Application of Mixed Group Decision Making to Safety Evaluation of Agricultural Products

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Abstract　In view of the gravity of issues concerning safety of agricultural products and urgency of resolving these issues，after analyzing the problems existing in safety of agricultural products，this article offers a method for evaluating safety of agricultural products on the basis of mixed group decision making. First of all，it introduces the factors influencing safety evaluation of agricultural products；subsequently，given that the judgment matrices offered by the group of experts contain both reciprocal and complementary judgment matrices in the process of jointly participating in evaluation arising from personal preference，it proposes to assemble expert information in order to obtain indicator weight using the OWA operator；finally，the process of evaluating safety of agricultural products is given.

Key words　Safety of agricultural products，Evaluation，Judgment matrix，Weight

　　The "crayfish" in 2010，leading to the dissolution of muscle，can be described as an "earthquake" in safety of agricultural products，making people attach great importance to the safety of agricultural products. There has been a series of issues，reported in the newspaper，concerning safety of agricultural products along with people's increasing attention to the safety of agricultural products，for example，the fattening crabs by taking contraceptives appear in dining table；cucumbers and tomatoes continue to grow in the fridge using ripening agent；the watermelon explodes in the field before ripening. Thus the gravity of issues concerning safety of agricultural products looms large，has made many urban residents feel that there are problems in agricultural products for meeting the most basic survival needs of people，seriously examining and weighing the moral standards of society[1]. The issues concerning safety of agricultural products are the issues related to the survival rights of the masses，and if the issues concerning safety of agricultural products cannot be resolved well，it will cause social panic，antisocial behavior，and social unrest，therefore，in addition to increasing the output of agricultural products，the state should also focus on resolving issues concerning safety of agricultural products. In order to solve issues concerning safety of agricultural products，we have to monitor the whole production process of agricultural products，and establish real-time evaluation system of safety of agricultural products，which can not only find issues concerning safety of agricultural products，but also provide healthy and safe living environment for the masses. On the basis of analysis of problems in safety of agricultural products，this article offers a method of evaluating safety of agricultural products with many people participating in evaluation.

1　Evaluation model of safety of agricultural products

1.1　Comprehensive evaluation model of safety of agricultural products　In general，the evaluation process of safety of agricultural products is to determine the set of factors affecting safety of agricultural products according to the characteristics of agricultural products. Given that the impact of each factor on safety of agricultural products is different，we need to determine the weight of factors influencing agricultural products. After determining the weight of corresponding factors，I integrate the evaluation value according to certain principle，so as to get comprehensive evaluation value of safety of agricultural products. The general comprehensive evaluation model of safety of agricultural products is as follows：

$$Security = C_1 w_1 + C_2 w_2 + \cdots + C_m w_m$$

where *Security* is comprehensive evaluation value of safety of agricultural products；variables C_1，C_2，$\cdots$，C_m signify the factor set of safety of agricultural products；variables w_1，w_2，$\cdots$，w_m signify the weight value of influencing factors C_1，C_2，$\cdots$，C_m.

1.2　Analysis of factors influencing safety of agricultural products　Determining the factors influencing safety of agricultural products is the primary condition for safety evaluatiFon of agricultural products，and making a set of scientific and rational evaluation indicator system of safety of agricultural products is a necessary condition for effectively managing production and sale of agricultural products. There have been some studies on the factors influencing safety of agricultural products，and in the existing provisions of national food security departments，there are also some evaluation indicators and the requirements. Based on the existing research results and main problems in safety of agricultural products，the factors influencing safety of agricultural products can be roughly divided into three aspects：the environment of place of origin，agricultural material inputs in production process of agricultural products，and the process of

transport, marketing of agricultural products. The factors influencing safety of agricultural products are subdivided into air quality (C_1), water quality (C_2), soil condition (C_3), the certification rate of agricultural products (C_4), the authentification of agricultural products (C_5), identification of agricultural products (C_6), and technological application of agricultural products (C_7), to evaluate the safety of agricultural products[2].

2 Weight determining of factors influencing safety of agricultural products

In the process of determining the weight of factors influencing safety of agricultural products, the method most used is to construct judgment matrix through the pairwise comparison, and derive the sequenced weight from judgment matrix. The pairwise comparison judgment matrix integrates the subjective and objective methods at the same time, so it is accepted by many experts and scholars. In the process of comparing the importance of influencing factors, based on different personal preferences, some experts choose reciprocal judgment matrix, while some experts choose the fuzzy complementary judgment matrix, so that there are different judgment matrices for the same influencing factor, that is, the problems of mixed group decision making arise[3]. In the process of dealing with this mixed group decision making, the two kinds of judgment matrix are usually converted into the judgment matrix with the same form, and the weight is derived and calculated. In general, the calculation formula of converting complementary judgment matrix into the reciprocal judgment matrix is as follows: $a_{ij} = 3^{5(f_{ij} - \frac{1}{2})}$. The formula of converting the reciprocal judgment matrix into complementary judgment matrix is as follows: $f_{ij} = \frac{1}{2} + \frac{2}{5}\log_9 a_{ij}$.

