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Determination of the degree of relationship between Activity Cost and Financial Management in beef cattle production in a region of Peru, based on Indeterminate Likert Scale and Neutrosophic Similarity

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Abstract. Activity Cost and Financial Management are two variables of vital importance in livestock production. This paper aims to measure the relationship existing between these two variables within the production of beef cattle in the Coto-Coto Chilca Livestock Fair in Peru. To do this, we selected 141 ranchers from the area to give their opinions regarding the behavior of these two variables. The data were represented with the help of an Indeterminate Likert Scale, to capture the uncertainty and indeterminacy of the respondents' opinion. Survey results were compared for the two variables using a measure of neutrosophic similarities. Neutrosophic similarities are used to measure the degree of similarity between two neutrosophic sets measured in certain aspects.

Keywords: Activity costs, financial management, profitability, resource optimization, Indeterminate Likert Scale, neutrosophic similarity measure, triple refined indeterminate neutrosophic set, refined neutrosophic set.

1 Introduction

The cost due to economic activities refers to the identification and analysis of the different activities for the allocation of the corresponding costs. Likewise, the cost by activities has the purpose of optimizing resources by identifying unnecessary activities and the efficient use of time, which makes it a great tool for making timely decisions and proposing policies that improve financial indicators to generate a competitive advantage, [1]. So, the cost by activities has the purpose of identifying highly relevant activities to assign a good cost to those that are generating a good performance for the organization.

Financial management consists of a process that seeks to plan, organize, direct, and control the economic activities and cash flows of organizations, to be able to make decisions regarding investment and financing issues in addition to stabilizing the relationship between risk and profitability, [2]. Financial management refers to the way of planning, organizing, directing, and controlling the economic movements of an organization to make financial decisions that benefit its profitability.

At an international level, in terms of production, livestock systems have evolved towards mixed agricultural-livestock and dairy production systems, among other changes. The rapid increase in per capita consumption of meat and milk has been accompanied by a change in dietary patterns. However, the benefits of expanding this activity must be carefully weighed against growing concerns about unintended consequences (particularly environmental damage and disease outbreaks).

At the national level in Peru, livestock farming has been a primary activity for the consumption and marketing of meat and milk, to provide income to livestock farmers through production. Therefore, farmers must know about breeding, feeding, and caring for animals, as well as the use of medications, supplements, and modifications to increase production.

Due to the volatile nature of the business world, reliable cost data is essential to make well-informed strategic decisions. Since accurate information is the cornerstone of any good choice, a flawed pricing system is a serious failure. Therefore, companies want reliable data to make important decisions. The expenses incurred by the company provide most of the data necessary for decision-making.

This article is focused on studying the variables Activity cost and Financial management, they are concepts of vital importance in the study of business sciences, the topic deals with the measurement of their behaviors and focusing them on our problem, for benefiting the beef cattle producers that gather at the Coto-Coto Sunday fair, our purpose is to determine the relationship between the Activities cost and Financial management in Beef Cattle Producers at this Livestock Fair.

The research design is included from a non-experimental level, the sample of study was made up of 141 beef cattle producers participating in the fair, to whom a questionnaire was applied under the Indeterminate Likert Scale as the measurement scale, [3-5].

To measure opinion, which is subjective, it is necessary to measure the uncertainty and at the same time the indeterminacy of the criteria given by the interviewee. That is why an indeterminate Likert scale is used to quantify the degree of agreement-disagreement of the interviewee with the item on which they are asked to give their opinion; in this case, how the two variables Activities cost and Financial management are appropriate. The Indeterminate Likert Scale is based on the triple refined indeterminate neutrosophic sets (TRINS) [6], which are part of the refined neutrosophic sets, where the component of indeterminacy is split into three other subcomponents, to obtain greater accuracy, [7-9].

To determine the degree of relationship that exists between the two variables, we apply a measure of neutrosophic similarity. Neutrosophic similarity is an extension of the concept of fuzzy similarity, where the degree of similarity between two elements belonging to different fuzzy sets is measured using the degree of uncertainty about a certain aspect [10-11]. In the case of neutrosophic sets, specifically Single-Valued Neutrosophic Sets, we have two additional components that are indeterminacy and falsity, which increase accuracy compared to fuzzy sets and similarities. In this case, we adapt the similarity formulas to the TRINS, which contains two additional components, five in total.

