INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2007/09–2–257–263
http://www.fspublishers.org

Eliciting Farmers' Goal Hierarchies: Comparing the Fuzzy Pair-Wise Method with the Simple Ranking Procedure

AYDIN BASARIR[1] AND JEFFREY M. GILLESPIE†
Gaziosmanpasa University, Faculty of Economics and Administrative Sciences, Department of Business Administration, Tasliciftlik Campus 60240 Tokat – Turkey, Phone: + 90 (356) 252 1616/2363; Fax: + 90 (356) 252 1673; Mobile: + 90 (533) 748 4566
†*Louisiana State University, Department of Agricultural Economics and Agribusiness, 101 Agricultural Administration Building, Baton Rouge, LA 70803-5604, Phone: (225) 578-2759*
[1]Corresponding author's e-mail: abasarir@gop.edu.tr; jmgille@lsu.edu

ABSTRACT

Beef and dairy producers' goal hierarchies over seven production goals were compared using fuzzy pair-wise comparison and simple ranking methods. Results showed both the 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.

Key Words: Fuzzy pair-wise comparison method; Simple ranking methods; Producer's goals; Non-parametric tests

INTRODUCTION

Economists generally assume that firms allocate limited resources such that profit is maximized. Farmers, however, have been shown to have multiple goals that influence resource allocation decisions. While for most farmers, maximizing profit is an important goal (or the most important goal), other goals such as conserving land for future generations and having their families involved in agriculture may also be important. Understanding goal structures of farmers helps to explain resource allocation decisions. While some goals may be complementary, others may compete, resulting in decisions not easily understood without a more thorough evaluation of goal structure. This study compares the results of two procedures that have been used to elicit the goal structures of farmers. The objective of this study was to determine whether the fuzzy pair-wise comparison and simple ranking elicitation procedures provide the same goal hierarchy structures for farmers.

A number of studies have examined farmer's goal structures, each finding that goals other than profit maximization/cost minimization are of importance in farmer decision making. Procedures used for eliciting goal hierarchies include the following: (1) Basic pair-wise comparisons (Thurstone, 1927; Smith & Captstick, 1976) require respondents to compare each goal with all other goals and indicate which is the most important. (2) Magnitude estimation (Stevens, 1957; Patrick *et al*., 1983) involves selecting a base goal, assigning it a base value for comparison purposes and asking respondents to compare the importance of all other goals to the base goal by assigning points accordingly. (3) The analytic hierarchy process (Saaty, 1980; Mendoza & Sprouse, 1989; Datta *et al*., 1992; Ball & Srinvasin, 1994; Schniederjans *et al*., 1995; Islam *et al*., 1997) utilizes pair-wise comparisons, but assigns cardinal measures of preference between goals. (4) A method has been used in which respondents were asked to distribute a fixed number of points among goals to indicate their relative importance (Kliebenstein *et al*., 1980). (5) The fuzzy pair-wise comparison method (Van Kooten *et al*., 1986) is similar to the analytic hierarchy process, with the additional assumption that degree of preference between goals is continuous and can be measured as such, rather than via discrete choices. (6) Finally, the simple ranking procedure provides a listing of goals and simply asks respondents to rank them from most to least important. This procedure is rarely used in studies that have an explicit objective of determining goal hierarchy, but is sometimes used in studies, where determining goal hierarchy is a secondary objective (e.g., Davis, 2002).

This study analyzes results of the fuzzy pair-wise comparison method and compares them with those of the simple ranking method. The fuzzy pair-wise comparison method is among the most recently introduced goal hierarchy elicitation procedures and its implementation is somewhat involved. On the other hand, the simple ranking procedure is relatively easy to administer. We were interested in whether the simpler procedure could be used in lieu of the more complicated ones in cases, where only an ordinal ranking of goals is desired. The fuzzy pair-wise comparison method requires producers to evaluate all possible combinations of goals and carefully evaluate, which is the most important. Thus, it is assumed that, if differences in ranking emerge, the fuzzy pair-wise method would lead to the most reliable results. We were un-aware of other studies that have compared results of goal hierarchy elicitation procedures.

Methods. Farmers' goal hierarchies are elicited via mail survey. Pilot testing of the questionnaire was conducted prior to its initial distribution to farmers. 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 questionnaire.

The survey population 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% of the sample, were farmers with 0 - 19, 20 - 49, 50 - 99 and more than 100 animals. The entire population (428) of Louisiana dairy farmers was surveyed.