After deriving the sequenced weight of judgment matrix given by different experts, we need to gather the sequenced weight of judgment matrix given by different experts, so as to form the final weight of factors influencing safety of agricultural products. Given that the expert weight is not easy to determine, we can use ordered weighted operator to gather weight when gathering weight of information given by experts. And the definition of the ordered weighted operator is as follows.

Definition: $OWA_\lambda(a_1, \cdots, a_n) = \sum_{j=1}^{n} \lambda_j b_j$ is called the operator of ordered weighted arithmetic average (OWA), where $\lambda = (\lambda_1, \cdots, \lambda_n)^T$, the place-weight vector associated with OWA; b_j is the j-th biggest element of $a_i (i = 1, 2, \cdots, n)$.

The place-weight λ_j can be determined by the following formula generally in advance:

$$\lambda_j = Q[j/(n-1)] - Q[(j-1)/(n-1)],$$

$$Q(r) = \begin{cases} 0 & \text{if} & r < a \\ (r-a)/(b-a) & \text{if} & a \leqslant r \leqslant b \quad a, b, r \in [0, 1] \\ 1 & \text{if} & r > b \end{cases}$$

Corresponding to the fuzzy linguistic quantifiable criteria: in the operator Q of "the majority", "half at least" and "as much as possible", the parameter pairs are $(a, b) = (0.3, 0.8)$,

$(0, 0.5)$, $(0.5, 1)$, respectively.

3 Evaluation steps of safety of agricultural products

Through the above analysis, the evaluation process of safety of agricultural products is as follows.

Step1 Information acquisition m experts are invited to evaluate the safety of agricultural products. Through the detection and inspection of the environment and production conditions in producing bases of agricultural products, the expert group selects percentage as the scale of evaluation. After group discussion, in accordance with the factors affecting the safety of agricultural products, the evaluation is carried out. Let the evaluation result obtained be: $C = (C_1, C_2, C_3, C_4, C_5, C_6, C_7)$.

Step 2 Determining of judgment matrix Through comparing the importance of factors influencing the safety of agricultural products pairwise, m experts obtain the comparative judgment matrix $R^k = (r_{ij}^k)_{7 \times 7}$. Let the set of experts offering fuzzy complementary judgment matrix be and the set of experts offering reciprocal judgment matrix be I_2.

Step 3 Unification of mixed judgment matrix The fuzzy complementary judgment matrix is converted into reciprocal judgment matrix using formula $a_{ij} = 3^{5(r_{ij} - 0.5)}$, so that all judgment matrices in set I_1 are converted into reciprocal judgment matrices, or all reciprocal judgment matrices are converted into all complementary judgment matrices using formula $a_{ij} = 0.5 + 0.41\log_9(r_{ij})$. Thus, finally all judgment matrices offered by experts are the judgment matrices with unified form. The weight vector of all judgment matrices is derived using the eigenvalue method. Let $R^k = (r_{ij}^k)_{7 \times 7}$, the weight vector derived $\eta_1^k, \eta_2^k, \cdots, \eta_7^k$.

Step 4 Weight determining of influencing factors Appropriate parameters a and b are chosen to calculate place – weight vector $\lambda = (\lambda_1, \cdots, \lambda_m)^T$. In the descending order, the weight of the first influencing factor derived by each expert $\eta_1^1, \eta_1^2, \cdots, \eta_1^m$ is arrayed, and the sequenced vector is $\mu_1^1, \mu_1^2, \mu_1^3, \cdots, \mu_1^m$, then the weight value of the first influencing factor is: $w_1 = \sum_{k=1}^{m} \lambda_k \mu_1^k$. The method of determining the weight of other influencing factors is the same, then the comprehensive weight vector of 7 influencing factors is: $w = (w_1, w_2, \cdots, w_7)$.

Step 5 Comprehensive evaluation and feedback of safety of agricultural products After determining the weight of influencing factors, I use simple weighting method to get the comprehensive evaluation value of safety of agricultural products as follows: $Security = (C_1 w_1 + C_2 w_2 + \cdots + C_7 w_7)$. According to the corresponding evaluation scale, we distinguish whether this comprehensive evaluation value is safe or dangerous, timely feed back to producers of agricultural products and the relevant management departments the evaluation results, and give corrective or disposal opinions in light of specific circumstances[4].

4 Conclusions

The safety of agricultural products is a sensitive issue in current stage, especially in the stage of rapid economic devel-

opment. If the issues concerning safety of agricultural products are prominent, the people will lose confidence in the government, thus affecting the peaceful and stable development of society. So the problem of agricultural products is not only people's problem of "shopping basket", but also related to China's unity and stability. Given that in the evaluation process of safety of agricultural products, there are certain preferences in simple determining of the weight of influencing factors, easily triggering deviation in evaluation results of safety of agricultural products, this article uses group decision-making to determine the weight of influencing factors on the basis of the actual situation of safety evaluation of the agricultural products, and offers a method of determining the weight of factors influencing safety of agricultural products having mixed group decision-making information of complementary judgment matrix and reciprocal judgment matrix, so that the evaluation results of the safety of agricultural products are closer to the actual situation, more ob-

jective, and more convincing[5].

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