In this article, we divide the presentation into a Materials and Methods section, where we present the fundamental concepts of the Indeterminate Likert Scale and Neutrosophic Similarity. This is followed by a Results section where the details of the study carried out are presented. We finish with the Conclusions.

2 Materials and Methods

This section summarizes the main theoretical contents that we used in the study. First, we offer the basic notions about the Indeterminate Likert Scale. The second subsection is dedicated to remembering the basic concepts of Neutrosophic Similarity.

2.1. Indeterminate Likert Scale

Definition 1 ([6]). The *Single-Valued Neutrosophic Set* (SVNS) N over U is $A = \{< x;\ T_A(x), I_A(x), F_A(x) > : x \in U\}$, where $T_A: U \rightarrow [0, 1]$, $I_A: U \rightarrow [0, 1]$, and $F_A: U \rightarrow [0, 1]$, $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$.

Definition 2 ([7]). The *refined neutrosophic logic* is defined such that: a truth T is divided into several types of truths: $T_1, T_2, \dots, T_p$, I into various indeterminacies: $I_1, I_2, \dots, I_r$ and F into various falsities: $F_1, F_2, \dots, F_s$, where all $p, r, s \geq 1$ are integers, and $p + r + s = n$.

Definition 3 ([6]). A *triple refined indeterminate neutrosophic set* (TRINS) A in X is characterized by positive $P_A(x)$, indeterminacy $I_A(x)$, negative $N_A(x)$, positive indeterminacy $I_{P_A}(x)$ and negative indeterminacy $I_{N_A}(x)$ membership functions. Each of them has a weight $w_m \in [0, 1]$ associated with it. For each $x \in X$, there are $P_A(x), I_{P_A}(x), I_A(x), I_{N_A}(x), N_A(x) \in [0,1]$,
$w_P^m(P_A(x)), w_{I_P}^m(I_{P_A}(x)), w_I^m(I_A(x)), w_{I_N}^m(I_{N_A}(x)), w_N^m(N_A(x)) \in [0, 1]$ and $0 \leq P_A(x) + I_{P_A}(x) + I_A(x) + I_{N_A}(x)(x) + N_A(x) \leq 5$. Therefore, a TRINS A can be represented by $A = \{\langle x;\ P_A(x), I_{P_A}(x), I_A(x), I_{N_A}(x), N_A(x)\rangle | x \in X\}$.

Let A and B be two TRINS in a finite universe of discourse, $X = \{x_1, x_2, \dots, x_n\}$, which are denoted by:

$A = \{\langle x;\ P_A(x), I_{P_A}(x), I_A(x), I_{N_A}(x), N_A(x)\rangle | x \in X\}$ and $B = \{\langle x;\ P_B(x), I_{P_B}(x), I_B(x), I_{N_B}(x), N_B(x)\rangle | x \in X\}$, Where $P_A(x_i), I_{P_A}(x_i), I_A(x_i), I_{N_A}(x_i), N_A(x_i), P_B(x_i), I_{P_B}(x_i), I_B(x_i), I_{N_B}(x_i), N_B(x_i) \in [0,1]$, for every $x_i \in X$. Let $w_i(i = 1,2,\ldots,n)$ be the weight of an element x_i ($i = 1,2,\ldots,n$), with $w_i \geq 0$ ($i = 1,2,\ldots,n$) and $\sum_{i=1}^{n} w_i = 1$.

The *generalized TRINS weighted distance* is ([6, 12]):

$$d_\lambda(A,B) = \left\{\frac{1}{5}\sum_{i=1}^{n} w_i \left[|P_A(x_i) - P_B(x_i)|^\lambda + \left|I_{P_A}(x_i) - I_{P_B}(x_i)\right|^\lambda + |I_A(x_i) - I_B(x_i)|^\lambda + \left|I_{N_A}(x_i) - I_{N_B}(x_i)\right|^\lambda + |N_A(x_i) - N_B(x_i)|^\lambda\right]\right\}^{1/\lambda} \quad (1)$$

Where $\lambda > 0$.

The Indeterminate Likert Scale is formed by the following five elements:

– Negative membership,
– Indeterminacy leaning towards negative membership,
– Indeterminate membership,
– Indeterminacy leaning towards positive membership,
– Positive membership.

These values substitute the classical Likert scale with values:

–Strongly disagree,
– Disagree,
–Neither agree or disagree,
– Agree,
–Strongly agree.

