GOALS AND OBJECTIVES OF FARMERS: THEORY, MEASUREMENT AND EMPIRICAL RESULTS[1]

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ABSTRACT - Although neoclassical economic theory assumes that producers seek to maximize profit, real world decision-making involves consideration of multiple goals. Three ways of incorporating multiple goals into models of the farm firm are briefly discussed. The "ranked goal", "substitution" and "satisficing" multiple goal models are contrasted in terms of the decision-making process assumed and the type of empirical information required from goal measurement.

Measurement techniques, developed primarily by psychologists, which can be used to measure farmers' goals are discussed. They are traditional paired comparisons, magnitude estimation, multidimensional scaling and conjoint analysis. This discussion stresses the demands that these techniques made on the respondent and properties of the information derived in relation to the needs of multiple goal models.

Results of an empirical study of farmers' goals are briefly reported. Emphasis is given to the procedure used, difficulties encountered and an overview of results. The paper concludes with some comparisons of the methods, difficulties in defining and measuring goals and some suggestions for further work. It is suggested that application of these methods to economic policy may be a more fertile field than farmers' goals.

Index terms: multiple goals, theory of the firm.

METAS E OBJETIVOS DOS AGRICULTORES: TEORIA, MENSURAÇÃO E RESULTADOS EMPÍRICOS

RESUMO - Ainda que a teoria econômica neoclássica assuma que os produtores rurais procuram maximizar a renda, o processo de tomada de decisões do mundo real envolve considerações de objetivos múltiplos. Neste trabalho são discutidos, brevemente, três maneiras de incorporar estes objetivos em modelos da firma agrí-

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cola: os modelos de objetivos múltiplos ordenados (ranked goal), os de substituição e os de satisfação. Estes modelos são confrontados em termos do processo de decisão assumido e do tipo de informação empírica requerida para a mensuração do objetivo.

Discutem-se técnicas de mensuração, desenvolvidas primeiramente por psicólogos, as quais podem ser utilizadas para medir os objetivos dos produtores. As técnicas são: as tradicionais comparações entre pares, estimação de magnitude, escalada multidimensional e análise de conjuntos. Estas discussões enfatizam as perguntas feitas ao entrevistado e as características obtidas em relação às necessidades dos modelos de objetivos múltiplos.

Ao final são discutidos, resumidamente, os resultados de um estudo empírico. Dá-se ênfase ao procedimento utilizado, às dificuldades encontradas e à revisão de resultados. O trabalho conclui com algumas comparações entre os métodos, apresenta dificuldades em definir e medir objetivos e faz algumas sugestões para trabalhos futuros. Sugere-se, por último, que a aplicação destes métodos para a política econômica poderá ser um campo mais fértil do que para a análise dos objetivos dos agricultores.

Termos para indexação: Objetivos múltiplos, teoria da firma.

INTRODUCTION

As economists we commonly wish to understand and predict the behavior of producers and consumers. Neoclassical economic theory under certainty assumes that consumers seek to maximize utility and producers seek to maximize profit. At least to some extent, those economists working with consumers and their behavior recognized that utility can not be measured and developed other means of quantifying preferences and predicting behavior. In contrast, on the production side we have been able to measure profit and have used it in our analyses. However, the profit maximization assumption has often been inadequate in explaining aggregate producer behavior and predicting individual farmer decision-making in a dynamic worldwith imperfect knowledge (Simon, 32, 33).

In the decision-making process, it is assumed the decision-maker goes through several steps (Johnson, et al., 15). These can be summarized as follows:

1. Identify the problem.
2. Identify alternative courses of action.
3. Determine the consequences of these alternatives.
4. Evaluate the alternatives.
5. Decide an implement the alternative selected.
6. Bear responsability for the decision.

Although goals and objectives are not specifically mentioned, they are very important. Commonly a problem is recognized as a difference between what one wishes and what is actually occurring -the difference between one's goals and reality. Goals may also influence the alternatives considered. For example, one farmer may have a goal of buying land while another farmer might not consider alternatives involving land purchase. Goals are especially important in the evaluation of alternatives step of the decision process. Goals are the criteria by which alternatives are judged or evaluated. Although economic theory assumes profit maximization, even limited contact with farmers indicates that multiple goals are considered in making decisions.

Although most of this discussion is oriented to the individual farmer, multiple goals generally exist for decision-makers at other levels of the economy. Many of the measurement techniques discussed are as applicable to other decision-making individuals or groups in the economy as they are to farmers.

Considerable disagreement exists with respect to the meaning of words such as goals, values, and objectives. This is especially true if one discusses long-run and short-run goals and values. However, this discussion distracts from the more general agreement that multiple goals, multiple values and/or multiple objectives are involved in decision-making (Keeney and Raiffa, 16). For the purposes of this paper, values are deep seated beliefs which change relatively little over time. An example would be the belief that land should be owned by those who cultivate it. However, all people do not necessarily share a value. A goal is more specific and an objective is even more specific like a target. For example, an individual may have a value indicating that travel is good, have a goal of traveling to Europe and a specific objective of saving $ 1,000 for the trip to Europe next year (Fitzsimmons and Holmes, 8, and Gasson, 9).

This paper is divided into four sections. First, the primary multiple goal models used at the individual farm level are reviewed with respect to differences in the decision-making process assumed and type of empirical information required by the model. Second, a number of techniques, developed primarily by psychologists, which could be used to measure farmers' goals are discussed. Third, the results of a project designed to utilize and compare these measurement techniques are briefly reviewed. The final section summarizes some of the difficulties involved in multiple goal research and makes suggestions with respect to further work with farmers and other decision-makers.

MULTIPLE GOAL MODELS

Linear programming models of individual or representative farms have been widely used to understand and predict the behavior of agricultural producers for nearly 30 years with considerable success. However, difficulties have also arisen. Commonly there are wide differences between the model results and the real world. Sometimes these differences are due to mistakes in modeling resource availability, resource requirements or other aspects of the production process. In other cases, to obtain more "realistic" results, constraints are added to the profit maximization formulation to reflect "risk", agronomic restrictions, and other considerations. An example is the constraint that small farmers be required to produce subsistence crops in addition to the "more profitable" commercial crops. Consideration of multiple goals may provide a better prediction of behavior than these artificial constraints.

