Goals of Beef Cattle and Dairy Producers: A Comparison of the Fuzzy Pair-Wise Method and Simple Ranking Procedure

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Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting, Mobile, AL February 1-5, 2003.

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Abstract

Beef and dairy producers' goal hierarchies over seven goals are compared using fuzzy pair-wise comparison and simple ranking methods. Results show the two methods do not provide similar goal rankings. Producers place greater importance on some goals than others, but are not in agreement as to the relative importance of goals.

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Economists generally assume that limited resources are allocated such that profit can be maximized. Besides maximizing profit, other goals may also be important. Most every farmer desires to maximize profit, but also perhaps desires to conserve land for future generations and/or have their families involved in agriculture. Understanding goal structure helps to explain resource allocation. While some goals may be complementary, others may compete, resulting in decisions not understood without a more thorough evaluation of multidimensional utility. For instance, some hobby farmers may place less emphasis on profit, resulting in decisions that do not necessarily lead to maximum profit. A farmer is assumed to satisfy as many goals as possible, first satisfying the most important goal or goals, then pursuing the less important ones.

Using fuzzy pair-wise and simple ranking procedures, the question, what is the goal hierarchy of Louisiana beef cattle and dairy producers, is addressed and the results of procedures are compared in this study. The objective of this research is to determine whether the fuzzy pair-wise comparison and simple ranking elicitation procedures provide the same goal hierarchy structures for livestock producers.

Literature Review

Major methods for eliciting goal hierarchies have included basic pair-wise comparisons, ratio scales (magnitude estimation), the analytic hierarchy process (AHP) and the fuzzy pair-wise comparison. The basic pair-wise comparison method (Thurstone) was widely used by researchers prior to the 1970's. For instance, of a number of goals, Smith and Capstick found that "Stay in business" and "increase farm size" as the most and least important of farmer goals, respectively. Other methods are generally variants of the paired comparison method.

Using magnitude estimation, a standard goal is presented to the respondent with an arbitrary value assigned as its magnitude (Stevens). The respondent then estimates the magnitude of each comparison goal with respect to the standard. Using magnitude estimation, Patrick et al. showed that avoiding being unable to meet loan payments and/or avoiding foreclosure and attaining a desirable level of family living were the top ranked goals among farmers.

The analytic hierarchy process (AHP) model has been used to obtain a ratio scale of importance for n goals. A matrix is set up consisting of judgments based on pair-wise comparisons of the relative importance between goals (Mendoza and Sprouse). AHP has been used by Saaty, Islam et al., Datta et al., Kim at al., Schniederjans et al., and Ball and Srinvasan.

Walker and Schubert discussed farm family values, roles, characteristics and decision-making processes. They categorized farm families as environmentally effective (EEF) and efficient entrepreneurs (EE). EEF farmers are traditional, with concern for family legacy and keeping the family farm. EE farmers think of farming as a business and are profit maximizers.

Kliebenstein et al. asked producers to distribute 100 points among 11 goals. "To be my own boss", "selling through the free market" and "can express myself" were the most important. Barnett, Blake, and McCarl researched goal hierarchies via multidimensional scaling for Senegalese subsistence farmers. Five goals were examined. Using pair-wise comparisons, they found that obtaining sufficient food for the family was the most important goal.

Van Kooten et al. (1986) evaluated the goal ordering of Saskatchewan farmers. By using the fuzzy pair-wise comparison method, they determined that avoiding low profits/losses, reducing farm debt, and making more profit were the most important three goals.

Of the studies discussed, researchers used either personal or telephone surveys to elicit goal hierarchies. Participants were generally producers attending specific farm-related programs.

Methods

In this study, goal hierarchies of producers are elicited via mail survey. Pilot testing of the survey was conducted prior to its distribution to producers. The second mailing, distributed approximately two weeks after the first, was a postcard sent to all surveyed, thanking the responders and reminding those who had not responded of the study. The third mailing, four weeks after the first, was directed to non-responders and included another copy of the survey.

