Study on the factors influencing the cost-effective of beef cattle breeding in China

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Abstract

The cost-effective of beef cattle breeding is an important part of the stable development of China's beef industry. From the perspective of the input and output of beef cattle breeding, the gray correlation system is used to empirically analyzes the influencing factors of beef cattle production efficiency in China by using the cost-effective data of China from 2006 to 2018, and discusses the impact of these factors on beef cattle production efficiency. The results shows that the main factors affecting the production efficiency of Chinese beef cattle are the selling price of 50 kg beef products, followed by the cost of green roughage, and finally the cost of calves, concentrate feed and labor cost. Based on this, the countermeasures and suggestions are put forward to increase the economic benefits of beef cattle breeding and ensure the safe supply of beef in China.

Keywords: Beef cattle breeding. Cost-effective. Influencing factor

1. Introduction

Beef cattle industry is one of the important industries in China. With the rapid development of China's economy, beef has become an indispensable meat food for Chinese residents. In recent years, the number of beef cattle breeding in China has shrunk, which is mainly manifested in the decrease in the number of beef cattle farmers year by year, the number of cow breeding stocks has decreased seriously, and the number of beef cattle breeding has decreased significantly. Although the beef price rise by a large margin in 2020,

with the increasing cost of beef cattle breeding and the low efficiency of breeding, small-scale farmers are still on the edge of losing money, and even some farmers begin to withdraw from the beef industry. According to the current development of China's beef cattle industry, the development of beef cattle production mainly depends on the improvement of production efficiency, government subsidies, and bank loans. Since government subsidies and bank loans cannot be implemented all the time, the development of the beef cattle industry mainly depends on the improvement of production efficiency. Therefore, it is of great practical significance to analyze the main factors affecting beef cattle production efficiency and their influence degree by using grey relational system to promote the sustainable development of beef cattle industry in China.

2. Literature Review

There are abundant research results on the cost-effective of beef cattle breeding at home and abroad, mainly focusing on the development of beef cattle industry (Wang Mingli, 2008; Cao Binghai, Zhang Yuejie et al., 2020) and the cost-effective of beef cattle breeding (Zhang Wei, Zhu Yueming et al., 2009; Cao Binghai, 2012; Stewart, 2010; Abdelradi, 2015; Tian Lu, Wang Yanhua, Zhang Yuejie, 2011; Wang Min, Han Tianlong et al., 2017; Cao Binghai, 2019).

Wang Mingli, Wang Jimin et al. (2008) considered that the industrial structure of beef cattle in China was unreasonable, and the backward breeding mode seriously restricted the development of beef cattle industry.

Zhang Wei, Zhu Yueming et al. (2009) believed that the input of feed cost significantly affected the fattening effect of beef cattle, and had a significant impact on the benefits of medium-scale beef cattle breeding.

Tian Lu, Wang Yanhua, and Zhang Yuejie (2011) pointed out that the main factors affecting the income of beef cattle farmers were the weight of beef cattle, the actual market price, the cost of purchasing calves and the input of concentrate and roughage.

Cao Binghai, Wan Fachun, Wang Zhisheng (2012) believed that Argentina and Brazil beef cattle breeding subsidy policies and subsidy measures was better than China, and China's beef cattle breeding mode lagged behind Brazil and the United States.

Stewart (2010) and Abdelradi (2015) believed that the rich local high-quality forage resources and large government subsidies in Brazil and Argentina made the cost of beef cattle breeding lower than that of Europe, the United States and Japan, and the benefits of large-

scale beef cattle breeding were higher.

Wang Min, Han Tianlong et al. (2017) believed that the main mode of beef cattle breeding in China was scattered breeding cows and off-site fattening, with extensive feeding management and breeding structure to be improved.

Cao Binghai (2019) believed that beef cattle breeding in China is in the stage of high investment and high cost. Under the condition of constant breeding scale and production cost, the utilization of hybrid advantage was an effective way to increase the income of beef cattle breeding.