MOTAD and variations of quadratic programming have been developed and utilized to explicitly incorporate risk for representative farms. However, even when risk is explicitly considered and resource availabilities and technical coefficients are "correct", there can be a considerable difference between what is predicted and the observed results. This difference may be due to multiple goals (Patrick and Kliebenstein, 28).

A wide array of multiple goal models have been developed (Keeney and Raiffa, 16; Zeleny, 41). The three discussed are representative of those used in agricultural economics (Patrick and Blake, 24). The first approach implicitly assumes a lexicographic utility function in which goals are rated in order of importance. Satisficing or target levels of achievement are specified for each of the goals. The model may be represented as:

$$(1)\ \text{Minimize } \Sigma \lambda_i^- \alpha_i^- + \Sigma \lambda_i^+ \alpha_i^+$$

subject to

$$(2)\ \Sigma G_{ij} X_{ij} + \alpha_i^- - \alpha_i^+ = g_i \quad \text{for all } i$$

$$(3)\ \sum_j a_{kj} X_j \leqslant b_k \quad \text{for all } k$$

$$(4)\ X_j, \alpha_i^-, \alpha_i^+ \geqslant 0$$

where λ^- and λ^+ are the preemptive priority levels for the negative and positive deviations of goal i, α_i^- and α_i^+ are the positive and negative deviations from the target level of goal i, G_{ij} is the matrix of objective achievement per unit of the decision variable X_j, g_i is the target level,

and equation 3 limits resource use to availability.

This model can be solved by a modified simplex technique which minimizes α_i^- for the first or most important goal. Attention then switches to satisfying the second goal, subject to the restriction that satisfaction with respect to the first goal does not decrease. Successively less important goals are considered as goals with higher priorities are satisfied, or a point is reached beyond which further improvement can not be achieved. No additional value or satisfaction is derived from overachievement of a goal and no trade-offs or substitutions among goals are permitted. In other words, overachievement of goal A will not compensate for failure to achieve goal B.

The "ranked MGM" views farmers' decision-making as sequential - first goal A, and then goal B. This implies that measurement techniques which yield the rank order of goals would be acceptable for this model. Goals are assumed to be independent, but because of their sequential nature, the preferability of a goal depends on the level of achievement of higher level goals. In other words, achievement of goal B has no value until the higher ordered goal A is achieved. Dobbins and Mapp (6) provide an empirical application and this model is discussed by Lee (18).

A second MGM has the same basic mathematical formulation, but the λ_i^+ and λ_i^- in equation 1 are the weights attached to the over- and under-achievement of goal i instead of the preemptive priority levels. This model can be solved by the simplex algorithm. This formulation assumes that goals are not ranked, all are of equal importance. Furthermore, the decision-maker can substitute achievement of one goal for another to increase satisfaction. Overachievement of one goal may substitute for underachievement of a second. Depending on circumstances, a zero weight may be assigned to under- or overachievement of a specific goal. The ratio of the weights of two goals represents the rate of substitution between them. Unless otherwise specified, the rate of substitution is constant for all levels of the goals and independent of the level of attainment of other goals. However, these assumptions can be relaxed by using step functions in the programming formulation.

This "substitution MGM" views decision-making as involving trade-offs. Assignment of weights to the under- and overachievement of goals implies measurement on a ratio scale. Because trade-offs are possible, goals must be of a similar level of abstraction so that the relative weights or trade-offs can be specified. Commonly, an additive preference function is assumed and the utility derived from one goal does not depend on the level of others. However, an alternative form, such as a

multiplicative function could be assumed. Wheeler and Russell (36) as well as Hatch, Harman, and Eidman (14) provide examples of this model.

A third way of modeling multiple goals has been used in simulation studies by Patrick and Eisgruber (27) and others. Each of the four goals considered was arbitrarily given a weight expressing its presumed relative importance to the decision maker. Ratings for four target levels of satisfaction with respect to each goal were developed. The overall level of satisfaction, S, can be expressed as:

$$(5)\ S = \sum_{i=1}^{4} Z_i A_i$$

where Z_i is the weight assigned to goal i and A_i is the rating of the target level attained for goal i. Both the goal weights and target levels may change as the socio-economic characteristics of the decision maker and the farm firm change.

Like the substitution MGM, the "satisficing MGM" also views decision making as involving trade-offs among goals, but the trade-offs are in terms of satisfaction. The Z_i values must be measured on a ratio scale and are constrained to add to one. Additivity of satisfaction from alternative goals is assumed and substitutability of satisfaction from goals is possible. Linear correspondence between the rating scale and the target levels is not required. For example, a rating of 1 may be assigned to a farm plan which provides an income of less than $10,000, 2 to a plan with an income of $10,000 to $20,000, a 3 for a plan with an income of $20,000 to $25,000, and a 4 for a plan with over $ 25,000 income. Because trade-offs of satisfaction rather than goal achievement occur, the goals do not need to be of exactly the same level of abstraction.

These three models differ in their conceptualization of the decision making process. The ranked goal MGM does not permit these trade-off or substitution of goals. Methods of measurement which indicate the order of goals is sufficient. Because no trade-offs are involved, goals may be of different levels of abstraction. In contrast, both the substitution MGM and the satisficing MGM do permit the trade-off of goals. Both methods implicitly require, at least in part, ratio scale measurement techniques and both require that the goals considered are of a similar level of abstraction to permit trade-offs to be meaningful. The essential difference between the substitution MGM and the satisficing MGM is that the former assumes that goals can be traded off directly

while the latter assumes the trade-off is in terms of satisfaction.

Although not discussed previously, all three models require that the target levels of the various goals be expressed in precise, quantative form. Qualitative, global conditions for goals are not sufficient for the MGMs discussed because they do not permit evaluation and comparison. For example, an annual income target of $ 15,000 can be used in comparisons and evaluations, but the target of a "good" income can not.

METHODS OF MEASUREMENT

In any attempt to measure goals, one should select and define goals in a manner appropriate for the specific situation. Abstract and non-quantifiable goals, such as good health, can not be included directly in a model. Goals which can be quantified should be expressed in specific terms such as dollars of income per year rather than just higher income. Finally, the goals included should be the most relevant to the type and time period of the decision being considered.

