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Measures to Control Environmental Pollution and the Use of Grey Situation Decision-Making for Family-Run Livestock Breeding Farms

Zaohong Zhou
School of Tourism and Urban Management, Institute of Poyang Lake Eco-economics, Jiangxi University of Finance & Economics, Nanchang, 330032, China

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ABSTRACT

This study applies the theory of grey situation decision-making to identify optimum measures under six areas of study for controlling environmental pollution from family-run livestock breeding farms. We itemize 24 countermeasures for controlling such pollution and determining intended goal and effect to establish grey situation decision-making model to obtain optimal decision-making scheme of management measures that conform to the environment of family-run livestock breeding farms. As a result, grey situation decision-making can provide a convenient and scientifically-based situation for identifying those renovation programs of measures which provide the optimal outcome for controlling the environmental impact of the farms.

INTRODUCTION

The 'No. 1 Central Document', evened by the Central Committee of the Communist Party in 2013 proposed the construction and development of 'family farms' in China as an important measure for agricultural intensification and as a significant innovative move towards better organization and the modernization of farming. World farming practice indicates that increasing scales of agricultural operations can maximize the income of farming families. In this way family farms can improve traditional farming methods in line with modern practice.

Family-run livestock breeding farms (FLBFs) can raise animals efficiently, decrease production costs, increase foreign exchange earnings and stabilize supplies for the domestic market. However, such expansion and increasing intensification of the livestock and poultry industries can result in the discharge of large concentration of livestock-waste causing serious environmental contamination problems. The first national census indicated that, in 2010, pollutant discharge from the livestock breeding and poultry industries was one of the most important sources of agricultural pollution in China (Chen et al. 2014). The chemical oxygen demand (COD) of the discharges from these industries contributes about 76 percent of the gross of COD from agricultural sources (Wu et al. 2014). As a developing country, China is showing a remarkable performance in its policies for comprehensive rural economic development. Nevertheless, with such progress in its rural economy, the problem of agricultural pollution is becoming increasingly prominent. In particular, the environmental events resulting from the breeding industry inevitably restrict the sustainable development of agriculture (Li et al. 2013). As new kinds of agricultural management organizations, the FLBFs, especially, need to take environmental management seriously.

Back in the 1960s and 1970s, many countries in the world those have developed animal husbandry, pollution problems of animal waste appeared (Henkens et al. 2001). The nitrate content of public water in Brittany in France had exceeded the allowed standards (Pierre et al. 2005). The content of ammonium and nitrogen salts had also exceeded the allowed standards as soil degradation in Eastern Mediterranean caused by livestock and poultry industry (Stylianos et al. 2012). According to the experimental analysis, Charalampos et al. (2012) have discovered the reason why soil degradation in Eastern Mediterranean got really serious, which was due to sedimentation of ammonia and nitrogen of excrement in intensive pig farm. The particular pollutants produced from a productive breeding industry depend largely on the types of animals being bred, the breeding methods used, the animal husbandry methods, the extent of feeding management, local climatic condition and so on. FLBFs of different types and with different management patterns can therefore discharge different pollutants in daily life.

SOURCES AND IMPACT OF POLLUTION FROM FAMILY-RUN LIVESTOCK BREEDING FARMS

The pollution from FLBFs can be divided into four main types: gaseous emissions, waste water, solid waste and noise.

The exhaust gases, causing most local concern, are mainly odorous gases like ammonia which escape from the animal houses, waste dumps and environmental protection facilities, and the bad smells created by decomposition.

Wastewater mainly includes the urine of livestock together with effluent from the disinfection and washing of animal buildings and from living and office accommodation. The main considerations are the COD_{cr}, BOD_5, SS (suspended solids), NH_3 content and the like.

The solid waste mainly consists of the excrement from the animal houses and the waste residue from manure treatment facilities. Noise pollution is principally from the calls of the livestock and the mechanical noise produced by the production equipment.

There are three main aspects of the effects of the pollution. First is the pollution of water resources. Raw sewage from the farm has a significantly high pollution load and contains a variety of materials. If it is incorrectly or incompletely processed, this can easily result in the pollution of nearby bodies of water.

