level of development of agricultural modernization	0.5855	0.6515	0.5484	0.7859	0.5781	0.6097

3.3 Calculating the synergy degree
Using Eq. 5, the synergy degree is easily acquired, shown in table 9.

Tab.9 The Synergy degree of informatization and agricultural modernization in central region

	Jiangxi	Henan	Shanxi	Hubei	Anhui	Hunan
Level of development of informatization	0.8544	0.7569	0.8719	0.9204	0.9014	0.8493
Level of development of agricultural modernization	0.5855	0.6515	0.5484	0.7859	0.5781	0.6097
The Synergy Degree	0.9651	0.9944	0.9481	0.9938	0.9522	0.9730

As can be seen, the central region's synergy degree is at a higher level, and they all belong to high coordination, which means the informatization and agricultural modernization are in a state of rapid development. Among them, Henan's synergy degree and Hubei's are the highest, Hunan's and Jiangxi's are also good, while Anhui's and Shanxi's are relatively low. While from the aspect of the subsystems' developmental level, the developmental level of informatization in central region is weak, which means there are still many constraints. The attention of promoting the integration of them which is paid by central region is not enough. The existing equipment is backward. The level of productization is not high, the application of information technology is not widespread, a lack of technology application demonstration, and the speed of popularization is slower.

DISCUSSION AND CONCLUSION

Now it seems that promoting agricultural modernization by the informatization is very important for economically underdeveloped areas, especially for the six provinces in central as the big agricultural provinces. Therefore,we should try harder to transform traditional agriculture efforts by the informatization, let the information industry be a pillar and auxiliary industry of the development of modern agriculture, and strive to take their development as the core. Promoting the depth of integration of them, gradually narrowing the digital divide and building agricultural informatization official statistics system. Accelerating resource integration and sharing to further enhance supporting capacity of informatization on agricultural modernization in central region.

4.1 Establishing a mechanism for the development of agricultural informatization
Identifying needs and striving to solve the problems about the endogenous dynamic and sustainable development is continued. First, further strengthening top-level design, giving full play to the responsibilities of various departments to strengthen coordination; the second is to strengthen the power of agricultural informatization system, including the power of social organization; third, paying attention to summarize and popularize advanced experience, and supporting the R&D and promotion of advanced information technology; fourth, further strengthening the combination of government and market forces,and carrying out government welfare information services.

4.2 Paying attention to the infrastructure of agricultural informatization
Through laying a solid foundation, the agricultural informatization can run smoothly. First, we must strengthen the

construction of related facilities to ensure smooth communication; the second is to support telecom operators to accelerate the construction of agricultural informatization and the promotion of broadband networks in rural areas; the third is to strengthen the research and development of key technologies and equipments, encourage research institutions and manufacturing enterprises in the region to develop sensors and softwares to meet the needs of agriculture, and encourage agricultural producers to use these key technologies and equipments.

4.3 Formulating and implementing subsidy policy
First, paying subsidy to farmers who buy information service, including Internet access, farmers IT training, etc; second, paying subsidy to the application of information technology products, such as farmers, agricultural enterprises that choose the products in the list which are recommended by the government, to give some subsidies to reduce the costs of the first users; third, supporting the service and business practices of enterprises and other market forces, giving some policy support and financial support, such as the reduction of its tax burden, increasing credit support, lowering lending rates, etc to solve the social environment of operation and development.

REFERENCES

[1] CHN Rongtai Lin; CHN Jian Tan, J. *Procedia-Social and Behavioral Sciences*,**2013**, 96:1774–1783
[2] CHN Lingxian Zhang; CHN Xue Liu; CHN Daoliang Li et al., *J. Mathematical and Computer Modelling,* **2013**,58(3-4):862-870.
[3] CHN Lixin Xu; CHN Min Cheng, *J. Technology and Investment*, **2013**,04(04):229-235.
[4] CHN Kepei Men; CHN Shudan Zhu, *J. Statistical and Application*, **2013**, 02(01):17-23.
[5] CHN Zhaohong Wang; CHN Wei Zhan, *J. Systems Engineering Procedia*, **2012**,5:49-54.
[6] CHN Wu Zhong-lun, Research on regional difference of agricultural modernization in China C. Grey Systems and Intelligent Services (GSIS), **2011** IEEE International Conference on:140-144.
[7] CHN Kaijiang Tang, *J. International Journal of Business and Management*, **2011**, 6(5).
[8] CHN JunYan Yang; CHN Wen Chen. *China J. Science China Technological Sciences*, **2010**,53(9):2510-2514.
[9] CHN Qi Wang; CHN Xiaodan Wang. Assessment of agricultural modernization level in Zhejiang using SPSS software C. Computer Science and Education (ICCSE), **2010** 5th International Conference on:1069-1073.
[10]CHN Carol Ting; CHN Famin Yi, *China J. Telecommunications Policy*, **2013**,37(8):626-638.