The four measurement techniques considered are paired comparisons, magnitude estimation, multidimensional scaling and conjoint analysis. These techniques have been largely developed by psychologists, but are being used in marketing and other areas. These methods are all based on self-report types of questionnaire or interviews. The self-report methods have various inherent problems because they are based on an individual's willingness and ability to describe his/her preferences or goals.

Paired Comparisons

The classic paired comparison method as developed by Thurstone (35) presents an individual with a pair of alternative goals. The individual is instructed to select the preferred alternative and the process is repeated for other pairs of goals. The procedure is relatively straightforward and does not make great demands on an individual. An individual's consistency can be evaluated based on the number of logical inconsistencies. The frequency of selection of the various alternatives by individuals in the group is used to derive a hierarchy of goal preferences. The Mosteller (21, 23) chi-square test measures the degree of consistency among the individuals within a group (David, 5).

The ordinal ranking derived from the selection frequency can be transformed into a scale with interval properties (like temperature) if a normal distribution of judgements is assumed. Although the ordinal

scale derived from the paired comparisons is suitable for the ranked goal MGM, the interval scale does not have the ratio properties necessary for the substitution and satisficing MGMs. The paired comparison approach yields a scale which typifies a group of individuals, but the goal scores may not reflect the preferences of a given individual within the group. This characteristic may limit the usefulness of the paired comparison technique in deriving the preferences of an individual farmer.

Magnitude Estimations

Developed by Stevens (34), magnitude estimation is a direct approach for obtaining ratio scaled preferences. An individual is asked to assign points or weights to specific goals in comparison with a fixed standard. For example, a farmer could be asked, "If goal A is given 100 points, how many points would you assingn to goal B?" If goal B is twice as important as goal A, it would get 200 points. On the other hand, if goal B is only half as desirable as the base goal A to the farmer, then only 50 points would be assigned. In an alternative procedure, called constant sum, the farmer would be asked to distribute a fixed number of points among the goals in proportion to their importance. These values are used to compute the trade-off weights.

The statistical assumptions are relatively simple and straightforward (Stevens, 34). However, the magnitude estimation does require an individual to be able to express the importance of one item relative to another in ratio terms (Ross, 29). Generally the ratio scaling procedures are repeated various times using different goals as the standard or base. The ratios among the items should be the same for a consistent individual regardless of the base goal (Hamlin, 13). Unlike paired comparisons, magnitude estimation scores represent an individual farmer's goal hierarchy. Because of the assumed ratio scale properties, the goal scores are comparable across individuals and scalar transformations can be made. The scores from magnitude estimation are suitable for the substitution and satisficing MGMs.

Multidimensional Scaling

Although not a measurement technique, multidimensional scaling (MDS) techniques are another way of analyzing goals ranked in order of preference or through the derived rankings from paired comparisons. Various types of MDS models exist which can produce scales for individuals or for groups (Carroll and Arabie, 3, Green and Rao, 10; Green and Wind, 12). The MDS techniques differ from the previously discus-

sed techniques in that they do not assume that all goals can be ordered on a single continuum. These models assume that individuals or groups assess goals on one or more underlying dimensions or perspectives. There is agreement that a goal is located at a specific point on a dimension. Each individual or group is presumed to have an "ideal point" on each dimension which is the most preferred position and the standard against which goals are judged on the dimension.

The "ideal point" model, one of the MDS techniques available, permits the simultaneous existence of several goal hierarchies, one on each dimension. Several checks on internal consistency are made and differences among groups are clearly specified. It is very heuristic in that it estimates the perspectives or dimensions which farmers use to evaluate goals and estimates the type of ideal which the group would find most desirable from these perspectives. Operationally it should be noted that although the number of dimensions can be specified by the analyst, the content of the dimension depends on the specific data (Kruskal and Wish, 17). The MDS techniques are sensitive to deviations from their assumptions and may not pertain to all decision contexts. Because the primary MDS scaling techniques produce scales with assumed ratio properties, goals scores obtained by this approach are suitable for all three classes of MGMs.

Conjoint Analysis

Conjoint analysis is concerned with the determination of the joint effect of two or more independent variables on the ordering of a dependent variable. Empirical applications have emphasized the scaling effects of conjoint analysis to develop specific interval scales from rank ordered data. Commonly an additive composition rule is assumed to apply, presumably with some error (Green and Tull, 11).

In conjoint analysis, individuals are asked to rank order bundles or clusters of goals in order of preference. For example, an individual would be asked to rank various possible combinations of levels of goals A, B, and C. A bundle defined as high levels of goals A and B with a low level of goal C would be compared with a bundle representing a high level of goal C and low levels of goals A and B. Some studies rank possible combinations of all of the variables (full profile - complete factorial) while other studies have used the full profile approach with experimental designs to reduce comparisons. Some other studies have used a two-factors-at-a-time approach instead of the full profile of all factors.

The analysis procedure is based on analysis of variance and can be applied to individuals or groups. Results of the analysis indicate the rel-

ative preference for each goal, for each level of a goal and for combinations of goals. This feature makes it possible to determine whether the utility derived from a goal is independent of the levels of other goals, and whether the substitution rate among goals is constant. The scales developed through conjoint analysis have interval properties, not the ratio properties required for the satisficing and substitution MGMs.

Conjoint analysis does have checks for internal consistency and it is fairly easy to administer. Like the paired comparison technique, an individual only indicates the order of preference among alternatives. Unlike magnitude estimation, no indication of the intensity of preference is required. However, the necessity of presenting clusters of goals limits the number of goals and levels of each goal which can be considered.

EMPIRICAL RESULTS

The results reported were drawn from a project with several objectives. The first was to identify, through a review of previous empirical studies, the primary goals expressed by farmers. Second was to measure the importance of farmer's goals using alternative methods of measurement and analysis. Third was to compare the results obtained from the various methods. Identifying possible relationships between the importance of goals and selected socio-demographic and economic characteristics of farmers was the fourth objective. Finally, usefulness of the alternative methods in an empirical setting was compared and suggestions were made for future research in the area.

