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METHODOLOGY FOR ASSESSING THE IMPACT OF INFORMATION AND DIGITALIZATION ON AGRICULTURAL DEVELOPMENT

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A B S T R A C T

The article discusses the methodology for determining the relationship and correspondence between the agricultural development and informatization. Research on the interdependence between agricultural informatization and agricultural economics has shown that they play an important role in mutual assistance and integration. To assess the relationship between the development of agriculture and information technology using the method of entropy values and correlation analysis, a methodology was developed to assess the degree of relationship and compatibility using regional data for a certain period.

K E Y W O R D S

Agricultural informatization, agricultural development, agricultural economy, digitalization, entropy.

Introduction

In order to bring agricultural development and product prices to a fair level [0], it is necessary to accelerate the pace of agricultural informatization and implement an effective combination of agricultural production and information technology [2]. If we study the history of the development of agricultural enterprises, the level of agricultural informatization is the basis for the continuous development of the agricultural economy, and the agricultural economy encourages the introduction of informatization in the development of the sector [3]. Due to the close relationship between agricultural economics and field information [4], we will consider the relationship between them. Acceleration of agricultural informatization is an inevitable choice for the development of sustainable agriculture [5]. Some scholars [6] consider agricultural informatization to cover the entire farming process and rely on modern information technology equipment such as information networks and digitalization to support agricultural activities, control and manage agricultural resources, and support agricultural economic development and social informatization, they believed that it should be understood as a broad concept. Other scholars [7] have developed a system of relevant indices, taking into account the economic, social and environmental benefits, to comprehensively evaluate the benefits of agricultural informatization to understand the importance of agricultural informatization.

Research on the role of agricultural informatization is mainly expressed in the contribution of agricultural informatization to the rural economy [8], the integration of agricultural informatization and agricultural technological upgrading [9], and in the relationship between agricultural informatization

and agricultural economy [0Some scholars have studied the contribution of agricultural informatization to the agricultural economy and put forward countermeasures and suggestions for increasing the level of informatization [0]. Other scholars also created an indicator system of agricultural informatization and agricultural modernization, evaluated the degree of integration of agricultural informatization and agricultural modernization in the country and large regions, put forward countermeasures and proposals for the integration of agricultural informatization and agricultural modernization [0].

Thus, scholars research on the relationship between agricultural informatization and agricultural economics has shown that they play an integral role in mutual support and integration. In order to assess the relationship between agricultural development and informatization, using the entropy value method and link coordination analysis, a methodology for assessing the levels of relationship and compatibility was developed using relevant regional data of a certain period.

Agricultural informatization becomes more useful when the agricultural producer has more information resources, which allows to increase the agricultural economy [0]. With the rapid development of agricultural information technology, the methods of obtaining agricultural information by farms have become more flexible and efficient. Information transfer is no longer carried out in the form of primitive communication between people in the past, but with the help of computers and modern communication networks. This change significantly increases the efficiency and quality of agricultural information use by farmers [6]. Improvement of ICT infrastructure helps to overcome information limitation and information asymmetry in rural areas and is a necessary preparation for agricultural informatization [0]. The purpose of the study is to develop models to estimate the degree of dependence and the degree of coordination based on the republican statistical data from 2015 to 2022 using the entropy value method and linkage coordination analysis; to calculate the level of interdependence and coordination of agricultural informatization and economic development of agriculture in the republic every year, comprehensively analyze the level of coordination between them and propose appropriate countermeasures and suggestions. By 2022, the level of television and radio coverage in the republic has exceeded 97%, the level of coverage of mobile communication has also exceeded 95%, and the level of broadband Internet coverage is also increasing. This will help agricultural producers to get agricultural information faster and more conveniently, and will help to develop agricultural informatization.

Table-1. System of evaluation indicators.

Degree indicators	**Secondary indicators**	
Level of agricultural informatization	Communication and information services, billion soums	X1
	ICT services in GDP share, in %	X2
	Mobile Internet users, one thousand people	X3
	Electricity consumption, million Wh	X4
	to the Internet connected number of subscribers, up to 100 in % relative to	X5
	100 houses to farms number of computers, pcs	X6
	Length of optical fiber communication lines, thousand km	X 7
Degree in agricultural economics	Gross agricultural product value, million soums	X8
	Village farm of the mah dynasty population soul per head ratio, soum	X9
	From the villages migration, person	X10

This study is based on the development of a qualitative analysis of the level of agricultural informatization and the level of economic development of the republic, as well as the development of a model for quantitative analysis of the level of coordination between them, without separately assessing the level of agricultural informatization and the level of economic development of agriculture.