Cao Binghai, Zhang Yuejie et al. (2020) believed that the contradiction between the rigid demand for beef and the insufficient supply of market in China was prominent, and the shortage of shelf cattle was still urgent. Imported beef was an important means to make up for the market gap.

In summary, most of research results at home and abroad have conducted theoretical analysis from the aspects of beef cattle industry development, farmers' income, breeding scale, breeding costs and benefits, but there are few results of empirical analysis on the cost-effective of beef cattle breeding in China. Therefore, this paper analyzes the main factors affecting the cost-effective of beef cattle breeding in China from the perspective of beef cattle breeding input and output, and puts forward some suggestions to reduce the cost of beef cattle breeding and improve its economic benefits.

3. Theoretical analysis model

Grey correlation degree refers to the uncertain correlation between things. The grey correlation order is often used to describe the strength, size and order of the relationship between events, that is, to analyze and determine the influence degree of system factors through the gray correlation degree. The gray correlation model is a quantitative analysis of dynamic indicators according to the development trend of things. It has strong dynamic characteristics and requires less sample size. The analyzed data does not need to have a distribution law, and the amount of calculation is less. The results are similar to the results of qualitative analysis, because the gray correlation system used in this study is a more practical and stable analysis method with strong advantages.

The general steps of grey relational analysis are as follows.

The first step assumes that there are N sequence, and each column contains M data. First, the original data should be standardized. There are two common processing methods.

Initial value treatment. divide all data by the first data to get a new data. The calculation formula is as follows:

$$X_{ij}^{(1)} = \frac{X_{ij}^{(0)}}{X_{i1}^{(0)}}$$

Mean value treatment. divide all data with the mean value, and the calculation formula is as follows:

$$X_{ij}^{(1)'} = \frac{X_{ij}^{(0)}}{\bar{X}_i}$$

The second step is to obtain the pole difference and the correlation degree in the correlation coefficient. Suppose the parameter sequence is Y, and the compared sequence is X_i (i=1, 2, ..., n), then the correlation coefficient of curve Y and X_i at the k-th point is calculated as follows.

$$\xi_i = \frac{\min\limits_i \min\limits_k \Delta_i(k) + \rho \max\limits_i \max\limits_k \Delta_i(k)}{\Delta_i(k) + \rho \max\limits_i \max\limits_k \Delta_i(k)}$$

among them $\Delta_i(k) = \left| y(k) - x_i(k) \right|$.

In the formula, $\Delta_i(k)$ represents the absolute difference between y and Xi of the k-th point; $\min\limits_i \min\limits_k \Delta_i(k)$ is the two-stage minimum difference; among them, $\min\limits_i \Delta_i(k)$ is the first-level minimum difference, which means that the minimum difference of each point is found on the i-th curve. $\min\limits_i \min\limits_k \Delta_i(k)$ is the second-level minimum difference, which means that the minimum difference in all curves x_i is found on the basis of finding the minimum difference in each curve. $\max\limits_i \max\limits_k \Delta_i(k)$ is the two-stage maximum difference. ρ is the resolution coefficient, which is generally taken as 0.5. Finally, the correlation degree of each curve is calculated, and the calculation formula is:

$$r_i = \frac{1}{n}\sum_{k=1}^{n} \xi_i(k), \quad k = 1,2, \quad \Lambda, \quad n$$

The third step is to arrange the correlation degree to get the correlation order. According to the correlation degree, the influence degree of each factor is analyzed. The greater the correlation, the greater the impact.

4. Sample selection and data description

The main factors affecting the production efficiency of Chinese beef cattle are divided into exogenous variables and endogenous variables. Exogenous variables mainly include government policies, technical progress (improved varieties), large-scale breeding (animal husbandry community), industrialized management, credit and other factors. These factors are the driving force of beef cattle production efficiency, but it is difficult to quantitatively analyze the impact of specific data on beef cattle production efficiency. In this study, the impact of external factors is analyzed by qualitative method, and qualitative analysis makes exogenous variables get better performance in endogenous variables.

