DETERMINATION OF FARMERS' GOAL STATEMENTS PRIORITIES AND FACTORS EFFECTIVE ON DECISION (AN APPLICATION OF FUZZY PAIRWISE COMPARISON ANALYSIS)

Ahmet Sahin, Assoc. Prof.
University of Kahramanmaraş Sütçü Imam, Faculty of Agriculture,
Department of Agricultural Economics, Kahramanmaraş, Turkey
Cihat Gunden, Assoc. Prof.
Dr. Murat Cankurt, Assis. Prof.
Dr. Bulent Miran, Prof.
Ege University, Faculty of Agriculture,
Department of Agricultural Economics, Bornova-Izmir, Turkey
Dr. Ibrahim Yildirim, Prof.
University of Yuzuncu Yıl, Faculty of Agriculture,
Department of Agricultural, Economics, Van, Turkey

Abstract:

The major objective of this study was to determine the priorities given by farmers to the previous selected goal statements and the factors which affect their decisions. Data of 2005 year was provided from 162 farmers settled in 10 villages in İzmir, Turkey. The goal priorities and the effective factors were determined using Fuzzy Pairwise Comparison and Logistic Regression Analyses, respectively.

Fuzzy Pairwise Comparison Analysis showed that risk minimization had the highest ranking in farmers' preferences with weight of 0.53 followed by profit maximization with 0.48 weights among four selected goal statements. Logistics Regression Analysis indicated that farmers who tended to take higher risks were those who involved in crop production, and adopted contractual production and input storage strategies while risk averter farmers consisted of farmers who were susceptible to natural conditions and preferred crop diversification.

Key Words: Farmers' Goals Priorities, Fuzzy Pair-wise Comparison, Logistic Regression

Introduction

Profit maximization, sustainable profit, cost minimization and risk minimization are among the major aims of farmers during their production and marketing activities.

Determining which aim has the priory is important in terms of efficient resource use and strategies to be selected (Van Kooten et al., 1986; Başarır and Gillespie, 2003; Günden and Miran, 2007). The risk degree levels that the farmers are ready to take have a key role to reach a desired profit level. Despite of difficulty of obtaining clear responses, various methods have been applied in order to determine the farmers' risk degree level (Karahan, 2002; Başarır, 2002; Günden, 2005; Miran, 2005; Şahin, 2008).

Determination of farmers' goal hierarchies is useful in terms of production planning and sustainable profitability. Studies regarding the goal preferences and ordering of farmers are abundant. Smith and Captick (1976) reported the farmers' goals of 'staying in business' and 'increasing farm size' as the highest and lowest ranks, respectively among 10 goals. 'to be my own bosses, 'selling through the free market' and 'can express myself' were reported as the most important ones among 11 selected goal statements (Kliebenstein et al., 1980). Van Kooten et al., (1986) reported the 'profit maximization' and 'reducing the farm dept' as the highest ranks among eight selected goal statements using fuzzy pair-wise comparison method. Walker and Schubert (1989) classified the farm families in terms of family values, roles, characteristics and decision making process into two groups namely environmentally effective and efficient entrepreneurs and expressed the first and the second groups in the mood of 'keeping the family farm' and 'business-oriented and profit maximization', respectively.

The major objectives of farmers were reported as ‘maximize gross margin’, ‘minimize working capital’, minimize hired labor’, minimize management difficulty’ and ‘minimize risk’ using a multi-criteria methodology (Sumpsi et.al. 1996). Aromolaran and Olayemi (2000), who used pair-wise comparison method, reported the major objectives of farmers as ‘farm household food security’, ‘limited use of external inputs’ and ‘maximum gross farm income’. The goal hierarchies of beef and dairy farmers were compared by Başarır and Gillespie (2003) using pair-wise comparison. The most important goals were cited as ‘maintain and conserve land’ and ‘avoid years of loss / low profit’ among seven selected goal statements. Among the seven selected goal statements for Turkish farmers using fuzzy pair-wise comparison method the most important goals were cited as ‘preserving their lands’ and ‘paying their depth’ (Günden and Miran, 2007).

The major aim of this study was to determine the farmers’ goal hierarchies and preferences among previously determined goal statements and the factors affecting farmers’ decisions.

