Modelling and Method for Beef Quality Risk Identification and Optimization in Beef Cattle Breeding

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Abstract: The meat industry is seeking to establish reassurance on traceability and production techniques that may help to promote confidence in the integrity and origin of the products. The overall tracing of beef quality is actually the risk identification and control along the supply chains of beef production. This study focused on the identification and control methods of quality risks in China traditional beef cattle breeding with optimization approaches concerned. The quality risks in beef cattle breeding were classified by features to develop the disseminated model of these risks and its algorithms. Then the theory of quality traceability was used and a concept model of quality risk control was proposed. Tracing units were divided and tracing nodes were set through optimization. The proposed risk identification and control models were capable of identifying and handling a product and the information attached to it throughout the whole production process to retail packs.

Key-Words: Beef Breeding; Risk Identification; Risk Control; Traceability

1 Introduction

The amount of beef cattle on hand was up to 141 million in China at the end of 2005, and in the same year the amount of beef cattle for slaughter ranked the top, more than Australia, USA and Brazil. However, as China beef cattle stockbreeding launched late, the production management of large-scale breeding farms still depended on traditional ways. It had disorders in beef production and circulation and lacked overall information about breeding, feeding, migration, epidemic prevention and medical treatment. These made China beef production could hardly meet the requirements of safety, high-quality, great efficiency and sustainability. With the trade globalization and livestock production industrialization, the production and consumption of beef products were gradually separated and the complicated supply system made consumers quite hard to obtain the safe information about the products they purchased. Therefore, to identify and control the beef cattle quality risk in the breeding process could be a guarantee for the beef quality and promote effective information transfer from the production beginning.

As for this, many studies had been done in establishing safety system framework of beef production. L.Orru´ and F.Napolitano [2] used the log management information and developed an optimal instruction selection model for the tracing system. Garrido [3] developed an information model tracing the numerically controlled manufacture flow and used the relations among CNC report data and CAD design and CAM data to analyze and identify the unexpected situations during manufacture. Regattieri [4] proposed a key factor identification method in effective traceable system. C.A. van Dorp, etc [5~7] used Gozinto Graphs method in the development of tracking and tracing information systems. Some also used FMECA method in traceability of food industry [8]. Many studies [9-11] in China developed traceable systems for China livestock products. The RFID technological approach used had great implications in relation to the cost associated with a traceability system and the ease of its deployment [12, 13]. Dimitris Folinas, etc. [14] mentioned a kind of data management method using XML. Koutsoumanis and Mousavi [15-18] talked about identifying and handling a product in whole process from breeding, production till retails.

Studies showed that traceable system was an important approach which could promote the vitrification of production information, guarantee the health of beef cattle and improve the safety of beef products. Anyway, in the quality risk information identification and control for beef cattle, predictive models were of great use and needed to be developed and improved [19, 20]. While for the process of quality tracing, recognizing and control of quality risk was actually the key for tracking and tracing of the whole beef cattle breeding. This paper studied the quality risk identification and control models in the beef cattle breeding and the implementation of corresponding tracing system.

2 Methods

2.1 Sorts of quality risks

Food quality information covers the whole circulation. Direct or indirect information is introduced by each or each batch of product during raw material take-over, production and finished product delivery, etc. All these information can be divided into two categories: technical information and administrative information.

Some measurable quality indexes can be used to represent cattle quality in breeding, such as bacteria superscale, contents of antibiotic, incretion and parasite, etc. Besides, there are some other factors, especially deleterious factors that impact the beef quality. While in fact, for the beef cattle breeding, it is implemented by certain raisers in certain environment with certain raw material, following regular feeding flow. So in the aspect of actual operation, the quality of beef cattle breeding will be influenced by the following factors: operators, raw material, feeding method and environment. And looking into the aspect of breeding techniques, the impact factors of quality will include two kinds. One is the technical-type risks concerning the healthy level of cattle, and the other is process-type procedure risks concerning the quality safety of beef. The former one can be indicated by various quality detection indexes of beef, impact factors including quality of feedings, varieties of cattle, etc. The latter is influenced by raisers operation, working attitude, accuracy and situation of the quality control equipments, regulation of operation methods, and working environment, etc.

