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A COMPARISON OF ALTERNATIVE MEASURES OF RISK AND APPLICATIONS OF RISK-PROGRAMMING MODELS FOR OPTIMAL FARM PLANNING OF BURLEY TOBACCO FARMS IN TENNESSEE

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ABSTRACT

In this study the effects of use of aggregate risk measures and risk models on the optimal farm organization of burley tobacco farms in Tennessee were analyzed. One hypothesis was that measures of risk based on aggregate data and existing risk models yield valid solutions to farm planning problems for such farms. A second hypothesis was that farm management practitioners should not reject any of the more common models or procedures for use in application to any farm. Practitioners should select a model with data requirements and solution characteristics that most closely conform to the requirements of the problem at hand.

Three objectives were established to test the two hypotheses. The first objective centered on estimation of the variance-covariance matrix of net returns necessary in the formulation of risk programming models. A second involved the identification and evaluation of alternative farm planning procedures that are characterized by estimates of expected returns and their variation for alternative farm organizations that vary in exposure to risk. The final objective involved validation of the risk planning procedures identified in farm applications.

In fulfilling the first objective, several econometric procedures were applied to the time-series of net returns for various farm enterprises. The resulting variance-covariance matrices were compared both in quadratic programming applications to representative burley tobacco farms and for conformity to various desirable characteristics of risk measures.

Risk models compared in the second objective included quadratic programming (QP), marginal risk constrained linear programming (MRCLP), minimization of total absolute deviations (MOTAD) and the single-index portfolio model. Model results were compared across various representative burley tobacco farms at differing levels of risk-aversion for conformity of enterprise selection and levels. Models were also evaluated at several points on the frontier of risk efficient choices for each farm.

In the final objective, FINPACK, a farm financial planning package, was applied to the representative farms to analyze differences between reported farm organization and alternative organizations suggested by the risk programming techniques. An evaluation of the sensitivity analysis portion of the FINPACK package was made.

While no statistical tests were applicable to the type of analysis performed, results supported the hypotheses of the study. Valid risk measures in terms of enterprise selection and levels were identified. Evaluated risk measures included those constructed from the nominal time-series of net returns, from the deflated time-series and from residuals of a simple moving average forecast of net returns, a weighted moving average forecast of net returns, a second-order trends removed forecast and from an integrated autoregressive and moving average forecast (ARIMA). Quadratic programming results from the generation of the mean-variance frontier of risk efficient choices for all representative farms showed substantial similarity across all these measures of risk. On the basis of conformity to desirable characteristics of risk measures, the measures formed from the residuals of

weighted moving average forecasts of the time-series of net returns was superior to the other evaluated risk measures. The set of risk measures examined did not include all possible measures. Given current computational capabilities, no significant advantage was discovered regarding ease of calculation for any measure.

Types of risk programming problems were identified so that choice among the evaluated alternative risk models could be made based on the characteristics of the available data and desired solution information. The range of covariances among possible enterprises was shown to be the most important factor in determining the type of model best suited for any application. Only when covariances were small or constant between alternatives were the computational advantages of the models that did not consider covariances shown to be significant. The single-index model was shown to be the least desirable model except in cases where aggregate risk data are incomplete.

Possible uses of a computerized farm financial planning package was demonstrated by example to be an excellent source of the type of data necessary for risk planning procedures. This package also provided a format for the evaluation of alternative farm organizations suggested by the risk modelling procedures.

In summary, this research demonstrates that appropriate aggregate measures of price and production risk exist that may be applied in several risk models. Solutions resulting from the application of these procedures in farm planning problems yield valid and useful farm management information.

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CHAPTER I

INTRODUCTION

THE ECONOMIC PROBLEM

Farmers in Tennessee are faced with uncertain prospects. While the production of various farm products have been stable sources of farm income in the past, pressures have always existed which force farmers to evaluate possible changes in farm organizations. Farmers may look to agricultural researchers and extension agents for alternative and/or supplemental enterprises which are able to utilize available resources without requiring large additional investments.

For change agents to efficiently recommend possible alternative enterprises, they must be able to evaluate not only the resource requirements of possible alternatives but also the attractiveness of each alternative to a particular farmer. Activities that may be highly attractive to one individual may not be so to another with a similar resource set. One important reason for this difference is that individuals differ in their response to perceived risk. While the increased expectational returns from one possible alternative may sufficiently outweigh any increased risk for one farmer, other farmers may find the increased risk outweighs potential gains. For every resource situation, given a range of possible activities or enterprises, a set of risk efficient choices exists that varies from low risk/low income to high risk/high income. This set of risk efficient choices has been called the risk efficient frontier in that alternative organizations not

included in this set result in higher levels of risk for every feasible income level. Conversely, higher incomes at any given risk level are infeasible. Every farmer should choose, in the absence of any other nonrisk related considerations, some point on this risk efficient choice set. The point on this frontier that an individual chooses depends on his or her level of risk aversion, so that by choice of farm plan that farmer has demonstrated his or her individual degree of risk aversion (Brink and McCarl, 1978).

THE RESEARCH PROBLEM

The extent to which risk models are useful as farm management tools can perhaps best be indicated by their ability to generate farm plans that are realistic in terms of farm organization without use of constraints on enterprise size that are not reflective of resource availabilities. The inability of linear programming procedures to achieve these realistic results in many cases has been a problem for farm management researchers.

Risk models may be described either as single stage or as sequential (Anderson, et al., 1977). Many farm management decisions can be described as sequential in nature, such as many pest management strategies or marketing decisions. Each decision is dependent not only on the existing circumstances but on previous decisions and their outcomes. In contrast, the formulation of the annual farm plan can be described as nonsequential. One could argue that the farm plan is the first stage in a sequential series of decisions. For usual modeling purposes, however, this plan can be regarded as a single stage process. While past farm

organizations and certain enterprise combinations may bias reorganization of the farm, a wide range of possible enterprises and levels are available to the farmer at this stage.[1]

Two very important and easily quantifiable sources of risk which must be addressed in any farm planning analysis are price risk and technical risk. One can measure the variability of prices and yields with some degree of accuracy, while marketing, technological and financial risks may, in most cases, be more difficult to measure. These last three sources of risk may also be of lesser importance, especially when considering only conventional crops with well established marketing institutions at this initial stage in the planning process.

If risk models considering only price and technical risk perform well in constructing realistic farm plans, assuming that farm managers are capable of accurately assessing their exposure to risk, the construction of risk models is possible. Further, researchers should be able to build risk models whose solution characteristics closely resemble existing farm plans. If researchers can identify a point near the generated frontier of risk efficient choices that most closely represents the actual organization of a particular farm firm, they will have estimated, by that point on the mean-variance (E-V) frontier of risk efficient choices, a level of risk aversion for that farmer (Brink and McCarl, 1978).

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[1]One also may argue that the continuation from year to year of any such ongoing enterprises does not simply reflect some ad hoc preference of the farmer, but is an indication of an imperfect market for fixed resources, among other things.

Modern farm management involves selection of enterprises to optimize some goal or set of goals for the manager, usually maximization of expected returns to certain fixed resource levels. Much applied farm planning currently centers around maximization of these expected returns in a linear programming model. While these linear models have been shown to be more appropriate than risk models for some applications, they do not consider the variation of returns possible in an atmosphere of uncertainty or the degree of risk aversion of the particular farmer. Research has shown that most individuals are to some degree risk averse and thus will assume higher levels of risk only when expectations of returns are higher. Linear techniques do not eliminate strategies based on the variance of returns or on the degree of risk aversion of a particular producer (Wiens, 1976; Pope, 1982b; Moscardi and deJanvry, 1977; Young, 1979; and Ramaratnam, et al., 1986). A need exists for identification of farm planning models that account not only for the existence of variation in the level of returns ex post but also for the degree of risk aversion of the farmer. Such models should be relatively simple to apply in individual situations. They also should present an accurate estimate of returns and their expected variation, allow for varying levels of risk aversion among producers, and be able to discriminate among a large number of choices (Young, 1984). These models should also be conceptually straightforward or, in other words, they should "make sense" both to the farm management practitioner and to the client.

