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RESEARCH ARTICLE

Research on the Management Strategy from the Perspective of Profit and Loss Balance

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Abstract

The management of pig farms is an issue with the actual background, to improve the profitability, there is an urgently need for farms to optimize the business strategy. This paper aims at pig breeding management issues, using break-even analysis, multivariate statistical analysis and condition forecasting method to establish the model of profit and loss balance. Through the analysis of reserving quantity, breeding time and other indicators, this paper calculated the average litter size per sow per year under the balance of profit and loss, the number of piglets selected as breeding pigs and the number of female pigs kept. According to the price prediction curve, with the principle of no loss, this paper obtained the maximum profit under the conservative business strategy. Besides, sensitivity analysis was carried out under different confidence levels of the forecast pig selling prices, and the management strategies for farmers with different risk preferences were worked out.

Keywords: *Business Strategy, Break-Even Analysis, Pig Breading, Sensitivity Analysis.*

Introduction

With the rapid development of market economy, meat, especially pork, has become a very important part of the food source in our country. Individual raising pigs for the purpose of consumption cannot meet the needs of the market for the pig industry. Since 2000, a variety of factors, especially in the support and promotion of national policy, pig rising of farmers began to transfer from raise in free range to large scale farm.

But due to the farmers do not own good management knowledge, lacks in the ability to analyze the economic, they often facing various problems. With the progress of science and technology, the concept of appropriate scale of farming is gradually popular; this kind of culture is helpful to reduce the cost of rising. At the same time, the flexible optimization of farming structure is conducive to reduce market risk. To have a good grasp of the "degree" of appropriate scale, farms need to combine the scale of their farms, facilities and other objective factors to analyze rationally. Based on such a purpose, the paper makes a measurement process of scientific large scale farm. The general process of pig breeding: pig farms use their own breeding pigs to breed. Female pigs give birth to piglets after 4 months of pregnancy. After lactation piglets become pigs, a part of the pigs are selected as breeding pigs, a small part of the pigs are sold directly to control the scale of farming, and most of the pigs are raised as porkers after castration. The growth period of sows is generally 3-5 years; pigs losing fertility will be harmlessly disposed.

The main breeding cost of pig farms is pig feed cost, plant and equipment and other fixed costs. At the same time, obtain the profit through the sale of porkers. Therefore, farms need to determine reserving quantity, breeding time and population size according to the market conditions to optimize business strategy in order to improve profitability.

Model Hypothesis

In order to solve the related problems, the following assumptions are put forward:

- The annual output of each sow is equal.
- Ignore the harmless treatment costs, the cost of artificial breeding.
- Do not consider the special circumstances such as illness.
- Pig sale under normal operating circumstances is not affected by the market.
- All fertile sows produce at the same time.
- Two fetal pig herds do not overlap time.

The Optimal Amount of Litter Size of Sows

Research Ideas

Through farmers visit found that piglet sale profit is very limited, therefore, do not consider the sale of piglet, pigs transformed into breeding pigs and porker only when they grow up. Because each pig's growth cycle is about 6 months, it is estimated that each sow can have 2 births per year. When sows and boars lose fertility should be put in force harmless treatment, the decreased number of breeding pigs caused by harmless treatment will be supplement by pigs of the next generation, to maintain the stability of the entire pig system.

Only in case of breeding pigs and porkers, pig farms income can only be determined by the sale of porkers. Cost of pig farm is composed by the fixed cost of breeding, the variable cost of porkers and the variable cost of sows. To reach the breakeven point, that is, the cost equals income.

Data Processing

Model Preparation

Because the scale remains constant, the fixed cost per sow per litter is C_1 (￥) within a growth cycle. Variable cost for piglets grow into porker is C_2 (￥/kg). Variable cost for piglets grow into breeding pigs is C_3 (￥/kg). The price of porkers is P (￥/kg). The average weight of porkers is w kg . The number of births that a sow can produce in a lifetime is k .The ratio of boars to sows is1: m . Average annual output per sow is Q .Through the data collection, obtained the following reference standards.