Second is air pollution. The wide range of malodorous gases from the breeding facility and from the decomposition occurring in manure-heaps include more than 200 kinds of hazardous substances such as methane, organic acids, ammonia and alcohol. These can pollute not only the area of the FLBFs themselves, but also the atmosphere of the surrounding region.

Thirdly, there is the potential for the spread of diseases. Excrement from pig farms, for example, contains large numbers of pathogenic microorganisms, together with the eggs of parasites and it also provides breeding conditions for mosquitoes and flies, which, in turn, increases the opportunity for the spread of zoonoses.

THE RANGE OF ENVIRONMENTAL MANAGEMENT MEASURES FOR FAMILY-RUN BREEDING FARMS

Production on FLBFs follows a standard pattern, with each aspect of the husbandry process being responsible for the generation and discharge of pollutants. However, ecologically, the location of FLBFs differs from that of most other industrial enterprises in China, as, in general, they are located on farmland in rural areas. Hence, the traditional administrative thinking of tail-end and single treatment methods is not necessarily the best.

WAY TO MANAGE POLLUTION FROM THE ANIMAL BREEDING INDUSTRY

According to the experience gained regarding the management of pollution from the livestock and poultry industries at home and abroad, an ecological and diversified governance model should be advocated. Ecological awareness in the overall regulation and control of pollution from the animal husbandry industry has resulted in the introduction of the concepts of 'cleaner production' and a recycling economy. As a result, there is a push towards establishing a virtuous circle of an integrated planting-breeding-processing industry. Such diversification can combine arable farming with animal breeding. As a raw material for producing methane, the excrement and sewage from the breeding industry can be used to meet the energy needs of the farms themselves. Animal-house slurry and biogas-production residues can be used as fertilizers for the arable and hydroponics component of the industry, thus helping to realize a self-contained virtuous circle.

Since pollution from animal husbandry includes, not just the impact on the immediate area, but also the more widespread environmental effects, the management of FLBFs should pay serious attention to the appropriate disposal of waste. Primarily, this should be by first rendering it harmless to the environment and then by making comprehensive use of these harmless products through recycling. This approach requires ecological awareness and the use of appropriate technology i.e. for the reduction and harmless recycling of pollutants.

This study has taken as an example, one family farm which is breeding pigs, where the 'clean production' approaches used by the farm were examined and their effects audited. These approaches were the result of implementing a system of technological measures for environmental management.

1. Breeding farm reform measures (a_1):
   a. Renovation of the sewage and rainwater diversion infrastructure of FLBFs(b_1).
   b. Renovation and environmental enhancement of the animal-house ventilation systems (b_2).
   c. Renovation of the potable water system in the animal buildings (b_3).
   d. Installation of water meters (b_4).
   e. Renovation of collection methods of poultry excrement (b_5).
   f. Renovation of secure channel(b_6).
   g. Renewal of the animal-house temperature control system (b_7).
   h. Renovation of the mosquito and fly control systems (b_8).

2. Measures for rendering waste harmless (a_2):
   a. Renovation of cesspool (b_9).
   b. Maintenance of the oxidation pond (b_{10}).
   c. Project of an effluent treatment facility including solid-liquid separation of excrement and wastewater (b_{11}).
3. Measures for the comprehensive use of effluent (a_3):
   a. Using biogas (b_{12}).
   b. Comprehensive use of biogas slurry (b_{13}).
   c. Setting up an organic fertilizer production line (b_{14}).
   d. Other processing methods for the management and use of solid excrement (b_{15}).
4. Measures of combination of farming and animal husbandry (a_4):
   a. Building deep-sea tanks (b_{16}).
   b. Laying pipe networks for the irrigation, fertilization and drainage of the arable land with material from the animal breeding facility (b_{17}).
5. Measures for reduction of the overall quantities of animal excrement and harmful gases produced (a_5):
   a. Implementing a system for regulating the quantities and nutritional value of feed provided to livestock (b_{18}).
   b. Adding appropriate amounts of activated charcoal to feed (b_{19}).
   c. Adding zeolite to feed (b_{20}).
6. Improvement and integration of management techniques (a_6):
   a. Enhancing staff training and improving their environmental awareness (b_{21}).
   b. Establishing sound environmental management protocols (b_{22}).
   c. Improving staff skills in relation to feeding management (b_{23}).
   d. Enhancing the overall management of sewage parameters (b_{24}).