OBJECTIVES OF STUDY

The objectives of this research were designed to address the problems, both theoretical and practical, that might be encountered in an application of a farm planning model that considers risk in a specific farm situation. The objectives addressed problems encountered when data for analyzing a particular farm are not complete and must be augmented with data from other sources. Specifically, the objectives were:

1. To develop measures of risk from aggregate data and compare their validity for use in construction of risk-efficient farm plans.
2. To develop alternative risk models using measures of risk identified in objective 1. Comparisons among models were to seek to identify the following:
   a. Models that yielded realistic results, in terms of enterprise selection and levels.
   b. The types of required data and desired information that may be indicative of the risk model best suited for application to any particular problem.
3. To use the risk measures and models developed in an application to farm data as a demonstration of the use of risk models in farm planning.

The first objective required estimation of the variance-covariance matrix of returns necessary for the quadratic programming (QP) procedures and the vector of deviations required for the minimiza-

tion of total absolute deviations (MOTAD) models. Recent interest in risk programming has centered around development of appropriate measures of uncertainty in risk programming models (McSweeny and Kenyon, 1987; and Kramer and Pope, 1981). Douglas L. Young (1980) described and published one set of guidelines for selection of such measures that have been widely adopted (Collins and Barry, 1986). These criteria are:

1. The measure should be based only on currently available data, including historical information.
2. Expectations of variables and their variances should be based on a limited number of time periods.
3. More weight should be given to recent information.
4. Variability should be measured as weighted mean-squared errors from a series of one step ahead forecasts.

These and other criteria have been applied in techniques for developing variance-covariance risk measures and serve to formalize assumptions implicitly made by choice of risk measure concerning the decision-making process. Because no universally acceptable procedure for measuring uncertainty has been developed, the goal was to compare risk measures that conformed in varying degrees to the set of criteria outlined by Young, as well as other criteria. The alternative measures of risk were applied to representative farms using a common risk model and the generated farm plans compared. The necessity of conformity to these "desirable characteristics" of risk measures when generating valid measures of risk were examined by determining if enterprise selection

and levels were equivalent using alternative measures of risk (McCarl and Apland, 1986; and McCarl, 1984).

The second objective was directed more toward farm management practitioners who may be interested in the evaluation of existing firm level decision models which account for risk in the decision-making process. The goal was to identify alternative farm planning procedures that were characterized by estimates of expected levels of returns and their variation for properties that appear to have usefulness to farm management professionals in applied analysis of actual farming activities. Data requirements, as well as typical applications for each alternative risk model, were also enumerated. Situations, if any, in which particular models generally were not appropriate were also identified. Models compared were quadratic programming (QP), minimization of total absolute deviations (MOTAD), marginal risk constrained linear programming (MRCLP) and the single-index portfolio model.

The final objective involved a demonstration of the principles developed in the first two and validation of these farm management tools in an application (McCarl, 1984). This objective was demonstrational in nature. In fulfilling this objective, an application of the principles and developed procedures was made to farm data. Choice of risk measure and model depended on the type, quantity and reliability of data. Deficiencies in data, particularly risk measures, were buttressed by additions of aggregate data. Typical applications of the particular model were discussed from the more practical considerations such as computer software and capacity requirements and use of existing computer record and financial management systems in providing the most accurate

information possible. FINPACK, a computerized farm financial management software package, was employed in an example application of linking risk models with such existing software packages for use by farm management practitioners.

CHAPTER II

LITERATURE REVIEW

GENERAL RISK THEORY

Theoretical interest in the role of risk in decision making in agriculture began in the early 1920s with Frank Knight's famous delineation of risk and uncertainty (Knight, 1921). Knight categorized as risk those areas where objective probabilities existed or where risk was insurable. He defined uncertainty as situations where probabilities could only be subjectively determined. This distinction between risk and uncertainty has been implemented in many areas of agricultural economics research. The distinction occupied the literature until the modern subjective approach to risk emerged (Brandow, 1977; and Brake and Melichar, 1977). Earl O. Heady's Economics of Agricultural Production and Resource Use (1952) has several chapters devoted to treatment of risk. His statement in 1949 that risk and dynamics were neglected areas of farm management research marked the beginning of an important era in modern farm management research (Jensen, 1977). This modern era had perhaps begun two years earlier with the expected utility approach to decision making developed by Von-Neuman and Morganstern (1947). Expected Utility Maximization (EUM) is based on a set of axioms developed by Von-Neuman and Morganstern which can be used to develop a utility function that accurately reflects decision maker preferences (Hey, 1979). Savage (1954) related subjective probability to expected utility in an EUM framework. Markowitz (1959) and Tobin (1958) applied

EUM axioms to decision making in portfolio analysis. During this period many researchers developed alternative efficiency criteria that partially order risky alternatives (Markowitz, 1959; Baumol, 1963; Hanoch and Levy, 1969; and Hadar and Russell, 1969). Safety-first rules were also developed during the 1950s and 1960s that were also capable of at least the partial ordering of risky alternatives (Telser, 1955-1956; Kataoka, 1963; and Roy, 1952).

In the 1960s and 1970s progress was made in the measurement of risk attitudes among decision makers. Several measures of risk aversion were developed such as the Arrow-Pratt measure of absolute risk aversion, defined as the first derivative of the utility function with respect to income divided by the second derivative (Pratt, 1964). Researchers subsequently proposed several methods to describe this measure empirically. Anderson, et al. (1977), proposed repeated application of hypothetical gambles to implement the certainty equivalent axiom of EUM in the Direct Elicitation of Utility (DEU) approach. This approach was criticized by King and Robinson who believed the DEU approach was not accurate enough to define a unique utility function. In their Risk-Interval (R-I) approach, they defined confidence intervals for the Arrow-Pratt measure (King and Robinson, 1981).

Another approach, the Observed Economic Behavior (OEB) approach (Anderson, et al., 1977; Young, 1979) has several advantages over the direct methods, DEU or R-I. The OEB approach can handle large amounts of data easily, yields quantitative measures of risk aversion without costly interviews and avoids the moral implications of hypothetical gaming situations. The OEB approach also avoids the question of whether

the results are germane to real economic problems or just to hypothetical situations. A severe limitation is the assumption that the entire difference between some assumed objective (usually firm profit maximization) and actual firm performance is a result of risk attitudes. Moscardi and deJanvry (1977), in an empirical application of OEB recommended careful screening of data to eliminate all influences except risk attitudes. They further noted that such a high degree of control is not easily achieved in practice. P. B. R. Hazell, in an OEB study in 1982, cited the Moscardi and deJanvry study in attributing solely to risk attitude the difference between observed performance and assumed objectives. Hazell noted that DEU approaches are not likely to be often used in farm management research because the OEB models are more attractive for use with the type of data generally available to researchers. Within a MOTAD framework, Brink and McCarl in 1978 used OEB to describe the risk aversion level of farmers by ascribing solely to risk aversion the differences between actual farm organization and the organization predicted by the risk model. Wolgin (1975) used OEB to test the efficiency of resource use by ranking crops by their marginal increment to risk and comparing that to the marginal value product (MVP) for various crop inputs. He then compared this difference to a ranking of intervals between the MVP for crop inputs and the prices of those inputs.

Wiens (1976) compared results of a QP risk model with actual land use in a Chinese village. He used OEB to match the primal solution of the QP problem with actual use patterns and the dual solution of the QP model with market prices for farm resources to show the level of risk aversion of the farmer. Aggregate farm production response to risk has

been described in studies by Just (1974, 1976) and Hazell (1982) using similar techniques but with limited success. Some researchers have contended more cost-effective methods of measuring aggregate risk attitudes will involve predictive econometrics. They have argued that these aggregate results were more sensitive to the particular risk measure used and to expectations of risk than to the actual risk attitudes of the farmers involved in the study.