To sum up, the beef quality risks in breeding refer to the gathering of all factors that influence the healthy level of beef cattle. The quality tracing objects of beef cattle in breeding are divided into the following four categories:

(1) Fattening potential of the cattle: basic information such as variety, weight, postural characters, medical history and level of medicine residue, etc.
(2) Feedings used for fattening cattle: the chief feedings including medicine, forage and water. The large-scale beef cattle breeding needed to shorten the fattening period and realized intensivism, which inevitably increased the immune operation frequency and employment of fodder additives for the cattle. These caused many beef quality problems. The multiplied incidences of beef cattle epidemic diseases then resulted in increasing usage of veterinary products and disinfectors. Therefore, attention should be paid on the feedings and it is the kernel in beef quality tracing, including remains of medicine and traits of beef, etc.
(3) Fattening technology: currently, many beef cattle breeding farms in China generally sell the cattle that are expected not to be used for slaughter to local retailers in very low price before they are getting ready for slaughter. This kind of low efficient breeding has increased the cost of production and quality risks of beef in market circulation. So tracing for fattening cattle processing needs to be taken into consideration.
(4) Real-time environment situations for fattening cattle: the non-product surroundings, including workers, machines, equipments, growing environment, especially the technical parameters such as farm ventilation, temperature and humidity, etc.

2.2 Risk Features Characterization

Of all the impact factors of beef quality, some are quantitive factors that can be measured by metric gauges and results are indicated by numerical values. The others are qualitative factors that can hardly be measured by detecting instruments, but only be evaluated by human sensing, for example, the working attitude of operators.

Here X quantitive factor, Y qualitative factor, ε occasional factor, η rating value of quality indexes (theoretical value), since the values of quality indexes are determined together by X , Y and ε, it is defined as equation (1):

$$\eta = F(X, Y, \varepsilon) \quad (1)$$

With view of risk management, risk transference refers to the hazards produced by the former feedings in usage or breading operation will be transmitted following the breeding procedure, that is, when one of the factors in system or its associations are in hazards, whatever it is, its output must be abnormal and might cause unusual situations. Hazard transmission is a procedure of successive triggering. Emergence of any risk factor will result in a series of hazards.

The beef cattle breeding are divided into combination of several simple breeding procedures. For each procedure, the risk transmission is indicated in Fig. 1.

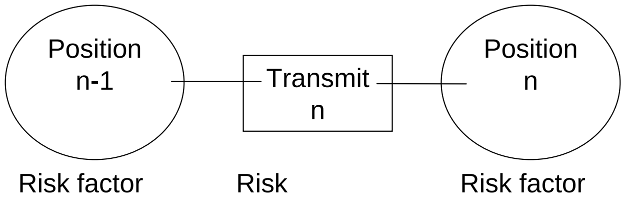

Fig.1 Sketch of risk transmission

Here the entity that has hazards on beef quality is defined as risk factor, and its carrier called risk undertaker. Define risk factor as P_{n-1} , risk complication as T_n , then,

$$P_{n-1} = \{p_{n-1,1}, p_{n-1,2}, p_{n-1,3} \cdots, p_{n-1,k}\} \quad (2)$$

$$P_n = \{p_{n,1}, p_{n,2}, p_{n,3} \cdots, p_{n,m}\} \quad (3)$$

$$T_n = \{t_{n,1}, t_{n,2}, t_{n,3} \cdots, t_{n,j}\} \quad (4)$$

In total there are k risk factors before procedure n and m risk factors after procedure n , i risk factors on procedure n , then the accumulation of risk transmission produced by risk undertakers in breeding is defined as