The population for the survey was Louisiana beef cattle and dairy producers. Of 13,100 beef producers in Louisiana, 1,472 were randomly selected from four categories. The categories, each of which constituted 25 percent of the sample, were producers with 0-19, 20-49, 50-99 and more than 100 animals. The entire population (428) of Louisiana dairy producers was surveyed. The seven goals with respect to the farming operation assessed in this study were to:

. **Maintain and Conserve Land**: I want to maintain and conserve the land such that it can be preserved for future generations.

. **Maximize Profit**: I want to make the most profit each year given my available resources.

. **Increase Farm Size**: I want to increase the size of my operation by controlling more land and/or having newer or larger equipment or buildings.

. **Avoid Years of Loss / Low Profit**: I want to avoid years of high losses or low profits. I want to avoid being forced out of business.

. **Increase Net Worth**: I want to increase my material and investment accumulations.

. **Have Time for Other Activities**: I want to have ample time available for activities other than farming, such as leisure or family activities.

. **Have Family Involved in Agriculture**: I want my family to have the opportunity to be involved in agriculture.

Fuzzy Pair-Wise Comparison

Partial membership is a central concept to fuzzy set theory (Zadeh). In standard full membership theory, "a set is a well-defined collection in the sense that each element of the universal set is either a full member of it (gets a mark of 1) or not a member (gets 0)" (Basu, 1984). Under partial membership, the fuzzy set is mapped over a [0, 1] closed interval. Thus, an element is assigned a value between 0 and 1, representing the partial membership the element has in the fuzzy set (Van Kooten et al., 2001). Fuzzy set theory is based on vague preferences.

Fuzzy pair-wise comparison has been used by Ells et al., Mendoza and Sprouse, and Boender et al. The method is similar to the basic pair-wise comparison as the respondent compares two goals. However, the degree of preference of one goal over another is elicited and respondents are also allowed to be indifferent between two goals. Unlike magnitude estimation, with this methodology, the scale value of each goal is based on the entire set of compared pairs.

A unit line segment as illustrated in Figure 1 is used. Goals X and Y are located at opposite ends of the unit line. Respondents are asked to mark an "×" on the line to indicate preference. In comparing the goals, whichever has the shortest distance to the mark is preferred to the other. The degree of the preference of X over Y, R_{XY}, is measured from the mark to the X where total distance from X to Y is 1. If $R_{XY} < 0.5$, $Y \succ X$; if $R_{XY} = 0.5$, $X \approx Y$; likewise, if $R_{XY} > 0.5$, $X \succ Y$. In the case of absolute preference for one alternative, R_{XY} takes the value of 1 or 0.

X_____|_____Y
0.5

Figure 1. Fuzzy Pair-Wise Approach for Making Comparison Between X and Y.

The number of pair-wise comparisons of goals, K, is determined by $K = n*(n-1)/2$, where n = the number of goals. For each paired comparison, R_{ij} $(i \neq j)$ is obtained. The

measurement of the degree by which j is preferred to i is obtained as $R_{ji} = 1 - R_{ij}$. After obtaining measurements, the individual's fuzzy preference matrix R can be constructed using:

$$R_{ij} = \begin{cases} 0 \;\; if \;\; i = j \;\; \forall \;\; i, j = 1,....., n \\ r_{ij} \;\; if \;\; i \neq j \;\; \forall \;\; i, j = 1,....., n \end{cases}$$

Following Van Kooten at al., the method can be explained simply by the $i \times j$ fuzzy preference matrix (R) such that

$$R = \begin{bmatrix} 0 & r_{12} & r_{13} & . & . & . & r_{1j} \\ r_{21} & 0 & r_{23} & . & . & . & r_{2j} \\ r_{31} & r_{32} & . & . & . & . & . \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ . & . & . & . & . & 0 & r_{i-1\,j} \\ ri1 & r_{i2} & . & . & . & r_{ij-1} & 0 \end{bmatrix} \qquad (1)$$

where each element of the matrix is a measure of how much goal i is preferred to goal j and takes on values in the closed interval [0, 1].