Considering the availability, integrity and continuity of the sample data, the time series data of beef cattle input and output are selected from 2006 to 2018 in "China Statistical Yearbook" and "National Agricultural Product Cost-benefit Data Compilation". The net income of each beef cattle is selected as the representative factor of production benefit, and the selling price of 50 kg beef cattle products, the labor cost of each head, the output of main product, the cost of each calves, the cost of concentrate feed, the cost of green roughage and the depreciation cost of fixed assets of each head were selected as the influencing factors of production efficiency. In order to minimize the interference of price changes, the net income and the selling price of 50 kg beef cattle products are deflated by the Chinese consumer price index. The labor cost per head, the cost of each calves, the cost of concentrate feed, the cost of green roughage and the depreciation cost of fixed assets are deflated by the price index of agricultural means of production, which was approximately converted into the index of physical quantity.

Table 1: Costs and benefits of beef cattle breeding

Year	Net Income (yuan / head)	Selling Price (yuan / 50kg)	labor Cost (yuan / head)	Production (kg/head)	Calves cost (yuan/ head)	Concentrate fee (yuan / head)	Green roughage fee (yuan / head)	Asset Depreciation (yuan / head)
2006	605.54	404.30	444.94	339.90	1189.69	384.17	155.21	21.46
2007	1168.97	584.30	410.71	327.48	1719.88	533.36	192.43	20.62
2008	1043.16	649.80	337.25	323.11	2268.28	713.94	188.35	17.76
2009	936.17	709.88	349.11	393.21	3003.38	949.99	246.57	18.93
2010	998.59	739.76	428.24	379.25	3057.94	985.32	269.46	21.47
2011	1602.78	893.55	501.03	360.03	3366.72	1070.08	272.26	21.99
2012	2288.53	1194.93	747.19	375.84	4582.35	1231.15	384.75	23.58
2013	2740.26	1355.50	916.96	412.24	5910.02	1331.79	471.45	27.34
2014	2324.53	1311.47	976.44	411.43	5725.83	1420.16	425.20	29.78

2015	2083.44	1256.98	1006.49	414.23	5682.55	1281.01	421.74	29.68
2016	2316.72	1252.99	1054.97	419.37	5609.78	1220.31	409.73	30.16
2017	2184.87	1272.12	1052.62	421.72	5952.06	1228.83	397.85	30.85
2018	2561.20	1320.69	1075.95	426.77	6064.26	1345.97	406.43	31.13

Data source: 2006-2018 “China Statistical Yearbook” and “National Agricultural Product Cost-benefit Data Compilation”

The author takes the net income per head of beef cattle as the dependent variable of system behavior, and takes the average selling price of 50 kg beef cattle products, labor cost, production of main products, cost of calves, cost of concentrate feed, cost of green roughage and depreciation of fixed assets as independent variables of system behavior. As can be seen from Table 1, China's net income showed a downward trend from 2013 to 2017, the selling price and output per 50 kg showed an upward trend, and the labor cost, calves cost and asset depreciation showed an upward trend. From 2016 to 2018, the fine fodder cost showed an upward trend, and the green roughage cost showed a downward trend. Although the net income of per beef cattle in China showed an increasing trend in 2018, there was still a certain gap between China and developed countries such as the United States and Australia. As the increase of beef cattle feeding cost was greater than that of price increase, the income of Chinese beef cattle farmers was not high, the enthusiasm of farmers for production decreased, and the number of beef cattle breeding decreased.

5. Qualitative analysis

Exogenous variables include factors such as government policies, technological progress (good varieties), degree of scale, industrialization, credit and other factors. The specific performance in endogenous variables is mainly from the following aspects.

The government policy is mainly reflected in the selling price of main products per 50kg in endogenous variables. Because of the fluctuation of beef product price, the government will control it according to the market demand. When the price of beef products is low, most beef farmers will reduce the amount of breeding and even withdraw from the beef industry, which will seriously affect the development of China's beef cattle industry. Therefore, the price of beef cattle products can reflect the effects of government policies.