Table 1: Reference standards of pigs

The time needed to rear a pig for slaughter	6 months
The unit cost of porkers	10.6￥/kg
The unit cost of breeding pigs	980￥
Feed inputs for a sow per child	2500￥
The average weight of slaughtered pigs	125kg
The number of births a sow can produce in a lifetime	10
The proportion of boars and sows	1:30
The average price of porkers	15.6￥
The price of feed for porkers	3.6￥/kg
The price of feed for breeding pigs	4￥/kg
The elimination rate of breeding pigs	1/8
The ratio of porkers to total number of the pigs	6.24%

Establishment of Break-even Model

A pregnancy cycle of a sow is considered as a time unit, and assuming that the time needed to rear a piglet for a porker is the same. As part of sows loss their reproductive capacity every year, some reserve sows are needed to make up the number of sows. k represents the number of births a sow can produce in a lifetime. $1/k$ represents the average number of sows eliminated, which is equal to the number of breeding sows needed to update. At the same time, there will be $1/km$ pigs transformed into boars per litter. Construct the break-even equation as equation (1).

$$C_1+(Q-\frac{1}{k}(1+\frac{1}{m}))wC_2+\frac{1}{k}(1+\frac{1}{m})C_3 \le (Q-\frac{1}{k}(1+\frac{1}{m}))wP \quad (1)$$

Calculated that:

$$Q=\frac{C_1+\frac{1}{k}(1+\frac{1}{m})(C_3+(p-C_2)w)}{(P-C_2)w} \quad (2)$$

In equation (1), the left represents the cost, the right side represents the income.

$\frac{1}{k}(1+\frac{1}{m})$ represents the number of breeding pigs per litter.

$Q-\frac{1}{k}(1+\frac{1}{m})$ represents the number of porkers per litter.

$(Q-\frac{1}{k}(1+\frac{1}{m}))wC_2$ represents the cost of porkers per litter.

$\frac{1}{k}(1+\frac{1}{m})C_3$ represents the cost of breeding pigs per litter.

$(Q-\frac{1}{k}(1+\frac{1}{m}))wP$ represents the sale income of porkers per litter.

The Simplification of Break-even Model

If do not set parameters k, set the proportion of piglets transformed into porkers as α, then equation(1) will transform into equation (3).

$$\begin{cases} Y = P\alpha wQ \\ C = C_1+\alpha wQC_2+(1+\frac{1}{m})(1-\alpha)QC_3 \\ Y \ge C \end{cases} \quad (3)$$

Calculated that:

$$Q \ge \frac{C_1}{(P\alpha w-\alpha wC_2-(1+\frac{1}{m})(1-\alpha)C_3)} \quad (4)$$

Result Analysis

Take the reference standards of table 1 into equation (3), obtained equation (5)

$$\begin{cases} Y = 1828.32Q \\ C = 2500+1305.51Q \\ Y \ge C \end{cases} \quad (5)$$

Draw the breakeven line diagram as figure 1.