$$p_{n,1} = F_{n,1}(p_{n-1,1}, p_{n-1,2}, p_{n-1,3} \cdots, p_{n-1,k}, t_{n,1}, t_{n,2}, t_{n,3}, \cdots, t_{n,i})$$

$$p_{n,2} = F_{n,2}(p_{n-1,1}, p_{n-1,2}, p_{n-1,3} \cdots, p_{n-1,k}, t_{n,1}, t_{n,2}, t_{n,3}, \cdots, t_{n,i})$$

$$\cdots\cdots$$

$$p_{n,m} = F_{n,m}(p_{n-1,1}, p_{n-1,2}, p_{n-1,3} \cdots, p_{n-1,k}, t_{n,1}, t_{n,2}, t_{n,3}, \cdots, t_{n,i})$$

In the above risk transmission, there is certain dependence between expressive risks and recessive risks. In this study the risk dependence mainly refers to risk accumulation and evocation, that is, subsequent risks may happen based on the known risks in feedings or breeding and thus cause risks or hazards accumulation and continue transmission.

3 Identification Model

3.1 Concept of quality risk transmission

According to the risk characteristics mentioned above, the risk identification system in this paper can be divided into two parts: key nodes based on breeding procedure, and quality units based on feedings. Then the emergence of quality hazards in beef cattle breeding can be explained as risk factors wandering every node and acting on every units for propagation.

To further study the life cycle of quality risks in breeding, a risk propagation model was proposed to explain the objective risk states. It consisted of risk propagation network and algorithm. The risk propagation network described how the risk wandered in the nodes and the accessing hierarchy and situation on every unit on the nodes. And the risk propagation algorithm showed the acting rules of risks.

3.2 Risk propagation model

The natural procedure of beef cattle breeding can be divided into several risk propagation network nodes, and then the operators, cattle, feedings and veterinary medicine on the nodes are the components. The (n, s) formed by the network node n and component s was defined as a unit on node n , called C_{ns}.

When a risk factor is formed on breeding node A, there is possibility of forming new risk factor on node B using the operative relation between the unit C_{Ai} on node A and unit C_{Bj} on node B. It is defined as $NNC_{Ai:Bj}$, or simplified as NNC_{AB} from A to B. An orderly six hexadic set $< A, i, B, j, P, W >$ is used to describe the risk information of $NNC_{Ai:Bj}$, where i, j are the components on node A and B, P the success probability of risk propagation by this NNC, $P \in [0,1]$, W the impact of one unit to another, $W \in [0,+\infty)$. Here, the following have to be noticed: (1) the operative relation mentioned referred to the interrelated operations in cattle breeding; (2) the quantitive criteria of attribute P and W depend on practical experience, historical records and subjective expectation, etc.

The risk network composed by breeding nodes, units and NNC is defined as risk moving pathway, with node A~D, component i , j , and vector e(Ai,Bj) used to indicate $NNC_{Ai:Bj}$ (Fig. 2).

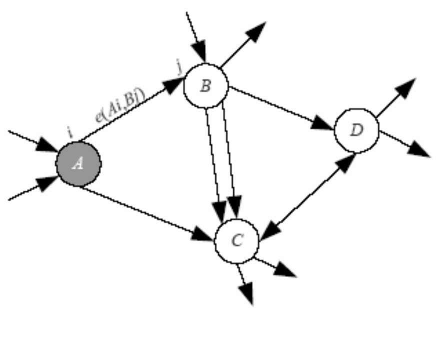

Fig.2 Risk Moving Pathway

In order to explain the relations between units based on risk acting pathway, there are the following definitions.

(1) the head unit of vector is called father of end unit and the end unit is called son. Further, the unit that meets any of the following requirements is called forefather of unit C, in which a) the father of unit C is the forefather of unit C, and b) the forefather of father of unit C is the forefather of unit C. Then, the

offspring can be defined similarly.