In the endogenous variables, the technical progress was mainly manifested in the cost of calves in the production cost of beef cattle, because the price of good beef cattle varieties in the market is higher, the cost of calves purchased by beef cattle farmers is higher, and the price of bad varieties in the market is lower. The improved varieties could bring better

economic benefits to beef cattle farmers.

The degree of scale in the endogenous variables was mainly reflected in the cost of concentrated feed, green roughage fee and labor costs. Although the total amount of fodder used in large-scale beef cattle breeding is relatively large, the conversion rate of concentrated feed per beef cattle was improved, the labor cost of each beef cattle was reduced, and the income of farmers was increased. Large-scale feeding of beef cattle guaranteed the quality of beef products, increased the unit output of beef products, and reduced the production cost of each beef cattle.

The main purpose of industrialized operation and credit were mainly to mobilize beef farmers to expand the scale of breeding, standardize the standards of the whole process of beef production, and also to better improve the quality of beef cattle products, improve the price of products, increase economic benefits and reduce production costs. Beef cattle breeding credit can mobilize the farmers' enthusiasm for raising beef cattle and promote the development of beef cattle industry.

6. Empirical analysis and discussion

The first step is to find the initial value of each value in the sequence. Standardize the data in Table 2 using the mean method.

Table 2: Meaning results of each data column

Year	Net Income (yuan / head)	Selling Price (yuan / 50kg)	labor Cost (yuan / head)	Production (kg/head)	Calves cost (yuan / head)	Concentrate fee (yuan / head)	Green roughage fee (yuan / head)	Asset Depreciation (yuan / head)
2006	0.3444	0.4060	0.6218	0.8829	0.2857	0.3646	0.4757	0.8590
2007	0.6649	0.5867	0.5740	0.8507	0.4130	0.5063	0.5898	0.8255
2008	0.5934	0.6525	0.4713	0.8393	0.5447	0.6777	0.5773	0.7108
2009	0.5325	0.7128	0.4879	1.0214	0.7213	0.9017	0.7557	0.7579
2010	0.5680	0.7428	0.5985	0.9851	0.7344	0.9352	0.8259	0.8593
2011	0.9117	0.8973	0.7002	0.9352	0.8085	1.0157	0.8345	0.8804
2012	1.3017	1.1999	1.0442	0.9763	1.1005	1.1686	1.1793	0.9439
2013	1.5587	1.3611	1.2815	1.0708	1.4193	1.2641	1.4450	1.0943
2014	1.3222	1.3169	1.3646	1.0687	1.3751	1.3480	1.3032	1.1920
2015	1.1851	1.2622	1.4066	1.0760	1.3647	1.2159	1.2926	1.1881
2016	1.3178	1.2582	1.4744	1.0894	1.3472	1.1583	1.2558	1.2073
2017	1.2428	1.2774	1.4711	1.0955	1.4294	1.1664	1.2194	1.2351

2018	1.4568	1.3262	1.5037	1.1086	1.4563	1.2776	1.2457	1.2463

The second step is the difference sequence of term values. According to Formula 1, the difference sequence is shown in Table 3.

Table 3: calculation results of difference sequence

Year	Net Income(yuan / head)	Selling Price(yuan / 50kg)	labor Cost(yuan / head)	Production (kg/head)	Calves cost(yuan / head)	Concentrate fee(yuan / head)	Green roughage fee(yuan / head)
2006	0.0615	0.2774	0.5385	0.0587	0.0202	0.1313	0.5145
2007	0.0782	0.0909	0.1858	0.2519	0.1587	0.0751	0.1606
2008	0.0591	0.1220	0.2460	0.0486	0.0843	0.0161	0.1174
2009	0.1803	0.0446	0.4889	0.1888	0.3692	0.2232	0.2254
2010	0.1748	0.0305	0.4171	0.1664	0.3672	0.2579	0.2913
2011	0.0144	0.2114	0.0235	0.1032	0.1040	0.0772	0.0312
2012	0.1018	0.2575	0.3254	0.2013	0.1332	0.1225	0.3578
2013	0.1976	0.2772	0.4878	0.1394	0.2946	0.1137	0.4644
2014	0.0053	0.0424	0.2535	0.0528	0.0258	0.0190	0.1302
2015	0.0771	0.2216	0.1091	0.1796	0.0308	0.1076	0.0031
2016	0.0596	0.1566	0.2284	0.0294	0.1595	0.0619	0.1105
2017	0.0346	0.2283	0.1473	0.1866	0.0764	0.0234	0.0077
2018	0.1307	0.0469	0.3483	0.0005	0.1793	0.2111	0.2105