For beef producers, of the 1,472 questionnaires mailed, 95 were un-deliverable 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%. Due to missing data, 28 surveys were un-usable and the analysis was conducted with 467 surveys. Of the 428 dairy surveys mailed, five of the farmers were out of business. Of the 423 remaining surveys, 130 were returned, for a return rate of 31%.

The seven goals with respect to the farming operation assessed in this study were:

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.

Each of the goals, were listed in the elicitation procedures, along with the one-sentence descriptions as shown above.

The fuzzy pair-wise comparison method. Partial membership is a central concept in fuzzy set theory (Zadeh, 1965). In full membership theory, a set is well-defined in that each element either is or is not a full member (Basu, 1984). Assuming 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). Thus, fuzzy set theory is based on some-what vague preferences.

The fuzzy pair-wise comparison method of eliciting goal structure has been used by Van Kooten *et al*. (1986), Ells *et al*. (1997), Mendoza and Sprouse (1989) and Boender *et al*. (1989). The method was similar to the basic pair-wise comparison as the respondent compares goals on a pair-wise basis. However, the degree of preference of one goal over another has been elicited and respondents are also allowed to be indifferent between goals.

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

Fig. 1. Fuzzy pair-wise approach for making comparison between X and Y

X_____|_____Y
0.5

The number of pair-wise comparisons of goals, *K*, was 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 was 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*. (1986), the method can be explained simply by the $i \times j$ fuzzy preference matrix (R) such that:

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

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. Equation (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 has been indicated. By examining the I_js, goals are ranked from most to least important.

Simple ranking of goals. Using the Simple Ranking procedure, respondents were 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 the greatest utility to the farmer. The least important goal is ranked "n". Its realization results in the lowest utility. A respondent was asked not to provide the same rank for two or more goals. Thus, this method requires respondents to make "all-or-nothing" choices for each paired comparison.

Non-parametric 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. Friedman's test was used to determine whether goals are equally important among farmers. The test consisted of *M* mutually independent rows (one for each farmer) and *N* elements (goals) in each row (Conover, 1971). Blocks were 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 or her 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:

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

Where, *F* is the Friedman statistic, M is the number of rows, N is the number of columns, R_j is a summation across the columns, and $\sum T$ is tied ranks, calculated as (4):

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

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

Using Kendall's *W* (Kendall's coefficient of concordance), the objective was to measure the agreement in rankings in the *M* blocks. The statistic can be written as:

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

If all *M* blocks were in perfect agreement, then the first treatment received the same ranking in all *M* blocks, treatment 2 received the same ranking in all *M* blocks and so forth. 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 one other and the values of both their mean and *W* are close to "0". For the values of 0.1, 0.3, 0.5, 0.7 and 0.9, the agreements are very weak, weak, moderate, strong and un-usually strong, respectively (Schmidt, 1997).

Consistency between the fuzzy pair-wise and simple ranking procedures. The Spearman Rank Correlation coefficient (SRC) was used to determine whether there is rank order correlation between the fuzzy pair-wise comparison and simple ranking methods. Following Gibbons (1997), the formula for SRC in the presence of ties was:

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

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 where *R* = 1 (R = -1), there is perfect (dis)agreement. *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. Similarly, $v' = (\Sigma v^3 - \Sigma v)/12$ for sets of *v* tied ranks in the Y sample (Gibbons, 1997).

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. As with any comparison of procedures, where preferences are being elicited, one must be concerned with whether the respondents' answers to the second set of questions (in this case, the fuzzy pair-wise comparison method) are an attempt to be consistent with his or her answers to the first set of questions (in this case, the simple ranking procedure). If this is the case, one would expect greater consistency among results. If results show inconsistency between the procedures, the researcher can be reasonably assured that the procedures would result in inconsistent measures if they were not used in the same questionnaire.

RESULTS

Thirteen % of the beef producers fell into the 1 to 19 animal category. With a fuzzy pair-wise weight of 0.54, Maintain and Conserve Land was the most important goal (Table I). 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 the rankings.

With six degrees of freedom and $\alpha = 0.001$, 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 (Table II). For both procedures, some goals are preferred over others. The values of Kendall's W were 0.16 and 0.21 for the fuzzy pair-wise and simple ranking procedures, respectively. These values show that the agreement among individuals in the goal rankings was between very weak and weak.

Twenty % of the beef observations were from 20 - 49 animals (Table I). Maintain and Conserve Land was the most important goal using both procedures. Increase in 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 were greater than the critical value F = 22.46. The null hypothesis was rejected and for both procedures, some goals were more important than others. With values of 0.16 and 0.25, Kendall's W for the fuzzy pair-wise and simple ranking procedures showed that the agreement between individuals in ranking goals falls between very weak and weak agreement.