It is possible to calculate a measure of preference, i, for each goal from the individual's preference matrix. Formula (2) measures the intensity of each goal separately.

$$I_j = 1 - (\sum_{i=1}^{n} R_{ij}^2 / (n-1))^{1/2} \qquad (2)$$

I_j values range from 0 to 1. As the value gets closer to 1, greater intensity of preference for the particular goal is indicated. By examining the I_js,,goals are ranked from most to least important.

In this study, the weights of each of the seven goals are calculated by using (2) on data obtained by the fuzzy pair-wise elicitation technique through a mail survey. Since the weight of each goal is the relative value of its utility, goals are ranked from most to least preferable.

Simple Ranking of Goals

With the Simple Ranking method, respondents are asked to rank the importance of the n goals from most to the least important, 1 through n, as follows.

Goal	Rank
1	_____
2	_____
.	.
.	.
.	.
n	_____

The most important goal is ranked "1". Its realization results in greatest utility to the farmer. The least important goal is ranked "n". Its realization results in the least utility. The respondent is asked not to give the same rank to two or more goals. Thus, this method requires respondents to make "all-or-nothing" choices for each paired comparison.

Nonparametric Statistical Analysis

The weight (utility) of each goal in the fuzzy pair-wise comparison and simple ranking models ranges from 0 to 1 and 1 to 7, respectively. Nonparametric statistics may be used to check for agreement between farmers' preferences in the ranking of goals (Friedman Test), and the degree of agreement (Kendall's W test). One may use Friedman's Test to determine whether goals are equally important within a block. The test consists of *M* mutually independent rows and *N*-variate random variable called *M* blocks (Conover). Blocks are arranged as:

		Treatment				
		1	2	3	……	N
Block:	1	X_{11}	X_{12}	X_{13}	……	X_{1N}
	2	X_{21}	X_{22}	X_{23}	……	X_{2N}
	3	X_{31}	X_{32}	X_{33}	……	X_{3N}
	.	…	…	…	……	…
	.	…	…	…	……	…
	.	…	…	…	……	…
	M	X_{M1}	X_{M2}	X_{M3}	……	X_{MN}

Where each block (row) is a producer's goal rankings according to his preferences. With seven goals, each row consists of seven values, which are the weights of goals elicited from a producer.

The Friedman test statistic in the presence of tied ranks is defined as

$$F_T = \frac{\sum_{J=1}^{N} R_j^2 - \frac{\left(\sum_{j=1}^{N} R_j\right)^2}{N}}{\frac{MN(N+1)}{12} - \frac{\sum T}{N-1}} \tag{3}$$

Where F is the Friedman statistic, M is the number of rows, N is the number of columns, R_j is the summation of the columns, and $\sum T$ is tied ranks, calculated as

$$\sum T = \frac{\sum_{j=1}^{k} \left(t_i^3 - t_i\right)}{12} \tag{4}$$

The null hypothesis is that there is no difference in preferences over goals among producers, and the alternative is that at least one goal is preferred over the others. The null hypothesis is rejected at level of significance *a* if the test statistic exceeds the *1- a* quantile of a chi-square random variable with *n-1* degrees of freedom.

Kendall's W (Kendall's coefficient of concordance) can be used in the same situations where Friedman's test statistic is applicable. The primary objective of Kendall's W is to measure the agreement in rankings in the M blocks. The statistic can be written as

$$W = \frac{12}{M^2 N(N+1)(N-1)} \sum_{J=1}^{N} \left(R_j - \frac{M(N+1)}{2} \right)^2 \tag{5}$$

If all *M* blocks are in perfect agreement, then the first treatment receives the same ranking in all *M* blocks, treatment 2 receives the same rank in all *M* blocks, etc. In such cases, the

resulting value of W is "1." In the case of perfect disagreement among rankings, the values of R_j are equal or very close to each other, and the values of both their mean and W are close to "0."

