

The Management System of Beef Cattle Breeding based on the Data Record of Whole Industry Chain

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Propagating and breeding of beef cattles is an important part of beef cattle production. It is very important for the beef cattle farming industry to breed excellent varieties through scientific breeding. China is in the development stage of the breeding industry, which is especially prominent. We designed and developed a cattle breeding management system based on the whole industry chain data records. The system can record the information of each beef cattle's estrus breeding, pregnancy test and abortion or birth, and handle the analysis records and give corresponding warning. At the same time, in the process of registration of estrus breeding information, the system calculated the descendant inbreeding coefficient of the cows' artificial insemination automatically to select better quality frozen semen. Finally the system can make the management more scientific and improve the effect of cattle breeding.

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1.Introduction

Since the reform and opening up, Chinese animal husbandry has developed rapidly and cattle breeding industry has become the world's third largest producer of beef in China's animal husbandry. Beef cattle production can not only improve the proportion of grain-saving livestock and ensure the national food security, but also adjust the resident dietary structure and improve the people's life. With the improvement of people's living standards, the beef cattle industry has become one of the most important animal industries in China gradually[1] . However, the average carcass weight of Chinese beef cattle is below the world average and the production efficiency is low. One of the main problems is that the beef cattle industry started relatively late and the beef cattle farming is still based on scattered and small-scale farmers farming. These activities make beef cattle products production and circulation disorder and lack of complete breeding, slaughter and segmentation, disease prevention and other aspects of information, which make the Chinese beef production difficult to fulfill the safe, high quality, efficient and sustainable requirements [2].

The beef breeding is an important part of beef cattle production. It has very important significance for beef cattle farming industry to breed good variety in a scientific way, especially in our country where the breeding industry is on the stage of continuous development. But there are many breeding units which blindly pursue the high yield of beef cattle and ignore the breeding performance recently, resulting in the beef cattle breeding effect and the breeding quality are relatively poor, and making the beef cattle breeding industry to be developed in a limited way. There are also some breeding units in the process of beef cattle breeding by using the unsuitable breeding methods to introduce foreign varieties blindly. This activity may loss my beef cattle varieties [3]. The breeding of beef cattle breeding data are mostly record artificially. This work not only takes up a lot of work tasks, but also is likely to make errors., The data is not conducive for preservation [4].

In order to solve the above problems, developing the beef cattle of whole industry data recording system is one of the reliability ways to improve the beef cattle information management. The system can record the national cattle breeding, slaughter and segmentation, disease prevention and information from other aspects in a more standardized manner. Users can query the cattle's position, variety, gender, coat color, date of birth, electronic ear tag, proportion of blood, source, birth field, management number, growth stage, breeding status, current parity, birth parity, appearance score and body condition score and others information. The system assigns an unique identity number to each cattle, containing up to 12 digits (including proofreading numbers), which can be applied to the management of cattles all over the world. This paper mainly introduces relevant functions of the cattle breeding in the system, including cattle estrus breeding registration, pregnancy registration, abortion registration, calving registration and cattle information, etc.. The system can record the pedigree information of each cattle, calculate the inbreeding coefficient of the frozen with inbreeding coefficient of female cow when implementing the breeding for cattle to make the breeding more scientific in the future.

2.Principle and Method

2.1 Requirement Analysis

This system can record details of each process in the beef cattle breeding, whether it is oestrus breeding, pregnancy test, abortion or delivery of the beef cattle. This system can also calculate the inbreeding coefficient between bulls and cows before mating, and the accuracy of pedigree documents must be recognized before calculating the inbreeding coefficients (especially to avoid genealogical loops), which is also an advantage of the system. The database will record the pedigree of each beef, based on the pedigree check rule of ICAR. Before determining the pedigree for official registration, the following steps must be completed: ①ensure the correct identification of matched cows ②ensure the correct identification of the donor bulls③ the registered date of birth should be within the range of + 6% of the average pregnancy days of the donor bulls after the mating day④ensure the correct identification of the offspring of matched beef ⑤the donor bulls must be recorded by artificial insemination or on site on the mating date, or verified by the surgical veterinarian.