(2) Suppose there are three nodes A, B, C and two vectors $e(Ai,Bj)$ and $e(Bj,Ck)$ in the risk acting pathway, and node A has vulnerability, which may be used by risk factor and form risk on node A. Then it is propagated on node B via $e(Ai,Bj)$, and transmitted to node C via $e(Bj,Ck)$. Therefore it can be seen that the risk has transferability and risk propagation process includes risk transmission and risk forming.

(3) The unit that has vulnerability is referred to as risk source. Different vulnerabilities on the same unit are regarded as different risk sources. The vectors in the whole breeding are called risk propagation paths. The effective methods of controlling risks are to properly eliminate risk sources and propagation paths according to optimal cost effect.

Based on the above description and definition, the risk acting pathway that can represent the risk situations is called risk network, defined as $D=(N,E)$, in which N is the set of all the acting pathway nodes with risk information, $N=\{N_i|F,R,S\}$ (Fig.3). N_i is the node and its attribute is described by F, R, S, in which F indicates all the inputs to N_i, including operators, cattle, feedings and medicine, etc., R is used to store the total risks of N_i, $F,R\in[0,+\infty)$, and S is the set of components on N_i that suffer from risks, $S=\{S_i|P,R,V\}$. S_i is the component on the node and its risk attribute is described by P, R, V, in which P is used to store the probability that hazards happen to S_i, $P\in[0,1]$ and R is used to store risks of S_i, $R\in[0,+\infty)$. V is the set of vulnerability that endangers the safety of S_i, $V=\{V_i|P,W,R\}$, in which V_i indicates the vulnerability and its risk attribute is described by P, W, R. P indicates the probability that the vulnerability is successfully attacked by risk factors, $P\in[0,1]$, W is the impact of weakness on beef cattle quality safety, $W\in[0,+\infty)$, and R is the risk brought by vulnerability, $R=P*W$. The risk network D not only formally describes the pathway of risk action, but also can store and represent the corresponding risk state of each node.

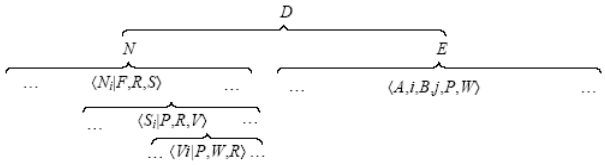

Fig.3 Hierarchy of risk network

Risks on one unit are caused together by many factors. According to the risk sources, there are two kinds: inside risks and outside risks, defined as R_i and R_o. The inside risks are usually caused by the vulnerability inside the units. The whole risk R_{ij}^A inside unit C_{Aj} consists of a series of inside risks $R_{ij1}^A \sim R_{ijn}^A$, in which $R_{ij1}^A = A.j.i.R$ indicates the risks caused by the weakness i of unit C_{Aj}. The outside risks refer to those propagated by the risks on the units of neighbour nodes, and the whole outside risk R_{0j}^A of unit C_{Aj} is composed by a series of outside risks $R_{oj1}^A \sim R_{ojn}^A$, in which risk R_{oji}^A comes from the unit C_{Bk} transmitted via $e(Bk,Aj)$, $R_{oji}^A = B.k.P*e(Bk,Aj).P*e(Bk,Aj).W$. Therefore the definition of risk propagation model can be made based on the concept of risk network.

To sum up, the risk propagation model is simply described as $M=(D,A)$, in which D is the risk acting pathway, A is the set of propagation algorithms. Each element in set A is an independent algorithm and describes the procedure of risk source diffusing risks to the network following the transmitting pathway. In model M, the network D is used to save the risk states of network information system, and each propagation algorithm represents the risk acting laws and changes the risk states of network D.

3.3 Solution of propagation model

As the risk network D might has vectorial loop, one problem that has to be faced with is the circulating risk propagation, that is, one unit may transmit the inside risk or existing outside risk to itself. To solve the problem, combination of reductionism and holism is applied. It can be known from the theory of reductionism that the whole risk of all interrelated units caused together by several risk sources is the comprehensive embodiment of risks on the interrelated units imposed by every risk source respectively. Firstly, the risk imposed by each risk source separately is propagated to all the available nodes. These risks are not counted together, but each unit is required to save its own risks and the risks that are propagated by each risk source via vectors.