GREY SITUATION DECISION-MAKING FOR THE ASSESSING OF ENVIRONMENTAL MANAGEMENT MEASURES IN FLBFs

The optimization of environmental management decisions is the key step in the implementation of such management. If only considered from the point of view of the external environmental and social factors, there will be increased costs for undertaking environmental management. Hence, decisions on such measures in FLBFs need to take account of all the social, economic, technical and environmental aspects. Since, there is little information available on some of these elements, this study adopts a 'grey situation' decision-making model to analyse the overall benefits resulting from each of several different combinations of potential situations.

Grey situation decision-making is an important element of grey system theory. It approaches decision-analysis in an overarching manner by comprehensively considering the four elements of the decision-making process. These are: event, countermeasure, effect and objective. The most significant characteristic of this method is that it is able to handle problems where the data needed for decision-making are incomplete (Deng 1998).

We have used grey situation decision-making to carry out an advantage analysis and a comprehensive evaluation for each environmental management measure employed in the FLBF. Therefore, we are able to show that grey situation decision-making is valuable in assessing the optimal choices for implementing environmental management measures in this kind of farm (Liu et al. 2012).

Research Techniques and Procedures

The principle of determining optimal schemes by grey decision-making is transforming each index in schemes to effect measures within limits. Subsequently, a value is generated for the effect of each indexed measure within the same program in order to provide a combined assessment of the outcome of all the effects (Kahneman et al. 1979). Finally, an assessment is made, based on these combined effects to ascertain the relative merits of each program being evaluated. There are four basic elements in grey situation decision-making: the event (the problem requiring a situation), the countermeasures (the measures for dealing with each problem), the effect (the real effect of each scheme on its target element) and the objectives (the criteria for evaluating the effect) (Tversky et al. 1992).

Taking the event as a_i, its countermeasure as b_j, the binary combination of the event and its countermeasure (a_i, b_j) is the situation S_{ij}, and the effect of the countermeasure on the event as γ_{ij}, then the ratio of the effect and corresponding situation γ_{ij} / S_{ij} is the decision element, while for multiple targets, the decision element of the k^{th} target is $\gamma_{ij}^{(k)} / S_{ij}$, we can thus construct the effect measure matrix with of i rows × j columns as $M^{(k)}$, the combined decision element of k targets is $\gamma_{ij}^{(\Sigma)} / S_{ij}$, and these constitute the comprehensive measure matrix of i rows × j columns as $M^{(\Sigma)}$. Transforming each element by optimal ordering in matrix $M^{(\Sigma)}$ by row and column, then we get a more useful decision matrix M^*. The final decision is then based on the size of the effect of each countermeasure.

The stages in grey situation decision-making are:

- Identifying the event a_i and countermeasure b_j,
- Constructing situation S_{ij},
- Identifying the objective k_p,
- Identifying the practical effect of an alternative target γ_{ij},

- Calculating the effect measure matrix $M^{(k)}$ of the alternative target,
- Calculating the comprehensive effect measure matrix $M^{(\Sigma)}$,
- Transforming $M^{(\Sigma)}$ by optimal ordering then we get the optimal ordering decision-making matrix M^{*}. According to the maximal effect measure, we process decision-making by choosing the best situation.
- Analysing the results of the combined decision-making (Liu & Lin 2006).

Optimization Decisions for Environmental Management Measures in a Family-Run Breeding Farm

Event set (a_i) and countermeasure strategy set (b_j): Set a_i from a_1 to a_6 is considered as event set, and set b_j from b_1 to b_{24} is considered as countermeasure strategy set.