The data used were from a sample of 91 farmers from a randomly selected list of agricultural producers in three Central Indiana counties. These counties are typical of much of the Central Corn Belt in the U.S. Almost all of the farmers grew corn, while soybeans and wheat were also common crops. Nearly 80 percent of the farmers had hogs and slightly less than half had cattle. The average farmer was 47 years old, had one year of post secondary education, and operated a farm of 218 hectares of which 49 percent was owned. Average annual gross farm income during 1976-1978 was $122,735. About 32 percent of the farmers worked off-farm, while 57 percent of the households had someone with an off-farm job. Average total assets were about $ 830,000 with debts of $ 125,000 (Whitaker, 37).

Numerical Rating Scales

The first section of the goal measurement questionnaire asked farm-

ers to indicate the importance of 34 goal related statements. If a statement was extremely important to them, they were instructed to circle the 8. If the statement was not at all important to them, they were to circle the 0. Intermediate positions were to be indicated by an intermediate number.

These numerical ratings scales do not allow interpersonal comparisons. For example, the conclusion that individual A feels more strongly about statement 1 than individual B because of the higher number assigned is not valid. Development of more aggregate scales, such as summing variables assigned to related statements, is also not valid. However, comparisons such as "X percent of those interviewed felt statement 1 was very important, but only Y percent thought statement 2 was very important" can be made.

The 34 statements were selected to reflect a variety of business and family goals expressed by farmers in previous studies. Many of the statements were felt to represent somewhat different ways of expressing a goal. For example, statements related to income included "increase my family's living standard quickly", "maintain my family's standard of living at its current level", and "have a family income comparable to what my wife and I could make if we lived in town". Risk, leisure, growth, community activities, and recognization as a good farmer were some of the other general areas. It was expected that farmers would tend to give a similar importance rating to related statements.

Factor analysis was used to identify the underlying goals in the set of 34 statements. In general, the results were less than satisfactory. A number of statements which were expected to cluster together did not. In other cases, some statements would cluster as expected, but another very unrelated statement would also be included in the group. It was not possible to give a satisfactory interpretation to the factor loadings which were obtained. Apparently the farmers tended to be very sensitive to differences in wordings of various statements. For example, the median value for the "increase living standard quickly" was 4.33 as compared with 6.48 for "maintain my family's living standard" and 5.55 for "an income comparable to what we could make in town" (Whitaker, 37).

Magnitude Estimation

The second section of the goal measurement questionnaire asked farmers to assign points to 7 goals indicating the importance of these goals relative to an eighth goal, the base which was assigned 100 points.

The procedure was repeated a total of three times using different goals as the base as a check on reliability. Spearman rho correlations of rank order were computed between sets of ratings as a test of an individual's consistency. The differences between the set with goal A-stable income (see Table 1) as a base and the sets with goal B-foreclosure and goal F-top farmer as the base were significantly different. Even when considering only the comparisons with goals B and F as the base, 9 individuals had Spearman rho correlation coefficients of less than .4 indicating a high degree of inconsistency. These individuals were eliminated as being unable to think in ratio terms (Patrick, Blake, and Whitaker, 26).

Table 1 indicates the mean, median and standard deviation of the goals for the sample. In general, there was considerable agreement in the implied rankings as indicated by the mean and median values for the sample. Goal E-desirable living standard was the fifth ranked goal in terms of mean, but was third in terms of the median. The mean values of goal A-stable income, goal D-net worth, and goal C-investment were very similar. The large standard deviations indicate a considerable variation in the values assigned to specific goals by individuals in the sample.

The information obtained from the magnitude estimation provides data which can be used to analyze farmers' risk-income preferences. As discussed previously, magnitude estimation produces ratio scaled values comparable across individuals. The same baseline or point of origin is established for all individuals and items are scored in terms of multiples of that baseline. The ratios among two or more individuals should be comparable even though a given goal may be more important to one farmer than the other when the goals are considered separately.

Two measures of risk-income preferences were developed using the magnitude estimation results. The first, a stability-income measure, is the average value of the points assigned in the second and third trials to the goal "a farm business which produces a stable income" when "attain a desirable level of family living" is indexed to equal 100 points. The second, a bankruptcy-income measure, is the average of the points assigned to the goal "avoid being unable to meet loan payments and/or avoid foreclosure on my mortgage" when desirable income is the index. The stability-income measure is interpreted as approximating the variability of outcome concept of risk, and the bankruptcy-income measure is in the safety-first context. Higher values indicate greater risk aversion. The mean value of the stability-income measure was 110, significantly less than the 142.9 mean of the bankruptcy-income measure. The simple linear correlation between the two measures was .355.

The risk-income preferences of farmers were hypothesized to vary

TABLE 1. Mean, median, and standard deviation of respondents magnitude estimation goal scores.

Goal Letter	Title[1]	Mean	Median	Standard Deviation
B	Foreclosure	414.37	217	744.80
A	Stable Income	332.17	200	594.19
D	Net Worth	328.30	175	598.19
C	Investment	324.83	175	595.13
E	Desirable Living Standard	293.59	188	397.50
H	Effort and Strain	202.03	126	294.16
G	Leisure	179.24	108	332.12
F	Top Farmer	100.00	100	--

[1] The complete goal statements are as follows:

B - To avoid being unable to make loan payments and/or avoid foreclosure on my mortgage.
A - A farm business which produces or stable income.
D - Having the value of my net worth increase steadily.
C - Selecting a farm enterprise with the highest return on investment.
E - To attain a desirable level of family living.
H - To reduce the physical effort and strain in my farming operations.
G - To have time away from the immediate responsibilities of the farm to spend in leisure and enjoyable activities.
F - To be recognized as a top farmer in my community.

Source: Whitaker, (37)

with characteristics of the operator, family and farm as well as target levels of various goals. The estimated coefficients and t values for the stability-income and bankruptcy-income equations in linear form with 77 observations are presented in Table 2. Positive coefficients indicate greater risk aversion as the variable increases.