Thus the risks can be decided to propagate to the offspring unit or not depending on the risk source and the circulating risk can be eliminated. Then based on the thought of holism, the united probability of risks on each unit and the integrated risks can be calculated according to distribution of different risks. Further, the integrated risks on the node can be figured out through accumulation of the risks on all the units of the node. Similarly, the integrated risk of the whole network can be obtained. The above precise propagation algorithm based on the thoughts of reductionism and holism is defined as RH algorithm, $RH \in A$.

The RH algorithm is implemented as follows:

Input: risk network $D=(N,E)$, set of vulnerability $V=\{n.s.v_i \mid v_i, n \in N, s \in n.S\}$, where $n.s.v_i$ indicated the vulnerability of unit C.

Output: D and the whole risk of quality in breeding, $R(D)$

(1) initialization: set of units $Q=\varnothing$, for all $n \in N, s \in n.S, n,R=0, n.s.P=0, n.s.R=0, n.s.PS=\varnothing$

(2) $while(v \neq \varnothing)$

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(3) to extract the vulnerability $m.i.v_j \in V$ and put the string $m.i.v_j.P$ into $m.i.PS$, C_{mi} into Q;

(4) to transfer the independent propagation sub-algorithm $RH_1(C_{mi},"m.i.v_j.P",Q)$;

(5) to delete C_{mi} from Q;

}

(6) for all $n \in N, s \in n.S$, transfer the integrated risk sub-algorithm $RH_2(C_{ns}, n.s.PS)$ and calculate $n.R=\sum_{s \in n.S} n.s.R(D)=\sum_{n \in N} n.R * n.F$;

(7) return of D and $R(D)$.

The RH algorithm was mainly composed by initialization ((1)), independent risk propagation ((2)~(5)) and integrated risk ((6)). To store the character string of probability multiplier, a temporary attribute, set PS, was added in the unit of D. The string transmitted into the unit each time was stored as one element of set PS, which was not necessary to work out their values. Besides, the set Q recorded all the units passing through the vectorial pathway in the order of risk propagation.

The sub-algorithm RH_1 was implemented as follows:

Input: unit C_{mi} character string $Pstr$, set of units Q

Output: null

(1) for all the vectors $e(mi,nj) \in E$,

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(2) if $C_{nj} \in Q$, then go to next;

(3) else, put the string $Pstr * e(mi,nj).P$ into $n.j.PS$ and put C_{nj} into Q;

(4) recursively transfer the $RH_1(C_{nj},"Pstr * e(mi,nj).P",Q)$;

(5) delete C_{nj} from Q;

}

With separate risk source, the independent propagation sub-algorithm RH_1 regarded C_{mi} as forefather and recursively propagated the string $Pstr$ to the offspring unit in DFS order. Here, information in the set Q was used to avoid the risk value mistakenly transmitted to itself by circulation (inside risk or given outside risk). If the next unit to be propagated was found in the set Q, which indicated the circulation occurred, the propagation would be terminated.

The sub-algorithm RH_2 was implemented as follows:

Input: unit C_{ns} set PS

Output: the united probability value of character format for PS

(1) while (there is element that has public right factor in PS)

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(2) extract a set of elements: $Pleft_i * e(ai,bj).P \in PS$, in which $Pleft_i$ is the string on the left excluding the public right factor;

(3) put the string $RH_2(0,\{Pleft_i\}) * e(ai,bj).p$ into PS;

(4) calculate the united probability $P = 1 - \prod_{i=1}^{|PS|}(1 - number(Pstr_i)), Pstr_i \in PS$;