REVIEW OF PROCEDURES AND MODELS USED

A. General Review of Risk Models

Several attempts have been made recently to apply various static forms of risk sensitive farm planning to planning at the individual firm level. Such methods have two major disadvantages in comparison to currently used farm planning approaches such as linear programming or partial budgeting. One is the very intensive farm-specific data requirements of full-matrix, quadratic programming E-V models, and the other is the lack of expertise among farm management practitioners, as well as their clients, in the understanding and application of such models. Efforts center around simplifying the informational data requirements so that individual problems can be handled by extension agents without extensive training in risk management.

One recent effort (Collins and Barry, 1986) centers around simplification of data requirements through use of econometric estimation of variance parameters by use of the single-index portfolio model and application of Tobin's theory of separation to allow use of "canned" data bases for a specific region (Sharpe, 1963, and 1970). The single-

index portfolio model was used to identify an optimal mix of risky enterprises. The proportion of this mix to the alternative riskless enterprises was identified by application of the theory of separation in order to achieve a specific expected income level at minimum risk.

The theory of separation is a principle by which risky decisions may be greatly simplified when the choice set includes riskless or low-risk alternatives (Figure 1). In principle the theorem states that

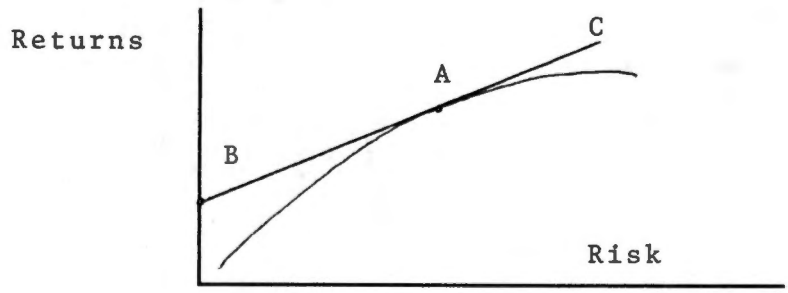


FIGURE 1. Graphical Example of the Theory of Separation

that in such a situation only one point, "A", on the risk efficient frontier of risky alternatives exists that maximizes utility for a given individual in the presence of riskless alternatives. Any other point on that frontier can then be described as being dominated by a mixed strategy of using some proportion of total resources in the mix of risky alternatives, with the remaining resources devoted to the riskless activities. The relevant E-V frontier then becomes linear in a single resource situation with at least one riskless alternative, with the choice of point on this line dependent on the degree of risk aversion of the decision maker. Point "B" represents total returns if all resources are devoted to the riskless enterprise. Any linear combination of these

two points dominates any other point on the E-V frontier of risky alternatives, and only if the farmer chooses point "A" will he or she be on this frontier. At points before tangency with the E-V frontier of risky alternatives, (B-A), the decision maker devotes some of his resources to the riskless alternative, while less risk averse managers become renters of the resource and devote the rented portion, as well as the owned portion, to the optimal mix of risky enterprises (A-C). The slope of the linear frontier then depends not only on returns and variances of the risky alternatives, but on the rental rate for the resource in riskless activities. The theorem also suggests that there is also an optimal mix of risky activities that is constant for all levels of risk aversion. Risk and income levels vary by changing the proportion of riskless enterprises to the proportion of the optimal mix of risky ones.

Limitations exist with this econometric approach used by Collins and Barry. First, this econometric estimation of the variance parameters does not allow the covariances of risky enterprises to be directly estimated. Actual risk may be greater or less than estimated depending on whether net return covariances are positive or negative, respectively (McCarl, et al., 1987). Second, no truly riskless alternatives are likely to exist in farm application of this technique; thus, application of the theory of separation is not strictly valid. However, in agricultural applications, situations do exist where levels of risk for some enterprises are lower by several degrees of magnitude than they are for others. In such cases, an argument may be made for application of this theorem where large portions of the E-V frontier approach

linearity. If a large segment of the frontier of risk efficient choices is composed of varying proportions between two or more groups of enterprises, the definition of the optimal mix of enterprises within each group may for many applications preclude the necessity of generation of the full E-V frontier.

Other recent risk models have used QP and MOTAD models as approximations of Expected Utility Maximization. Differences in these models usually center around generation of the risk portion of the objective function (Apland, et al., 1984; Brink and McCarl, 1978; Persaud and Mapp, 1979; and Kramer and Pope, 1982). Because of the difficulty in eliciting expected variances and covariances for possible activities, the generation of some estimates of these parameters became necessary. Efforts also centered around identifying the average degree of risk aversion among various groups of farmers.

Marginal risk constrained linear programming (MRCLP) is also used in risk modelling (Chen and Baker, 1974). This model is similar mathematically to quadratic programming and data requirements are identical.

Many analysts believe QP to be preferable for most applications and that other models should only be applied where size of the model or informational limitations preclude the use of QP. However, the models based on the linear programming algorithm have advantages over the quadratic models in the facility with which certain postoptimal procedures such as parametric and range analysis may be performed (Samuelson, 1947).

1. Quadratic programming and mean-variance analysis. Mean-variance analysis applied to decision making under uncertainty in a quadratic programming framework is conceptually straightforward (Arrow, 1971). The decision maker seeks to maximize expected utility subject to a set of linear constraints. By making several reasonable assumptions about the utility function of the decision maker, the objective function may be formulated as maximizing expected returns less some risk penalty.

The advantage of such a formulation is that it closely models one theoretical conception of how decisions are actually made. The more (or less) risk averse a decision maker is, the greater (or less) the risk penalty should be. A risk-averse person will not assume greater risk without expectation of greater returns. Quadratic risk programming is consistent with existing decision theory in an Expected Utility Maximization approach.

In the event that decisions are to be made in a QP framework, decision makers must base not only their estimates of returns on their expectations of prices and yields, but they must form some expectations of the variances of those returns. Because producers may be able to quantify expected returns but can rarely estimate or quantify levels of expected risk, the development of a proxy measure of expected risk, or net return variation, becomes necessary. Further, the chosen degree of risk aversion for the producer is arbitrary, yet crucial in determining the optimal risk efficient farm plan. Despite these and other limitations, QP continues to be the most common risk model applied to decision making at the farm level. Because of the extensive data requirements, much research effort has centered around estimation of the variance-

covariance matrix of returns (McSweeny and Kenyon, 1987). Thomas, et al. (1972), estimated return variances and covariances for selected farm enterprises based on time series data for use in a separable programming risk model. Covariances not significantly different from zero were later dropped, and the two models compared. The mean-variance efficient choice sets did not greatly differ. Thomas, et al., as well as Love (1972), believe that farmers base planning decisions on the long-term mean of historical returns and see any deviation from that return as a random event. Other researchers have whitened or removed nonrandom variation from the time series of returns so that random events are considered to be deviations from expected components of moving averages (Brink and McCarl, 1978; and Persaud and Mapp, 1980). ARIMA procedures have also been applied to this time series (Ibrahim and Williams, 1978; and Klien, 1978)

In spite of the problem of estimating return variances, quadratic programming has had numerous applications in farm management research, as well as in portfolio analysis. Applications of QP in empirical analysis for farm planning include estimation of risk efficient choice sets for Illinois grain farmers (Scott and Baker, 1972), comparison of utility maximization and profit maximization in California (Lin and Seaver, 1978) and a test of effect on risk levels of participation in government farm commodity programs (Musser and Stamoulis, 1981). Mundy, et al. (1987), used QP in examining the changes in net farm income and in income variation when alternatives to burley tobacco were considered in farm planning. Studies have also included marketing activities in a QP framework to determine what changes occur in the risk-efficient

choice set when contract crops are grown (Musser, et al., 1980; and Kliebenstein, 1975). Many other QP studies have been done. Portfolio QP risk models are represented by the work of Robinson and Brake (1979), Barry, et al. (1981), and Barry and Willmann (1976).

2. Single index portfolio analysis. Single-index portfolio analysis has been used to generate a series of estimates of the variation in net returns for possible enterprises that combines the effects of variance of an enterprise with the effects of possible covariances among enterprises (Elton, et al., 1976, 1978, and 1981; and Sharpe, 1963 and 1970). The single-index model provides a computationally efficient alternative to quadratic programming in describing risk-efficient choice sets.