The relationship between Friedman's test and Kendall's W is as follows:

$$W = \frac{F}{M(N-1)} \tag{6}$$

Kendall's W is a simple modification of Friedman's test statistic. The hypothesis test which uses W as the test statistic can be checked by using Friedman's test instead of Kendall's W. For the values of 0.1, 0.3, 0.5, 0.7 and 0.9, the agreements are very weak, weak, moderate, strong, and unusually strong, respectively (Schmidt).

Consistency between the Fuzzy Pair-Wise Comparison and Simple Ranking Methods

The Spearman Rank Correlation coefficient (SRC) is used to determine whether there is rank order correlation between the fuzzy pair-wise comparison and simple ranking methods. In the simple ranking procedure, goals take values from 1 to 7. On the other hand, in the fuzzy pair-wise comparison, goals can be ordered from the most important (value = 1) to the least important (value =7). Following Gibbons, the formula for SRC in the presence of ties is

$$R = \frac{n(n^2-1) - 6\sum D_i^2 - 6(u' + v')}{\sqrt{n(n^2-1) - 12u'}\sqrt{n(n^2-1) - 12v'}} \tag{7}$$

where R is the SRC, which takes values between -1 and +1, D is the difference in ranks and n is the number of observations. In extreme cases, If $R = 1$, indicates there is a direct association and perfect agreement; $R = -1$ indicates there is an inverse association and perfect disagreement; and $R = 0$, indicates no association. $u' = (\Sigma u^3 - \Sigma u)/12$ for u, the number of observations in one X sample that are tied at a given rank, and the sum is over all sets of u tied ranks; and similarly, $v' = (\Sigma v^3 - \Sigma v)/12$ for sets of v tied ranks in the Y sample" (Gibbons).

The significance of the SRC can be calculated by using $z = R\sqrt{n-1}$, where z is a two-tailed test. If z is greater than the critical value, then there is correlation between the methods.

Results

For the beef producers, of the 1,472 surveys mailed, 95 were considered undeliverable due to a change in address, death, or the farmer being out of business, reducing the beef producer sample to 1,377. Of these, 495 were returned, resulting in a response rate of 36 percent. Due to missing data, 28 surveys were unusable and the analysis was conducted with 467 surveys. Of the 428 dairy surveys mailed, five surveys were considered undeliverable, due to being out of business. Of the 423 surveys, 130 were returned, for a return rate of 31 percent.

Fuzzy Pair-Wise and Simple Ranking Goal Weights

Thirteen percent of the producers fell into the 1 to 19 animal category. With a fuzzy pair-wise weight of 0.54, goal Maintain and Conserve Land was the most important (Table 1). Have Time for Other Activities was the second most important, and the least important was Increase Farm Size. Using the simple ranking procedure, Maintain and Conserve Land was also the most important and Increase Farm Size was the least important. Avoid Years of Loss / Low Profit was the third most important goal using both methods. Otherwise, there were differences in rankings.

With *6* degrees of freedom and a=0.001, critical value *F*=22.46. Since the values of 55 and 73 for the Friedman test for both the fuzzy pair-wise and simple ranking procedures, respectively, are greater than 22.46, the null hypothesis is rejected. For both procedures, one can conclude that some goals are preferred over others. The values of Kendall's W are 0.16 and 0.21 for the fuzzy pair-wise and simple ranking procedures, respectively. These values show that the agreement between individuals in the goal rankings is between very weak and weak.

Twenty percent of the observations were from the 20-49 animal category (Table 2). Maintain and Conserve Land was the most important goal using both procedures. Increase Farm Size was again the least important using both procedures. Maximize Profit and Avoid Years of Loss / Low Profit were in the second and third levels of importance, depending upon procedure. Otherwise, all goals had the same ranking with both procedures. Friedman's test values for both methods are greater than the critical value F = 22.46. The null hypothesis is rejected, and for both procedures, some goals are more important than others. With values of 0.16 and 0.25, Kendall's W for fuzzy pair-wise and simple ranking show that the agreement between the individuals in ranking the goals falls between very weak and weak agreement.