Methodology and data

Fuzzy Pair-Wise Comparison

Fuzzy theory began with a paper on “fuzzy sets” by Zadeh in 1965. Fuzzy set theory is an extension of crisp set theory (Tanaka, 1997). Fuzzy sets are sets with boundaries that are not precise. Thus, fuzzy sets describe ranges of vague and soft boundaries by degree of membership (Lai and Hwang, 1994). The membership in a fuzzy set is a matter of a degree (Klir and Yuan, 1995). Fuzzy set is characterized by a membership function, which is allowed to choose an arbitrary real value between zero and one.

Fuzzy pair-wise comparisons were first used by Van Kooten et.al., (1986) to study farmers’ goal hierarchies for use in multiple-objective decision making. The first step of fuzzy pair-wise comparison approach is data collection by using a unit line segment as illustrated in Figure 1. Two goals, profit (*P)* and cost © are located at opposite ends of the unit line. Farmers are asked to place a mark on the line to indicate the degree of their preferred goal. A measure of the degree of preference for goal *P* over *C*, r_{pc}, is obtained by measuring the distance from the farmer’s mark to the *P* endpoint. The total distance from *P* to *C* equals 1. If $r_{pc}<0.5$, goal *C* is preferred to *P*; if $r_{pc}=0.5$, the farmer is indifferent between P and C; and if $r_{pc}>0.5$, then goal *P* is preferred to C. $r_{pc}=1$ or $r_{pc}=0$ indicates absolute preference for goal *P* or *C*. For example, if $r_{pc}=1$, then goal *P* is absolutely preferred to *C* (Van Kooten et al, 1986).

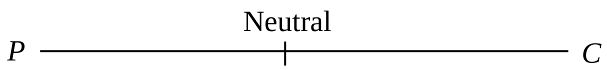

Figure 1. Fuzzy method for making pair-wise comparison between goals *P* and *C*

This study employed four farmers’ goal statements. The number of pair-wise comparisons, λ, was calculated as follows:

$$\lambda = n * (n-1)/2 \tag{1}$$

Where *n* = the number of goals. Thus, a farmer made six pair-wise comparisons in a personal interview.

In the second step of fuzzy pair-wise comparison method, for each paired comparison (i,j), r_{ij} (i≠j) was obtained. r_{ij}’s values was collected directly from the farmer. Also r_{ij} (i≠j) is a measure of the degree by which the farmer prefers goal i to goal j and $r_{ji}=1- r_{ij}$ represents the degree by which j is preferred to i. farmers’ fuzzy preference matrix *R* with elements was constructed as follows (Van Kooten et al.,1986).

$$R_{ij} = \begin{cases} 0 \quad if \ i = j \ \forall i, j = 1, ..., n \\ r_{ij} \ if \ i \neq j \ \forall i, j = 1, ..., n \end{cases} \tag{2}$$

Finally, a measure of preference, μ, was calculated for each goal by using farmers’ preference matrix R. The intensity of each goal was measured separately by the following equation:

$$\mu_j = 1 - \left(\sum_{i=1}^{n} R_{ij}^2 / (n-1) \right)^{1/2} \tag{3}$$

μ_j has a range in the closed interval [0,1]. The larger value of μ_j indicates a greater intensity of preference for goal j. As a result, farmers' goals were ranked from most to least preferable by evaluating the μ values.

To analyze farmers' preferences derived from fuzzy pair-wise comparison, nonparametric statistical tests were used (Başarır and Gillespie, 2003). Friedman test was used to establish whether the goals were equally important within a block, which farmers' goal is ranking according to his/her preferences. Since four goals were presented to farmers, each row included four values which are the degree of goals exposed from a farmer. The null hypothesis was that there would be no difference in preferences over the goals among farmers. Alternatively, at least one goal would be preferred over the others.

Logistic Regression

Logistic regression extends the linear model to problems in which the response is either a category or a binomially distributed count (Agresti, 1996). Logistic regression allows one to predict a discrete outcome, such as group membership, from a set of variables that may be continuous, discrete, dichotomous, or a mix of any of these.