The model was used by Collins and Barry (1986) in an application of Tobin's Separation Theorem to describe the risk-efficient choice set for California farmers. The computational advantages of this method over more traditional E-V methods were described as significant. The Collins and Barry study may be the first application of this method to agricultural problems. The single-index portfolio model has usually been applied in business and finance research.

3. Minimization of total absolute deviations (MOTAD). Minimization of total absolute deviations (MOTAD) models (Hazell, 1971) are a linear alternative to the quadratic risk models. The concept involves the minimization of total (or negative) absolute deviations around expected income subject to the constraint set. The risk-efficient solution set may be estimated by parametrically solving the problem on

expected income. A commonly used formulation minimizes, in a linear programming format, the sum of negative deviations from expected income subject to an income constraint.

If the objective function is used to specify return parameters and variables, data requirements for the MOTAD model are similar to those required for quadratic programming. While the MOTAD model does not require formulation of a variance-covariance matrix, it may indirectly consider covariances among alternatives.

The advantages of MOTAD models lie in their computational simplicity and in the assumption that the normality of the distribution of returns is not required. A normal distribution of net returns is required only in the event that the programmer chooses to minimize only negative deviations. The same application of the Theory of Separation can be made with this model as with the nonlinear techniques.

The disadvantages of MOTAD models are that they are less theoretically appealing. They also are, by definition, less statistically efficient than the nonlinear techniques. The identified optimums may be very close to those identified by quadratic alternatives, but no test is readily available to quantify that distance without actually constructing the quadratic programming (QP) model. The MOTAD alternative to the QP procedure was first described by Fisher (1920). He, as well as Davies and Pearson in 1934, established that variances estimated in this way are approximately 88 percent as efficient as the directly estimated population standard deviation. The relative asymptotic efficiency of the sample mean absolute deviation is 88 percent.

The first application of MOTAD in agricultural economics was by P. B. R. Hazell in 1971. He described the technique in detail and gave an illustration of its use in developing a farm plan. Later risk models utilizing the MOTAD approach include the 1978 Brink and McCarl study of Illinois grain farmers previously mentioned, a 1979 study of the effects of varying the degree of disposability of inputs on the risk-efficient choice set by Persaud and Mapp, as well as a later study by the same authors (1980) using MOTAD to model alternative production and marketing strategies. Schurle and Erven (1979) discussed the effect of errors in estimation of variances in farm planning using a MOTAD model. They addressed the question of how much change in risk is involved in a change of enterprise mix when returns are held constant. The authors raised serious questions about the validity and usefulness of all E-V type models as approximations of farmer behavior by showing only slight differences in total risk for a relatively wide range of farm organizations.

MOTAD models continue to be used in farm management research as alternatives and approximations to quadratic programming. Computational advantages inherent in using the linear algorithm, as in performing sensitivity analysis and parametric procedures, provide valid opportunities for their applications in research (Apland, et al., 1984; and Gebremelskel and Shumway, 1979). These models also continue to be used, along with QP and other E-V type models, in comparisons with newer forms of risk planning models (Kramer and Pope, 1981; and McCamley and Kliebenstein, 1986).

4. Marginal risk constrained linear programming (MRCLP). Chen and Baker (1974) proposed another alternative to QP risk models that may be formulated as a linear programming problem. The central assumption is that the decision maker seeks to maximize expected returns, provided that the marginal contribution of each enterprise to total variance does not exceed its expected net return divided by the risk aversion coefficient of the decision maker. Assuming net returns per unit constant over a reasonable range, the risk averse behavior of the farmer may be described in terms of the marginal risk constraint.

B. Computerized Farm Financial Planning Aids

Computerized farm financial planning aids have been in use in the farm management profession practically since the development of the modern computer. These management aids continue to provide researchers as well as farm managers with insightful information regarding current farm organization and financial stability. They also provide a format for exploring future organizational goals and objectives. However, these aids often provide only limited information regarding the potential stability of existing or projected future farm organizations. One such package, the FINPACK farm financial planning package, was developed by the Center for Farm Financial Management, University of Minnesota (University of Minnesota, 1985). Released for general use in 1986, it was adopted by several states including Tennessee as an important farm financial management tool. FINPACK is currently being used by Tennessee in providing intensive farm management assistance to individual farmers.

CHAPTER III

PROCEDURE

STATEMENT OF RESEARCH HYPOTHESES

Several risk models are available, the best of which is only an approximation of reality in that the elicitation of expectational returns vectors for possible enterprises or subjective estimates of variances and covariances of net returns for these enterprises is impossible (Just, 1975a and 1975b). Because planning at this stage is strictly a priori, events may occur ex post that will cause differences between the original farm plan and the organization that is actually implemented in any year. Probabilities of events not included in returns variances may also contribute to these differences. A hypothesis of this study was that none of these alternative risk models has any theoretical advantage in all situations even though some may have computational advantages (Just, 1976). Also hypothesized was that when variations in returns among alternative enterprises were influenced by common factors (i.e., weather), use of time-series procedures to remove all nonrandom movements of returns were not necessary conditions for generation of valid risk measures (Collins and Barry, 1986). Finally, theoretical grounds for the rejection of any of the more common risk models or measures in application to any farm do not exist. Farm management practitioners should select the model with data requirements and solution characteristics that most closely conform to the requirements of the problem at hand (Atwood, et al., 1986).

COLLECTION OF DATA

A. Background of the Burley Tobacco Industry in Tennessee

Because of the general homogeneity of production technology, the burley tobacco industry in Tennessee is well suited to farm management analysis. Tennessee farmers produced approximately 127 million pounds of tobacco on 61,710 acres in 1985 (U. S. Department of Agriculture, 1986). Tobacco accounted for approximately 11 percent of total cash receipts of Tennessee farms in 1985, a percentage surpassed only by income from dairy with 13 percent and soybeans with 12 percent. (When all classes of beef production were considered together, income from beef was also greater.)

While tobacco production has been a major contributor to farm net returns in Tennessee, the typical tobacco producing unit has not changed substantially in size in the past 25 years, primarily because of the institutional and geographic constraints imposed by the production control/price support program. Improvements in tobacco production have come primarily through improved varieties and more efficient use of fertilizers and pesticides and not through increased mechanization of this labor-intensive crop. While changes in the institutions controlling tobacco production have altered the contractual arrangements under which tobacco is grown, most tobacco in Tennessee is produced by small growers on small owned, share leased, or cash leased acreages.

The scale of tobacco production on a farm is typically limited by several factors. While availability of quota is an important constraint, lack of available barn space for curing and the very high

seasonal labor requirement also severely restrict the potential size of the tobacco crop on any particular farm. These limitations tend to lead to production on small acreages and contribute to the existence of a large set of alternative rental arrangements between owners of these limiting resources and the prospective producers of the crop. By selecting among these alternatives not only can the landlord specify an expected income level and amount of assumed risk, but renters of these resources can to a large degree do the same. These alternative arrangements provide the farm management practitioner with sets of alternatives that range from practically riskless to relatively risky. Farm plans can then be constructed to approximate a given level of risk by dealing with alternatives within each set. The existence of these sets also make the tobacco industry ideally suited to application of the theory of separation in the choice among these alternatives, as well as to comparisons among existing risk models.

B. Survey Description and Technique

A mail survey of Tennessee burley tobacco growers was conducted by the Department of Agricultural Economics and Rural Sociology in 1984. Management and production data from approximately 1,000 burley producers were elicited. The survey was conducted in 46 Tennessee counties where 30 acres or more of burley was grown per county. Names and addresses of growers in the sample were obtained from extension agents. The sample size varied by county according to acreage of burley tobacco as shown in Table 1.

The sampling procedure involved the n^{th} number technique. The sample was drawn from the population of all burley producers in each county. Each producer received an initial mailing that included the questionnaire and a cover letter explaining the purpose and goals of the survey. Nonrespondents were reminded periodically by postcard one week after the initial mailing, followed by a second mailing of the original questionnaire and a revised cover letter about two weeks later. Approximately 60 percent of the producers completed and returned the questionnaire.