Respondents are asked to give their opinion on a scale of 0-5 about their agreement in each of the possible degrees, which are "Strongly disagree", "Disagree", "Neutral", "Agree", "Strongly agree", for this end, they were provided with a visual scale like the one shown in Figure 1.

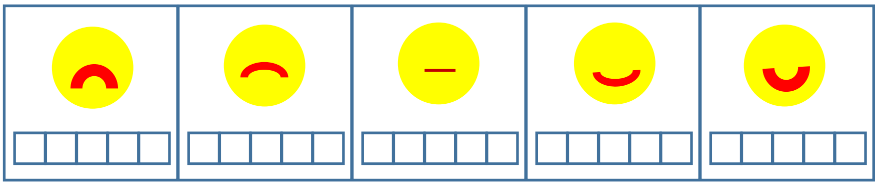

Figure 1. Graphic representation of the proposed Indeterminate Likert Scale.

2.2. Some Notions on Neutrosophic Similarity

Definition 4: ([10-11, 13-16]) The *degree of similarity* between two single-valued neutrosophic sets A and B is a mapping $S: \mathcal{N}(X) \times \mathcal{N}(X) \to [0,1]^3$, where $\mathcal{N}(X)$ is the set of all single-valued neutrosophic sets in $X = \{x_1, x_2, \cdots, x_n\}$, such that $S(A,B) = \left(S_T(A,B), S_I(A,B), S_F(A,B)\right)$ satisfies conditions (S1)-(S4).

(S1) $S(A,B) = S(B,A), \forall A, B \in \mathcal{N}(X)$,

(S2) $S(A,B) = \underline{1} = (1,0,0)$ if and only if $A = B$,

(S3) $S_T(A,B) \geq 0, S_I(A,B) \geq 0, S_F(A,B) \geq 0, \forall A, B \in \mathcal{N}(X)$,

(S4) If $A \subseteq B \subseteq C$, then $S(A,B) \geq S(A,C)$ and it satisfies $S(B,C) \geq S(A,C)$.

Definition 5: ([10-11]) Let $A, B \in \mathcal{N}(X)$ in $X = \{x_1, x_2, \cdots, x_n\}$, then a measure of similarity between A and B is calculated by $S(A,B) = \left(S_T(A,B), S_I(A,B), S_F(A,B)\right)$, where $S_T(A,B)$ is the degree of similarity of truthfulness, $S_I(A,B)$ is the degree of similarity of indeterminacy, and $S_F(A,B)$ is the degree of similarity of falsity. The formulas for similarity are the following:

$$S_T(A,B) = \left(\sum_{i=1}^{n}\left[\frac{min\ (T_A(x_i), T_B(x_i))}{max\ (T_A(x_i), T_B(x_i))}\right]\right)/n \quad (2a)$$

$$S_I(A,B) = 1 - \left(\sum_{i=1}^{n}\left[\frac{min\ (I_A(x_i), I_B(x_i))}{max\ (I_A(x_i), I_B(x_i))}\right]\right)/n \quad (2b)$$

$$S_F(A,B) = 1 - \left(\sum_{i=1}^{n}\left[\frac{min\ (F_A(x_i), F_B(x_i))}{max\ (F_A(x_i), F_B(x_i))}\right]\right)/n \quad (2C)$$

$\forall x_i \in X$.

Definition 6: ([10-11]) Suppose that for each $x_i \in X = \{x_1, x_2, \cdots, x_n\}$ a weight $w_i \in [0,1]$ is associated such that $\sum_{i=1}^{n} w_i = 1$. Let $A, B \in \mathcal{N}(X)$, then a weighted similarity measure between A and B is calculated by

$S_w(A,B) = \left(S_w^T(A,B), S_w^I(A,B), S_w^F(A,B)\right)$, where $S_w^T(A,B)$ is the degree of similarity of truthfulness, $S_w^I(A,B)$ is the degree of similarity of indeterminacy, and $S_w^F(A,B)$is the degree of similarity of the falsehood. The formulas for similarity are the following:

$$S_w^T(A,B) = \sum_{i=1}^{n} w_i \left[\frac{min\,(T_A(x_i),T_B(x_i))}{max\,(T_A(x_i),T_B(x_i))}\right] \quad (3a)$$

$$S_w^I(A,B) = 1 - \sum_{i=1}^{n} w_i \left[\frac{min\,(I_A(x_i),I_B(x_i))}{max\,(I_A(x_i),I_B(x_i))}\right] \quad (3b)$$

$$S_w^F(A,B) = 1 - \sum_{i=1}^{n} w_i \left[\frac{min\,(F_A(x_i),F_B(x_i))}{max\,(F_A(x_i),F_B(x_i))}\right] \quad (3c)$$

$\forall x_i \in X$.