(5) if $C_{ns} \neq 0$, then

$n.s.R = \sum_{i=1}^{|PS|} \begin{cases} number(Pstr_i) * e(vw,xy).W \\ n.s.v_i.R \end{cases}$, and if right factor of $Pstr_i$ was a vector, then $e(vw,xy).P$, $n.s.P = P$;

(6) return $string(P)$

}

The integrated risk sub-algorithm RH_2 could work out the united probability $n.s.P$ of unit C_{ns} and integrated risk $n.s.R$ based on set PS. As mentioned above, the risk of unit C_{ns} consists of inside risk and outside risk. For the outside risk, the probability of unit vector should be considered and it was equal to itself probability multiplying the united probability of its father. However, in risk propagation, the risks of different forefather units were propagated independently to the father units without calculation of concrete united probability, but in the format of character strings stored as elements in set PS. So the method of public right factor extraction was used to calculate the unite probability of father units and forefather units. Therefore each element in set PS was reviewed and if public right factor was found, it would be picked out to allow the risk probability on father nodes transferring into a new set. The procedure would be recurred until there was no more public right factor in the new set. If public right factor was not found, the united probability and integrated risk could be calculated out according to the above formula showed in (5). The symbols, $string()$ and $number()$ in the algorithm indicated the format of character string and number respectively.

4. Optimization

4.1 Quality tracing-based risk control

The tracing system had been divided into two levels, the intra-corporation tracing and inter-corporation tracing. It involved identity and tracing covering stages of raw materials, semi-finished and finished products, warehouse, shipment, etc. as well as agents, retailers, logistics and clients considering quality after production.

Since the beef cattle breeding in China is extensive under the pattern of farmer family management. Large-scale breeding farms will not purchase the cattle from farmers until they are in fattening stage. So the connections between nodes of industrial beef cattle breeding chains in China are incompact and far behind the industrial development pattern of large-scale, integrative management in developed countries. While considering the situation of “less land and more population”, the low-level integration of cattle breeding industrial chain will remain for a long time in the future. Thus the quality risk control in stage of fattening for beef cattle breeding enterprises is a key task in China.

Next, detailed descriptions on tracing precision and width were concerned for quality tracing. Based on this, a concept model of quality risk control in beef cattle breeding management was developed.

4.2 Traceable Resource Unit

TRU (Traceable Resource Unit) was proposed by Kimetal years ago. It was the only identity for a product batch in the tracing chain. If a traceable unit was a non-aggregation, it retained the information of original unit. Otherwise, it had unique identity information like all the traceable units.

Cattle breeding costs a relatively long period of time. Realization of quality tracing can guarantee each TRU remained unique in the long time span. Each TRU is unique and not equivalent, with different feature attribute. In successive processing of inputs, definition of each TRU is different. TRU may depend on the environmental variables in the inputs or fattening procedure. Different activity and environmental variable produce different TRU. This study developed a TRU system centered on cattle individuals in breeding and realized automatic identification of each tracing unit by use of RFID technology. Table 4 showed a traceable source unit system.

Table 4 Traceable Source Unit System of Cattle Breeding

Unit	Tracing precision	Information acquisition
Fattening cattle	Each cattle	Dynamic information of cattle before import and during fattening
Feeding stuff	Batch	Quality and quantity
Feed additives	Batch	Quality, quantity and usage
Medicine	Dose	Quality, quantity and usage
Sanitization	Batch	Quality, quantity and usage
Immunity	Dose	Quality, quantity and usage
Operators	Each person	Operational information in breeding

A risk control data collection system for automatic identification and data exchange on tracing unit was developed in this study on the basis of integrated RFID tracking and tracing system. Functions included: (1) recording the source of tracing units, current quality states and quantities (if possible); (2) accomplishing the dynamic modification of tracing unit marked information and data exchange of main system. With RFID technology, researchers can accurately obtain related information of inputs (especially quality information) in beef cattle breeding as well as operative quality of feeders on certain feeding phase. Thus potential risks can be properly judged before hazard occurs. If already happened, possible connections that might cause the hazards could be found out by use of RFID.