TABLE 1

SAMPLING PROCEDURE: COUNTY ACREAGE OF BURLEY TOBACCO AND NUMBER OF PRODUCERS SURVEYED

County Burley Tobacco Acreage	Number of Producers Surveyed
30-100	10
101-300	20
301-1,000	30
1,001-2,000	35
2,001 +	40

Producers were questioned about the general size of their operation as well the acreages devoted to various crops and livestock numbers on the farm. They also responded to questions concerning their holdings of durable assets such as barns, machinery and equipment. Most importantly, the survey contained several questions regarding the production of burley tobacco. Farmers were asked to provide information

about the size of their tobacco crop in the past and expected size in the future. They were questioned as to what they considered to be the most limiting factors in tobacco production on their farm. They were also asked to designate by poundage produced under alternative leasing arrangements the total production of tobacco for the year, as well as cash rent paid or received for quota. The survey described 11 types of contractual agreements under which tobacco could be produced. These contractual tenancy arrangements could be ranked by amount of risk accruable to the farmer and the landlord.

CONSTRUCTION OF REPRESENTATIVE FARMS

Results from the 1984 survey contained only limited information about the resources of the responding farmers. Results also included little information about production techniques used to produce reported farm products. More complete information concerning the production of the responding farms was included in the results. For example, the survey identified price paid or received for quota, source and availability of labor for the tobacco crop, information regarding harvesting and marketing methods and information on use of machinery for tobacco. Representative farms were constructed using the reported production as a basis for synthesizing both representative levels of resources for each type of farm and estimating various production parameters for each enterprise. The basis for this approach lies in the general homogeneity of production techniques for farm products within the tobacco producing areas of Tennessee, and the low level of production necessary to capture most economies of size and scale for most agricultural enterprises.

Surveys were sorted by geographical production area, and no statistically significant differences at the .05 level were discovered to exist in enterprise composition or size within representative farms across the areas of Tennessee covered by the survey. While this economic engineering approach would be less applicable for studies proposing macroeconomic type recommendations, it seemed appropriate to the stated objectives of this study.

The process of sorting the collected data was, by nature, arbitrary both in the number of representative farms to be described and in the required qualifications for inclusion of an observation into a representative farm group. Further, the representative farms may or may not be designed to be mutually exclusive and assignment of an observation to one representative farm may or may not preclude its inclusion in another (Sheehy and Alexander, 1965). In the construction of representative farms for purposes of this study, farms were classified into farm types based on gross income received by selected enterprises on that farm. Gross income was chosen over net income to rank enterprises because of the characteristic low net returns received by some farm enterprises in recent years. For example, a large beef cow-calf enterprise might possibly return less net income than a very small fresh vegetable enterprise, but the farm be more representative of a beef cow-calf producing farm. Gross income level for each enterprise was not solicited directly in the survey but was calculated by application of standard budgets to crop acreages and livestock numbers reported. The result of this system of classification is that farm types were not mutually exclusive. A farm could be classified as "dairy" or "beef" or

"row-crop" and could be in more than one group. While recognizing that such segregation might lead to some errors in the aggregation of data, the necessity of limiting the total number of representative farms justified such a procedure (Day, 1963). Types of farms were selected so that the resource complement in terms of land, labor, capital and machinery were similar for each farm within a given type. Types of burley tobacco producing farms identified were row-crop, beef, dairy and hog. Farms with 10 or more beef cows could be considered as beef cattle farms, farms with more than 30 acres of row-crops produced could be considered row-crop farms, the presence of more than five sows qualified the farm to be classified as a hog-producing farm, as the presence of more than two dairy cows qualified the farm to be classified as dairy. While sizes of enterprises required for inclusion of any farm into a representative farm type were small, the size of farms in the survey were small. In some cases, enterprises as small as the minimum required would be unrealistic, considering that common enterprise budgets were used for all farm enterprise sizes, but a justification was that these small sized enterprises were the extreme, and that the average size was large enough to be considered realistic. Dominant type of farm tenancy was determined within each farm type by determination of the predominant form of tenancy under which most of the tobacco grown on each farm was produced. Tenancy types considered were owner/operator, which included cash leasing arrangements, sharecrop and landlord. However, because no farm operators identified from the survey were predominantly landlords in the production of the tobacco crop, this category was deleted. Finally, farms were classified as to size by dividing each

farm type and tenancy classification at the mean level of gross returns produced by the predominant type of activity on the farm.

Application of standard budgets to these reported production levels for each representative farm resulted in determination of levels of limiting resources for each farm. Resources judged to be potentially limiting were land by class, labor by two-month period and capital by type. Available land was classified as row-crop or pastureland. While row-cropland could be leased out, the only provision for the acquisition of additional row-crop acreage was in the availability of a sharecrop tobacco enterprise. Pasture acreage was fixed for each farm. Capital was classified as operating, investment and machinery. Investment in machinery was separated from other investment capital because of the difference in farm types. With dairy or hog farms, a larger proportion of investment capital would be for production facilities, while the investment for row-crop farms would largely be for machinery. Additional constraints were added to model tobacco quota availability and curing capacity, dairy and hog production facilities and facilities for the storage of hay. Also modelled was the availability of additional hired labor by two-month period, limited by the supervisory capacity of the farm operator. The supervisory capacity of the operator was a function of the hours of labor per period contributed by the operator.

Because the degree of risk-aversion of sharecrop farmers might be substantially different from landlords or owner/operators, farms were further classified by the predominant form of business organization of the tobacco crop. However, this division into type of tenancy arrangement was not made on the basis of degree of risk-aversion because

construction of the full frontier of risk-efficient choices does not depend on degree of risk-aversion. Division was made in this way because the resource complement for short range (annual) planning decisions may be substantially different for each type of tenancy. For example, a landlord might not possess the machinery complement necessary to begin actual production of the crop in the given length of run even though all other necessary factors were available.

Research studies, especially models that use representative farm approaches, are subject to two important types of errors, errors of specification and aggregation. The relative importance of each type of error depends on the use of the research. Research may be directed toward the macroeconomic level of aggregate supply and policy recommendations or the microeconomic individual farm level. Research may also be designed to be applied to problems between these two extremes (Schaller, 1966). This study centered on the farm level approach. While a meaningful course of action for an individual producer cannot be determined without some estimate of the effects of collective farmer actions, errors in aggregation in microeconomic studies may be of lesser importance. A properly specified model may be inaccurate if errors in aggregation exist or if the collective actions of farmers are not considered. However, the model will not properly reflect the response of any farmer if it contains serious errors of specification. If errors of aggregation are present, the model may not yield acceptable results over the long run; however, if serious errors of specification are contained in the model, results will be inaccurate for any planning horizon. Any representative farm research contains both types of errors

to some degree. The researcher should be diligent in his or her efforts to reduce their effects. The procedure adopted for this research perhaps sacrificed aggregation bias in favor of specification accuracy. Because of the possibility of such biases, no specific macroeconomic policy recommendations were intended. Complete representative farm construction results are presented in Tables 2 and 3.

DEVELOPMENT OF ENTERPRISE BUDGETS

Enterprise budgets for relevant farm activities were adapted from budgets developed by the Agricultural Extension Service, University of Tennessee, for 1984 (Tennessee Cooperative Extension Service, 1983a and 1983b). Although the extension budgets represent production levels achieved by only the upper 25 percent of farmers, they were used to establish a common standard level of costs for the various enterprises for all farms. Production at this level was feasible for all representative farms and was not dependent on some unattainable production technology. Because these budgets were developed prior to the 1984 marketing year, they were calculated using expected yields and prices for the various enterprises, as well as expected cost levels for inputs. These net returns from the developed budgets were used in the objective function for each model developed in this study. Gross returns were used in classification of farms into types as discussed above.