Twenty-one percent of the beef observations were from the 50 - 99 animals. Again, Maintain and Conserve Land was the most important and Increase Farm Size was the least important goal. Maximize Profit became the second most important goal for both procedures. Results of the two procedures were 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 was rejected and for both fuzzy pair-wise and simple ranking procedures, some goals were preferred over the others. With values of 0.19 and 0.31, Kendall's W for fuzzy pair-wise and simple ranking procedures showed very weak to weak agreement between individuals.

Forty-six % of the beef observations were from producers, who had 100 or more animals. Avoidance of years of loss/low Profit was the most important goal for the fuzzy pair-wise analysis (Table I). 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 were greater than critical value F = 22.46. The null hypothesis was rejected and for both procedures, some goals were preferred over the others. With values of 0.16 and 0.22, Kendall's W for fuzzy pair-wise and simple ranking methods showed very weak to weak agreement between individuals.

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 procedures differed (Table III). The overall means for the fuzzy pair-wise comparison procedure show that the most and least important goals for the population were Maintain and Conserve Land and Increase Farm Size. The sixth ranked goal was Have Family Involved in Agriculture. Otherwise, the rankings differed between the two procedures.

Since the entire population of dairy producers was surveyed, the analysis of goal structure was conducted for the entire dairy sample. Dairy producers were more concerned with financial goals than were beef producers, as expected (Table I). Avoid Years of Loss/Low Profit was slightly more important than Maximize Profit using the fuzzy pair-wise procedure. On the other hand, for the simple ranking procedure, Maximize Profit was the most important goal, followed by Avoid Years of Loss/Low Profit. The third and fourth most important goals for the fuzzy procedure were 'increased net worth' and 'maintain and conserve land'. For the simple ranking, the latter was the third and the former 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.

Table I. Descriptive statistics of goal scores for beef cattle and dairy producers

Variable	Fuzzy pair-wise comparison method				Simple ranking procedure			
	Mean	Std Dev	Minimum	Maximum	Mean	Std Dev	Minimum	Maximum
Beef Producers with 1 -19 Animals								
Maintain and Conserve Land	0.54	0.14	0.11	0.77	5.37	1.92	1.00	7.00
Have Time for Other Activities	0.51	0.11	0.26	0.75	4.18	1.81	1.00	7.00
Avoid Years of Loss / Low Profit	0.48	0.11	0.24	0.69	4.44	1.58	1.00	7.00
Have Family Involved in Agriculture	0.48	0.18	0.04	0.97	3.67	1.99	1.00	7.00
Maximize Profit	0.47	0.14	0.10	0.83	4.56	1.77	1.00	7.00
Increase Net Worth	0.44	0.12	0.10	0.71	3.60	1.66	1.00	7.00
Increase Farm Size	0.36	0.16	0.04	0.90	2.19	1.77	1.00	7.00
Beef Producers with 20 – 49 Animals								
Maintain and Conserve Land	0.56	0.16	0.11	0.93	5.57	1.71	1.00	7.00
Avoid Years of Loss / Low Profit	0.50	0.10	0.28	0.80	4.60	1.46	1.00	7.00
Maximize Profit	0.49	0.13	0.14	0.82	4.84	1.81	1.00	7.00
Increase Net Worth	0.47	0.12	0.15	0.75	4.04	1.61	1.00	7.00
Have Time for Other Activities	0.46	0.16	0.04	0.98	3.44	1.85	1.00	7.00
Have Family Involved in Agriculture	0.42	0.15	0.07	0.72	3.03	1.89	1.00	7.00
Increase Farm Size	0.34	0.15	0.03	0.78	2.53	1.82	1.00	7.00
Beef Producers with 50 – 100 Animals								
Maintain and Conserve Land	0.56	0.13	0.11	0.92	5.63	1.74	1.00	7.00
Maximize Profit	0.51	0.13	0.10	0.78	5.04	1.58	1.00	7.00
Avoid Years of Loss / Low Profit	0.50	0.12	0.16	0.76	4.61	1.54	1.00	7.00
Increase Net Worth	0.48	0.13	0.20	0.80	4.38	1.51	2.00	7.00
Have Time for Other Activities	0.43	0.15	0.05	0.77	3.06	1.58	1.00	7.00
Have Family Involved in Agriculture	0.42	0.18	0.07	0.99	2.65	1.67	1.00	7.00
Increase Farm Size	0.35	0.17	0.01	0.97	2.64	1.98	1.00	7.00
Beef Producers with 100+ Animals								
Avoid Years of Loss / Low Profit	0.53	0.12	0.05	0.94	4.77	1.57	1.00	7.00
Maintain and Conserve Land	0.52	0.14	0.11	0.97	5.23	1.76	1.00	7.00
Maximize Profit	0.50	0.12	0.14	0.97	5.15	1.72	1.00	7.00
Increase Net Worth	0.48	0.12	0.11	0.92	4.02	1.65	1.00	7.00
Have Time for Other Activities	0.46	0.16	0.05	0.99	3.13	1.73	1.00	7.00
Have Family Involved in Agriculture	0.44	0.15	0.02	0.98	3.21	1.93	1.00	7.00
Increase Farm Size	0.35	0.14	0.04	0.71	2.51	1.76	1.00	7.00
Dairy Producers								
Avoid Years of Loss / Low Profit	0.540	0.13	0.21	1.00	4.98	1.57	1.00	7.00
Maximize Profit	0.537	0.12	0.25	0.93	5.51	1.47	1.00	7.00
Increase Net Worth	0.506	0.12	0.13	0.94	4.40	1.73	1.00	7.00
Maintain and Conserve Land	0.489	0.15	0.05	0.98	4.78	1.70	1.00	7.00
Have Time for Other Activities	0.478	0.15	0.04	0.87	3.42	1.63	1.00	7.00
Have Family Involved in Agriculture	0.405	0.17	0.06	0.79	2.78	1.72	1.00	7.00
Increase Farm Size	0.289	0.13	0.03	0.59	2.14	1.65	1.00	7.00