Logistic regression predicts the probability that the dependent variable event will occur given a subject's scores on the independent variables. The predicted values of the dependent variable can range from 0 to 1. If the probability for an individual case is equal to or above some threshold, typically 0.50, then our prediction is that the event will occur. Similarly, if the probability for an individual case is less than 0.50, then our prediction is that the event will not occur.

Logistic regression is more flexible than the other techniques. It has no assumptions about the distributions of the predictor variables; the predictors do not have to be normally distributed, linearly related, or of equal variance within each group in logistic regression. Unlike multiple-regression analysis, which also has distributional requirements for predictors, logistic regression cannot produce negative predicted probabilities (Hosmer and Lemeshow, 2000).

Logistic regression analysis is especially useful when the distribution of responses on the dependent variable is expected to be nonlinear with one or more of the independent variables. In logistic regression, there is a (binary or dichotomous) response of interest, and the predictor variables are used to model the probability of that response. Since the model produced by logistic regression is nonlinear, the equations used to describe the outcomes are slightly more complex than those for multiple regressions (Tabachnick and Fidell, 2001).

In this study, binary response variable was of interest. Independent variables denoted by the vector x={x_1, x_2 ,..., x_p} . The conditional probability that the outcome is present was calculated with the following formula.

$$P(Y = 1/ x) = \pi(x) \qquad (4)$$

The logit of the multiple regression model was given by

$$g(x) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_p x_p \qquad (5)$$

in which case the logistic regression model was

$$\pi\ (x) = [1+ exp(-\beta\ 0 -\beta 1X)]^{-1} \qquad (6)$$

where the outcome variable, π(x) , is the probability of having one outcome or another based on a nonlinear function of the best linear combination of predictors with two outcomes (Gujarati,1989).

This linear regression equation created the logit or log of the odds:

$$\log[\hat{\pi}/(1-\hat{\pi})] = \beta_0 + \sum_{j=1}^{p} \beta_j X_{ij} \qquad (7)$$

That is, the linear regression equation is the natural *log* (*log$_e$*) of the probability of being in one group divided by the probability of being in the other group. The procedure of estimation that leads to the least squares function under linear regression model, when the error terms are normally distributed, is maximum likelihood, and the goal is to find the best linear combination of predictors to maximize the likelihood of obtaining the observed outcome frequencies. Maximum likelihood estimation is an iterative procedure that starts with arbitrary values of coefficients and determines the direction and size of change in the coefficients that will maximize the likelihood of obtaining the observed frequencies.

Four goal statements were selected and presented to farmers to respond.

a) Profit Maximization: The producers is supposed to be optimistic regarding production and marketing conditions. Profit maximization requires the producer take high risks in his activities.

b) Reasonable Profit: The producer is supposed to be pessimistic and he is satisfied with the highest income from the worst alternative.

c) Cost Minimization: A given production quantity is aimed with minimum cost. The producer minimizes his probable regrets.

d) Risk Minimization: This goal statement assumes that the producer is risk averter. He wants to obtain a guarantied profit with minimum risks.

Data

The data of 2005 year was obtained from 162 farmers in 10 selected villages of İzmir, Turkey. (The third biggest city in terms of population suited near Aegean Sea) by personal interviewing through means of a structured questionnaire. The sample size was determined by simple random sampling method (Newbold, 1995).

The variables used in the analyses and their descriptions are presented at Table 1. Base statistics for general characteristics of farmers and farms is given at Table 2.

Results and discussions

Goal hierarchies of Farmers

Fuzzy pair-wise comparison model showed that the risk minimization was farmers' most important goal with the weight of 0.53 followed by profit maximization with 0.48 weights (Table 3). Friedman test was significant, which indicated the producers' priority of some goal statements over the others. Kendall's W test showed that farmers' agreement in goals ranking was weak. The priority goal statements found in this study was in line with some previous reported results, which indicated the highest farmers' goal statements as risk minimization and gross margin maximization (Sumpsi et. al, 1996; Başarır and Gllepspie, 2003; Aromolaran and Olayemi, 2000; Walker and Schubert, 1989). However, the highest ranking goal statements of this study differed from the farmers' goal statements reported as 'to be my own bosses, 'selling through the free market' (Kliebenstein et al. 1980) and 'preserving our lands' and 'paying our depth' (Günden and Miran, 2007).