Budgets were developed for the production activities as shown in Table 4. These enterprises were common to the farms reported on the growers survey. In addition, other activities included the option of not producing any farm products, leasing out some owned resources (land

TABLE 2

REPRESENTATIVE TOBACCO FARMS: REPORTED ENTERPRISES AND LEVELS

Farm Type:[a]	Row-Crop Farms				Dairy Farms			
Tenancy:[b]	Owner/Operator		Sharecropper		Owner/ Operator		Sharecropper	
Size:[c]	Small	Large	Small	Large	Small	Large	Small	Large
Tobacco quota (lbs.)								
a. Owner/operator	6,276	9,173	1,250	0	4,943	5,247	0	95
b. Sharecrop	0	333	10,325	2,600	86	100	722	6,000
c. Landlord	591	667	0	0	87	0	0	0
Dairy cows (hd.)	.13	0	0	0	31	193	16	200
Beef cows (hd.)	62	140	33	12	12	33	3	0
Hogs (hd.)								
a. Sows	.09	0	0	0	1	3	.3	0
b. Feeder pigs	0	0	0	0	3	8	1	0
Field crops (ac.)								
a. Corn	46	268	38	100	11	82	0	3.7
b. Soybeans	27	106	5	25	0	18	0	0
c. Wheat	3	107	0	0	0	7	0	0
Number reported	22	12	4	1	23	14	3	2

Farm Type:	Beef Cattle Farms				Hog Farms			
Tenancy:	Owner/Operator		Sharecropper		Owner/ Operator		Sharecropper	
Size:	Small	Large	Small	Large	Small	Large	Small	Large
Tobacco quota (lbs.)								
a. Owner/operator	2,749	5,981	576	262	4,640	5,969	2,420	0
b. Sharecrop	8.7	467	4,275	2,307	133	0	7,800	14,000
c. Landlord	39.1	97.6	0	0	78	0	0	0
Dairy cows (hd.)	0	0	0	0	1	0	0	0
Beef cows (hd.)	29	97	16	63	57	70	53	0
Hogs (hd.)								
a. Sows	.17	0	0	0	12	200	12	200
b. Feeder pigs	0	0	0	0	34	1,200	34	2,800
Field crops (ac.)								
a. Corn	2.5	4.1	0	3.25	37	71	37	250
b. Soybeans	.45	.22	0	0	17	31	22	0
c. Wheat	0	.61	0	0	13	38	0	0
Number reported	69	41	7	4	49	8	3	1

[a]Farms were classified as to type by the presence of particular enterprises. See text for complete explanation.

[b]Farms were divided as to tenancy of the tobacco crop by the arrangement under which most of the tobacco was grown. See text for complete explanation.

[c]Farms were divided as to size according to gross returns to predominant farm enterprises after sorting into type and tenancy classifications. See text for complete explanation.

TABLE 3

REPRESENTATIVE FARMS: CALCULATED RESOURCES AVAILABLE

Farm Type:[a]	Row-Crop Farms				Dairy Farms			
Tenancy:[b]	Owner/ Operator		Sharecropper		Owner/ Operator		Sharecropper	
Size:[c]	Small	Large	Small	Large	Small	Large	Small	Large
Row-cropland (ac.)	78	419	44	125	31	219	13	113
Pastureland (ac.)	109	245	58	21	91	492	41	450
Capital (dollars)								
a. Machinery	2,448	11,477	1,826	3,509	1,246	7,275	496	4,588
b. Operating	20,892	67,056	12,739	14,724	12,941	66,784	5,217	50,918
c. Investment	4,403	16,466	2,628	4,260	5,167	28,527	2,211	24,941
Tobacco quota (ac.)	2.6	3.8	.5	0	2.1	2.2	.1	0
Total labor (hrs.)	608	3,642	1,952	799	2,669	12,887	1,120	12,796

Farm Type:	Beef Cattle Farms				Hog Farms			
Tenancy:	Owner/ Operator		Sharecropper		Owner/ Operator		Sharecropper	
Size:	Small	Large	Small	Large	Small	Large	Small	Large
Row-cropland (ac.)	4	7	.24	3	78	142	60	250
Pastureland (ac.)	51	170	28	111	120	122	92	0
Capital (dollars)								
a. Machinery	279	650	285	343	2,298	3,853	2,207	7,485
b. Operating	6,881	21,572	4,037	13,291	22,934	97,564	19,577	186,624
c. Investment	1,030	2,804	578	1,364	5,060	9,693	3,617	16,004
Tobacco quota (ac.)	1.1	2.5	.24	.1	1.9	2.5	1	0
Total labor (hrs.)	635	1,741	789	919	1,921	2,930	2,033	4,974

[a]Farms were classified as to type by the presence of particular enterprises. See text for complete explanation.

[b]Farms were divided as to tenancy of the tobacco crop by the arrangement under which most of the tobacco was grown. See text for complete explanation.

[c]Farms were divided as to size according to gross returns to predominant farm enterprises after sorting into type and tenancy classifications. See text for complete explanation.

TABLE 4

FARM ENTERPRISES AVAILABLE ON REPRESENTATIVE FARMS

1. Corn for grain or silage	8. Grade A dairy
2. Soybeans	9. Burley tobacco, owner/operator
3. Wheat	10. Burley tobacco, sharecrop
4. Wheat-soybeans	11. Burley tobacco, cash lease
5. Hay	12. Corn for silage
6. Beef cow-calf	13. Feeder pigs
7. Farrow-to-finish hogs	

and tobacco quota), leasing in additional resources (land, labor and quota) and purchasing additional livestock feed. No restrictions were placed on the size of each enterprise other than the limitations imposed by availability of resources, including tobacco quota. Budgets are presented in Appendix Tables 2-11.

CONSTRUCTION OF RISK MEASURES

To develop a time-series of net returns for use in calculating the variances and covariances of returns for use in the development of risk measures, the producer price index of prices paid by farmers for inputs (PPI) was applied to quantities and prices of inputs for the various enterprises from the 1984 budgets. A historical time-series of fixed and variable expenses for previous years was generated in this way for each enterprise. The error in estimates of variation in returns introduced by calculating historical costs of production in this way should be small because even though changes in production technology were ignored by this procedure, most variation in net returns was a

product of price and yield variability, not cost variability. While little cost variability is captured by such a process, the contribution of variation of cost to total net returns variation for these farm enterprises was small. Further, while actual production data for each year would be more desirable, such data are not generally available. Gross returns for activities were developed by applying historical seasonal average prices to annual yields as reported in Agricultural Statistics for Tennessee (USDA, 1954 to 1986). Net returns to operator land, labor and management were calculated by subtracting budget costs from gross returns for each year. Vectors of gross returns, net returns and product prices were developed in this way for each farm enterprise for the years 1954-1984. Application of historical price and yield data to old extension budgets (Tennessee Cooperative Extension Service, 1957 to 1984) and comparison of these returns with those calculated by the above method at approximately 10-year intervals provided a check that the resulting time-series of returns were realistic. Figure 2 provides a graphical example of the similarity between movements in returns calculated by these methods for one enterprise, soybeans. While no meaningful statistical tests of the difference between the two could be applied because of the small number of observations, the differences between them can be described as small. More importantly, differences in variances of net returns between the two were also small, averaging about 3 percent. Correlation between movements of the two measures were high, at about .98 on the average. This procedure for establishing a time-series of net returns does not consider changes in technology of production of any enterprise. However, the results were assumed to be a

