Research on Corn Cost and Benefit in Heilongjiang Province Based on Grey Correlation Analysis

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Abstract. Grey correlation model is adopted for analyzing corn output value per mu in Heilongjiang Province and influencing factors from 2006 to 2013 aiming at status quo of corn cost and benefit in Heilongjiang Province. Results showed that influencing factors of corn output value per mu can be sequenced as follows according to size: pesticide cost > family labor discount > machinery operating cost > seed cost > labor hiring cost > chemical fertilizer cost. Finally, related suggestions are proposed according to status quo and research results.

Introduction

Guarantee of grain security is an important strategy related to national economy, people's livelihood and national security. China is a developing agricultural country, China undergoes rapid economic development since China's reform and opening up, meanwhile arable land is decreasing, population continues to increase, thereby leading to very sharp contradiction between human and land. Grain demand is bound to keep growth trend for a long term in the future. In addition, guarantee of national grain security is also a basic goal for rural reform and development in China. It is urgent for China to solve the following major problems: to ensure effective supply of major agricultural products, reasonably coordinate contradiction between food security and farmers' income increase, drive farmers to become rich, and promote agriculture efficiency increase under the background of national grain security.

Heilongjiang province is the main commodity grain base in China, and its grain production cannot be ignored. Corn is one of grain crops with the largest production around the world. China is a corn production power, and its total output ranks No. 2 in the world. Corn has become important grain crop, feed source, economic crop and industrial raw material in China with gradual improvement of people's living standard and development of corn industry. It has more and more important position in agricultural production and national economic development. Therefore, reduction of corn production cost, improvement of production yield, and decrease of its market value have positive and important roles to safeguard China grain food security, promote international competitiveness of corn, strengthen the farmers' growing enthusiasm, and raise farmers' income.

Previous corn yield evaluations pay more attention to corn output per mu or output value per mu in the corn belts. However, cost consumed by corn in the whole production process can not be disclosed. Contents in two aspects of cost and benefits must be considered from the perspective of comprehensive evaluation, thereby obtaining a rational evaluation result. In the paper, grey correlation analysis method is combined with corn cost benefit evaluation for providing a new method for comprehensive evaluation of corn benefits.

Data source and research method

Data source

Data in the study is obtained from National Agricultural Product Cost-benefit Data Collection (2006 ~ 2013). Corn output value per mu (X_0) in Heilongjiang Province is selected as explained variable, six major influencing factors of seed cost (X_1), pesticide cost (X_2), chemical fertilizer cost (X_3), mechanical operating cost (X_4), family labor discount (X_5) and labor hiring costs (X_6) are

selected as explanatory variables according to contents and various statistic indicators from Corn Benefit and Cost Statistics in Different Regions and Corn Cost and Labor Condition in Different Regions provided in the collection. Specific raw data is shown in table 1.

Table 1 Corn output value per mu in Heilongjiang Province and influencing factors thereof from 2006 to 2013

Year	X_0	X_1	X_2	X_3	X_4	X_5	X_6
2006	508.64	17.05	6.17	65.18	44.58	65.74	10.3
2007	457.99	22.25	7.13	66.12	46.72	70.69	11.43
2008	597.12	21.97	8.53	98.45	63.84	77.98	11.14
2009	606.93	24.78	8.71	91.16	66	88.93	15.67
2010	762.87	37.09	9.70	89.66	78.23	103.73	15.57
2011	916.78	45.7	10.96	103.2	91.91	126.72	26.99
2012	1006.64	56.39	13.39	116.77	115.84	158.87	32.02
2013	1017.98	59.92	12.17	119.97	135.13	190.33	30.11

Note: unit of each variable is yuan.

Research methods

An abstracted complex system is formed by various cost factors influencing corn output per mu and grain production process. Development trend of corn benefit is determined by joint functions of various cost factors. Influence of concrete factors on corn output per mu should be comprehended. Grey correlation analysis is a kind of system theory analysis method for describing relationship intensity, size and sequence among factors with grey incidence degree sequence. The analysis method has the following advantages of less sample demand, low requirements on data distribution rule, high precision, high consistency between qualitative analysis and quantitative analysis results, etc. Therefore, it is suitable to adopt grey correlation analysis in the research.