Representing the situation S_{ij}: The situation (S_{ij}) for the event a_i (i = 1, 2, ..., 6) and countermeasures b_j (j = 1, 2, ..., 24) binary combinations, namely $S_{ij} = (a_i, b_j)$. In the present embodiment, combinations of the above six kinds of events and responses 24 may constitute situation matrix rows × 24 columns 6.

Objective set (k_p): The set of decision-making objective criteria is $k_p = (k_{1,} k_{2,} k_3)$ = aggregate investment, technically difficulties, effect of implementation.

Decision-making matrix model: As there are 3 decision-making objectives in this study, multiple-objective decision-making is required, therefore including three single-objective decision-making matrices $M^{(k)}$ (k = 1, 2, 3) and the comprehensive decision-making matrix $M^{(\Sigma)}$. These four matrices are all represented in the dimensions of our 6 row × 24 column matrix, so our model including these four decision-making matrices, $M^{(k)}$ is:

$$M^{(K)} = (M_1^{(K)}, M_2^{(K)}, \cdots, M_6^{(K)}) = \begin{vmatrix} \frac{\gamma_{11}^{(K)}}{S_{11}} & \frac{\gamma_{12}^{(K)}}{S_{12}} & \cdots & \frac{\gamma_{124}^{(K)}}{S_{124}} \\ \frac{\gamma_{21}^{(K)}}{S_{21}} & \frac{\gamma_{22}^{(K)}}{S_{22}} & \cdots & \frac{\gamma_{224}^{(K)}}{S_{224}} \\ \vdots & \vdots & & \vdots \\ \frac{\gamma_{61}^{(K)}}{S_{61}} & \frac{\gamma_{62}^{(K)}}{S_{62}} & \cdots & \frac{\gamma_{624}^{(K)}}{S_{624}} \end{vmatrix}$$

In the formula, $\gamma_{ij}^{(k)}$(i = 1, 2,…,6; j = 1, 2,…,24) is the measure of the effect under the k^{th} objective (k = 1, 2, 3), and $S_{ij} = (a_i$ and $b_j)$ is the situation.

Calculation of the impact of an effect: Determining the impact of an effect is an important aspect of grey situation decision-making. The assessment of the effect of an effect measure depends on its actual impact on each situation being investigated in the comparison. In general, it includes upper effect measure, lower effect measure and moderate effect measure. The formulae for measuring the impact are different for the different goals.

$$\text{Upper effect measure:} \gamma_{ij}^{(k)} = \frac{U_{ij}^{(k)}}{\max\limits_i \max\limits_j U_{ij}^{(k)}} \quad ...(1)$$

$$\text{Lower effect measure:} \gamma_{ij}^{(k)} = \frac{\min\limits_i \min\limits_j U_{ij}^{(k)}}{U_{ij}^{(k)}} \quad ...(2)$$

$$\text{Lower effect measure:} \gamma_{ij}^{(k)} = \frac{\min\limits_i \min\limits_j U_{ij}^{(k)}}{U_{ij}^{(k)}} \quad ...(3)$$

In the formulae, $\gamma_{ij}^{(k)}$ is the effect measure of situation S_{ij} under the k^{th} target; $U_{ij}^{(k)}$ is the actual effect on the situation S_{ij} under the k^{th} target; $\max\limits_i \max\limits_j U_{ij}^{(k)}$ and $\min\limits_i \min\limits_j U_{ij}^{(k)}$ are the actual maximum and minimum values of the effect in all situations under the k^{th} target, U_0 is a specified acceptable value. The calculated values of $\gamma_{ij}^{(k)}$ can be represented in a matrix termed the 'effect measure matrix' $M_{ij}^{(k)}$. The value of $\gamma_{ij}^{(k)}$ is always less than 1(Liu & Lin 2006).

This study separately quantizes each of the three targets $K_{1,}$ K_2 and K_3 into 6 levels (6, 5, 4, 3, 2, 1) representing big → small, good → bad or easy → difficult.