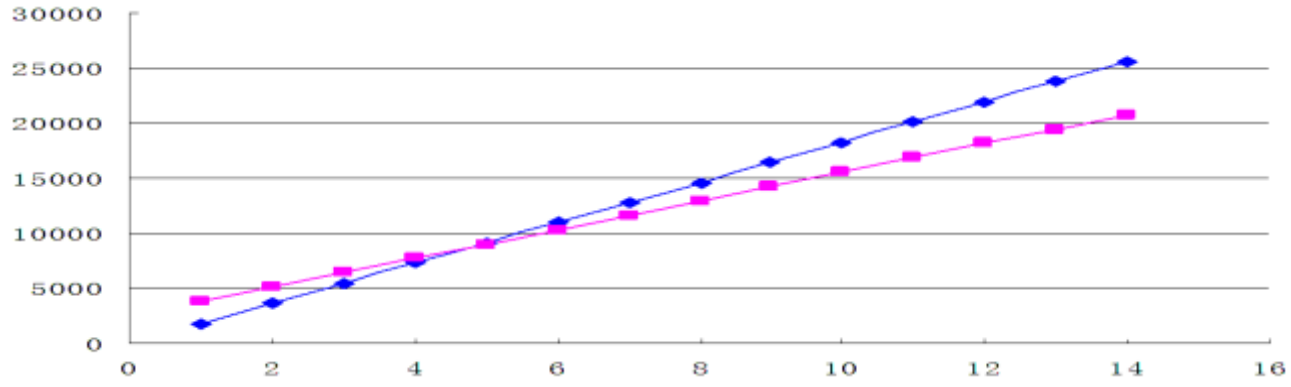

Fig.1:Break-even point diagram

From Figure 1 can get the litter size of pigs $Q=4.78$ in breakeven point. So per sow on average products at least 9.56 litter per year. Per sow on average must products at least 10 litter per year to maintain the management of the farm. Pigs over 10 can bring a profit of 200 yuan per head, so there will be a profit of 2000 yuan per year.

The Proportion of Pigs Selected as Breeding Pigs and the Number of Female Pigs Kept

Research Ideas

In the reproductive period, the annual output of the sow is about 2 or so, and the survival rate is about 9 per litter. According to the farm's largest farming scale is 10000, when

the scale of the farm reached saturation and keep the dynamic balance, the number of sows and the ratio of sows to boar unchanged. We can assume all fertile sows give birth at the same time, sales at the same time when piglets develop into porkers and then the second litter is produced. That is two fetal pig herds time do not overlap. According to the equation: the number of sows eliminated is equal to the number of piglets selected as breeding pigs, conversion ratio of piglets and number of female pigs kept can be calculated.

Data Processing

Conversion Ratio

Set z as the Conversion ratio of piglets turned into breeding pigs. And assuming that when the farm is in the balance condition, the number of fertile sows remains as x, the ratio of boars to sows is $1:m$. Each fertile sow breeds two litters one year, the litter size is Q. The reproductive time of the sow is fixed as n (where n is 3,4,5). The number of sows eliminated each year is x/n .Obtain the relationship equation as equation (6).

$$\frac{x}{n}=\frac{2Qxzm}{m+1} \quad (6)$$

And calculated that $z=\frac{m+1}{2Qmn}$.

By the expression, we can see the value of z is related with Q and m .Under normal circumstances the change of m and n is not much, Q changes more obviously. Because the number of pigs has great randomness, when the growth period and breeding mode remain unchanged, Q can be regarded as random variables, the bigger Q is, the smaller z is.

In the same way when Q is very stable, the efficiency of different mating methods obtained are not the same, the greater m is the higher the efficiency of breeding boars is. Thus the piglets set aside for reserving is smaller.

Number of Female Pigs Kept

Assume that each fertile sow breeds tow litters one year and consider a fertility cycle of 5 to 6 months, the paper gets the the result as equation(7).

$$x+\frac{x}{m}+Qx\le 10000 \quad (7)$$

So when the farm reaches its maximum size, the number of fertile sows can be calculated.