The attributes considered in this analysis explain less than onehalf of the total variation in risk-income preferences, and the overall stability-income equation is just significant at the 10 percent level. Age had the positive sign expected from previous studies in the stability-income equation, but the t value was extremely small. However, age was negative and statistically significant in the bankruptcy-income equation. Education was included through two dummy variables and both were positive, indicating greater risk aversion by educated farmers, in the stability-income equation. This was contrary to the expected relationship, but neither coefficient was significant. In the bankruptcy-income

TABLE 2. Estimated coefficients of risk-income equations, Central Indiana farmers, 1979.[a] (n=77).

Variable	Stability-income	Bankruptcy-income
Age (years)	0.1180 (0.2379)	-1.6638 (1.9553)
Technical education[b]	7.8791 (0.7401)	0.7300 (0.0400)
College education[c]	21.8448 (1.5180)	-11.7801 (0.4773)
Children under 18[d]	-23.2410 (1.7246)	-40.6141 (1.7561)
Percent debt	0.0655 (0.3554)	1.775 (3.7237)
Off-farm job[e]	-15.8244 (1.6638)	-30.8419 (1.8895)
Planned future income ($1,000)	-0.3212 (0.9503)	-0.9558 (1.6476)
Planned percent debt	0.3243 (1.7401)	0.2128 (0.6652)
Planned net worth growth (percent over 3 years)	0.2426 (1.6728)	0.6469 (2.5590)
Constant	101.7751 (10.3260)	217.0740 (3.9935)
R^2	0.2047	0.4097
F	1.9155	5.1657

[a] "t" values are indicated in parentheses.

[b] Technical education is coded as 1 for technical training beyond high school or some college and 0 for no additional training.

[c] College education is coded as 1 if college was completed and 0 otherwise.

[d] Children under 18 is coded as 1 if there are children under 18 years of age in the household and 0 otherwise.

[e] Off-farm job is coded as 1 if the farm operator or spouse has an off-farm job and 0 otherwise.

Source: Patrick, Blake, and Whitaker, 27.

equation, college education had the expected negative sign, but was less

than one-half the size of the standard error. The presence of children under 18 years of age in the household was associated with lower levels of risk aversion in both equations. Although the percent debt had only a limited relationship to risk aversion in the stability-income equation, it was highly significant in the bankruptcy-income equation. If either the farmer or spouse had an off-farm job, then both risk-income measures were significantly reduced. The higher planned future income, the lower the apparent risk aversion, while planned percent debt and percent net worth growth had positive coefficients in both equations.

The bankruptcy-income index had significantly higher value than the stability-income index suggesting farmers may give greater weight to the safety first concept of risk. The R^2 of the bankruptcy-income descriptive model was also higher than for the stability-income measure, but a substantial amount of variation was not explained. This implies that specific risk-income preferences are not highly concentrated within subgroups of farmers on the basis of factors of **a priori** interest. Possibilities of inferring individual risk-income preferences through commonly observed socio-demographic and economic attributes are limited.

Paired Comparisons

The magnitude estimation and traditional forced choice paired comparison information was used for the Thurstone scaling. In the magnitude estimation, the assignment of points relative to the base goal indicates the preference of each goal relative to the base goal. Those assigned more than 100 points can be assumed to be preferred to the base goal in a two way choice comparison while those receiving less than 100 points would not be preferred to the base. The comparisons implied in the magnitude estimation procedure were supplemented with traditional forced choice comparisons for the instances in which direct comparisons had not occurred. A total of 86 individuals provided data for analysis. All of these respondents were consistent at least the 5 percent probability level, indicating highly reliable respondents.

The Thurstone Case V procedures utilize information from the group and assume that standard deviations of the goal ranking are equal. Case V scaling procedures were applied and the scale values indicated in Table 3 were obtained. Avoiding foreclosure (goal B) was the top ranked goal while effort and strain (goal H), leisure (goal G) and top farmer (goal F) were the lowest ranked goals. These rankings were the same as those obtained from both the mean and median values from the magnitude estimation procedures. While stable income (goal A) was the second highest ranked goal by the magnitude estimation procedures, it was fifth in the Thurstone Case V scaling. For desirable living

TABLE 3. Thurstone scaling case V, mean differences and scale values.

Goal Pair	Mean Difference	Scale Value	Goal Title
		2.397	B — Foreclosure
BE	.377	2.020	E — Desirable living standard
ED	.371	1.649	D — Net Worth
DC	.071	1.578	C — Investment
CA	.426	1.152	A — Stable income
AH	.201	.951	H — Effort and strain
HG	.270	.681	G — Leisure
GF	.681	.000	F — Top Farmer

Source: Patrick, Blake, and Whitaker, (26).

standard (goal E) the situation was inverted. Net worth (goal D) was ranked above investment (goal C) by both procedures, but the values were very similar as indicated by the mean difference in Table 3.

The Mosteller (21, 23) chi square value, which is used to evaluate the overall solution, of 175.45 with 21 degrees of freedom, indicated that the expected proportions were significantly different from these observed. Furthermore, the scale values did not adequately reflect the preferences of the farmer sample. This lack of fit could have been caused by various factors including unequal standard deviations, non-normality or lack of unidimensionality.

Thurstone Case III procedures, which relax the assumption of equal standard deviations, were also applied (Mosteller, 22). Again there was a significant difference between the actual and reproduced proportions, indicating that unequal standard deviations of goal rankings were not the cause of difficulties with the Case V procedures. The Bradley Terry-Luce algorithm (2,19) was used to transform the data and Trurstone-like scaling procedures were then applied, but there were still significant differences between the original and reproduced proportions. This suggests that multidimensionality of goals, rather than unequal standard deviations or non-normality were the cause of the difficulties with Thurstone type scalings.

Multidimensional Scaling

Multidimensional scaling uses the same information as the Thurstone

scaling of paired comparisons. However, as indicated previously, it assumes individuals or groups assess goals on more than one underlying dimension or perspective. A number of scaling techniques are available and the Schonemann and Wang (31) algorithm was used. This algorithm is discussed by Moore, Pessemeir and Little (20).