The groups of age, education level, risk attitude of farmers and land size differed significantly in terms of reasonable profit, cost minimization, risk minimization and reasonable profit/risk minimization goal statements of farmers, respectively (Table 4).

Factors Effective on Goal Statements

The logistic regression analysis results indicated that crop production had negative effect on risk minimization; natural conditions had positive effects on profit maximization and reasonable profits and negative effect on cost minimization and risk minimization; contractual production had positive effect on cost minimization and risk minimization and negative effect on profit maximization; production planning had positive effect on cost minimization; crop diversification had negative effect on cost minimization and risk minimization; input storage had positive effect on profit maximization and negative effect on cost minimization and risk minimization; product processing had positive effect on risk minimization; suggestions regarding agricultural activities had positive effect on cost minimization and finally chance had positive effect on profit maximization and negative effect on cost minimization (Table 5).

The farmers who involved in crop production; and who adopted contractual production and input storage strategies tended to take a higher risk to reach profit maximization. The risk averter farmers were those who considered the natural conditions seriously; and who adopted the crop diversification and thus satisfied with a comparable low profit.

Cost minimization goal was preferred by farmers who believed in product planning; who took into consideration the suggestions made regarding the agricultural activities; and who considered the chance as a big player in agricultural production.

Conclusion

The highest and lowest priority of farmers was risk minimization and cost minimization, respectively, which indicates that the farmers are ready to afford high costs to reach profit maximization goal as long as they are protected against risks stemmed from production and marketing activities.

To alleviate the production risks, contractual production is seen as a useful tool, which infers that policies to expand the contractual farming in various fields are expected. In addition, further product processing is another measure, which the farmers in the region are ready to adopt. Agribusiness is already at high concentrated level in the region compared to most of other regions in Turkey. However, it can still be improved in terms of relatively disadvantages sub-sectors.

Taking into consideration the susceptibility of farmers against risks, the policy makers is required to expand the scope of agricultural insurance, which a significant step was initiated under Agricultural Insurance Pool application in 2005 through Agricultural Insurance Code No. 5363. Among the cited aims of Insurance Pool are extending the insurance coverage; incentive for participation to reinsurances; coordination of activities of insurance companies and government subsidies; encouraging the participation in insurance and prevent unfair competition in the prices.

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Table 1: Variables used in the analyses and their descriptions

Variables	Unit	Description
Age	year	Age of farmer in years
Education	year	Farmer's years of schooling
Farm size	categorical	Total cultivated land 1: <30, 2: 31-100, 3: 101+ decar
Crop production	dummy	1: Yes 0: No
Risk attitude	dummy	1: Risk averter 0: Risk lover
Agree with agricultural production affected by natural conditions	scale	Five point scale; 1: Strongly disagree, ..., 5: Strongly agree
Agree with contractual production	scale	Five point scale; 1: Strongly disagree, ..., 5: Strongly agree
Agree with agricultural planning	scale	Five point scale; 1: Strongly disagree, ..., 5: Strongly agree
Agree with crop diversification	scale	Five point scale; 1: Strongly disagree, ..., 5: Strongly agree
Agree with storage inputs before production period	scale	Five point scale; 1: Strongly disagree, ..., 5: Strongly agree
Agree with processing agricultural production	scale	Five point scale; 1: Strongly disagree, ..., 5: Strongly agree
Apply suggestion for agr. activities	scale	Five point scale; 1: Strongly disagree, ..., 5: Strongly agree
Agree with agricultural production affected by chance	scale	Five point scale; 1: Strongly disagree, ..., 5: Strongly agree

Table 2. Base Statistics for General Characteristics of Farmers and Farms

Variables	Mean	Standard deviation	Min	Max	No. Respondents*	%
Age (years)	44.92	11.87	18.00	76.00		
0-35					44	27.16
36-55					89	54.94
56-+					29	17.90
Education (years)	6.09	2.37	3.00	15.00		
Farm size (decar)	81.21	76.88	6.00	400.00		
0-30					56	34.57
31-100					65	40.12
101-+					41	25.31
Crop production (dummy)						
1: Yes					94	58.02
0: No					68	41.98
Risk attitude (dummy)						
1: Risk averter					105	64.81
0: Risk lover					57	35.19
Agree with agricultural production affected by natural conditions (scale)	4.13	1.41	1.00	5		
Agree with contractual production (scale)	1.65	1.24	1.00	5		