The purpose of breeding management is to monitor each link and manage the breeding process according to the historical situation[5].The system should summarize the knowledge of beef cattle breeding management and adopt scientific breeding calculation method, give the breeding warning. The breeding warning includes warning of suitable mating cows, warning of inbreeding coefficient and warning of expected date of childbirth warning. The system should help select high quality frozen semen, improve the quality of artificial insemination in beef cattle, realize the digital management of beef cattle basic information, realize intelligent management of the beef cattle breeding module.

2.2 Overall Design of the System

The beef cattle breeding management system used object-oriented design method and focused on the breeding management of beef cattle[6]. It can be divided into three parts: information collection, information processing and information application. The information application is mainly used to make some warning management of beef cattle with detailed shown in Figure 1:

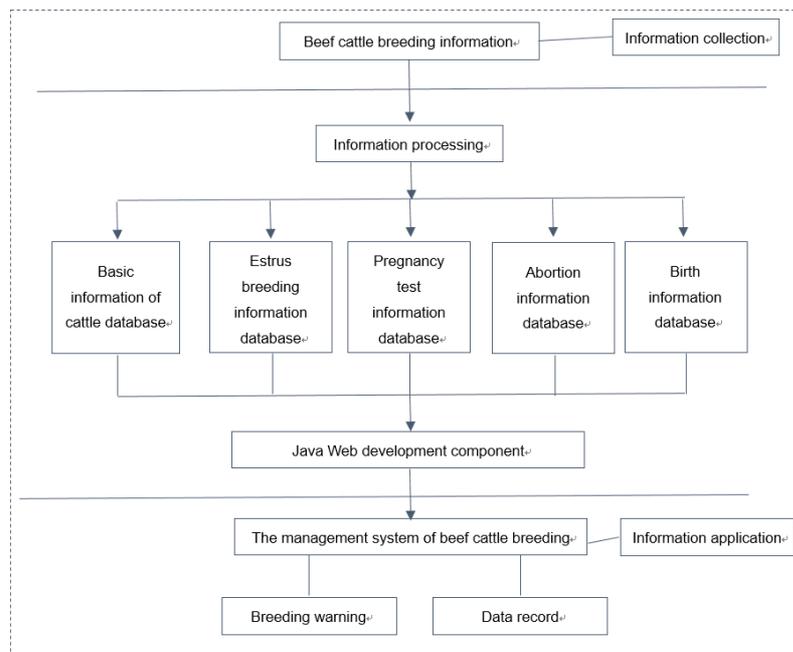


Figure 1: Overall Framework of the System

2.3 Calculation Method of Inbreeding Coefficient

The inbreeding coefficient of beef cattle can be calculated according to Formula (2.1). Among them, n_1 stands for the algebra of fathers to a common ancestor, n_2 stands for the algebra of mother to a common ancestor and F_A stands for the inbreeding coefficient of an ancestor. The database will record the inbreeding coefficient of each beef cattle. When the common ancestor is not an inbred individual, F_A will be set to 0. In order to calculate the inbreeding coefficient of the target individual, the pedigree of matched cows and donor bulls should be firstly searched in the database records, also the common ancestor of target individual parent and the number of common ancestor. These data will be substituted into the formula to calculate the inbreeding coefficient. The inbreeding coefficient of these two cattles' breeding for next generation will be calculated. As this method only records the parents number of each cow and the calculated inbreeding coefficient, this system will adopt the general formula to calculate the inbreeding coefficient.

$$F_x = \sum \left(\frac{1}{2}\right)^{n_1+n_2+1} \cdot (1 + F_A) \tag{2.1}$$

2.4 Warning Method to Suitable Mating Cows

Firstly, the manager selects the cattle ranches, cattle cowsheds and cattle pens that need warning, and then sets the warning conditions for selected ranches, cowsheds or pens. The warning conditions include young breeding cows of which the birth time reached a certain period of time, young breeding cows whose weights reach certain kilograms. These conditions can be set according to the actual situation of different cattle ranches. When a cow satisfies either of these conditions, the system would give a warning, then the breeder will go to the ranch to determine whether there is a need for mating based on the cow's specific conditions. Also, for the cows that have been delivered, the system must take into account at the time interval for the cows to receive mating again. The first insemination after delivery is not easy to conceive too early; if too late, the cost of raising is expensive. Practice shows that the beef cattle were mated at 60~90 days postpartum and the situation conception rate is the highest[7].