$$x=\frac{10000}{1+\frac{1}{m}+Q}$$

Result Analysis

Conversion Ratio

$$z=\frac{m+1}{2Qmn}$$

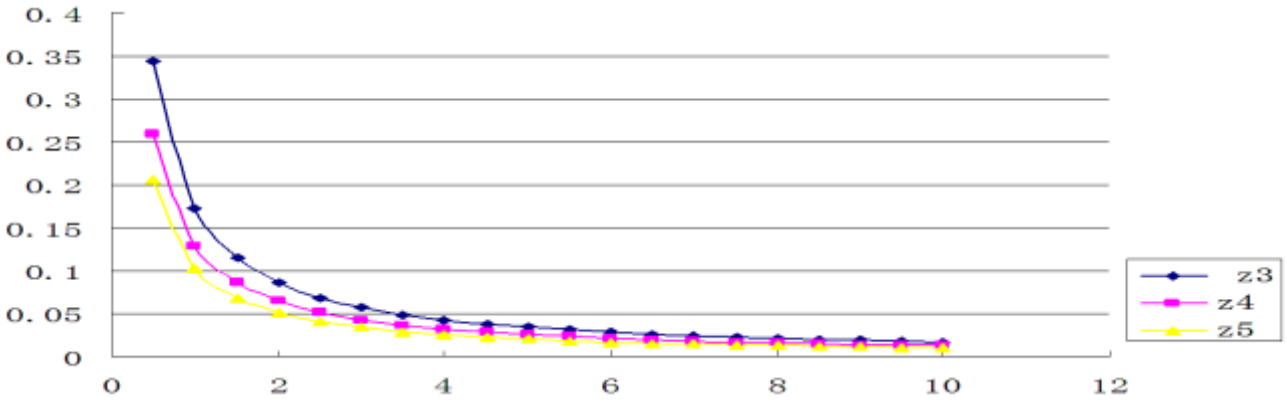

Fig. 2: Conversion ratio and the litter size

In figure 2, X-axis represents Q, Y-axes represents z. When the ratio of boars to sows is fixed, the ratio of piglets to breeding pigs z is in inverse proportion to the growing period of the sow n and the litter size per year Q .When Q equals 10 and m equals 30, respectively take n as 3,4 and 5,we can get the value of z as 1.72%, 1.29%, 1.03% respectively.

Number of Female Pigs Kept

When the farm reaches its maximum size, we can calculated the number of fertile sows $x = 10000/(1+1/m+Q)$,take Q as 10 and m as 30 into the equation respectively, we obtain the value of x as 906.This result show that the number of female pigs kept approximately equals 906 when the farm reach its maximum.

Analysis on the Optimal Management Strategy of Pig Farms

Research Ideas

Based on forecast curves of pig price changes in 3 years after 9 months[1], this paper aims at determining the best management strategy of the pig farm. First, finds the break even price according to the break even equation, then determines the reliability level by taking the forecast price as a random variable. If predict price is greater than the break-even point price under the 90% confidence level, takes the greatest scale for breeding; Otherwise does not breed. This paper takes the aim of realizing the maximum benefit of the farm and tries to find out the optimal breeding time and the best time to sell, so as to determine the best sales strategy and the corresponding average profit.

Description of the horizontal axis: the first year represents the time starting the forecast, D2 represents the second year, followed by analogy.

Data Processing

Model Preparation

The number of pigs kept is determined by breeding time and seed number, therefore, this paper considers three aspects: 1) The time to sale porkers should meet the relative peak of the market price forecasting curve; 2) The time to sale porkers should avoid the relative low trough of the market price forecasting curve; The number of pigs kept should determined by the principle of not losing money according to the market price forecasting curve. Under the condition that each fertile sow breeds two litters one year and the litter size is 9, through the break-even equation we calculated the price as equation (8).

Fig.3: Three years price forecast curve

$$\bar{p} = \frac{C_1 + awQC_2 + (1+\frac{1}{m})(1-a)QC_3}{awQ} \quad (8)$$

In the breakeven point, the price of live pigs was 14.32 yuan/. That is, sale price should above 14.32 to ensure that the sale does not loss. Since three years after the price of live pigs is a predictive value with a lot of uncertainty, so we need to seek out the price of live pigs in the balance of profit and loss under a certain degree of probability, in order to ensure a certain probability of not losing money, and on this basis to achieve maximum profit. The price is divided into 10 days a cycle, there are 109 cycles of three years in total.

Assuming that the price follows a uniform distribution, and the fluctuation range is up and down 5%.Find out the price range beyond 14.32 according to equation(9), and the specific price fluctuations as shown in figure 4

$$\hat{p} = \frac{1*0.1}{p*1.05 - p*0.95} + p*0.95 \quad (9)$$

[1] Problem C
in the National College Mathematical Modeling Competition of 2014: http://www.mcm.edu.cn.

The time of a sow from conception to pregnancy requires 12 cycles, porkers from birth to sale requires 15 cycles, namely 27 cycles are needed from a sow gets pregnant to the piglets grows into porkers.