Definition 7: ([10-11]) Let $A, B \in \mathcal{N}(X)$ in $X = \{x_1, x_2, \cdots, x_n\}$, then a measure of similarity between A and B is calculated by $L(A,B) = \left(L_T(A,B), L_I(A,B), L_F(A,B)\right)$, where $L_T(A,B)$ is the degree of similarity of truthfulness, $L_I(A,B)$ is the degree of similarity of indeterminacy, and $L_F(A,B)$ is the degree of similarity of falsity. The formulas for similarity are the following:

$$L_T(A,B) = 1 - \frac{\sum_{i=1}^{n}|T_A(x_i)-T_B(x_i)|}{\sum_{i=1}^{n}|T_A(x_i)+T_B(x_i)|} \quad (4a)$$

$$L_I(A,B) = \frac{\sum_{i=1}^{n}|I_A(x_i)-I_B(x_i)|}{\sum_{i=1}^{n}|I_A(x_i)+I_B(x_i)|} \quad (4b)$$

$$L_F(A,B) = \frac{\sum_{i=1}^{n}|F_A(x_i)-F_B(x_i)|}{\sum_{i=1}^{n}|F_A(x_i)+F_B(x_i)|} \quad (4c)$$

$\forall x_i \in X$.

Definition 8: ([10-11]) Let $A, B \in \mathcal{N}(X)$ in $X = \{x_1, x_2, \cdots, x_n\}$, then a measure of similarity between A and B is calculated by $M(A,B) = \left(M_T(A,B), M_I(A,B), M_F(A,B)\right)$, where $M_T(A,B)$ is the degree of similarity of truthfulness, $M_I(A,B)$ is the degree of similarity of indeterminacy, and $M_F(A,B)$ is the degree of similarity of falsity. The formulas for similarity are the following:

$$M_T(A,B) = \frac{1}{n}\sum_{i=1}^{n}\left(1 - \frac{|T_A(x_i)-T_B(x_i)|}{2}\right) \quad (5a)$$

$$M_I(A,B) = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{|I_A(x_i)-I_B(x_i)|}{2}\right) \quad (5b)$$

$$M_F(A,B) = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{|F_A(x_i)-F_B(x_i)|}{2}\right) \quad (5c)$$

$\forall x_i \in X$.

Definition 9: ([10-11]) Let $A, B \in \mathcal{N}(X)$ where $X = \{x_1, x_2, \cdots, x_n\}$, then a measure of similarity based on the distance between A and B is calculated by:

$$S^1(A,B) = \frac{1}{1+d(A,B)} \quad (6)$$

Such that $d(A,B)$ is a distance function between the two single-valued neutrosophic sets.

Let us recall that the distance function satisfies the following axioms $\forall A, B, C \in \mathcal{N}(X)$:

(1) $d(A,B) \geq 0$ and $d(A,B) = 0$ if and only if $A = B$,

(2) $d(A,B) = d(B,A)$,

(3) $d(A,C) \leq d(A,B) + d(B,C)$.

3 Results

First of all, we establish the similarity formula that we use in data processing. We start with the generalized Triple Refined Indeterminate Neutrosophic weighted distance with the help of Equation 1. $\lambda = 1{,}2$ are the two values that define the Hamming and Euclidean distances, respectively.

We define the neutrosophic similarity on the TRINS using formula 6 combined with the distance in (1).

To collect the data, 141 cattle farmers participating in the Coto-Coto Livestock Fair in Peru were asked to give their opinions on Activity costs per and Financial management.

The survey must be evaluated for each question for each of the possible evaluations on a scale of 0-5 as shown in Figure 1. 0 indicates that the given evaluation grade is not accepted and 5 means the maximum grade for such evaluation, this step must be done on every possible evaluation. Figure 2 shows an example to rely on.

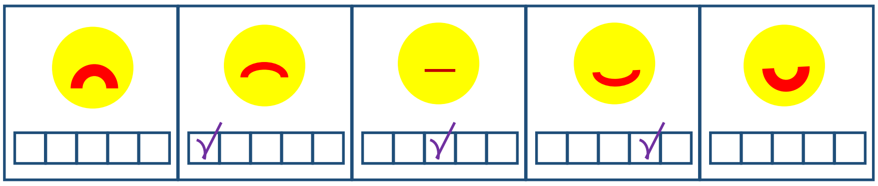

Figure 2. Example of the graphic use of the proposed Indeterminate Likert Scale.