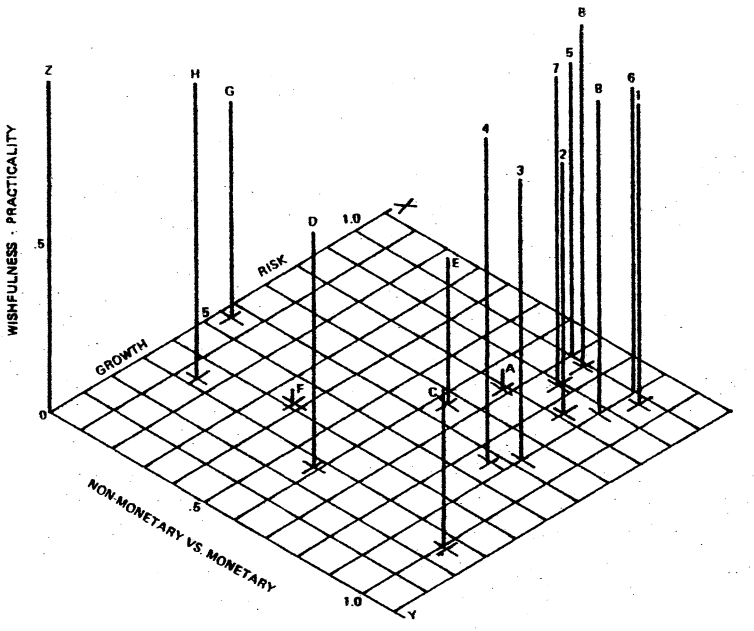
For the MDS scaling analysis, 8 subgroups based on average gross farm income and whether the farmer wished to buy land were developed. Subgroups 1, 3, 5 and 7 were composed of farmers who did not wish to buy land in the under $40,000; $40,000 to $80,000; $80,000 to $120,000; and over $120,000 income classes, respectively. Subgroups 2, 4, 6 and 8 were composed of farmers in the same respective gross income classes who wished to buy land. This classification was developed to provide eight subgroups of approximately equal size rather than from a priori hypotheses. Future research could use other socio-economic characteristics, together with suitable sampling and data collection techniques, to classify more meaningful subgroups.

The three dimensional MDS solution provided the best overall and subgroup test of fit. The chi-square goodness of fit criterion indicates whether the distance matrix can reproduce the original proportion matrix. Although one subgroup had a goodness of fit probability of .597, four groups were over .9. The overall test of fit indicates no significant difference between the original and reproduced proportion matrices. This indicates the solution was a quite acceptable portrayal of subgroup differences in evaluation of goals, and that differences among subgroups were reproducible.

Figure 1 is a three dimensional plot of the coordinates of the goals (letters) and subgroup (numbers) ideal points. On the X-axis, the stable income (A) and avoiding foreclosure (B)goals ciuster in the upper range, while investment (C), net worth (D), and effort and strain (H) cluster near the bottom.This axis is interpreted as a risk-growth continuum with a growth orientation at one end and risk aversion at the other.The Y axis has investment (C) at one end and leisure (G) and effort and strain (H) at the other. These goals, together with the middle goals, indicate a change from non-monetary to monetary considerations and the axis is interpreted as a monetary vs. non-monetary continuum. The third, or Z dimension, although clear in a statistical sense, is more difficult to interpret. Foreclosure (B), effort (H), and net worth (D) are near the top of the Z axis, while top farmer (F) and stable income (A) are near the bottom. This axis is considered to be a feasibility dimension with "practicality" on the high end and "wishfulness" on the other.

On each of the three dimensions, the variations in ideal points among subgroups are less than the differences among goals. All of the

FIG. 1. Multidimensional scaling of subgroups ideal points (numbers) and goal coordinates (letters).



subgroups tend to cluster on the "practicality" extreme of the feasibility dimension or Z axis and the "monetary" extreme of the Y axis or monetary vs. non-monetary dimension. The greatest differentiation occurred on the X axis or risk-growth dimension. Subgroups 3 and 4 ($40,000- $80,000 gross income) are located near the middle suggesting that growth is more important to them than to other groups. In contrast, other subgroups tend to stress avoiding risk rather than growth.

The MDS distance matrix (Table 4) indicates the distances among goals for the various subgroups. The closer that a value is to zero, the closer that a goal is to a subgroup's ideal point and the stronger the subgroup's preference for the goal. This matrix has Euclidian distance or ratio scale properties permitting comparisons of the relative importance of goals for a subgroup as well as comparisons among subgroups. For example, the .4101 value on avoiding foreclosure (goal B) indicates it is 2.63 times as important as the 1.0795 value on a desirable living standard (goal E) for farmers in subgroup 1. In contrast, the relative importance (.6894/.5828 = 1.18) of goals E and B were nearly

equal for subgroup 2. These ratios represent the trade-off values of various goals for different subgroups. However, it can be difficult to interpret how goals B and E are measured in this case. This illustrates the need for goals to be defined in operationally meaningful ways. Barnett, Blake and McCarl (1) have used trade-off weights derived from MDS in the objective function of a goal programming study of Senegalese farmers.

TABLE 4. Multidimensional scaling distance matrix between goals and subgroups.

Goals[a]	Subgroups 1	2	3	4	5	6	7	8
A	1.5242	1.2264	1.4603	1.6146	1.4381	1.5212	1.4575	1.5641
B	.4101	.5828	.7559	.7765	.2793	.3343	.2518	.3636
C	1.3590	1.0561	.8042	.8535	1.3369	1.4227	1.3384	1.2556
D	1.4305	1.0607	.8679	.8349	1.1724	1.4463	1.2039	1.2835
E	1.0795	.6894	.8324	.9490	.8765	1.0776	.9064	1.0367
F	2.0355	1.6451	1.7224	1.8075	1.8090	2.0316	1.8457	1.9919
G	1.7994	1.4975	1.5424	1.5177	1.3930	1.7535	1.4467	1.6936
H	1.8159	1.5201	1.4153	1.3254	1.4233	1.7892	1.4709	1.6569
Goodness of fit[c]	.597	.972	.979	.917	.983	.688	.854	.712

[a] See Table 1 for goal descriptions.

[b] Subgroups 1, 3, 5 and 7 were composed of farmers who did not wish to buy land in the under $40,000; $40,000 to $80,000; $80,000 to $120,000; and over $120,000 gross income classes, respectively. Subgroups 2, 4, 6 and 8 were composed of farmers in the same respective income groups who wished to buy land.

