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Abstract: The rapid development of agricultural modernization in Hubei province has an influence on cultivated land resources variations to a certain degree. This paper used grey relational analysis method ’combined with Hubei province cultivated land area decreased data within the year covering 2000 to 2010 and agricultural modernization development index data, then analyzed the influence relationship between agricultural modernization development and cultivated land resources variations. Through calculating then obtained the relational degree of each index of agricultural modernization and cultivated land resources variations in Hubei province r_{01}=0.6518, r_{02}=0.6814, r_{03}=0.6737, r_{04}=0.6904, r_{05}=0.7002, r_{06}=0.6175 ’turned out to be r_{05}> r_{04}> r_{02}> r_{03}> r_{01}> $r_{06}$by sequencing. Result shows that irrigation index-effective irrigation area has the highest relational degree on cultivated land resources variations, three chemical indexes are in the second place followed by successively are plastic films, fertilizers and pesticides according to relational degree, then the electrification index-electricity consumption and the last mechanization index-total power of agricultural machinery. The sequence means water conservancy facilities construction and reasonableness and scientificalness of its utility should be taken into seriously, and the dependence degree of using fertilizers, pesticides and plastic films should be reduced in the meanwhile, electrification and mechanization development of modern agriculture should be kept improving the production efficiency and protecting cultivated land resources.

Keywords: Hubei province, agricultural modernization, cultivated land variations, gray relational analysis

1. INTRODUCTION

With the development of economy, agricultural production model of Hubei province has changed from a kind of closed, self-supporting and low level type of traditional agriculture model into a kind of open, commutative, advanced and high level type of modern agricultural model. Therefore, the labor productivity level and resources output level has been improved. However, the rapid development of modern agriculture relies heavily on advanced agricultural production material and technical conditions, such as modern agricultural electrification, mechanization, irrigation, chemicalization and informatization and so forth, The using of large machines can cause excessive soil tillage and aggravate wind & water erosion of cultivated land soil, also a large number of pesticides, fertilizers and plastic sheeting's long-term use can lead to the soil fertility damage and the problems of effective nutritional element imbalances and soil hardening and finally result in cultivated land area reduction and quality of arable land degradation[1]. As China's important agricultural production base, Hubei province’s cultivated land resource is the foundation of food production and agricultural development. Thus, analysis of the influence relationship of agricultural modernization and cultivated land resource variations in Hubei province has very important practical significance to realize the win-win situation of agricultural modernization development and effective use and protection of cultivated land resources in Hubei province.

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2. RESEARCH STATUS AT HOME AND ABROAD

In 1991, United Nations Food and Agriculture Organization pointed out that the sustainable development of the modern agriculture is to apply a based method of certain using and maintaining the natural resources and carry out technical revolution and mechanism change in order to meet agricultural production output demand of contemporary people and future generations and maintain cultivated land soil and water resources [2]. Altieri thought modern agriculture should satisfy the cultivated land in soil fertility recoverability and economic rationality at the same time which meant if modern agricultural development wanted to attain sustainable development with high production and efficiency then it must develop harmoniously with ecological environment [3].Also, Japan emphasized too much on improving the land productivity, relied excessively on pesticides and fertilizers and led to soil and water loss of cultivated land resources in a long period of post-war time during the progress of modern agricultural development and it was until 1990s that Japan put forward "environmental preservation agriculture" measures and ensure that the modern agricultural development was sustainable development and environmental friendly that Japan finally solved the problems of soil and water loss and soil pollution efficiently [4].Tong Shaoyu thought that the modern agricultural production which included large-scale production and professional and intensive production used a big amount of chemical fertilizers and large agricultural machinery and led to not only the soil erosion and land degradation, but also biodiversity decrease [5].Guo Jianqin considered that the modern agricultural characteristic was intensification, mechanization and chemicalization and large machinery ploughed soil deeply led to soil and water loss and soil hardening [6].Cao Huaying,Zhang Huanling and Zhang Lin thought that agricultural chemicals like hexachloro-cyclohexane soprocide was not easy to break down and Irrigation would also destroy the soil aggregate structure and make the soil colloid inflation then finally led to cultivated land fertility conditions deteriorated [7]. Wang Dongxia, Lv Fengxiang and Shang Fenlian indicated that although the installation level of agricultural development has been improved, the vestigital problem of facilities like mulching films caused soil moisture reduction and weakened the land soil drought resistance [8].