Agree with agricultural planning (scale)	1.99	1.23	1.00	5		
Agree with crop diversification (scale)	3.20	1.53	1.00	5		
Agree with storage inputs before production period (scale)	2.11	1.50	1.00	5		
Agree with processing agricultural production (scale)	1.25	0.62	1.00	5		
Apply suggestion for agr. activities (scale)	2.31	1.27	1.00	5	237	62.37
Agree with agricultural production affected by chance (scale)	1.69	1.29	1.00	5	143	37.63

Table 3: Base statistics for farmers' goal statements

Farmers' goal statement	Mean	Standard deviation	Minimum	Maximum
Minimize risk	0.53	0.27	0.10	0.90
Maximize profit	0.48	0.29	0.10	1.00
Making suitable profit	0.42	0.17	0.07	0.90
Minimize cost	0.39	0.14	0.10	0.86

Friedman p<0.01
Kendall's W = 0.02

Table 4: The relationship of some variables with farmers' goal statements

Variable	Number of Farmers	Profit Maximization	Reasonable Profit	Cost Minimization	Risk Minimization
Age					
0-35	44	0.49	0.46*	0.40	0.48
36-55	89	0.46	0.42*	0.38	0.55
56-+	29	0.52	0.36*	0.40	0.53
Education					
0-5	125	0.49	0.41	0.38**	0.52
6-11	22	0.38	0.42	0.46**	0.58
12-+	15	0.48	0.48	0.36**	0.47
Land					
0-30	56	0.45	0.38**	0.40	0.57*
31-100	65	0.51	0.46**	0.38	0.48*
101-+	41	0.47	0.41**	0.39	0.54*
Risk attitude					
Risk averter	105	0.46	0.42	0.39	0.56*
Risk lover	57	0.52	0.42	0.38	0.47*

* p<0.10 Kruskal Wallis ** p<0.05 Kruskal Wallis

Table 5: Logistic regression analysis results for farmers' goal statements.

Variables	Profit Maximization		Reasonable Profit		Cost Minimization		Risk Minimization	
Constant	-6.41871	***	-5.84728	***	-5.12439	***	-4.78136	***
	(0.257548)		(0.156957)		(0.12924)		(0.216977)	
Crop Production	0.15988		0.104228		-0.0470497		-0.181877	*
	(0.124622)		(0.0759481)		(0.0625361)		(0.10499)	
Natural Conditions	0.112058	***	0.045668	*	-0.0664898	***	-0.0982707	***
	(0.0410837)		(0.0250376)		(0.0206161)		(0.0346118)	
Contractual Production	-0.119112	**	-0.0202147		0.0740089	**	0.104584	**
	(0.0568892)		(0.03467)		(0.0285474)		(0.0479275)	
Production Planning	-0.025062		0.0014818		0.0650997	**	0.000465879	
	(0.0616745)		(0.0375863)		(0.0309488)		(0.051959)	
Crop Diversification	0.0431444		0.0339616		-0.0331744	*	-0.0727777	**
	(0.0393456)		(0.0239784)		(0.0197439)		(0.0331476)	
Input Storage	0.132403	*	0.0417103		-0.111119	***	-0.152523	**
	(0.0751163)		(0.0457781)		(0.0376939)		(0.0632833)	
Product Processing	-0.132448		-0.0908649		0.0895682		0.214727	**
	(0.108173)		(0.065924)		(0.0542822)		(0.0911329)	
Suggestion for Agricultural Activities	0.0942634		0.0228888		-0.0646614	**	-0.0052092	
	(0.0584918)		(0.0356466)		(0.0293516)		(0.0492777)	
Chance	0.0877417	*	-0.022686		-0.080873	***	-0.0551131	
	(0.045103)		(0.0274871)		(0.0226331)		(0.037998)	
χ^2	13.0588	***	4.45749	***	2.6085	***	11.1684	***
R-sq	0.0584614		0.0240567		0.201726		0.0280553	

***Significant at 1% level, ** Significant at 5% level, * Significant at 10% level