[c] Goodness of fit expressed as upper tail probabilities.

Source: Patrick, Blake, and Whitaker, 26.

These results indicate that farmers do view goals in a multidimensional framework. This implies that because of their implicit assump-

tion of unidimensionality, the other rating scales, Thurstone scaling and magnitude estimation procedures may be oversimplified approaches to measuring farmers' goals. Although the labeling of the dimensions in an MDS solution can be criticized as largely subjective, statistical tests do indicate that there are systematic differences in goal perceptions among subgroups. Furthermore, the statistical tests also indicate that these subgroup differences can be conceptualized and measured by a multidimensional ideal point model.

Unlike the techniques previously used to measure goals, multidimensional preference scaling is based on subgroup differences and is suited to analysis of heterogenous data. Future research should consider both the dimensions of farmers' goal evaluations and the subgroup or factors which produce these dimensions. MDS can be used to identify differences, and similarities, among groups of farmers. Other multidimensional measurement and scaling procedures such as INDSCAL (Carroll and Chang, 4) and ALSCAL (Young and Lewychyj, 40) can be used to obtain scalings for individuals. These scales can be compared across individuals and could be used in standard econometric prediction models.

Conjoint Analysis

The final part of the goal measurement questionnaire asked farmers to rank order 27 combinations of income, risk of bankruptcy, and hours worked per day. Net income or income available for consumption levels of $10,000, $15,000 and $20,000 per year were used in this study. Although the range of net income in the areas studied was probably substantially greater than the range considered in this study, it was expected that farmers could distinguish between these income levels and yet these levels would be within the general limits of their experience. The risk or probability of bankruptcy levels considered were 1, 5 and 10 percent. The number of hours worked per day considered were 7. 10 and 13 hours per day.

The farmer was presented with 27 cards, in random order, each with one of the possible combinations of income, risk and work and asked to rank order them. It was suggested that the farmer first sort the cards into piles such as "good", "regular", and "bad". Then the cards within each pile were ordered and the overall ranking reviewed. Time constraints precluded some farmers from participating, but 76 of the 91 farmers interviewed completed this part of the questionnaire.

The first step of the analysis was a check of consistency of ranking. It was assumed that an individual would prefer, ceteris paribus, more

income to less; less risk of bankruptcy to more, and less work to more. However, because of the number of alternatives considered, an individual could make a mistake and invert alternatives. If an individual made more than 10 percent of the total possible inversions, they were considered inconsistent and excluded from analysis. A high percentage of inversions could also indicate a farmer did not understand the task. Over 84 percent, 64 of 76 farmers, had less than 10 percent inversions and 53 had less than 5 percent inversions. Of the 12 farmers who were inconsistent in the conjoint analysis (or did not understand), 6 were among the 9 individuals inconsistent in the magnitude estimation procedure. This suggests no major difference in the consistency of individuals using the two methods. A limited number of individuals apparently are unable to respond consistently with either method.

The MONANOVA (Monotone Analysis of Variance) algorithm was used in the analysis (Green and Tull, 11). This algorithm seeks values for the level of each attribute which, when combined in an additive manner, best reproduces the original rank order of the alternatives as indicated by the respondent. These values, called part-worths or utilities, indicate the relative importance of factors. In less than full factorial designs, the part-worth values can be used to predict the utility value of excluded alternatives. These part-worth values can also be used to determine the trade-offs or compensating variations to maintain total utility constant.

Of the 64 individuals considered to be consistent, 50 had "stress" values in the MONANOVA analysis of 20.0 percent or less indicating an acceptable level of fit (Fernandez, 7). "Stress" is basically a measure of how well the derived results match the data. A stress value of 0 to 5 percent is considered "impressive", 5 to 10 percent is "satisfactory", 10 to 15 percent is "acceptable" and 15 to 20 percent implies caution.

The results (Fernandez, 7) indicate that an additive model of utility is consistent with the ranking of 50 of the 64 farmers analyzed. For the 14 farmers with stress values of more than 20 percent, an alternative model of utility may be more consistent than the additive. Later analysis compared the additive and a simple multiplicative model of utility and found that the goodness of fit measures were consistently better for the additive model. An attempt was made to fit a group solution for the 64 consistent individuals and the 50 individuals with acceptable levels of stress. In both instances, the solution had a very high level of stress indicating that common set of utility values to reproduce the rankings could not be determined. This suggests that substantial differences exist among individuals which respect to the importance of goals or the importance of levels of goals.

The part-worth functions and their associated utilities can be used to determine the relative importance of the various factors to a respondent. The goal or factor with the widest range of utilities is the one with the greatest relative importance. Of the 50 farmers having acceptable levels of stress, 28 (56 percent) had risk as the most important factor, 18 (36 percent) considered income as most important and 4 (8 percent) gave the greatest importance to leisure. When considering the order of preference for all three goals, 23 individuals had the preference of risk, income, leisure (group G_{RIL}); and 16 had an order of income, risk and leisure (group G_{IRL}). The other 14 individuals were scattered among the other four possible orderings.

For the groups G_{RIL} and G_{IRL}, a typical ranking of the 27 alternatives was developed based on the average of the individuals in the group. This typical ranking was analyzed by the MONANOVA algorithm and the part-worths used to compute compensation ratios for the risk-income, income-leisure, and risk-leisure trade-offs. The part-worths associated with the specific levels of each attribute can be combined to determine the "utility" associated with a specific combination of attributes. The compensation or trade-off ratio between two of the goals simply indicates how much one goal must vary to offset a given change in another goal and have "utility" be the same.

Table 5 presents the compensation or trade-off ratios for the G_{RIL} and G_{IRL} groups. These compensation ratios are computed as increases and decreases from the middle level of each goal, $15,000 income, a 5 percent chance of bankruptcy and a 10 hour workday. For group G_{IRL}, an increase of 1 percent in risk would require an income increase of $1,051.57 for total utility to remain constant as compared with $2,513.88 for group G_{RIL}. If income decreased by $1,000, group G_{IRL} would require a 2.34 percent decrease in risk as compared with a 0.41 percent decrease for group G_{RIL} for utility to remain constant. An increase of 1 hour in the workday requires an increase in income of $904.33 for the G_{IRL} group and $1,374.20 for the G_{RIL} group to compensate. Decreases in income or increases in risk require very large changes in the workday for utility to remain constant. This indicates that leisure is relatively unimportant to farmers, especially when income decreases or risk increases. These trade-off ratios could be used in linear programming models to weight changes and compare alternatives. Given the differences in trade-off ratios, it could be expected that these groups would react quite differently to the same alternative if information about both income and risk was provided.