3. WHAT IS GRAY RELATIONAL ANALYSIS?

Grey Relational Analysis(GRA) is a kind of multifactor statistical analysis method, according to the sample data of all the factors between two systems, the similar or different degree of the development trend and the similarity degree of the sequence geometry curves to judge whether its contact closely. The closer of the curves, the greater relational degree between the corresponding sequences [9-10].

Grey relational analysis calculation procedure as follows:

- Analyzing the original data and determining a dependent variable sequence and several independent sequences. Supposing the dependent variable sequence:

$$Y_0(t) = \{y_0(k) \mid k = 1,2,...,n\} \tag{1}$$

Supposing the independent variable sequences:

$$Y_i(t) = \{y_i(k) \mid k = 1,2,...,n\}, (i = 1,2,...,N) \tag{2}$$

- Applying standardization and initialization of the original data to ensure that the original data dimension unity, e.g. initialization of the original data:

$$X_0(k) = \frac{y_0(k)}{y_0(l)} \tag{3}$$

$$X_i(k) = \frac{y_i(k)}{y_i(l)} \tag{4}$$

- Calculating the difference sequence by calculating the absolute difference value between the dependent sequence and corresponding period independent sequence:

$$\Delta_{0i}(k) = | x_0 - x_i(k) | \tag{5}$$

Then determining the maximum absolute difference Δ_{max} and the minimum absolute difference Δ_{min}.

- Calculating relational coefficient by formula as follows:

$$\xi_i(k) = \frac{\min_i \min_k | x_0(k) - x_i(k) | + \rho \max_i \max_k | x_0(k) - x_i(k) |}{| x_0(k) - x_i(k) | + \rho \max_i \max_k | x_0(k) - x_i(k) |} \tag{6}$$

ξ_i (k) is relational coefficient between $x_0(t)$ and x_i (t) in period k; ρ is resolution ratio which is in [0, 1] value interval and generally ρ≤0.5463.

- Calculating the relational degree by formula as follows:

$$r_{0i} = \frac{1}{n} \sum_{k=1}^{n} \xi_{0i}(k) = \frac{1}{n} [\xi_{0i}(1) + \xi_{0i}(2) + ... + \xi_{0i}(n)] \tag{7}$$

Then Sequencing the relational degree by numerical size, if $r_{01} > r_{02}$, it means that the dependent variable sequence Y_0 (t) is much more similar to Y_1 (t) than to Y_2 (t).

4. GREY REATIONAL DEGREE CALCULATION AND ANALYSIS ON AGRICULTURAL MODERNIZATION DEVELOPMENT AND CULTIVATED LAND RESOURCE VARIATIONS

According to the data of agricultural modernization development and cultivated land resources variation covering 2000 to 2010 in Hubei province, suppose the cultivated land resource variation data sequence is the dependent variable sequence $Y_0(t)$ and the independent variable sequences are the agricultural modernization development indexes, including electrification index- electricity consumed in rural area $Y_1(t)$, chemicalization indexes- consumption of fertilizers $Y_2(t)$, agricultural insecticides $Y_3(t)$ and plastic films $Y_4(t)$, irrigation index- effective irrigation area $Y_5(t)$ and mechanization index-total power of agricultural machinery Y_6 (t).

Table 1. Agricultural modernization development and cultivated land resources variation

	cultivated land reduction (1000 hec)	electricity consumption (100 mil kWh)	Fertilizers (10000 t)	pesticides (10000 t)	plastic films (10000 t)	effective irrigation area (1000 hec)	total power of agricultural machinery (10000 kW)
2000	28.97	60.86	247.08	11.54	4.76	2072.53	1414.00
2001	38.50	60.2	245.27	10.97	4.94	2027.9	1469.24
2002	98.06	60.74	256.97	10.63	5.12	2006.49	1557.40
2003	173.67	63.11	302.04	9.99	5.34	2043.69	1661.70
2004	34.45	64.79	281.92	11.26	5.51	2071	1768.60
2005	35.77	70.09	285.83	11.02	5.46	2064.59	2057.37
2006	15.16	75.86	292.48	13.17	5.48	2056.63	2263.15
2007	15.41	87.79	299.9	13.56	5.84	2095.4	2551.08
2008	6.39	98.06	327.66	13.84	5.91	2139.41	2796.99
2009	9.45	104.27	340.26	13.85	6.12	2145.99	3057.24
2010	5.46	109.78	350.77	14.00	6.38	2187.17	3371.00

4.1 The original data dimensionless processing

Based on the data of 2000 as a benchmark, initializing each data sequences can ensure dimension consistent and get initialized data sequences $X_0(t)$,$X_1(t)$, $X_2(t)$, $X_3(t)$, $X_4(t)$, $X_5(t)$ and X_6 (t).