When choosing a combination of two indicators, the value of a comprehensive index 0] and Lee [13]. 0A system of indicators to measure the coordination between agricultural informatization and the level of economic development of agriculture is defined as shown in table-1.

Based on the different characteristics and features of each evaluation index in the evaluation index system, the use of direct primary data for research and analysis may increase the influence of the evaluation index with a high value in the analysis and reduce the role of the evaluation index with a small value in the analysis [06]. Therefore, to ensure the reliability of the calculation results, the data are normalized according to the min-max standardization method described in this article. Clearly formula as follows :

$$Y_{ij} = \frac{X_{ij} - X_j\min}{X_j\max - X_j\min}$$

where Yij is represents the normalized value of the j-th (i=1,2,3,4,5,6,7,8,9,10) index for the i-th (j=1,2,3,4,5,6,7,8) year; Xij represents the initial data of the j-th index for the i-th (i=1,2,3,4,5,6,7,8) year; Xj min represents the minimum initial data for eight years for each evaluated index; and Xj max which represents the largest initial data for each evaluation index over eight years.

The method of entropy value determination is an important application of entropy theory in the field of weight determination. The degree of dispersion and the importance of analyzing each estimated indicator can be evaluated by the entropy value and the weight of the index [07]. As a rule, the lower the entropy value, the greater the degree of variability of the index value, the greater the weighting coefficient, the more information is given, the greater role it plays in the comprehensive assessment, and vice versa [0]. The rationality of the index weight coefficient directly affects the reliability of the complex assessment result and even the correctness of the decision made. The entropy method is a combination of static and dynamic weight, and its novelty lies in its flexibility, which compensates for the shortcomings of the subjective weight method and makes the evaluation more scientific and reasonable. In order not to affect the calculation result of the analysis, this paper uses the entropy value method to determine the weight of each index. The exact calculation steps are as follows: calculate the share of the index value according to the standardized index data:

$$P_{ij} = \frac{Y_{ij}}{\sum_{i=1}^{n} Y_{ij}}, \qquad (i = 1, 2, 3, \dots, n)$$

This on the ground Pij in the i-th year is what of the j indicator share represents

Calculation of the information entropy of each evaluation indicator (that is, describing the uncertainty of the occurrence of each possible event of the information source):

$$E_j = -\frac{1}{\ln(n)} \sum_{i=1}^{n} \left(P_{ij} \ln\left(P_{ij}\right)\right)$$

Here, Ej represents the information entropy of the jth index.
Calculating the usefulness of information:

$$D_j = 1 - E_j$$

Calculation of the weight of each evaluation indicator:

$$W_j = \frac{D_j}{\sum_{j=1}^{n} D_j} \ (j = 1, 2, 3, \dots, n)$$

where Wj represents the weight of the j-th evaluation index. Since there are ten evaluation indices, the number of years, n , is equal to 8 here .
Also $\sum_{j=1}^{n} W_j = 1$
It is an indicator of comprehensive assessment of agricultural informatization and agricultural economic development efficiency for each year:

$$U = \sum_{i=1}^{n} (W_j Y_{ij})$$

For objective assessment, the method of determining the entropy value for the level of agricultural informatization and the level of economic development of agriculture is selected, then the model for measuring the relationship between agricultural informatization and economic development of agriculture and agricultural informatization is used.
The degree of dependence assessment model is used to measure the influence between two or more systems to reflect the degree of interdependence and mutual constraints between the systems. This paper examines the degree of interrelation between agricultural informatization and agricultural economic development as a relationship between "agricultural informatization" and "agricultural economic development". The calculation formula is given below:

$$C = 2 \times \left[\frac{U_1 \times U_2}{(U_1 + U_2)^2}\right]^{\frac{1}{2}}$$

where C represents the degree of interdependence between agricultural informatization and agricultural economic development, U1 represents the comprehensive evaluation index of agricultural informatization, and U2 represents the comprehensive evaluation index of agricultural economic development. Degree of interaction C ∈ [0, 1]; When C = 1, the level of communication reaches the maximum level, in which the interaction between agricultural informatization and agricultural economic development reaches the maximum level, and when C = 0, the level of communication reaches the minimum value, which indicates the absence of interaction between the level of agricultural information and agricultural economic development. economic development, that is, these two develop in an irregular direction. The higher the value of C, the stronger the correlation effect between them. The model for the analysis of the degree of interdependence mainly reflects the degree of mutual stimulation and mutual restriction between agricultural information and agricultural economic development without distinguishing the directions of action. However, it cannot reflect the degree of coordination between them. Therefore, in order to more accurately reflect the degree of coordination between them, he developed a model for evaluating the degree of interdependence between agricultural information and agricultural economic development based on the degree of interdependence model. The model looks like this:

$$T = \alpha \times U_1 + \beta \times U_2 \ , \quad D = \sqrt{C \times T}$$

where T is a comprehensive index of agricultural informatization and economic development of agriculture; U_1 - comprehensive assessment index of agricultural information; U_2 - comprehensive assessment index of economic development of agriculture; and, in turn, the contribution coefficients of α, βagricultural informatization and agricultural economic development. In this paper, when studying the degree of coordination between the relationship between agricultural informatization and agricultural economic development, both are considered very important and $\alpha + \beta = 1$, therefore, $\alpha = \beta = 0{,}5$ it is assumed that [0

Table 2. Criteria for the level of coordination of dependence.

coordination level D value range.	Coordination level (M)	level of coordination classification (N)
0 . 0 ≤ D ≤ 0.1	1	extreme inconsistency
0 .1 < D ≤ 0.2	2	intermediate serious inconsistency
0 .2 < D ≤ 0.3	3	average discrepancy
0.3 < D ≤ 0.4	4	slight inconsistency
0 .4 < D ≤ 0.5	5	on the brink of inconsistency
0.5 < D ≤ 0.6	6	perfect compatibility
0.6 < D ≤ 0.7	7	light compliance
0.7 < D ≤ 0.8	8	average compliance
0.8 < D ≤ 0.9	9	good compatibility
0.9 < D ≤ 1.0	10	high compatibility

D represents the degree of coordination between agricultural information and economic development of agriculture, and D ∈ [0, 1]. When D = 1, the degree of coordination between agricultural information and economic development of agriculture is at its best, and when D=0, it indicates that there is no degree of coordination between them. When the value of D tends to 1, it indicates that the degree of coordination between them is high. 10 classification standards for the degree of coordination are defined as shown in table-2, corresponding to the calculations for determining the degree of coordination of dependence.

Put compare table-1 if the statistical data of the Samarkand region and the republic 2015-2022:

Table-3. Statistical indicators of Samarkand region.

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
2015	350.5	1, 9	758.2	2912.6	21.4	38	1.1	14 300.0	4068.5	10755
2016	410.7	1, 8	865.0	2 947.5	23.9	39	1.2	17,088.6	4768, 2	10950
2017	536.5	2 , 0	1 018.7	3 247.8	27.6	40	1.3	21,506.8	5889.5	12183
2018	620.3	1.9	1 225.7	4 425.8	32.6	42	1.5	25,658.0	6897.1	12779
2019	633.7	1.6	1 505.9	2 769.7	39.2	45	2.1	28 379.5	7470.4	11314
2020	716.9	1, 7	1 795.4	4 130.1	45.9	50	6.1	33 759.4	8706.7	15097
2021	835.8	1, 6	2 132.5	4 603.3	53.5	52	11.0	41 206.1	10221.5	14941
2022	1 073.7	1.7	2 407.4	4,795.9	59.1	53	15.9	42,088.9	10220.2	12014

Table-4. Statistical indicators of the republic.