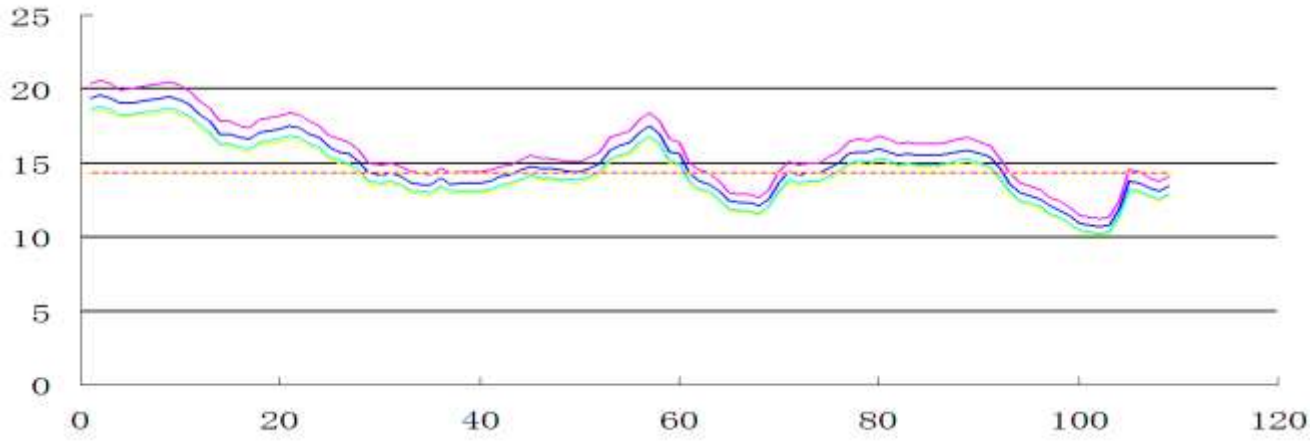

Fig. 4: The fluctuation range of the price of porkers

The price range calculated in equation (9) can guarantee not loss is the appropriate price range for sale, using the appropriate price range for sale subtracts 27 cycles can get the suitable breeding time. The results are shown in table 2.

Table 2: The best breeding period and the corresponding date

The best breeding period	27-35	51-65
The corresponding date	D3.3.2-D3.5.22	D3.11.2-D4.3.22
Best selling cycle	53-61	77-92
The corresponding date	D3.11.12-D4.2-2	D4.7.2-D4.12.12

Note: ten days for one cycle, the starting point for the D2.6.12, the end point for the D5.6.12, a total of 109 cycles.

Establishment of Model

Because the best breeding time contains more than one cycle, and sow in the best matching period are empty, sows can be bred at any cycle of the best breeding period, as long as the guarantee that all can be sold during the bestselling cycle. In order to maximize profits, should try to choose the price at the maximum point of the curve or near the point.

The greater the price of live pigs, the greater the profit. Known that the total number of sows is 910 in the 27 cycle, excluding the natural death of the sow, the pig will not eliminate before the next breeding. According to figure 3, select the D3.3.2-D3.5.22 cycle range for breeding, select D3.11.2-D4.3.22 cycle range for selling.

And the higher price corresponding to the higher breeding number of pigs.

Result Analysis

According to the number of sows kept and the number of porkers, calculate the cost and income in three years, and obtain the total profit.

$$\begin{cases} C = 3*C_1 + 2500*\sum_{t=1}^{109} q_m(t) + w\sum_{t=1}^{109} q(t)C_2 \\ Y = \sum_{t=1}^{109} p(t)q(t) \\ Y = R - C \end{cases} \quad (10)$$

In equation (10), C_1 represents the fixed cost of the farm per year. q_m represents the total number of breeding pigs.

Due to the average cost per sow per little is 2500 yuan, so in three years the cost of the sow is equal to the cumulative number of sows involved in production multiplied by 2500. The cost of porkers is equal to the total number of feeding porkers multiplied by the average breeding cost per porker. $p(t)$ represents the selling price of porkers in time t . $q(t)$ represents the selling amount of porkers in time t .

So we can get:

$$R = 9100*3*15.6*125 = 53235000$$

$$C = 1000*3*2500 + 9100*10.6*3*125 = 43672500$$

$$Y = 53235000 - 43672500 = 9562500$$

Therefore, the average profit of three years Y/3=3187500.