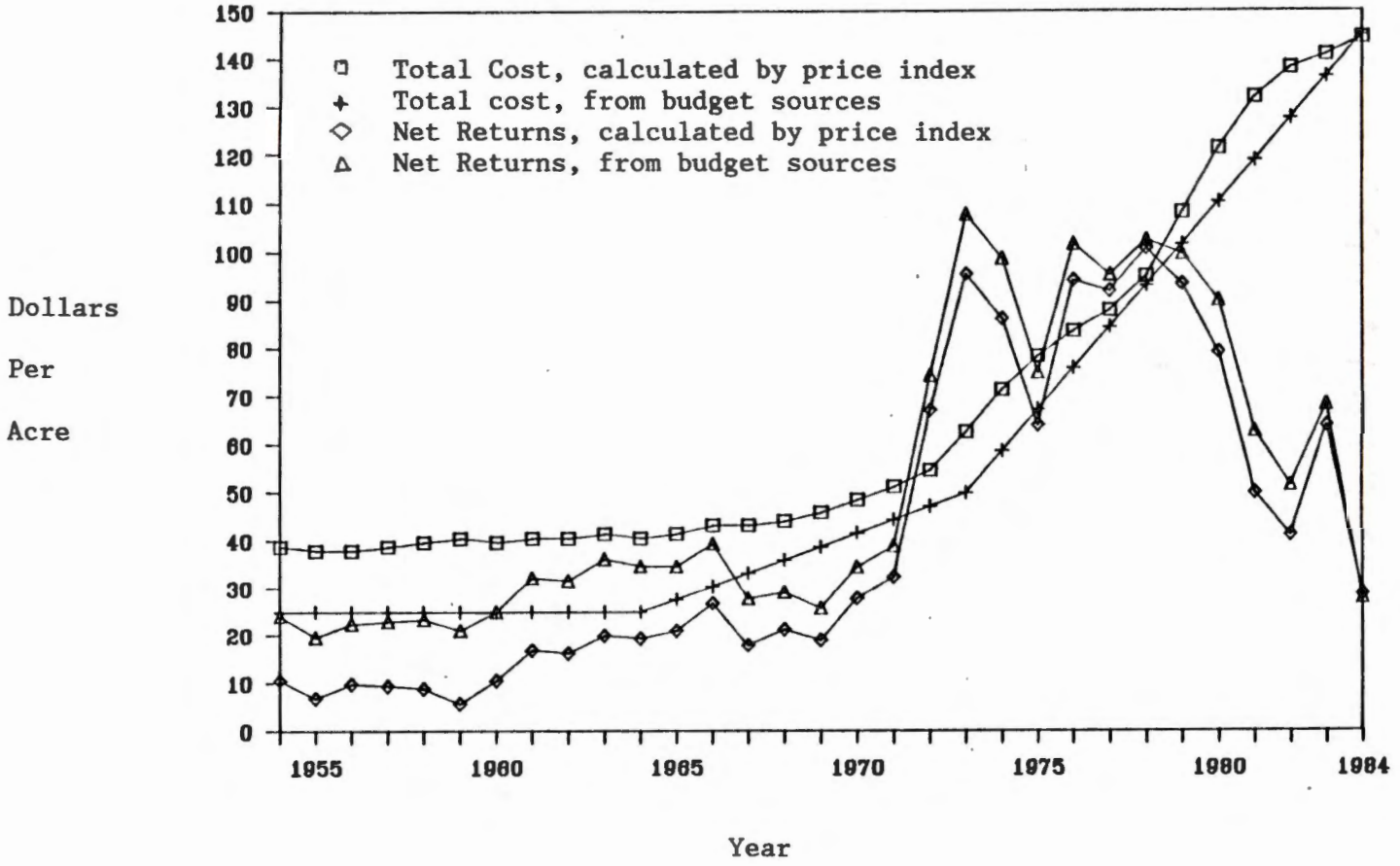


FIGURE 2

Costs and Net Returns for Soybeans, Calculated by Application of a Producer Price Index, Compared to Costs and Returns as Published in Extension Service Budgets, for the Years 1954 - 1984, in Nominal Dollars

close approximation of the movements in levels of returns over the past 30 years. The vectors are presented in Appendix Table 12.

These series of prices, gross returns and net returns were used in construction of variance-covariance matrices and deviation vectors. First, the matrices and vectors were developed using nominal prices and returns. Then, because of the general trend in the index of prices paid by farmers over the past 30 years, variances, covariances and deviations were calculated using deflated costs and returns. Other econometric procedures were used to generate vectors of residuals containing only random movements for the net returns series. Time series procedures applied included second-order trend removal, simple and weighted moving averages and ARIMA techniques.

When a quadratic programming format is used to portray decision making, the distribution of the random variables, usually net returns, is usually shown or assumed to be normal. The reason for this assumption is that any normal distribution is completely described by the mean and variance alone, with all higher moments equal to zero. Researchers usually cannot assume decision makers ignore the higher moments like skewness or kurtosis. If the returns distribution can be shown to be multinormal and if the effect on the utility function of each higher moment is additive, then these higher moments must have no effect on the identified optimum. If returns are not normally distributed, researchers are forced to either assume decision makers do not consider higher moments or that the effects of higher moments are symmetrically distributed for each enterprise (Buccola, 1986). Both are strong assumptions. The violation of either of these assumptions is sufficient

to invalidate results obtained in an analytical model. However, in practical applications of the technique where results are used in field applications as approximations of the true optimum, effects of these higher moments are usually considered small enough to be ignored. As distributions approach the normal, these effects are naturally reduced. These problems are avoided if the relevant variables can be shown to be normally distributed.

Net returns vectors for the various crop and livestock enterprises that were developed for the 30-year period were tested for normality. The possibility that returns were not normally distributed could not be rejected above the 10 percent level of significance for any enterprise. Tests were not conclusive for any enterprise primarily because of the low number of observations generated for each series. Similar series of returns have been tested for distribution type by other researchers (Carter and Dean, 1960; Day, 1965; and Collender and Zilberman, 1985). Research using time-series data without removal of nonrandom elements in which net returns have been shown to be normally distributed have been extremely rare.

In work with risk programming where the assumption was made that decision makers behave as if they subjectively remove trends or otherwise whiten the returns series vectors, greater success in showing returns to be normally distributed has been demonstrated (Brink and McCarl, 1978; and Persaud and Mapp, 1980). These studies proceeded under the assumption that any identified optimum closely approximated the theoretical point and that further assumptions about the utility function of the decision maker were not necessary.

The deflated time-series of net returns and prices for each enterprise was tested to determine whether or not they were normally distributed. The hypothesis that they were not normally distributed could not be rejected at any acceptable level of significance for most enterprises ($a <= .10$).

Integrated autoregressive moving average techniques (ARIMA) were applied to the deflated time-series of net returns for each enterprise. Because of the limited number of observations used, ARIMA modeling could not be effectively applied because the loss of a large number of degrees of freedom reduced the efficiency of tests of the time-series residuals for nonrandom elements. A risk measure based on ARIMA forecasts of expected net returns was included because of the prevalence of such measures in current risk research (Ibrahim and Williams, 1978; and Klien, 1978). However, statistical tests of the ARIMA residuals indicated that the hypothesis of nonnormality could be rejected at significance levels below 10 percent.

The deflated time-series of returns were also "whitened" by application of moving average procedures. Residuals from a five-term simple moving average were also used in construction of a variance-covariance matrix. Residuals were also generated using a five-term weighted moving average with relative weights of 10, 25, 50, 75 and 100 (normalized). Tests of these series indicated that the hypothesis of nonnormality could be rejected at levels of significance below 10 percent.

Finally, deflated net returns vectors were subjected to second-order trend removal, and again these residuals were used in calculation

of a final variance-covariance matrix. While confidence intervals of tests of these residuals were wide, the hypothesis of nonnormality could be rejected at the 10 percent level of significance.

Confidence intervals for these tests, because of a limited number of observations and the loss of a large number of degrees of freedom in some of the more advanced procedures, were wide. The resulting vectors were used in construction of variance-covariance matrices for the QP type models. Similar procedures were used in the development of deviations vectors for use with the MOTAD models. Complete variance-covariance matrices are presented in Appendix Table 13.

In this research, the first objective was the validation of risk measures based on aggregate (state) price and yield data for use in farm management oriented applications of risk modelling. In spite of the application of McCarl's "validation by results" principle as previously described, some justification must be offered for not choosing to compare these aggregate measures of risk to farm-specific data. This defense is centered on two considerations, the first theoretical and the second of a more practical nature.