Seven specialists were invited to participate in the research. They were first asked subjectively to assess the effects of the three targets. Then the mean value of all the specialists' assessments was taken to construct three, separate, single-objective decision-making matrices (k = 1, 2, 3) to calculate their assessment of each effect measure. Finally, we used the mean values of the specialists' weightings of the objectives to calculate effect measure of the comprehensive decision-making matrix .

Now, let us take (k = 1, 2, 3, 4) as an example to explain the calculation process. After calculation of the mean value derived from the specialists' assessments, we obtain the decision-making matrix whose objective is to represent the amount of required investment.

$$M^{(1)} = \begin{vmatrix} 4.14 & 4.29 & 4.14 & 3 & 3.71 & 3.57 & 4.14 & 5 & 1.86 & 2.43 & 2.86 \\ 3.57 & 2.57 & 2.43 & 1.43 & 3.29 & 1.57 & 2.43 & 2.14 & 4 & 3.86 & 4 \\ 3 & 1.86 & 2.14 & 1.71 & 1.86 & 2 & 2.14 & 1.86 & 3 & 2.57 & 5.57 \\ 2 & 2 & 1.71 & 1.43 & 1.86 & 1.57 & 1.71 & 1.86 & 2 & 2.14 & 2.57 \\ 2.86 & 3.14 & 1.86 & 1.29 & 1.29 & 2 & 2.71 & 1.71 & 3.43 & 3 & 3.57 \\ 1.57 & 1.57 & 1.43 & 2 & 2 & 1.86 & 2.14 & 1.57 & 1.86 & 2.14 & 2.43 \end{vmatrix}$$

$$\left.\begin{matrix} 1.14 & 2.71 & 6 & 2.86 & 1.86 & 2.29 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 2.71 & 3.29 & 4.43 & 4.71 & 2.86 & 2 & 1.14 & 2.43 & 2.14 & 1.14 & 1.14 & 1 & 1.14 \\ 4 & 4.57 & 3.57 & 4.57 & 2.29 & 1.86 & 1.57 & 1.14 & 1.29 & 1.29 & 1.43 & 1.14 & 1.14 \\ 2.86 & 3.29 & 3.29 & 3.14 & 3.57 & 3.43 & 2.14 & 1.29 & 1.43 & 1.29 & 1.43 & 1.57 & 1.14 \\ 4.43 & 3.57 & 1.14 & 1.71 & 2.43 & 2.29 & 4.14 & 4.29 & 3.71 & 1.29 & 1.43 & 1 & 1.29 \\ 2.43 & 2.57 & 2.14 & 2.29 & 1.86 & 2.14 & 2.57 & 2.14 & 2.14 & 2.71 & 3 & 2.71 & 2.86 \end{matrix}\right|$$

In view of the requirement for determining the appropriate level of investment for environmental management, the easiest situation of assuming that 'the smaller the better' is incorrect not only considering economic benefit. For this objective we therefore take moderate effect measure to calculate the effect of each measures, while four as the proper value are quite moderate as the values we get are from 1 to 6, we get the effect measure matrix $M_{ij}^{(1)}$ which highlights the amount of investment:

$$M_{ij}^{(1)} = \left|\begin{matrix} 0.96 & 0.93 & 0.97 & 0.80 & 0.93 & 0.90 & 0.97 & 0.80 & 0.65 & 0.72 & 0.78 & 0.58 & 0.76 \\ 0.90 & 0.74 & 0.72 & 0.61 & 0.85 & 0.62 & 0.72 & 0.68 & 0.99 & 0.97 & 0.99 & 0.76 & 0.85 \\ 0.80 & 0.65 & 0.68 & 0.64 & 0.65 & 0.67 & 0.68 & 0.65 & 0.80 & 0.74 & 0.72 & 0.99 & 0.87 \\ 0.67 & 0.67 & 0.64 & 0.61 & 0.65 & 0.62 & 0.64 & 0.65 & 0.67 & 0.68 & 0.74 & 0.78 & 0.85 \\ 0.78 & 0.82 & 0.65 & 0.60 & 0.60 & 0.67 & 0.76 & 0.64 & 0.88 & 0.80 & 0.90 & 0.90 & 0.90 \\ 0.62 & 0.62 & 0.61 & 0.67 & 0.67 & 0.65 & 0.68 & 0.62 & 0.65 & 0.68 & 0.72 & 0.72 & 0.74 \end{matrix}\right.$$