In the example in Figure 2, it can be seen that the respondent expressed grade 0 of "strongly disagree", grade 1 of "disagree", grade 3 of "neutral", grade 4 of "agree", and grade 0 of "strongly agree". This allows us for obtaining greater precision in capturing the opinion and feelings of the respondent since there is not always a single possibility of agreement-disagreement with what is asked, rather in general there is a mixture.

The steps to follow are those:

1. Evaluate at all levels of opinion the degree of agreement-disagreement that an appropriate "Activity cost" is being applied in local livestock farming.
2. Evaluate at all levels of the opinion of the degree of agreement-disagreement that adequate "Financial management" is being applied in local livestock farming.
3. Each grade selected for each agreement-disagreement is associated with a value of 0.2. In the example in Figure 2, it is true that "Strongly disagree" has a value of $0(0.2) = 0$, "Disagree" has a value of $1(0.2) = 0.2$, "Neutral" is $3(0.2) = 0.6$, and so on. Finally, in the example, we have a TRINS equal to $(0,0.2,0.6,0.8,0)$.
4. Each of the 141 ranchers is consulted about their opinion. The data is collected and converted into the form of TRINS. Let $C(X)$ be the TRINS on "Activity cost" and $M(X)$ denotes the TRINS on "Financial management", for each of the respondents $X = \{x_1, x_2, \dots, x_{141}\}$.
5. It is calculated $d_2(C, M)$ (Equation 1) with $\omega_i = \frac{1}{141}$ $\forall x_i \in X$, and then the degree of similarity (Equation 6). This last index is the one required to determine the relationship between one variable and another.

Figures 3 and 4 contain the bar graphs with the degree of satisfaction-dissatisfaction for each of the two variables.

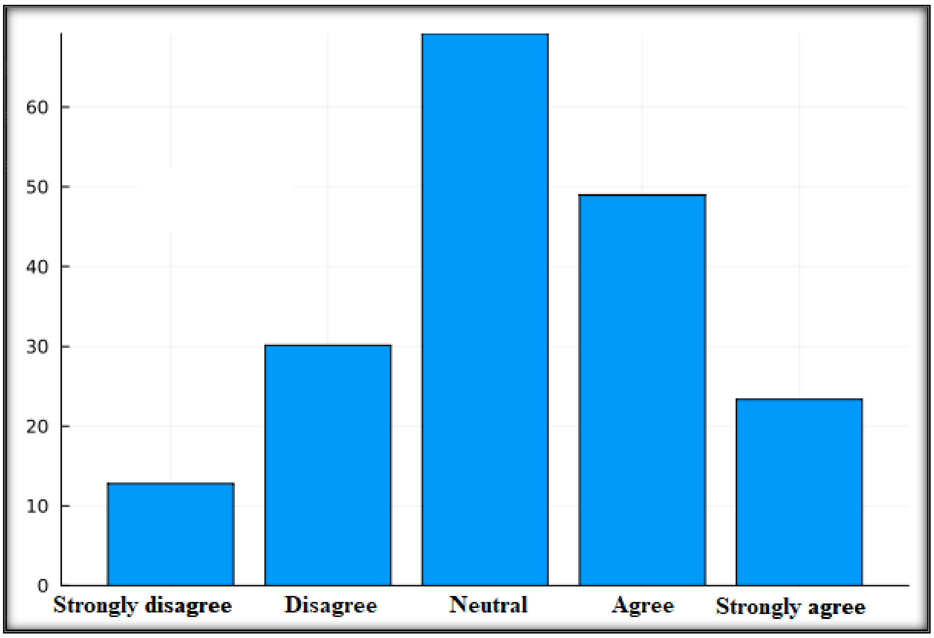

Figure 3. Bar chart on the degree of agreement-disagreement regarding "Adequate cost for activities" in percentage.