TABLE 5. Compensation ratios of income-risk, income-work and risk-work for selected groups of farmers.[1]

	Income	Risk	Work
	($1,000)	(1 percent)	(1 hour/day)
		GROUP G_{IRL}	
Increases			
Income $1,000	—	0.95	1.11
Risk 1 percent	$1,051.57	—	-11.57
Work (1 hour/day)	$904.33	0.09	—
Decreases			
Income $1,000	—	-2.34	-17.76
Risk 1 percent	-$426.89	—	0.83
Work (1 hour/day)	-$56.30	-1.20	—
		GROUP G_{RIL}	
Increases			
Income $1,000	—	0.40	0.73
Risk 1 percent	$2,513.83	—	-13.20
Work (1 hour/day)	$1,374.20	0.75	—
Decreases			
Income $1,000	—	-0.41	-5.25
Risk 1 percent	-$2,421.96	—	1.76
Work (1 hour/day)	-$190.72	-0.57	—

[1] The compensation or trade-off ratios are calculated from the middle value of each attribute. This represents a $15,000 income, 5 percent chance of bankruptcy and a 10 hour workday with the excluded factor held constant in each trade-off. Linear piecewise approximations are assumed, implying the trade-offs are constant within the range of the data.

Source: Fernandez, 7

An analysis was made to determine whether some common socio-economic varibles were associated with the ordering of goal preferences. Age, average gross farm income, acres owned, acres rented and total acres were some of the socio-economic varibles considered. No significant differences among groups were found for the average values of the variables considered. However other socio-economic and demographic variables might be associated with differences in goal order preferences.

CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

When comparing the paired comparison, magnitude estimation and conjoint measurement techniques, no method is clearly superior in terms of ease of application. All of the techniques have limitations with respect to the number of alternatives or comparisons which can be considered. Paired comparisons involve only a simple choice between two alternatives and should not cause difficulties for farmers with limited levels of education. In contrast, the magnitude estimation procedures require individuals to think in ratio terms. Even highly educated individuals may have difficulty in maintaining consistent ratios among a number of statements as the process is repeated changing the base of comparison. However, asking uneducated farmers to distribute a fixed number of stones among a limited number of goals in proportion to their importance has been effective (Barnett, Blake, and McCarl, 1). Although relatively simple, a large conjoint analysis imposes a considerable load on a respondent. Use of conjoint analysis among illiterate respondents appears quite limited, although illustrations and pictures have been used in some marketing studies.

The vast majority of the farmers were consistent in their responses with all of the measurement techniques used. Consistency of response was a greater problem with conjoint analysis and magnitude estimation than with the paired comparison. A number of individuals did not complete the conjoint analysis because it was the last part of the questionnaire and some individuals were unwilling or unable to continue the interview because of time constraints. The somewhat greater inconsistencies with conjoint analysis may reflect it being the last technique applied rather than any additional difficulty associated with the technique. A study specifically designed to test consistency and reliability would be necessary to compare methods.

The results suggest that farmers do view goals in a multidimensional framework rather than from a single perspective. This implies that Thurstone scaling techniques are inadequate to reflect goal perspectives of farmers. Multidimensional scaling techniques can better reflect these goal perspectives and also have numerical characteristics more suitable for use in linear programming models. The conjoint analysis results indicate a simple additive model provides an adequate explanation of the ranking of farmers' goals. There are no strong interactions of goals within the range considered, indicating a full factorial design is not necessary in conjoint analysis. Experimental designs can increase the number of factors and levels considered without increasing the number of alternatives which must be evaluated.

There appear to be only very limited possibilities of characterizing farmers with respect to their goal preferences on the basis of easily determined socio-economic and demographic factors. On the other hand, farmers do differ in their goal orientations in ways which are likely to effect their decisions and behavior. This indicates that future research should stress easily used methods to identify a farmer's goal preferences rather than attempting to infer goal orientations based on socio-economic and demographic factors. Detailed studies may be necessary to identify goal preferences and trade-offs for major groups of farmers which could be used in research and policy analysis. Rapid methods of identifying the general goal orientation of farmers should be developed to facilitate individualization of extension recommendations.

In planning future research on goals and objectives, there is a need to consider the types of decisions which will be analyzed. The research discussed in this paper focused on goals which were hypothesized to influence intermediate, investment type decisions. However, there was very little empirical evidence to indicate which goals are important in this type of decision situation. It is expected that the goals considered would differ, or at least the way in which they manifest themselves would change, depending on the decision situation. Part of the research in this area should identify the goal considered or influencing specific types of decisions.

Future research should also give greater consideration to specific levels of individual goals. Although the conjoint analysis did not indicate interactions among goals, farmers may react very differently to the same level of a goal. For example, a large farm operator may have a considerably higher income goal than a small farm operator. Individuals with different financial situations are likely to react differently to the same level of risk. Two individuals with the same general pattern of goal preferences may react very differently to an alternative because of the differences in target levels of goals.

Use of these methods has been considerably broader than just measurement of the goals and objectives of farmers. Considerable use has been made in the marketing area to identify the product attributes which the consumer considers desirable (Wierenga 38). Companies have attempted to identify opportunities for new products - essentially to identify what the consumer wants and provide it. These methods can also be used by firms to determine how they are viewed relative to other firms in the industry.

These measurement techniques also have considerable potential application in the area of agricultural and economic policy. Decisions in

the public sector involve politics, competing goals, and trade-offs. Measurement techniques such as those discussed could be used to determine preferences of policy-makers for incorporation into macro planning models. Perhaps these techniques could be combined with the Willis and Perlack (39) procedure of generating a set of solution and interacting with decision-makers. This may be a more fertile area for application of these techniques than measurement of farmers' goals.

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