2.5 Calculation Method of Expected Date of Childbirth

When the beef cattle have been mated, the expected date of childbirth can be calculated. The average gestation period of cows is 285 days, and the expected date of childbirth can be calculated by using the method of “the month is reduced by 3, the day is added by 10” As the database records the mating date of each mating cow, it is possible to estimate the expected date of childbirth. Before half a month or so, the vulva of bossy would swell, the root of the tail on both sides depressed and the breast intamescentia; before one or two days of the delivery, there would have hyaline grume outflowing from vulva and the bossy would get up and curl up over and over again and feel birth pain approach childbirth, discharge waste frequently and restless[8].

2.6 Database Design

From the demand analysis, we can get the data to be recorded during the breeding process of beef cattle and design the relevant database in the process of beef cattle breeding accordingly. It is necessary to record the beef cattle individually, so firstly, we need to design beef cattle individual information table, then design the beef cattle oestrus breeding table. The following two tables can record the most important information in the process of beef cattle breeding. The main fields for the two tables are as follows:

ID	Field name	Field types	Width	remarks
1	Cattle ID	Varchar	20	Primary key
2	Cattle ranch ID	Varchar	30	
3	Cowshed ID	Varchar	20	
4	Cattle pen ID	Varchar	20	
5	Variety name	Varchar	20	
6	Sex	Char	5	
7	Date of birth	Datetime		
8	Growth phase	Char	20	
9	Breeding state	Char	20	
10	ID of father	Varchar	30	
11	ID of mather	Varchar	30	
12	Coefficient of inbreeding	Double	30	

Table 1:Basic Information of Individual Beef Cattle

ID	Field name	Field types	Width	remarks
1	Breeding ID	Varchar	30	Primary key
2	ID of cowinestrus	Varchar	30	
3	ID of frozen semen	Varchar	30	
4	Date of rutting	Datetime		
5	Date of breeding	Datetime		
6	Methods of breeding	Char	20	
7	Breeding worker	Char	30	
8	Number of semen	Float	30	
9	Coefficient of inbreeding	Double	30	

Table 2:Information of Estrus Breeding

3.Results

3.1 Breeding Data Entry

In the breeding data entry, firstly select the cattle farm and related barns to be recorded. The system will display the number of cows in the barns and the animal breeder chooses the breeding cows. And we can check all the basic information of this cow according to the cow number. Before the breeding registration, input the ID number of donor bull into the system. The system will calculate the inbreeding coefficient based on the beef cattle's pedigree. If the inbreeding coefficient is less than 0.05, the system will allow the breeding registration of this mating cow and this frozen semen.

There still are a lot of important information to be recorded after oestrus breeding, including records of pregnancy information, abortion information, and delivery information. In the process of pregnancy test, the data had to be recorded including the number of cows examined for pregnancy, the pregnancy test date, the pregnancy examiner, the status of pregnancy test, the status of pregnancy, the status of the uterus, the left ovary, the right ovary and the relevant comments. If a cow has a miscarriage, the data have to be recorded including the abortion cow number, the date of abortion, the cause of abortion, the discoverer and relevant comments. In the cows' delivery, the data have to be recorded including the cow number, the calving date, the degree of calving difficulty, the sibling number, the midwife, the afterbirth status and relevant comments. These data are generated from all processes after artificial insemination not only for rigorous genetic breeding, but also for breeding management of group or individual levels[9].

3.2 Breeding Warning

After the manager has input individual information of beef cattle, the system would calculate the breeding status of all the cows according to the current date, and automatically gives the warning of the key link. This paper introduces the warning from three aspects, including the warning to suitable mating cows, the donor bulls to meet the inbreeding coefficient and the expected date of childbirth of pregnant cows. These warnings give a scientific and effective remind to farm managers to help them finish the work of beef cattle breeding at the most suitable time.