Twenty-one percent of the observations were from the 50-99 animal category. Again, Maintain and Conserve Land was the most important and Increase Farm Size was the least important goal (Table 3). Maximize Profit became the second most important goal for both procedures. Results of the two procedures are consistent; all goals were in the same relative ranking with both procedures. For this category, Friedman test values of 110 and 187 for the fuzzy pair-wise and simple ranking procedure, respectively, are greater than critical value F = 22.46. The null hypothesis is rejected, and for both fuzzy pair-wise and simple ranking procedures, some goals are preferred over the others. On the other hand, with the value of 0.19 and 0.31, Kendall's W for fuzzy pair-wise and simple ranking show that the agreement between individuals in ranking the goals is between very weak and weak agreement.

Forty-six percent of the observations were from producers who had 100 or more animals. Avoid Years of Loss / Low Profit was the most important goal for the fuzzy analysis (Table 4). Again, the least important goal was Increase Farm Size. According to the simple ranking procedure, Maintain and Conserve Land was the most important goal. Only two goals kept the

same ranking using both procedures. For this group, the Friedman's test values for both procedures are greater than critical value F = 22.46. The null hypothesis is rejected, and for both procedures, some goals are preferred over the others. With values of 0.16 and 0.22, Kendall's W for fuzzy pair-wise and simple ranking methods show that the agreement between the individuals in ranking the goals is between very weak and weak agreement.

To determine the goal structure for the population of beef producers, the weighted means of the four groups were calculated as $\sum_{i=1}^{m} \frac{n_i}{N} * w_i$, where m is the number of size categories, n_i is the number of producers in size category i, N is the number of producers in the total population, and w_i is the average weight of the goal for size category i. The weighted statistics for both the fuzzy pair-wise and simple ranking were fairly consistent (Table 5). The overall means for the fuzzy pair-wise comparison procedure show that the most important first and second goals for the population were Maintain and Conserve Land and Avoid Years of Loss / Low Profit. For the third importance level, Maximize Profit and Have Time for Other Activities competed with one another. Increase Net Worth, Have Family Involved in Agriculture and Increase Farm Size were in the fifth, sixth and seventh most important levels, respectively. According to the overall means, the first, sixth and seventh ranked goals were the same in both procedures. Maximize Profit, Avoid Years of Loss / Low Profit, Increase Net Worth, and Have Time for Other Activities were in different position.

Since the entire population of dairy producers was surveyed, the analysis of the goal scores was conducted for the dairy population. Dairy producers were more concerned with financial goals, as expected (Table 6). Avoid Years of Loss / Low Profit was slightly more important than Maximize Profit in the fuzzy procedure. On the other hand, for the simple ranking procedure, Maximize Profit was the most important goal, and the second most important goal

was Avoid Years of Loss / Low Profit. The third and fourth most important goals for the fuzzy procedure were Increase Net Worth and Maintain and Conserve Land. For the simple ranking, Maintain and Conserve Land was the third and Increase Net Worth was the fourth most important goal. The degree of importance of the other goals was the same using both procedures. Dairy producers gave the least importance to Increase Farm Size.

There are some differences in the goal orders of the beef cattle and dairy producers. First of all, as expected, the dairy producers were more profit oriented. This may be partially because the business was a primary source of their income. While most of the beef cattle respondents (57 percent) had an off farm job, only 21 percent of dairy producers had an off farm job. Maintain and Conserve Land was ranked substantially lower for dairy producers.

For the dairy producers, the Friedman's test values are greater than critical value F = 22.46. The null hypothesis is rejected, and for both fuzzy pair-wise and simple ranking procedures, some goals are preferred over the others. With the values of 0.29 and 0.33, Kendall's W for fuzzy pair-wise and simple ranking show that the agreement between the individuals in ranking the goals is between very weak and weak agreement.