Table II. Results of the friedman's and kendall's W tests

Size Category	Fuzzy pair wise		Simple ranking	
	Friedman's Test	Kendall's W Test	Friedman's Test	Kendall's W Test
Beef 1 – 19 Animals	55	0.16	73	0.21
Beef 20 – 49 Animals	94	0.16	142	0.25
Beef 50 - 99 Animals	110	0.19	187	0.31
Beef 100+ Animals	209	0.16	284	0.22
Dairy Producers	224	0.29	259	0.33

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 partial, because the business was a primary source of their income. While most of the beef cattle respondents (57%) held off farm employment, only 21% of dairy producers held off farm jobs. Also, dairy production tends to be more capital intensive (Boucher & Gillespie, 1996 - 2000) and labor intensive than beef production, discouraging hobby farmers from entering the dairy industry. 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 was rejected and for both fuzzy pair-wise and simple ranking procedures, some goals are preferred over the others. With values of 0.29 and 0.33, Kendall's W for fuzzy pair-wise and simple rankings showed very weak to weak agreement between individuals in ranking the goals.

The SRC was used to check for rank order correlation between the simple ranking and fuzzy pair-wise comparison methods (Table IV). The null and alternative hypotheses

Table III. 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 IV. Spearman rank correlation test statistics for consistency of goal scores in fuzzy pair-wise and simple ranking procedures

Beef cattle producers			Dairy producers		
Percentage	Spearman Coefficient	Consistency	Percentage	Spearman Coefficient	Consistency
29	<0.57	Not Consistent	33	<0.57	Not Consistent
12	0.57 to 0.70	Consistent at 10%	13	0.57 to 0.70	Consistent at 10%
49	0.71 to 0.990	Consistent at 5%	47	0.71 to 0.990	Consistent at 5%
10	1	Exactly consistent	7	1	Exactly consistent

were: H_0: There is no association (the fuzzy pair-wise comparison & 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% level is 0.57. The values of the SRC for 29% of the beef cattle producers were less than 0.57. Thus, their goal scoring with the fuzzy pair-wise and simple ranking procedures were inconsistent. Twelve % of the beef producers had SRC values between 0.57 and 0.70, significant at the 10% level. The SRC values for 49% of the producers were between 0.70 and 0.99, significant at the 5% level. The rankings using both procedures were exactly the same for only 10% of the beef producers.

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

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

CONCLUSIONS

Results suggest that the fuzzy pair-wise comparison method and the simple ranking procedure cannot be used interchangeably. The rankings of goals using both procedures were the same for only ten % of the beef cattle and seven % of the dairy producers. In cases, where only two of the seven goals had switched positions, one continues to be able to obtain usable information; however, the relatively high percentage of producers, whose rankings differed considerably, was rather surprising. An interesting follow-up question is which of the two methods most accurately represents producer preferences? While we do not have a definitive answer to this question, we expect the fuzzy pair-wise comparison to result in a more accurate ranking, given that producers must compare each goal with every other goal, forcing the respondent to carefully consider each paired goal combination. This however, would be a suitable area for future research.