In the sales strategy, specifically plan the kept number of sows and porkers, put the kept number of different periods in a time sequence and trace these points, then we can get the variation curve of the kept number of sow and porkers. (Figure 5 and 6)

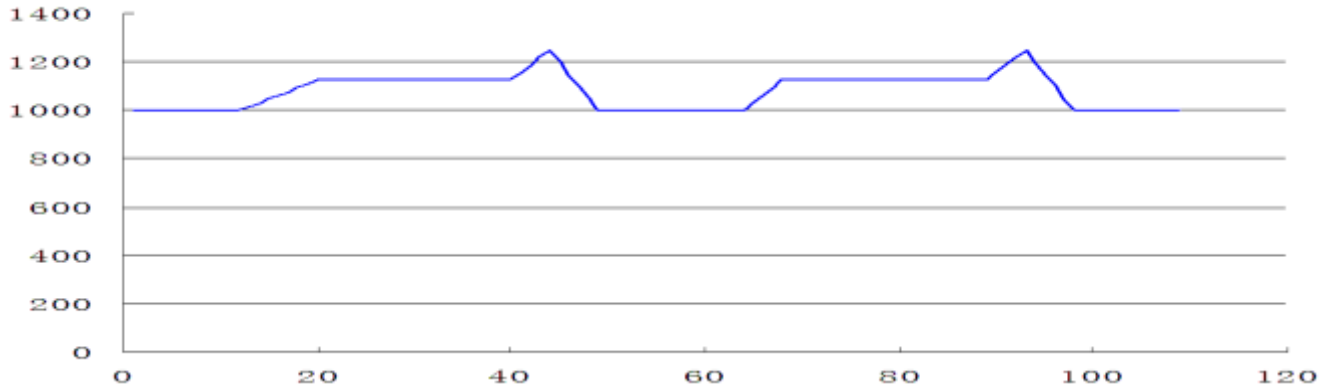

Fig.5: Trend chart of the number of sows

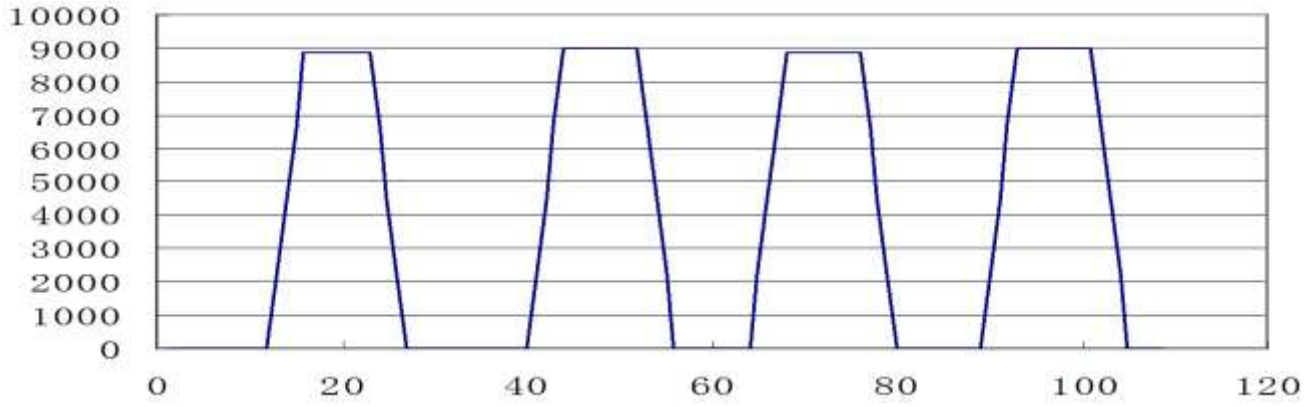

Fig.6: Trend chart of the number of porkers

Sensitivity Analysis

In the problem of analysis on the optimal management strategy of pig farms in part 5 of this paper, due to the pig price is a predicted value, there is a certain error with the real price. The forecast price cannot be directly used as a reference price. So the analysis of the problem should take the reliability of the data into consideration.