Consistency between the Fuzzy Pair-Wise Comparison and the Simple Ranking Methods

To check for rank order correlation between the simple ranking and fuzzy pair-wise comparison methods, the SRC was used (Table 7). The null and alternative hypotheses were: H_0: There is no association (the fuzzy pair-wise comparison and simple ranking procedures provide different goal rankings). H_1: Association exists. (The procedures provide the same rankings). With seven goals and, thus, 6 degrees of freedom, the critical value of the SRC at the 10 percent level is 0.57. The values of the SRC for 29 percent of the beef cattle producers were lower than 0.57. Thus, their goal scoring with the fuzzy pair-wise and simple ranking procedures

were not consistent. Twelve percent of the producers had SRC values between 0.57 and 0.70, which were significant at the 10 percent level. The SRC values for 49 percent of the producers were between 0.70 and 0.99, which were significant at the 5 percent level. The rankings using both procedures were exactly the same for 10 percent of the beef producers.

The SRC values for 33 percent of the dairy producers were lower than 0.57. Thus, the null hypothesis that the goal scoring in both procedures was consistent could not be rejected. Thirteen percent of producers had SRC values between 0.57 and 0.70, which were significant at the 10 percent level. The coefficient values for 47 percent of the producers were between 0.70 and 0.99, which was significant at the 5 percent level. The ranking of goals in the fuzzy pair-wise and simple ranking procedures were exactly the same for seven percent of the dairy producers.

Overall, the goal rankings were not consistent at the 10 percent level for 33 percent of producers, and were exactly consistent for only nine percent of the producers. These results suggest that the two procedures cannot be used interchangeably to elicit goal hierarchies.

Conclusions

Using the fuzzy pair-wise comparison method, the most important goal was Maintain and Conserve Land for beef cattle producers. The second and third most important goals were: Avoid Years of Loss/Low Profit, and Maximize Profit, respectively. Using the simple ranking procedure, the second and third most important goals switched positions relative to fuzzy procedure. According to SRC test, the rankings of goals using both procedures were the same for only 10 percent of the cattle producers. Using the fuzzy pair-wise comparison method, the most important goal of dairy producers was to Avoid Years of Loss / Low Profit. The second, third and fourth most important were: Maximize Profit, Increase Net Worth, and Maintain and Conserve Land. Using the simple ranking procedure, the first and second, and the third and

fourth most important goals switched positions relative to the fuzzy procedure. According to SRC test the rankings of goals using both procedures were the same for only 7 percent of the dairy producers. These results provide evidence that the two procedures cannot be used interchangeably to elicit goal hierarchies.

For both beef cattle and dairy producers, some goals were significantly preferred over the others. The greater importance placed on financial goals by the larger beef producers is likely due to their greater capital investment and the greater percentage of their income that comes from cattle production. The greater importance placed on financial goals by dairy producers than beef producers is likely due to their greater capital investment, greater asset specificity, and greater percentage of income that comes from the farm. While these general conclusions can be made, one must also recognize that the agreement between farmers within a size category or enterprise in the goal ranking was between very weak and weak agreement.

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Table 1. Descriptive Statistics of Goal Scores for Beef Cattle Producers Who Had 1-19 Animals*.

	Fuzzy Pair-Wise					Simple Ranking			
Variable	Mean	Std Dev	Minimum	Maximum	Variable	Mean	Std Dev	Minimum	Maximum
CONSFUZZ	0.54	0.14	0.11	0.77	CONSRANK	5.37	1.92	1.00	7.00
LEISFUZZ	0.51	0.11	0.26	0.75	PROFRANK	4.56	1.77	1.00	7.00
RISKFUZZ	0.48	0.11	0.24	0.69	RISKRANK	4.44	1.58	1.00	7.00
FAMIFUZZ	0.48	0.18	0.04	0.97	LEISRANK	4.18	1.81	1.00	7.00
PROFFUZZ	0.47	0.14	0.10	0.83	FAMIRANK	3.67	1.99	1.00	7.00
NWORFUZZ	0.44	0.12	0.10	0.71	NWORRANK	3.60	1.66	1.00	7.00
SIZEFUZZ	0.36	0.16	0.04	0.90	SIZERANK	2.19	1.77	1.00	7.00

Friedman's test = 55
Kendall's W =0.16

Friedman's test =73
Kendall's W = 0.21

Table 2. Descriptive Statistics of Goal Scores for Beef Cattle Producers Who Had 20-49 Animals*.