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
2015	5181.5	1.6	7 793.7	45008.6	26.6	47	20	99604.6	3210.7	12 561
2016	6306.8	1.8	9 022.9	45058.8	30.2	49	22.1	115599.2	3661	17,983
2017	8196.7	1.9	10 258.8	46746.3	34.5	50	24.5	148199.3	4613.8	24 562
2018	10332.6	1.7	12,668.6	60744,8	40.4	52	26.6	187425.6	5739.3	25 473
2019	10891.7	1.4	15,651.2	54174.8	48.8	55	36.6	216283.1	6503.6	34 682
2020	13852.3	1.5	17,946.5	53839.8	58.4	60	68.6	250250.6	7380.9	77 971
2021	17755.1	1.6	20,991.8	56268,9	65.8	63	118.0	303415.5	8779.6	111 919
2022	24508.1	1.8	24,017.6	59109.3	75.0	64	170.6	345191.7	9786.7	99,064

Table-5. Determining the weight of evaluation indicators.

Degree indicators		**Samarkand region**		**Republic**	
		Entropy	Weight	Entropy	Weight
Level of agricultural informatization	X1	0.850	0.073	0.704	0.111
	X2	0.857	0.069	0.730	0.102
	X3	0.820	0.087	0.826	0.065
	X4	0.801	0.097	0.804	0.074
	X5	0.824	0.085	0.674	0.123
	X6	0.808	0.093	0.833	0.063
	X7	0.590	0.199	0.636	0.137
Degree in agricultural economics	X8	0.851	0.072	0.654	0.130
	X9	0.861	0.067	0.727	0.103
	X10	0.685	0.153	0.759	0.090

By calculating the entropy value of the ten evaluation indicators, it can be seen that the accuracy of the information reflected in them, the entropy value method for weighting the indicators is perfect. The level of agricultural informatization of ten indicators in the Samarkand region, the weight of the length of optical fiber communication lines (0.199) is higher than the average weight (0.1), the consumption of electricity (0.97) and the number of computers per 100 farms (0.93) is equal to the average weight; from the level of agricultural economy, the weight of population migration from villages (0.153) had the greatest impact. This indicates that the level of coordination of agricultural informatization and economic development of agriculture in the region is determined by infrastructure development and personnel issues. According to the republic, communication and information services (0.111), the share of ICT in GDP (0.102), the number of subscribers connected to the Internet in the region (0.123), the length of optical fiber communication lines (0.137), these three evaluation indicators are agricultural informatization and coordination of agricultural economic development has the greatest effect on measuring the level. Since these three indicators are related to the content of the agricultural informatization index, the development level of agricultural informatization is the main factor affecting the coordinated development of these two levels. The weights of agricultural output (0.130), agricultural output per capita ratio (0.103) from the level of agricultural economy show that agricultural development also has its share in this coordination. Therefore, accelerating the implementation of

agricultural informatization is one of the priority areas of coordination of agricultural informatization and agricultural economy development.

Table-6 shows that in the period from 2015 to 2022, the level of correlation between agricultural information and agricultural development has a stable high index and continues to grow. The level of compliance increased steadily until 2022 in the Samarkand region and slightly decreased in 2022, while the increase continued in the republic.

Table-6. Degrees of dependence and compatibility

	Samarkand region					Republic				
	C	**T**	**D**	**M**	**N**	**C**	**T**	**D**	**M**	**N**
2015	0.001	0.030	0.004	1	extreme inconsistency	0.005	0.026	0.011	1	extreme inconsistency
2016	0.859	0.045	0.196	2	intermediate serious inconsistency	0.713	0.069	0.221	3	average discrepancy
2017	0.964	0.121	0.343	4	slight inconsistency	0.869	0.116	0.318	4	slight inconsistency
2018	0.956	0.187	0.423	5	on the brink of inconsistency	0.901	0.173	0.394	4	slight inconsistency
2019	0.953	0.135	0.358	4	slight inconsistency	0.973	0.174	0.411	5	on the brink of inconsistency
2020	0.983	0.313	0.554	6	perfect compatibility	0.972	0.267	0.510	6	perfect compatibility
2021	0.961	0.395	0.616	7	light compliance	0.970	0.377	0.605	7	light compliance
2022	0.825	0.425	0.592	6	perfect compatibility	0.937	0.481	0.671	7	light compliance

In general, agricultural informatization and agricultural economic development are increasingly interrelated and mutually limited, which is mainly reflected in the rapid growth of the agricultural economy and is encouraged by the development of agricultural informatization.

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