The third step is to calculate the minimum and maximum values of the two poles.

$$M = \max_{i} \max_{k} \Delta_i(k) = 0.5385$$

$$m = \min_{i} \min_{k} \Delta_i(k) = 0.0005$$

The fourth step is to calculate the correlation degree of each data.

First, the correlation coefficient is calculated. According to the calculation formula.

$$\xi_i = \frac{\min\limits_{i} \min\limits_{k} \Delta_i(k) + \rho \max\limits_{i} \max\limits_{k} \Delta_i(k)}{\Delta_i(k) + \rho \max\limits_{i} \max\limits_{k} \Delta_i(k)} \quad \rho \in (0, \infty)$$

it becomes the resolution coefficient. The value is usually 0.5.

Secondly, the correlation degree is calculated. The calculation formula of correlation degree is as follows:

$$r_i = \frac{1}{n} \sum_{k=1}^{n} \xi_i(k), k = 1,2,\Lambda,n$$

In the grey relational model, when ρ is equal to 0.5 (generally taken as 0.5), the

correlation degree ρ is greater than 0.5 and close to 1, which indicates that the sequence of factors has strong correlation with the net income sequence of beef cattle products, and the strength of these comparative sequence factors will directly affect the production efficiency of beef cattle. According to the grey correlation model, the correlation degree is greater than 0.5, and the order of the correlation degree from large to small is selling price, green roughage cost, calves cost, concentrate feed cost, labor cost, asset depreciation and output. There is a strong correlation between the selected systematic comparison factor sequence and the beef cattle production benefit sequence. The selected factor sequence is reasonable, and the correlation degree of all the comparison factor sequences on the beef cattle production benefit is sorted reliably (in Table 4).

Table 4 : Correlation data of each indicator

Year	Net Income (yuan / head)	Selling Price (yuan / 50kg)	labor Cost (yuan / head)	Production (kg/head)	Calves cost (yuan / head)	Concentrate fee (yuan / head)	Green roughage fee (yuan / head)
2006	0.8155	0.4935	0.3340	0.8225	0.9319	0.6735	0.3442
2007	0.7764	0.7489	0.5929	0.5176	0.6304	0.7833	0.6276
2008	0.8214	0.6894	0.5236	0.8486	0.7630	0.9454	0.6977
2009	0.6000	0.8595	0.3558	0.5890	0.4225	0.5477	0.5453
2010	0.6075	0.9000	0.3930	0.6193	0.4238	0.5117	0.4812
2011	0.9509	0.5612	0.9213	0.7243	0.7227	0.7786	0.8977
2012	0.7269	0.5121	0.4536	0.5733	0.6703	0.6886	0.4302
2013	0.5779	0.4937	0.3563	0.6601	0.4784	0.7044	0.3677
2014	0.9825	0.8655	0.5161	0.8375	0.9143	0.9359	0.6753
2015	0.7788	0.5496	0.7130	0.6010	0.8990	0.7159	0.9906
2016	0.8203	0.6334	0.5420	0.9032	0.6292	0.8145	0.7104
2017	0.8877	0.5421	0.6476	0.5917	0.7804	0.9219	0.9742
2018	0.6745	0.8533	0.4368	1.0000	0.6014	0.5615	0.5623
correlation degree	0.7708	0.6694	0.5220	0.7145	0.6821	0.7372	0.6388

As presented in the Table 4, the price of main products per 50 kg of beef cattle has the greatest correlation with the net income of raising beef cattle. That is to say, the closest factor is the price of main product per 50 kg beef cattle to the development trend of net income. The price of main product of beef cattle is the main factor affecting the income of beef cattle breeders, and also the main factor affecting the development of beef industry.