4.3 Optimization of tracing nodes

For large-scale cattle farms in China, their quality risk control includes three key stages, that is, cattle import, breeding and fattened cattle for slaughtering. (1) In the cattle import, formal investigation is performed on healthy states, fattening potential and related immune records of imported cattle. Registration and feeding observation are also conducted. (2) Stage of breeding has the most deep influence and intensive quality risk on beef cattle quality safety. It includes technical design of cattle fattening and daily feeding operations conducted by veterinaries, feeders and farm supervisors, such as feedings preparation, feedings filling, disease diagnosis, medical treatment, disinfectant operation and immune medicine, etc. (3) In the stage of fattened cattle for slaughtering, investigation will be performed on cattle healthy states and medicine halting period. Cattle quality tracing records are also formed based on logs of breeding for clients to understand the beef quality from the original source.

Survey on some large cattle breeding enterprises showed that the batch-based cattle management had reduced to some extent the tracing range of sources when the hazards occurred. But it was far away from optimal management with view of decreasing the ventures of enterprises and increasing tracing precision. Thus in order to achieve rapid and effective quality risk management and safety tracing, the procedure of breeding has to be divided into several key nodes that can be monitored. And based on this, tracing unit management centering on cattle individual identification system will be implemented for cattle breeding and implied consequence of tracing unit hazards will also be established in the breeding system.

Current tracing units in cattle breeding of China were optimized. Cattle individual identification was emphasized in this study (see Fig. 2).

Before optimization, in stage of cattle import, examination and management (records keeping) were performed on each batch of cattle. The number assigned to each cattle was not fixed. After breeding for some time, the farm can only differentiate the cattle growth and healthy states depending on batches. It was impossible to have detailed record and grasp of exact situation of each beef cattle. The optimization used in this study was that a unique serial number was assigned to each cattle by RFID card and individual archive was established, which would be updated timely by RFID card in system database by way of tracing records.

Optimization of tracing nodes was completed by the following procedures.

(1) Entity identity for original production system, totally different from serial number of production batch. A batch might have several tracing units and also a tracing unit might be included in more than one batch.

(2) Graphic description for original production chain. Generally in the tree structure, nodes represented tracing units, connecting father and son units.

(3) Determination of the disseminating ratio or merge ratio of tracing units. Its dissemination meant a father unit divided into two or more son units. And the merge meant two or more father units merging into one son unit. In the production system, the average disseminating (merge) ratio indicated the distributing of production chain and maximal disseminating (merge) ratio assured the reliable precision of system. The minimal disseminating (merge) ratio was used to estimate the tracing accuracy. As illustrated in Fig.4, assume unit A divide into four unit B and meanwhile, unit B originated from three unit A. Then it was denoted as three unit A evolving into four unit B.

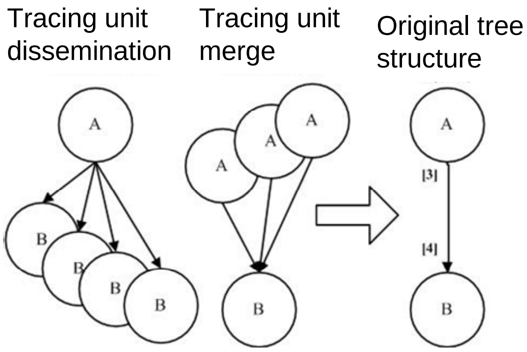

Fig.4 Dissemination and merge of tracing units

(4) Analysis of original production system traceability. In the tracing of the production procedure, accuracy of dissemination and merge ratio guaranteed the precision of tracing.

(5) Analysis of dissemination (merge) tree and establishment of "optimization procedure", shown in Fig.5. Analysis was done on each tracing unit to optimize the tree structure based on minimal dissemination (merge) ratio.