$$\left.\begin{matrix} 0.67 & 0.78 & 0.65 & 0.70 & 0.57 & 0.57 & 0.57 & 0.57 & 0.57 & 0.57 & 0.57 \\ 0.90 & 0.85 & 0.78 & 0.67 & 0.58 & 0.72 & 0.68 & 0.58 & 0.58 & 0.57 & 0.58 \\ 0.90 & 0.87 & 0.70 & 0.65 & 0.62 & 0.58 & 0.60 & 0.60 & 0.60 & 0.58 & 0.58 \\ 0.85 & 0.82 & 0.90 & 0.87 & 0.68 & 0.60 & 0.61 & 0.60 & 0.61 & 0.62 & 0.58 \\ 0.58 & 0.64 & 0.72 & 0.70 & 0.97 & 0.93 & 0.93 & 0.60 & 0.61 & 0.57 & 0.59 \\ 0.68 & 0.70 & 0.65 & 0.68 & 0.74 & 0.68 & 0.68 & 0.76 & 0.80 & 0.76 & 0.78 \end{matrix}\right|$$

Thus, we can therefore identify the most advantageous countermeasures for each of the six different events as seen from the objective of the required investment at an acceptable level. Similarly, we can calculate target 2 for lower effect measure and target 3 for upper effect measure, and we obtain $M_{ij}^{(2)}$ and $M_{ij}^{(3)}$.

Calculation of the combined effect of the measures $M^{(\Sigma)}$: In fact, the calculation of each single-objective effect measure is processing normalization of intended effect in different targets which is convenient for calculating comprehensive effect measure.

An averaging method or a weighted method could be adopted to calculate this combined effect. Comprehensive comparative analysis shows that adopting the weighted method is more appropriate for this decision-making problem. The weights of target M_1, M_2 and M_3 are 0.40, 0.20, 0.40, and using these with $M_{ij}^{(1)}$, $M_{ij}^{(2)}$ and $M_{ij}^{(3)}$ we can obtain the combined effect of the measure for the situation, $M^{(\Sigma)}$:

$$M^{(\Sigma)} = 0.40 \times M_{ij}^{(1)} + 0.20 \times M_{ij}^{(2)} + 0.40 \times M_{ij}^{(3)} \quad ...(4)$$

So the matrix for the combined effect of the measures is:

$$M^{(\Sigma)} = \left|\begin{matrix} 0.81 & 0.83 & 0.77 & 0.71 & 0.84 & 0.84 & 0.74 & 0.71 & 0.57 & 0.66 & 0.68 & 0.54 \\ 0.69 & 0.58 & 0.57 & 0.56 & 0.63 & 0.53 & 0.55 & 0.59 & 0.89 & 0.91 & 0.89 & 0.63 \\ 0.66 & 0.55 & 0.56 & 0.55 & 0.60 & 0.57 & 0.60 & 0.57 & 0.70 & 0.60 & 0.68 & 0.84 \\ 0.53 & 0.57 & 0.55 & 0.57 & 0.60 & 0.57 & 0.56 & 0.58 & 0.55 & 0.57 & 0.62 & 0.66 \\ 0.54 & 0.67 & 0.53 & 0.55 & 0.55 & 0.52 & 0.56 & 0.52 & 0.53 & 0.61 & 0.52 & 0.68 \\ 0.53 & 0.55 & 0.55 & 0.67 & 0.62 & 0.56 & 0.56 & 0.55 & 0.57 & 0.56 & 0.60 & 0.56 \end{matrix}\right.$$