The correlation degree between green roughage fee and net income is the second, that

is, feed fees such as alfalfa, corn straw and grass are close to the net income trend of beef cattle production, which indicates that the green roughage fee has a great impact on the development of beef cattle industry.

There is a great correlation between the calves cost and the net income, that is, the trend of the calves fee and the net income of beef cattle production is relatively close, which has a great impact on the production efficiency of the beef cattle. Especially in recent years, the high price of the calves and the decrease of the number of the beef cattle raised have affected the production of the main products of the beef cattle, resulting in the low net income.

The correlation degree of concentrate feed fee, labor cost and net income is slightly smaller than the first three items, indicating that the trend of net income of beef cattle production is close to that of green fodder cost and labor cost, which has a certain impact on beef cattle production efficiency, indicating that concentrated feed fees and labor costs have a greater impact on the development of the beef cattle industry.

The degree of correlation between fixed asset depreciation, output and net income is relatively lower, mainly because fixed asset depreciation is the deposited cost, and the difference in output per beef cattle is small, which has the least impact on net income.

7. Conclusions and recommendations

From the grey correlation model established above, it can be seen that in the beef cattle industry system, the selling price of 50 kg beef cattle products, green roughage fee, calves fee, concentrated feed fee, labor cost, fixed asset depreciation fee, and main product output are all factors have an impact on the economic benefits of the beef cattle industry. The specific influence degree is that the selling price of every 50 kg beef cattle products and the cost of green roughage have the greatest impact on the net income of beef cattle production, which indicates that increasing the price of main products of beef cattle and reducing the cost of green roughage have a positive role in increasing farmers' income and improving people's living standards. Secondly, the production benefit of beef cattle was greatly affected by the cost of calves, concentrate feed and labor cost, while the depreciation cost of fixed assets and the yield have insignifcant impact on the net income of beef cattle. Based on the cost-effective theory, the grey correlation method is used to quantitatively analyze the factors that affect the production efficiency of beef cattle in China. By sorting the gray correlation degree of the factors affecting the production efficiency of beef cattle, the main factors affecting the

production efficiency of beef cattle in China are found.

Based on the conclusions, some suggestions are put forward to improve the efficiency of beef cattle production in China:

Small and medium-sized beef cattle breeding areas should be promoted, and the scale of beef cattle breeding should be gradually expanded. China's beef cattle breeding mode is mainly free-range, and its added value and management level are low. According to the specific situation of beef cattle industry development in China, small and medium-sized breeding should be developed to reduce the feed cost and labor cost of beef cattle breeding, so as to improve the production efficiency of beef cattle in China.

The work of beef cattle breeding should be strengthened. Due to the poor production efficiency of beef cattle in the past few years, beef cattle breeding was not profitable, so many farmers have withdrawn. The recession of breeding has led to the decline of the overall quality of beef cattle. Although some inferior beef cattle have been eliminated, due to the decline in the number of breeding, the farmers are the poor awareness of breeding, especially the low investment in improvement, which leads to the decline of beef cattle quality level. Therefore, the establishment of a complete beef cattle breeding system can produce high-quality beef cattle products and increase the price of beef cattle products.

Improve the industrialization level of beef cattle breeding and enhance the degree of organization of beef cattle farmers. The government should increase the support of beef cattle breeding leading enterprises to promote the development of beef cattle breeding industry. The implementation of beef cattle breeding industrialization service can improve beef cattle breeding technology, expand the scale of breeding, and form a stable beef cattle production base. Encourage the beef cattle breeding cooperatives, associations and other organizations to improve management, reproduction, disease prevention and control, and sales of beef cattle main products for beef cattle farmers, thereby increasing the degree of organization of beef cattle production.

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