	Fuzzy Pair-Wise					Simple Ranking			
Variable	Mean	Std Dev	Minimum	Maximum	Variable	Mean	Std Dev	Minimum	Maximum
CONSFUZZ	0.56	0.16	0.11	0.93	CONSRANK	5.57	1.71	1.00	7.00
RISKFUZZ	0.50	0.10	0.28	0.80	PROFRANK	4.84	1.81	1.00	7.00
PROFFUZZ	0.49	0.13	0.14	0.82	RISKRANK	4.60	1.46	1.00	7.00
NWORFUZZ	0.47	0.12	0.15	0.75	NWORRANK	4.04	1.61	1.00	7.00
LEISFUZZ	0.46	0.16	0.04	0.98	LEISRANK	3.44	1.85	1.00	7.00
FAMIFUZZ	0.42	0.15	0.07	0.72	FAMIRANK	3.03	1.89	1.00	7.00
SIZEFUZZ	0.34	0.15	0.03	0.78	SIZERANK	2.53	1.82	1.00	7.00

Friedman's test = 94
Kendall's W = 0.16

Friedman's test = 142
Kendall's W = 0.25

*Suffixes FUZZ and RANK refer to rankings from the fuzzy pair-wise comparison and simple ranking method, respectively. Prefixes CONS, RISK, PROF, NWOR, LEIS, FAMI, and SIZE refer to the goals, Maintain and Conserve Land, Avoid Years of Loss / Low Profits, Maximize Profit, Maximize Net Worth, Have Time for Other Activities, Have Family Involved in Agriculture, and Increase Farm Size, respectively.

Table 3. Descriptive Statistics of Goal Scores for Beef Cattle Producers Who Had 50-99 Animals*.

	Fuzzy Pair-Wise					Simple Ranking			
Variable	Mean	Std Dev	Minimum	Maximum	Variable	Mean	Std Dev	Minimum	Maximum
CONSFUZZ	0.56	0.13	0.11	0.92	CONSRANK	5.63	1.74	1.00	7.00
PROFFUZZ	0.51	0.13	0.10	0.78	PROFRANK	5.04	1.58	1.00	7.00
RISKFUZZ	0.50	0.12	0.16	0.76	RISKRANK	4.61	1.54	1.00	7.00
NWORFUZZ	0.48	0.13	0.20	0.80	NWORRANK	4.38	1.51	2.00	7.00
LEISFUZZ	0.43	0.15	0.05	0.77	LEISRANK	3.06	1.58	1.00	7.00
FAMIFUZZ	0.42	0.18	0.07	0.99	FAMIRANK	2.65	1.67	1.00	7.00
SIZEFUZZ	0.35	0.17	0.01	0.97	SIZERANK	2.64	1.98	1.00	7.00
Friedman's test =110					Friedman's test =187				
Kendall's W = 0.19					Kendall's W = 0.31				

Table 4. Descriptive Statistics of Goal Scores for Beef Cattle Producers Who Had 100+ Animals*.

	Fuzzy Pair-Wise					Simple Ranking			
Variable	Mean	Std Dev	Minimum	Maximum	Variable	Mean	Std Dev	Minimum	Maximum
RISKFUZZ	0.53	0.12	0.05	0.94	CONSRANK	5.23	1.76	1.00	7.00
CONSFUZZ	0.52	0.14	0.11	0.97	PROFRANK	5.15	1.72	1.00	7.00
PROFFUZZ	0.50	0.12	0.14	0.97	RISKRANK	4.77	1.57	1.00	7.00
NWORFUZZ	0.48	0.12	0.11	0.92	NWORRANK	4.02	1.65	1.00	7.00
LEISFUZZ	0.46	0.16	0.05	0.99	FAMIRANK	3.21	1.93	1.00	7.00
FAMIFUZZ	0.44	0.15	0.02	0.98	LEISRANK	3.13	1.73	1.00	7.00
SIZEFUZZ	0.35	0.14	0.04	0.71	SIZERANK	2.51	1.76	1.00	7.00
Friedman's test =209					Friedman's test =284				
Kendall's W = 0.16					Kendall's W = 0.22				

*Suffixes FUZZ and RANK refer to rankings from the fuzzy pair-wise comparison and simple ranking method, respectively. Prefixes CONS, RISK, PROF, NWOR, LEIS, FAMI, and SIZE refer to the goals, Maintain and Conserve Land, Avoid Years of Loss / Low Profits, Maximize Profit, Maximize Net Worth, Have Time for Other Activities, Have Family Involved in Agriculture, and Increase Farm Size, respectively.