3.2.1 Warning to Suitable Mating Cows

The system realizes the early warning of the adaptation cows according to the conditions set by the ranch administrator. The choice of adaptation of cows conditions is shown in Figure 2 . The warning conditions include the young breeding cows' growth age and growth weight, the adult cows' time after delivery. After setting the conditions, the system can automatically summarize the eligible adaptation cows. The eligible adaptation cows are shown in Figure3 , including the cattle ranch, the cattle cowshed, the cattle pen, the cattle ID, the reproductive state, the postpartum days and the months of age. It can be seen that when the reproductive state of cows is not breeding and months of age of cows is about 18 months or when the reproductive states of cows is postpartum and postpartum days is about 80 days,the system gives an early warning of possible estrus,administrators can make corresponding decisions according to the warning. The intelligence of the system improves the management level of cattle and improves the breeding effect of beef cattle when compared to the traditional management style.

warning to suitable mating cows

ranch selection :

- BeiJing Ranch
 - Cowshed3
- China Ranch
 - Cowshed5

warning condition :

birth months

weight kg

postpartum days

[Summary data](#)

Figure 2: Warning condition of suitable mating cows

>> warning >> warning to suitable mating cows

<input type="checkbox"/>	cattle ranch	cattle cowshed	cattle pen	cattle ID	reproductive state	postpartum days	months of age	warning
<input type="checkbox"/>	BeiJing Ranch	BJCowshed02	Pen201	CH0111120170028	Non breeding		19	Possible estrus
<input type="checkbox"/>	BeiJing Ranch	BJCowshed02	Pen202	CH0111120170035	Non breeding		18	Possible estrus
<input type="checkbox"/>	BeiJing Ranch	BJCowshed03	Pen301	CH0111120170046	Non breeding		17	Possible estrus
<input type="checkbox"/>	BeiJing Ranch	BJCowshed01	Pen101	CH0111120170005	Postpartum	90	31	Possible estrus
<input type="checkbox"/>	BeiJing Ranch	BJCowshed01	Pen102	CH0111120170011	Postpartum	60	29	
<input type="checkbox"/>	BeiJing Ranch	BJCowshed01	Pen102	CH0111120170015	Postpartum	20	27	
<input type="checkbox"/>	China Ranch	CRCowshed05	Pen501	CH0001120170025	Breeding	140	33	
<input type="checkbox"/>	China Ranch	CRCowshed03	Pen302	CH0001120170012	Postpartum	95	40	Possible estrus
<input type="checkbox"/>	China Ranch	CRCowshed08	Pen812	CH0001120170026	Breeding	120	32	

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Figure 3: Warning Data of Suitable Mating Cows

3.2.2 Inbreeding Warning

This warning occurs before mating. Before carrying out artificial insemination, we firstly need to select the cows that need mating, and then input the donor bulls' ID number, calculate in accordance with the inbreeding coefficient formula mentioned above. If the calculated semen coefficient is greater than 0.05[10], the system will give a reminder to the manager that this mating cow is not allowed to accept the frozen semen of this donor bull.

3.2.3 Expected Date of Childbirth Warning

After the cows have been mated, the system is able to warn the cows' expected date of childbirth according to the calculation method of expected date of childbirth. The system can automatically summarize the cows that can meet the warning conditions, and show details of the cows, including the cattle ranch, the cattle cowshed, the cattle pen, the cattle ID, the months of age and the match date. The recording and automatic analysis of mating data have improved utilization of the cows and promoted the sustainable development of beef cattle industry.

4. Conclusion

This paper mainly introduces the breeding management process based on the beef cattle's industry chain data recording system. This system can record detailed data of beef cattle

breeding process. Each cattle across the country has an unique ID number, which is recorded according to the animal ID number standard of ICAR to improve the accuracy of beef cattle identification. In the process of beef cattle's oestrus mating information registration, this system can achieve the automatic calculation of next generation's inbreeding coefficients of the mated cows during artificial insemination, and select high quality frozen semen, record each beef cattle's oestrus, pregnancy, abortion and delivery information, handle and analyze the recorded data and then give corresponding warning to help breeders manage the beef cattle groups in more scientific and effective manner and improve the breeding effect. In addition, the system can collect the beef cattle's information distributed across the country, then analyze the data by using the big data technology, which could provide important data support for the future beef cattle breeding work.

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