Grey correlation analysis method is adopted in the paper, and basic steps of grey correlation analysis are shown as follows:

(1) Determine to-be-analyzed data sequence, set a reference sequence, namely primary sequence as follows:

$$\chi_o(k)=\{\chi_o(1),\chi_o(2),\cdots,\chi_o(n)\};$$

Set comparative sequence, namely the secondary sequence as follows:

In the formula, $\chi_o(t)$ represents dependent variable of analysis sample, $\chi_i(t)$ represents independent variable of analysis sample, i represents a factor, $i=1,2,3\cdots$.

(2) Treatment of sequence initial value. Preliminary treatment aims at making the sequence dimensionless, and obtaining public intersection point. The operation can enhance the comparability between the sequences, and form a new primary sequence: $y_o(k)$, and secondary sequence: $y_i(k)$, and calculation formula is shown as follows:

$$y_o(k)'=\frac{y_o(k)}{y_o(1)},\quad y_i(k)'=\frac{y_i(k)}{y_i(1)} \tag{1}$$

（1） Absolute error sequence: the calculation formula is shown as follows:

$$\Delta_{oi}(k)=|y_o(k)-y_i(k)|,\quad i=1,2,\cdots,n;k=1,2,\cdots,m \tag{2}$$

（2）Set correlation coefficient: calculation formula is shown as follows:

$$\xi_{oi}(t)=\frac{\Delta_{\min}+\rho\Delta_{\max}}{\Delta_{oi}(k)+\rho\Delta_{\max}} \tag{3}$$

In the formula, $\Delta_{\min}$ and $\Delta_{\max}$ represent the minimum value and maximum value in formula (1), $\rho\in(0,1)$ refers to resolution ratio, and its value does not affect correlation analysis of primary sequence and secondary sequence. 0.5 is adopted in the paper. The value between 0 and 0.35 represents weak correlation; value between 0.35 and 0.7 represents medium correlation, and value between 0.7 and 1 represents strong correlation.

（3） Calculate correlation: the calculation formula is shown as follows:

$$\gamma_{oi} = \frac{1}{n}\sum_{t=1}^{n}\xi_{oi}(t) \tag{4}$$

The final result is correlation between reference sequence and comparative sequence. by analyzing the correlation Fitting degree between the two sequences can be confirmed through analyzing correlation.

Grey relation analysis and results

Next, grey correlation calculation is implemented on corn output value per mu and cost influencing factors thereof. Initial value new matrix table 2 is obtained through dimensionless processing by formula (1) according to table 1. Absolute error sequence is obtained on initial value data after dimensionless processing according to formula (2), thereby obtaining table 3. The maximum difference and minimum difference in the matrix can be found, $\Delta_{\min}$ =0.3010, $\Delta_{\max}$=0.0022. Then, all values are brought into formula (3) for obtaining correlation coefficient matrix as shown in table 4. Finally, correlation value γ_{oi} can be obtained according to formula (4).

Table 2 Initial value matrix

X_0	X_1	X_2	X_3	X_4	X_5	X_6
0.6926	0.4783	0.6430	0.6948	0.5553	0.5956	0.5378
0.6237	0.6242	0.7431	0.7048	0.5820	0.6405	0.5967
0.8131	0.6164	0.8890	1.0494	0.7952	0.7065	0.5816
0.8265	0.6952	0.9078	0.9717	0.8221	0.8057	0.8181
1.0388	1.0406	1.0109	0.9557	0.9744	0.9398	0.8129
1.2484	1.2821	1.1423	1.1001	1.1449	1.1481	1.4091
1.3708	1.5820	1.3955	1.2447	1.4429	1.4394	1.6717
1.3862	1.6811	1.2684	1.2788	1.6832	1.7244	1.5720

Table 3 Absolute difference matrix

Δ_{01}	Δ_{02}	Δ_{03}	Δ_{04}	Δ_{05}	Δ_{06}
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.2143	0.0496	0.0022	0.1373	0.0970	0.1549
0.0006	0.1194	0.0811	0.0417	0.0168	0.0269
0.1967	0.0759	0.2363	0.0179	0.1066	0.2315
0.1313	0.0813	0.1452	0.0044	0.0207	0.0083
0.0018	0.0279	0.0831	0.0644	0.0990	0.2259
0.0337	0.1061	0.1483	0.1035	0.1003	0.1607
0.2113	0.0248	0.1261	0.0722	0.0686	0.3010