Assuming that the real price is subject to the uniform distribution of the upper and lower 5% ranges of the average value of the forecast price. Different confidence levels were selected to be able to get different breeding intervals and develop different business strategies. The sensitivity analysis of confidence level is significant for different risk loving breeders.

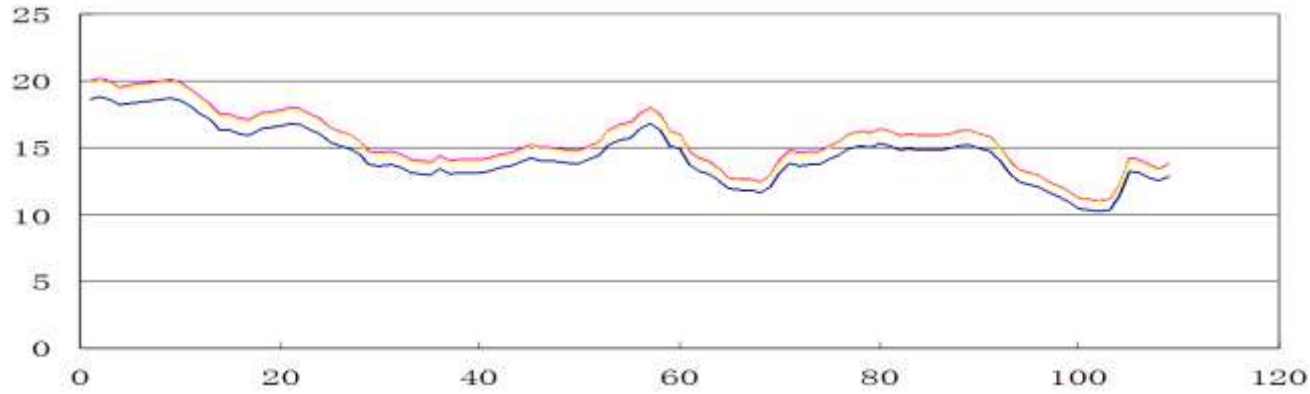

Fig.7: Sensitivity analysis of confidence level

In figure 7, the red line, the yellow line and the blue line are represent 90%, 80% and 70% confidence level respectively. And according to the different confidence level, the best breeding period changed as well, the specific result are shown in table 3.

Table 3: The Best breeding period and the corresponding date under different confidence level

The confidence level	70%	80%	90%
The best breeding period	44-61	48-60	49-60
The corresponding date	D3.7.22-D4.2.12	D3.10.2-D4.2.2	D3.10.2-D4.2.2
Best selling cycle	74-92	75-92	75-91
The corresponding date	D4.6.22-D4.12.22	D4.7.2-D4.12.22	D4.7.2-D4.12.12

From table 3 we can see that the best breeding period under 70% confidence level is bigger than the best breeding period under 80% confidence level of 6 breeding cycles. The best breeding period under 80% confidence level is bigger than the best breeding period under 90% confidence level of 2 breeding cycles. In each breeding cycle 60 sows are bred, each pregnant sow can produce 980 piglets (50*0.98*20=980). Due to low confidence level is relatively to low price, assuming per porker can profit 50 yuan on average.

So we can calculate that farmers under 70% confidence level are expected to yield more than farmers under 90% confidence level of 343000 yuan (7*980*50=343000). But due to the confidence level drops, the error between expectation value and the real value will increase, and the expected effect also will be greatly reduced. Therefore, the expected price and reliability should be selected according to the situation, in order to limit the probability of loss.

Conclusions

Based on the work flow and cost estimation of pig farms, take the break-even balance and moderate scale as the guiding ideology, this paper gives the corresponding scale of farming and the plan of pig breeding. At the same time, based on the reasonable forecast of pig selling price in 3 years after 9 months, taking into account the corresponding cost changes, the paper aims to reach the maximum benefit on the basis of stable operation. And a mathematical method was put forward the management strategy of pig farms in the next 3 years using methods of cost-benefit analysis, multivariate statistical analysis and condition forecasting. These methods to plan the number of pigs kept and breeding scale are of great practical guiding significance, for pig farmers [1-8]

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