Table 5. Goal Weight of All Categories Ranked by Overall Mean for Beef Cattle Producers.

	Categories and Number of Farms for Fuzzy Pair-Wise				Overall Weighted	Categories and Number of Farms for Simple Ranking				Overall Weighted
Size Category	0-19	20-49	50-99	100+	Mean For	0-19	20-49	50-99	100+	Mean for
Number of Producers in Population	6600	4200	1200	1100	Fuzzy	6600	4200	1200	1100	Ranking
Maintain and Conserve Land	0.54	0.56	0.56	0.52	0.55	5.37	5.57	5.63	5.23	5.45
Avoid Years of Loss / Low Profit	0.48	0.50	0.50	0.53	0.49	4.44	4.60	4.61	4.77	4.53
Maximize Profit	0.47	0.49	0.51	0.50	0.48	4.56	4.84	5.04	5.15	4.74
Increase Net Worth	0.44	0.47	0.48	0.48	0.46	3.60	4.04	4.38	4.02	3.85
Have Time for Other Activities	0.51	0.46	0.43	0.46	0.48	4.18	3.44	3.06	3.13	3.75
Have Family Involved in Agriculture	0.48	0.42	0.42	0.44	0.45	3.67	3.03	2.65	3.21	3.33
Increase Farm Size	0.36	0.34	0.35	0.35	0.35	2.19	2.53	2.64	2.51	2.37

Table 6. Descriptive Statistics of Goal Scores for Dairy Producers.

	Fuzzy Pair-Wise					Simple Ranking			
Goals	Mean	Std Dev	Minimum	Maximum	Goal	Mean	Std Dev	Minimum	Maximum
RISKFUZZ	0.540	0.13	0.21	1.00	PROFRANK	5.51	1.47	1.00	7.00
PROFFUZZ	0.537	0.12	0.25	0.93	RISKRANK	4.98	1.57	1.00	7.00
NWORFUZZ	0.506	0.12	0.13	0.94	CONSRANK	4.78	1.70	1.00	7.00
CONSFUZZ	0.489	0.15	0.05	0.98	NWORRANK	4.40	1.73	1.00	7.00
LEISFUZZ	0.478	0.15	0.04	0.87	LEISRANK	3.42	1.63	1.00	7.00
FAMIFUZZ	0.405	0.17	0.06	0.79	FAMIRANK	2.78	1.72	1.00	7.00
SIZEFUZZ	0.289	0.13	0.03	0.59	SIZERANK	2.14	1.65	1.00	7.00
Friedman's test =224					Friedman's test =259				
Kendall's W = 0.29					Kendall's W = 0.33				

Table 7. Spearman Rank Correlation Test Statistics for Consistency of the Goal Scores in the Fuzzy Pair-Wise and Simple Ranking Procedures for Beef Cattle Producers.

Percentage	Spearman Coefficient	Consistency
29	<0.57	Not Consistent
12	0.57 to 0.70	Consistent at 10%
49	0.71 to 0.990	Consistent at 5%
10	=1.00	Exactly consistent

Table 8. Spearman Rank Correlation Test Statistics for Consistency of the Goal Scores in the Fuzzy Pair-Wise and Simple Ranking Procedures for Dairy Producers.

Percentage	Spearman Coefficient	Consistency
33	<0.57	Not Consistent
13	0.57 to 0.70	Consistent at 10%
47	0.71 to 0.990	Consistent at 5%
7	=1.00	Exactly consistent