Table 4 Grey correlation analysis results of corn output value influencing factors per mu in Heilongjiang Province

Year	ξ_{01}	ξ_{02}	ξ_{03}	ξ_{04}	ξ_{05}	ξ_{06}
2006	0.3351	0.7730	1.0000	0.3545	0.4664	0.5202
2007	1.0000	0.4715	0.6037	0.6616	1.0000	0.8954
2008	0.3545	0.6230	0.3394	0.8435	0.4385	0.4158
2009	0.4519	0.5991	0.4568	1.0000	0.9468	1.0000
2010	0.9891	0.9646	0.5979	0.5489	0.4603	0.4220
2011	0.7646	0.5094	0.4515	0.4240	0.4565	0.5104
2012	0.3383	1.0000	0.4927	0.5185	0.5750	0.3518
2013	1.0054	1.4146	1.0183	1.0634	1.3154	1.0555
Correlation(γ)	0.6549	0.7944	0.6200	0.6768	0.7074	0.6464
Incidence order	4	1	6	3	2	5

Grey correlation calculation of corn output value influencing factors per mu in Heilongjiang Province shows that the correlation is as follows: pesticide cost > family labor discount >machinery operating costs > seed cost > labor hiring cost > chemical fertilizer cost, wherein, correlation between corn seed cost and output value per mu is up to 0.7944, and it belongs to strong correlation; correlation between family labor discount and output value per mu is also higher than 0.7, and it can be defined as strong correlation; correlation between the remaining four influencing factors and corn output value per mu is higher than 0.6, but less than 0.7, and it belongs to medium correlation.

Conclusions and Recommendations

Gray correlation calculation analysis on corn output value per mu in Heilongjiang Province from 2006 to 2013, and influencing factors shows that pesticide cost and family labor discount is main factors leading to fluctuation of corn output value per mu. Machinery operating cost, seed cost, labor hiring cost and chemical fertilizer cost also have greater influence on fluctuation of corn output value per mu.

The following suggestions are proposed for reducing corn cost per mu and improving corn benefit per mu on the basis of analyzing fluctuation influencing factors of corn output value per mu in Heilongjiang Province:

(1) Increase government subsidies: Cost must be further reduced in order to enhance market competitiveness of corn in Heilongjiang Province and achieve the goal of continuously increasing corn production. The government should explore to establish corresponding guarantee system of effective supply safety boundary in agricultural material market. Firstly, price check intensity should be increased, seed and fertilizer price should be stabilized to further expand the scope of seed subsidies and agricultural machine subsidies, and increase subsidy amount. Secondly, science and technology promotion department should guide farmers to increase farm fertilizer application, vigorously promote precise sowing and fertilization techniques, and improve the utilization efficiency of pesticides and fertilizers. As a result, environmental cost in the production process can be reduced on one hand, farmer's planting enthusiasm also can be improved, thereby providing guarantee for sustainable land use and agricultural sustainable development.

(2) Increase investment in science and technology: investment proportion of science and technology should be increased in the process of corn planting in order to improve corn output per mu and total production. Firstly, science and technology popularization department should vigorously promote high-quality seed of corn, precise seeding and fertilizing technology, improve the utilization rate of fertilizers, reduce production cost, and greatly develop agricultural machinery cooperatives and agricultural machinery households, thereby enhancing the mechanization level of corn planting process. Secondly, corn planting experts should be hired for introducing corn production process, and corn quality can be improved on the bass of ensuring corn output per mu and total production.

(3) Overall planning and rational layout: corn regional planting and large-scale planting are adopted, which is beneficial for providing technical guidance and service collectively, reducing costs, improving benefits, and facilitating nearby corn processing and acquisition. We should focus on the development of corn industry. Corn deep processing industry should be suitably developed in corn main production area under allowable condition, thereby improving corn utilization rate, increasing comprehensive benefits of corn, and promoting production and income increase for farmers.

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