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 scale 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 there was little agreement among farmers as to the relative importance of the goals.

Though the results of the two procedures were inconsistent, one can conclude that goal weights differ and that while profit maximization is an important goal for farmers, it may not provide the primary incentive for farmers' allocation decisions. A farmer, who weighs maintaining and conserving land or having the family involved in agriculture as highest will likely make different decisions than the farmer, whose most important goal is profit maximization. Understanding goal structure is a good first step in being able to explain, why farmers make the decisions they make.

REFERENCES

Ball, J. and V.C. Srinivasan, 1994. Using Analytic Hierarchy Process in House Selection. *J. Real Est Fin Econ*., 9: 69–85

Basu, K., 1984. Fuzzy Revealed Preference Theory. *J. Econ. Theory,* 32: 212–27

Boender, C.G.E., J.G. De Graan and F.A. Lootsma, 1989. Multi-Criteria Decision Analysis with Fuzzy Pair-wise Comparisons. *Fuzzy Sets and Systems*, 29: 133–43

Boucher, W.R. and J.M. Gillespie, 1996 - 2000. *Projected Cost and Returns and Whole Farm Analysis for Major Agricultural Enterprises*. Louisiana State University Agricultural Center, Department of Agricultural Economics and Agribusiness

Conover, W.J., 1971. *Practical Nonparametric Statistics*. John Wiley and Sons, New York

Datta, V., K.V. Sambasivarao, R. Kodali and S.G. Deshmukh, 1992. Multi-Attribute Decision Model Using the Analytic Hierarchy Process for the Justification of Manufacturing Systems. *Int. J. Prod. Econ.,* 28: 227–34

Davis, C.G., 2002. Factors Affecting the Selection of Business Arrangements by Hog Producers in the United States. *Ph.D. Dissertation*, Louisiana State University

Ells, A., E. Bulte and G.C. Van kooten, 1997. Un-certainty and Forest Land Use Allocation in British Columbia: Vague Priorities and Imprecise Coefficients. *For. Sci*., 43: 509–20

Gibbons, J.D., 1997. *Non-parametric Methods for Quantitative Analysis,* (3rd Edition). American Sciences Press, New York

Islam, M., Anwarul, M.T. Tabucanon and D.N. Batanov, 1997. Selection of Database Models for Computer Integrated Manufacturing Systems Using the Analytic Hierarchy Process. *Int. J. Comp. Integr. Manuf*., 10: 394–404

Kliebenstein, J.B., D.A. Barrett, W.D. Hefferman and C.L. Kirtley, 1980. An Analysis of Farmers' Perceptions of Benefits Received from Farming. *N Cen. J. Agric. Econ.,* 2: 131–6

Mendoza, A.G. and W. Sprouse, 1989. Forest Planning and Decision Making Under Fuzzy Environment: An Overview and Illustration. *For. Sci*., 35: 481–502

Patrick, G.F., B.F. Blake and S.H. Whitaker, 1983. Farmers' Goals: Uni-or Multi-Dimensional. *American J. Agric. Econ*., 67: 315–9

Saaty, T.L., 1980. *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation*. McGraw-Hill, New York

Schmidt, R.C., 1997. Managing Delphi Surveys Using Non-parametric Statistical Techniques. *Decision Sci*., 28: 763–74

Schniederjans, M.J., J.J. Hoffman and G.S. Sirmans, 1995. Using Goal Programming and the Analytic Hierarchy Process in House Selection. *J. Real Est. Fin. Econ*., 11: 167–76

Smith, D. and D.F. Capstick, 1976. Establishing Priorities Among Multiple Management Goals. *Southern J. Agric. Econ*., 16: 37–43

Stevens, S.S., 1957. On the Psychophysical Law. *Psychophys Rev.* 64: 153–81

Thurstone, L.L., 1927. A Law of Comparative Judgement. *Psychophys Rev*., 32: 273–86

Van Kooten, G.C., E. Krcmar and E.H. Bulte, 2001. Preference Un-certainty in Non-market Valuation: A Fuzzy Approach. *American J. Agric. Econ*., 83: 487–500

Van Kooten, G.C., R.A. Schoney and K.A. Hayward, 1986. An Alternative Approach to the Evaluation of Goal Hierarchies among Farmers. *Western J. Agric. Econ*., 11: 40–9

Zadeh, L.A., 1965. Fuzzy Sets. *Information Control*, 8: 338–53

(Received 27 February 2006; Accepted 25 June 2006)