ECONOMICAL and ENVIRONMENTAL ANALYSES of TWO SWINE TERMINATION SYSTEMS - A FUZZY APPROACH

ROHENKOHL¹, Julio E.; MARTINELLI² JR, Orlando and DOS REYS³ Marcos A.

¹ Economist, PhD student PPGDR - UFRGS. Rua João Pessoa, 31. IEPE/UFRGS. 90040-000 - Porto Alegre -RS-Brazil. Fone:55 (51) 3316 3281 julioroh@hotmail.com
² Economist, Prof. Dr., Economic Sciences Dept., CCSH- UFSM. Santa Maria - RS
³ Agricultural Eng., Prof. Dr., Agricultural Education and Rural extension Dept., CCR/UFSM. Santa Maria - RS

ABSTRACT: The article discusses some aspects to the choice of hog termination systems and manure control at Vale do Caí region (Rio Grande do Sul State). From the fuzzy logic and fuzzy sets theories presents an analytical model which suits economical variables – through the calculation of the production costs (termination) of hogs- with the perception of the hog raisers and agronomists in respect to the environmental impact of two termination systems (deep bedding and manure storage).

KEYWORDS: environmental and economical analysis; fuzzy logic

INTRODUCTION: The presence of several economic-technical and socio-environmental aspects in the adoption of confined hog termination systems and manure control at the deep bedding and manure storage does not allow a clear criteria definition which attends simultaneously to the fewer negative environmental impact and to the fewer costs of production. Through the comparison between the results of the fuzzy set decision models designed to the city of Tupandi and surroundings at the Vale do Caí region, one aims to verify which hog termination system is superior considering at the same time the potential negative environmental impact and economical costs.

MATERIAL AND METHODS: Starting from a contextual analysis of the world and national hog production and reaching the characterization of the study area, the sample space was determined. The production system according to GOMES et al. (1992), presents a range of basic components which can be coordinated into distinct technical and economical configurations, each one originating a different classification of the production system. Facing complex situations and uncertainties, the use of the fuzzy sets tools (ZADEH (1965), KLIR e FOLGER (1988)) allows to mold a decision rule close to social values and to contribute to the approximation between the theoretical analysis and reality. Following RAGIN (2000), the work analyses the diversity of linguistics variables in a tentativeness to build a bridge between complexity and generality through a number of interviews and structured questionnaires covering the hog keepers and technicians. Finally, two evaluation models of the economical and environmental impact were mounted using fuzzy-sets. The first model used the hog termination costs information and the opinions of 32 hog keepers regarding the negative environmental impact of the activity. The second used the same hog termination costs crossing the opinions of two agronomists concerning the negative environmental impact. In both cases it was followed the fuzzy approximate reasoning approach. The comparison between the outcomes of the intersections from the economical impact module and the environmental impact module of each production system produced the results of this work.

RESULTS AND DISCUSSION: The necessity and sufficiency analysis was done regarding a proportion of explained results of 65% to the significance level of 10%, with association adjusts to the variable-sets of 0,10 bottom and up. In this test it was confirmed the necessity and insufficiency to “cheap ration” and “low initial hog price” to all the 19 of 21 cases where the association between the case and low cost was different of zero. Five other casual combinations pass the sufficiency test to achieve “low cost”, that is, these combinations had 65% of the cases (with 10% of significance and
with an association adjust of 0.10) with equal or lower association grades with the association to “low cost” (table 1). Four different paths pointed out in the test to achieve “low cost” involved the complements (~) of “good weight to slaughter”, or of “high working capital”, or of “low depreciation”, or of “low workmanship”. These paths demonstrated that, in 65% of the cases, having “cheap ration” and “low initial hog price” it is possible to achieve a “low cost”.

It was assumed a strong hypothesis of the impossibility that the negation of “low workmanship”, “good weight to slaughter”, “high working capital” and “low depreciation”, alone, could be sufficient to result a “low cost” of production. This is equivalent to say that a “good conversion” associated to “good weight to slaughter” prevails over any “floor” of fuzzy association grades of the other potentially sufficient causes which can determines this result.

Table 1: Extract of the sufficient sets in 65% of the cases with a adjust of 0.10 (association grade)

<table>
<thead>
<tr>
<th>Hog keeper/floor</th>
<th>Good conversion ∩ good weight</th>
<th>~ high working capital</th>
<th>~ low depreciation</th>
<th>~ low workmanship</th>
<th>~ good weight to slaughter</th>
<th>Low cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>A slatted</td>
<td>0,32</td>
<td>0,14</td>
<td>0,56</td>
<td>0,22</td>
<td>0</td>
<td>0,17</td>
</tr>
<tr>
<td>B smooth</td>
<td>0,32</td>
<td>0,19</td>
<td>0,35</td>
<td>0,11</td>
<td>0</td>
<td>0,02</td>
</tr>
<tr>
<td>B’ bed</td>
<td>0</td>
<td>0</td>
<td>0,04</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C smooth</td>
<td>0,44</td>
<td>0,83</td>
<td>0</td>
<td>0,33</td>
<td>0,56</td>
<td>0,05</td>
</tr>
<tr>
<td>D smooth</td>
<td>0,04</td>
<td>0,57</td>
<td>0,49</td>
<td>0,22</td>
<td>0,96</td>
<td>0</td>
</tr>
<tr>
<td>E smooth</td>
<td>0,24</td>
<td>0,60</td>
<td>0,34</td>
<td>0,22</td>
<td>0,76</td>
<td>0,14</td>
</tr>
</tbody>
</table>

The approximate reasoning process consists in the intersection of the fuzzy sets “low cost” (hog production costs) and three “environmental impact” (air, water, and soil). It is possible to find more than one combination and each one represents a path or a possibility of the fuzzy rules base, according to the different situations and perceptions of the reality. The aggregation of the different reasonable combinations results in the economical and environmental impact of the termination system under analysis (deep bedding and manure storage). The ‘defuzzification’ of the resulting area from the aggregation through the MAX-mean method allows the comparison of the economical and environmental impact of the different termination systems. The hog keepers evaluated in terms of “high”, “medium” or “low” the impact of the hog production on the air (which they can perceive only by the stench), on the surface waters and on the soil. In order to translate these verbal expressions into association grades concerning the unacceptability or acceptability of the different sets, it was defined that “high” corresponds to an association grade of (µ) de 0,75; “medium” corresponds to the ambiguity (µ = 0,5) and “low” corresponds to the an association grade of 0,25.