$$\left.\begin{matrix} 0.62 & 0.63 & 0.58 & 0.58 & 0.59 & 0.53 & 0.48 & 0.52 & 0.39 & 0.39 & 0.39 & 0.42 \\ 0.69 & 0.72 & 0.69 & 0.59 & 0.55 & 0.52 & 0.56 & 0.58 & 0.47 & 0.54 & 0.54 & 0.52 \\ 0.68 & 0.58 & 0.77 & 0.76 & 0.77 & 0.58 & 0.46 & 0.49 & 0.54 & 0.60 & 0.53 & 0.59 \\ 0.63 & 0.71 & 0.62 & 0.72 & 0.68 & 0.57 & 0.50 & 0.51 & 0.52 & 0.51 & 0.55 & 0.50 \\ 0.64 & 0.59 & 0.58 & 0.54 & 0.53 & 0.89 & 0.85 & 0.85 & 0.49 & 0.54 & 0.57 & 0.56 \\ 0.60 & 0.64 & 0.62 & 0.57 & 0.59 & 0.58 & 0.53 & 0.54 & 0.59 & 0.73 & 0.67 & 0.66 \end{matrix}\right|$$

Thus, the optimum overall strategy involving all six events can be obtained. The best situation for the first event is the fifth decision, for which the value is 0.84; the best situation for the second event is the tenth decision where the value is 0.91; the best situation for the third event is the twelfth decision with a value of 0.84; the best situation for the fourth event is the sixteenth decision which has a value of 0.72; the best situation for the fifth event is the eighteenth decision with a value of 0.89; and the best situation of the sixth event is the twenty-second decision where the value is 0.73. From this, the overall effect of the countermeasures, arranged in the order of benefit, based on the decision criteria for each event can be seen in Table 1.

This study has analysed environmental management in a family-run livestock breeding farm using a grey situation decision-making model. The research indicates the benefits of this approach for establishing advantageous strategies when taking into account diverse potential measures for reform. For example, the most advantageous reform in this farm situation is indicated as being the renovation of the method used for the discharge of waste; at the same time it also determines the most appropriate order for applying the other various measures. The results of the research fit well with the economic, technological and environmental conditions of family-run livestock breeding farms.

With the development of such farms, the problem of environmental management has become of wide social concern. At the same time, the government is currently actively promoting these, while requiring the implementation of measures for their cleaner operation. Applying a grey situation decision-making model to the implementation of measures for environmental management in FLBFs is a valuable tool for selecting the most appropriate technology.

CONCLUSION

Table 1: Results of optimized decisions on environmental management measures in a family-run livestock breeding farm.

Event (a_i)	Optimized order of countermeasures (b_j)
Getting renovation measures of the breeding farm (a_1)	$b_5 > b_6 > b_2 > b_1 > b_3 > b_7 > b_4 > b_8$
Measures of harmless management (a_2)	$b_{10} > b_9 > b_{11}$
Comprehensively using measures (a_3)	$b_{12} > b_{15} > b_{13} > b_{14}$
Measures combining planting and breeding (a_4)	$b_{16} > b_{17}$
Measures of emission reduction of animal excrement and harmful gas (a_5)	$b_{18} > b_{20} > b_{19}$
Improving measures of technique level of integrative (a_6)	$b_{22} > b_{23} > b_{24} > b_{21}$

Grey situation decision-making is based on an event selection strategy to determine optimum approaches, carried out using a merit-based procedure for judging the different measures against their potential impact on the objectives. Applying its theory and methodology when considering the environmental management of FLBFs as a set of events, and then setting multiple targets closely related to these events, enables us to acquire the result of grey situation decision-making, through a comprehensive assessment. Finally the outcomes of environmental management decisions for FLBFs determined by this method are undoubtedly more reliable than those resulting from single-factor analysis. We know from the decision-making process that the reliability of the results for determining the best environmental management approach for a FLBF depends both on the accuracy of setting the objectives for the analysis and on the veracity of the data. The more closely related the objective is to the environmental management event in the FLBF itself, and the more comprehensive the range of target setting, the more accurate and reliable the results of the grey situation decision-making will be.

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