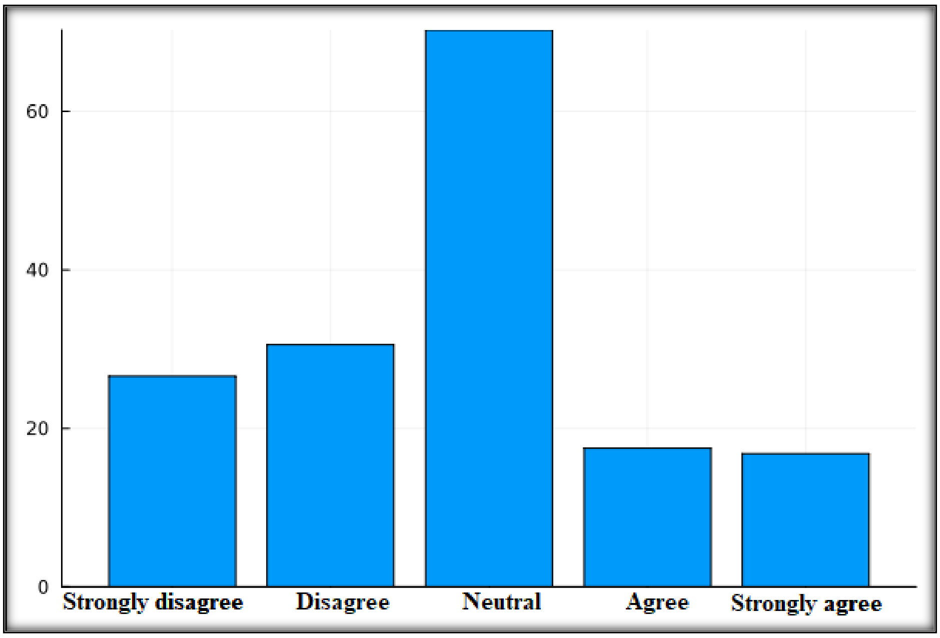

Figure 4. Bar chart on the degree of agreement-disagreement regarding “Appropriate financial management” in percentage.

The graphs in Figures 3 and 4 do not add up to 100% of the respondents. This is because the percentage of each of the opinions is calculated in terms of what each respondent thinks, who may have contradictory opinions when $T_A(x_i) + I_{T_A}(x_i) + I_A(x_i) + I_{F_A}(x_i) + F_A(x_i) > 1$.

Specifically, the degree of “Strongly agree” was calculated by $\sum_{i=1}^{141} T_A(x_i)$, the degree of “Agree” by $\sum_{i=1}^{141} I_{T_A}(x_i)$, the degree of “Neutral” by $\sum_{i=1}^{141} I_A(x_i)$, the degree of “Disagree” by $\sum_{i=1}^{141} I_{F_A}(x_i)$, and the degree of “Strongly disagree” by $\sum_{i=1}^{141} F_A(x_i)$.

Each of these values was divided by 141 and multiplied by 100 and this is how the percentages shown in both figures were obtained.

We have gotten the distance $d_2(C, M) = 0.433504$, and therefore the degree of similarity is equal to $S^1(C, M) = \frac{1}{1+0.433504} = 0.69759$.

This is interpreted as there is a degree of similarity over the average. Thus, there is a relationship between both measured variables.

Conclusion

Livestock activity has great cultural, nutritional, economic, and social importance in the rural populations of all or almost all countries. It is a source of food in terms of meat and milk, it is also a source of employment, and it maintains a traditional trade. That is why in modern times, with such high population growth, it is essential to correctly measure and manage the economic variables that are part of the production of beef and milk. Two of them are Activity cost and Financial management. In this work, we set out to study the behavior of these two variables in the town of Coto-Coto, Chilca, Peru, surveying 141 ranchers who participate in the local livestock fair. We are determined to have the greatest possible accuracy with the objective of obtaining the result that most closely resembles reality. We also accept that opinions have biases that are based on vagueness, uncertainty, and indeterminacy. The tool chosen was an Indeterminate Likert Scale that satisfies all these requirements. Additionally, we compare the individual results of each rancher's opinion on each of the variables using a measure of neutrosophic similarity, in this case, adapted to the TRINS. The results show a tendency towards neutrality regarding whether or not there is adequate behavior in both variables. Moreover, “Activity cost" shows a neutral behavior toward the positive, and "Financial management" has a neutral behavior toward the negative. The similarity between both was approximately 0.7, which is interpreted as that there is a positive relationship between both variables, therefore the improvement of one of them will imply the improvement in the other. It is recommended as a strategy to improve these variables, one and the other to produce better conjoint results. These are only previous results; in a future work we revisit this problem with more detail.

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