Inference process

\[ \text{Figure 1: Low cost (acceptable) } \cap \text{ unacceptable impact on the air } \cap \text{ unacceptable impact on the water } \cap \text{ unacceptable impact on the soil } = \text{ economical and environmental impact (E.E. I.) BAD.} \]
The association functions utilized to the Environmental Impact sets were:

\[ \mu = \frac{x - 0.5}{0.5}, \text{to acceptability, that is, } 0 \leq x \leq 0.5, x \in \mathbb{R}^{+} \text{ and } \]
\[ \mu = \frac{(x - 0.5)}{0.5}, \text{to unacceptability, that is, } 0.5 < x \leq 1, x \in \mathbb{R}^{+}; \text{ where } x = \text{Environmental Impact} \]

The intersection of the sets was done through the minimum operator (MIN) and the aggregation through the MAX operator. The output variable is called economical and environmental impact (E.E.I) which varies between zero and one. As far as the ‘deffuzification’ value is close to one (1), and as bigger as the area under the general fuzzy decision, better the economical and environmental impact. Regarding the hog keepers perception, the base of the fuzzy rules are as follows: four associations to unacceptable sets implies EEI very bad; three associations to unacceptable and one to acceptable implies EEI bad; two associations to unacceptable and two acceptable results in a EEI reasonable; one association unacceptable and three acceptable results in a EEI good; and finally four association to acceptable results in a EEI very good. To the manure storage termination system, the analysis is presented in figure 1. 

The association functions of the fuzzy representation of the conclusion EEI bad are as follows:

\[ \mu = \frac{x}{0.3}, \text{ to } 0 \leq x \leq 0.3, x \in \mathbb{R}^{+} \text{ and } \]
\[ \mu = \frac{(0.6 - x)}{0.3}, \text{ to } 0.3 < x \leq 0.6, \text{ x } \in \mathbb{R}^{+}, \text{ where } x = \text{E.E.I.} \]
The E.E.I. bad is also the E.E.I total of the manure storage system because there is only one situation from the hog keeper’s perceptions. Since this is the only possible combination derived from the analysis of the hog keeper’s questionnaires, a MAX-medium ‘defuzzication’ of the result was done. The E.E.I. total to manure storage is represented by the association functions as follows:

\[
\mu = \frac{x}{0.3} \quad \text{to} \quad 0 \leq x < 0.08; \quad \mu = 0.25 \quad \text{to} \quad 0.08 \leq x \leq 0.52;
\]

\[
\mu = \frac{(0.6 - x)}{0.3} \quad \text{to} \quad 0.52 < x \leq 0.6; \quad \mu = 0 \quad \text{to} \quad x > 0.6; \quad \text{where} \ x = \text{E.E.I. and} \ x \in R^+.
\]

The MAX-medium M.M. = \((0.52 + 0.08) / 2 = 0.30\).

The analysis of the deep bedding system is presented in figure 2. As far as, according to the hog keepers, two basic rules were considered plausible, the fuzzy E. E. I. general conclusion was obtained through the MAX aggregation of two fuzzy conclusions derived from the fuzzy base of rules. Each conclusion of base rule contributes to the general representation of the plausible E. E. I. The association functions of the possible situations aggregated in the E. E. I total of the deep bedding are as follows:

\[
\mu = \frac{x}{0.3}, \quad \text{to} \quad 0 \leq x \leq 0.08; \quad \mu = 0.25 \quad \text{to} \quad 0.08 < x < 0.82;
\]

\[
\mu = \frac{(0.9 - x)}{0.3} \quad \text{to} \quad 0.82 \leq x \leq 0.9; \quad \text{where} \ x = \text{E.E.I. and} \ x \in R^+.
\]

The MAX medium MM. = \((0.82 - 0.08) / 2 = 0.45\).

CONCLUSIONS: The intersection of the opinions from hog keepers and agronomists using only production costs, ammonia emission and water consumption indicates that the manure storage system is superior to the deep bedding system. However, the opinions of the technicians indicated a possible fewer impact on the soil to the deep bedding system. Besides, as far as the reduction of the water consumption in the hog breeding activity has been traditionally related to a wondering about a excessive manure dilution and not to the consumption itself and its impact on water availability, the fuzzy set of water consumption may be overestimated. A closer reality representation will appear when the situation becomes worse and a consequent deeper analysis of the question. The importance given by the agronomists to the environmental impact comes from the water consumption and facing the circumstances that characterize the region they recommend an extreme attention in the process of diffusion of the deep bedding technology in regions with similar conditions. Despite the smooth floor wastes more water during the hog breeding activity, no fuzzy parameter have been found to determine a difference between this sub type and the slatted floor in terms of environmental impact. In this way, despite the fact that the diversity has been identified, it was not possible to describe it until now. In the economical point of view, both sub types are capable to obtain low costs of production considering the divergences in the installation costs (lower to the smooth floor) and in feeding conversion (better in the slatted floor).

REFERENCES