Table 2. Initialized data sequences of each index

	cultivated land reduction (1000 hec)	electricity consumption (100 mil kWh)	Fertilizers (10000 t)	pesticides (10000 t)	plastic films (10000 t)	effective irrigation area (1000 hec)	total power of agricultural machinery (10000 kW)
2000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2001	1.3290	0.9892	0.9927	0.9506	1.0378	0.9785	1.0391
2002	3.3849	0.9980	1.0400	0.9211	1.0756	0.9681	1.1014
2003	5.9948	1.0370	1.2224	0.8657	1.1218	0.9861	1.1752
2004	1.1892	1.0646	1.1410	0.9757	1.1576	0.9993	1.2508
2005	1.2347	1.1517	1.1568	0.9549	1.1471	0.9962	1.4550
2006	0.5233	1.2465	1.1837	1.1412	1.1513	0.9923	1.6005
2007	0.5319	1.4425	1.2138	1.1750	1.2269	1.0110	1.8042
2008	0.2206	1.6112	1.3261	1.1993	1.2416	1.0323	1.9781
2009	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2010	1.3290	0.9892	0.9927	0.9506	1.0378	0.9785	1.0391

4.2 Calculating difference sequence

According to formula (5), calculating the data can obtain the maximum absolute difference Δ_{max}=5.12914 and the minimum absolute difference Δ_{min}=0.

4.3 Calculating relational coefficient and gray relational degree

Because $\rho \leq 0.5463$ and in order to improve the resolution ratio, determing ρ=0.3.According to formula (6) and (7), then obtaining the final gray relational degree of each index as follows: r_{01}=0.6518, r_{02}=0.6814, r_{03}=0.6737, r_{04}=0.6904, r_{05}=0.7002, r_{06}=0.6175 and turning out to be $r_{05} > r_{04} > r_{02} > r_{03} > r_{01} > r_{06}$ by sequencing.

Table 3. Grey relational degree of each index

	electricity consumption (100 mil kWh)	Fertilizers (10000 t)	pesticides (10000 t)	plastic films (10000 t)	effective irrigation area (1000 hec)	total power of agricultural machinery (10000 kW)
cultivated land reduction(1000 hec)	0.6518	0.6824	0.6737	0.6904	0.7002	0.6175

5. CONCLUSIONS

In the grey relational analysis of modern agriculture development and cultivated land resources variation in Hubei province (Table 3):

- Irrigation index-effective irrigation area Y_5 (t) has the highest relational degree to cultivated land resource variations Y_0 (t), three chemical indexes are in the second place and successively are plastic film Y_4 (t), fertilizers Y_2 (t) and pesticides Y_3 (t) according to relational degree, then the electrification index-electricity consumption Y_1 (t) and the last mechanization index-total power of agricultural machinery Y_6 (t).

- The relational degree of irrigation index-effective irrigation area Y_5 (t) to cultivated land resource variations is r_{05}=0.7002 which is in the highest place of all indexes. Result shows that the strength of the construction of water conservancy facilities has a major influence on the cultivated land resources and the convenience of irrigation also caused soil and water loss of farmland in Hubei province.
- Three chemicalization indexes-plastic film Y_4 (t), fertilizers Y_2 (t) and pesticides Y_3 (t) are r_{04}=0.6904, r02=0.6814, r03=0.6737 respectively and very close to each other.It means that agricultural production in Hubei province depend a great extent on a large amount of using plastic film fertilizers and pesticides and thus lead to soil hardening and degradation and cultivated land loss.
- Electrification index-electricity consumption Y_1 (t) and mechanization index-total power of agricultural machinery Y_6 (t) have less effect on the cultivated land loss relatively. Result indicates that agricultural production in Hubei province uses the electric power resources and mechanical equipments effectively.

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