(6) Improvement and optimization of breeding procedure. Improvement was made in beef cattle fattening and breeding according to the optimization results in step (5). The tracing records and database were used for the identity of tracing unit and implementation of tracing system.

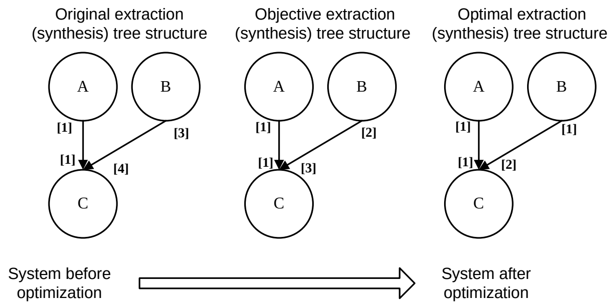

Fig.5 Optimization of tracing tree

The tracing units in beef cattle breeding featured in most of China farms were optimized following the above procedures. In the process, the emphasis was laid on the individual identity of fattening cattle to enhance the ability of quality risk identification and control. Fig 6 indicated the optimized procedure of cattle in large-scale breeding farms. Before optimization, the batch of cattle was used for inspection and archives and the identity number for each cattle was not fixed. Then after breeding of a period of time, it was hard to have accurate records and information for each cattle. When quality problems came forth, it was hard to find out the source. While after optimization, an exclusive ID was assigned to each cattle and individual archives were established so that the accuracy requirements of tracing could be satisfied.

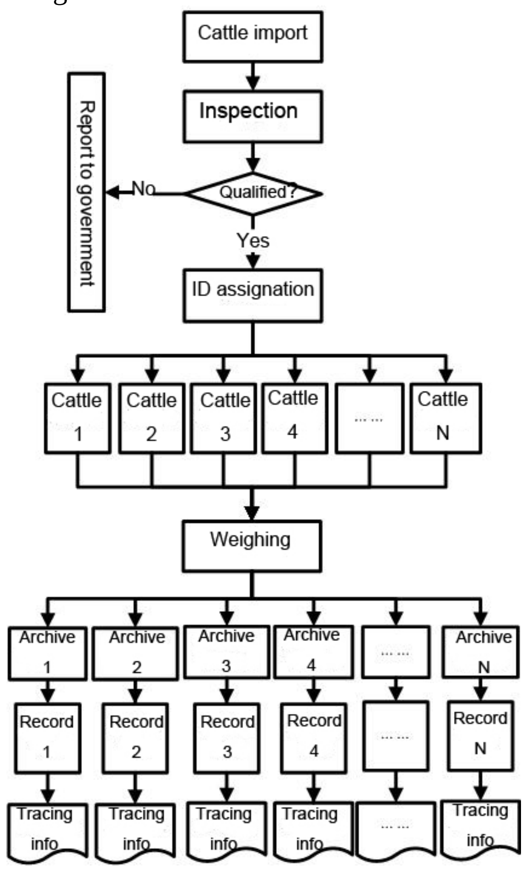

Fig.6 Optimization of cattle breeding procedure

With the above optimization, it had improved the management precision in breeding process and reduced the breeding (fattening) information faults caused by information confusion and lack of mark.

5. Conclusion

This paper mainly studied the risk identification and risk control that influenced beef quality in cattle breeding. Firstly, the identification of beef cattle quality risks was studied and features of these risks were classified and characterized. Concept of risk propagation was defined and quality risk propagation model was developed based on nodes, units and risk acting pathway. Model algorithms were also concerned.

Secondly, selection of beef cattle quality risk control method was studied. Quality tracing system was established to control the identified risks and concept model of quality risk control was developed. Tracing precision and scope of system was determined by definition of tracing unit system and optimization of tracing nodes.

Acknowledgments

Thanks are due to National Science & Technology Support Program (2006BAD10A07-02), National 863 Program (2006AA10Z267) , and National Natural Science Foundation of China under Grant (30700481) from Ministry of Science & Technology of China for financial support.

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