First, if the E-V model of decision making as presented is accepted, an assumption must be made that the measure of risk to be used is truly representative of the subjective estimates of the riskiness of the various enterprises made by the farmer. The particular variance-covariance matrix of net returns to be used must also represent the relationships between the variations of net returns among the different enterprises. Of course, this comparison is impossible with any data without actually eliciting these subjective estimates from the decision

maker. Further, while individual farm historical data should produce a variance-covariance matrix of net returns characterized by more variation than one produced using aggregate data (Debrah and Hall, 1987), the assumption that the farmer bases those subjective risk estimates solely on the past performance of the individual farm, discounting completely all aggregate information is strong. More likely the subjective risk estimates of a farmer are based on all readily available information, including aggregate data. If these subjective risk estimates are constructed from all available information, including aggregate data, the problem becomes one of weighting farm-specific versus aggregate information. Aggregate information may be as important or more so than individual farm data, given that individual farm data is often essentially qualitative in nature, not completely accurate, and does not extend over a very long time period. At the very least risk measures based solely on aggregate data contain some proportion of the information used by decision makers in forming the required subjective risk estimates just as risk measures developed solely from farm-specific data contain a proportion. No a priori reason to expect that risk measures derived from one type of data should perform better than the other as a proxy measure of that subjective risk estimate is obvious. Although farm-specific risk estimates may exhibit higher variation than aggregate measures, risk models characteristically consider only relative variation, not absolute, in the specification of risk-efficient choice sets.

Secondly, and more practically, these subjective risk estimates are difficult and expensive to estimate accurately. Any statistical comparison between the subjective risk estimate assumed to actually be

used by the farmer and any measure developed nonsubjectively must be made over a wide range of observations. Eliciting these subjective risk estimates for comparison to the aggregate estimates is well beyond the scope of this research. Comparisons of aggregate risk measures to subjective measures elicited from farmers would probably not be statistically testable unless measured on a very large scale over a wide range of farm sizes, types and geographical areas.

CONSTRUCTION OF MODELS

A. Quadratic Programming

Many equivalent formulations of the QP risk model exist. Construction of an E-V frontier requires parameterization of the risk-aversion coefficient; therefore two forms of the problem were considered. The first was written as

$$\text{Maximize } Z = c'x - \alpha/2x'Wx$$

$$\text{Subject to: } Ax \leq b$$

$$x \geq 0$$

where:

Z = the value of the objective function to be maximized

c = an nx1 vector of expected returns

x = an nx1 vector of activity levels to be discovered

W = an nxn variance-covariance matrix

A = an mxn matrix of technical coefficients

b = an mx1 vector or resources, and

α = a scalar risk-aversion coefficient

Only the relative magnitudes of the two terms (c'x and x'Wx) in the objective function are important in the generation of the risk-efficient choice set in this formulation. Consequently, the parameterization of c, involving only n terms (where n is the number of possible activities or enterprises) has the same effect as parameterization of the risk-aversion coefficient, α, involving n^2 terms. This parameterization is easily accomplished in the objective function by multiplying c by a scalar parametrically varied from zero to unbounded. The effect of doubling the values of c is the same as halving the value of α. In this formulation the value of the objective function is not equal to net returns so that both net returns and total variance of the solution must be separately calculated from the solution values of x. However, total net returns are given by c'x and total variance is calculated as x'Wx. Both suggest a more computationally efficient formulation of the quadratic programming problem.

The second formulation of the quadratic programming problem is formulated so that solution values for both expected returns and expected variance of returns do not need to be separately calculated. The exact formulation is given by

Minimize $Z = x'Wx$

Subject to: $c'x = \lambda$ (λ is a scalar parametrically varied from 0 to unbounded)

and $Ax \leq b$

$x \geq 0$

Where all other variables are as described for the preceding formulation. This quadratic programming problem is mathematically equivalent to the first formulation, but in this case the solution directly yields

net farm income (λ). Total variance of the solution is equal to the value of the objective function.

B. Minimization of Total Absolute Deviations

The MOTAD model involves an alternative estimation of population variation in estimating the variation of returns for possible farm organizations. This alternative estimate has been termed the mean-absolute deviation and may be defined as

$$A = 1/s \sum_{h=1}^{s} \left| \sum_{j=1}^{n} (c_{hj} - g_j)x_j \right|$$

where:

A = total mean-absolute deviation

s = number of observation or periods

c_{hj} = net return of enterprise j in period h

g_j = average net return of enterprise j over the s periods

x_j = level of activity j in the farm plan for j=1 to n where n is the total number of possible enterprises

Because A can be shown to be an unbiased estimator of population mean-absolute deviation, a model can be constructed in which expected net return and mean-absolute net return deviations are decision parameters in the selection of optimal farm plans. The major difference between using variances and covariances as estimates of income variation and mean-absolute deviation is that interrelationships between activities are not directly accounted for in estimates of population mean-absolute deviation. This disadvantage means that no directly elicited responses of an individual decision maker regarding subjective estimates

of the variation in net returns of any enterprise can be incorporated into the model. The main advantage of using deviation rather than variances is that deviations permit the use of a linear programming algorithm rather than a quadratic one. At the time P. B. R. Hazell first applied MOTAD to agricultural problems, no generally acceptable quadratic programming algorithm was available. Even now the application of quadratic programming does not lead automatically to global optimums.

Because 1/s is constant and thus does not affect solution values of x or A, the problem was formulated to minimize sA. Following Hazell's example, the problem was written as:

$$\text{Minimize } sA = \sum_{h=1}^{s} \left| \sum_{j=1}^{n} (c_{hj} - g_j)x_j \right|$$

$$\text{Subject to: } c'x \geq \lambda \qquad (\lambda \text{ parametrically varied from zero to unbounded})$$

$$Ax \leq b$$

$$x \geq 0$$

where sA represents total-absolute deviations, c is a vector of expected gross margins for the current planning period and other variables are as previously defined. To convert this to a LP problem, new variables were defined as:

$$y_h = (c'_h - g')x$$

where g is a vector of average net returns for each enterprise during the h periods and c_h is a vector of net returns for all enterprises in period h. In this way, each element of y_h, for example c_{ih}, represented net returns for the i^{th} enterprise in period h. The variable y_h represents the sum of deviations in net returns for all enterprises for a

single period and may be either positive or negative in sign. The variable may also be defined as:

$$y_h = y_h^+ - y_h^-, \text{ and}$$

$$y_h^+, y_h^- >= 0$$

where y_h^+ and y_h^- represent positive and negative sums of deviations in net returns for period h respectively. By this manipulation the y_h satisfy the nonnegativity constraint of linear programming. Further, if y_h^+ and y_h^- are selected so that one is zero, then

$$y_h = y_h^+ - y_h^- \text{ for } h = 1 \text{ to } s$$

The linear programming problem then becomes

Minimize $sA = (y_h^+ - y_h^-)$

Subject to: $(c'_h - g')x - y_h^+ - y_h^- = 0$ (to force either y_h^+ or y_h^- to 0 in each period)

plus the usual constraints

$c'x =$

$Ax <= b$

$x >= 0$

The following matrix notation was defined to describe a more manageable notation for this LP problem. Let C be an s by n matrix constructed as a set of time-series vectors for n activities over s years:

$$C = \begin{bmatrix} C_{i1} & \cdots & C_{in} \\ \vdots & & \vdots \\ C_{s1} & \cdots & C_{sn} \end{bmatrix}$$

where C_{ij} is net return for the j^{th} activity in the i^{th} year. The columns represent the enterprises, the rows represent observations or years.

Also, let g be an 1 by n vector of average gross margins for n activities, and let x be an n by 1 vector of activity levels to be discovered. Finally, define G as an s by n matrix formed by g'i where i is the 1 by s unit vector. Thus:

$$G = \begin{bmatrix} g \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ g \end{bmatrix} = \begin{bmatrix} g_1 \cdot \cdot \cdot \cdot \cdot \cdot g_n \\ g_1 \cdot \cdot \cdot \cdot \cdot \cdot g_n \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ g_1 \cdot \cdot \cdot \cdot \cdot \cdot g_n \end{bmatrix} \qquad (sxn)$$

The first MOTAD constraint to satisfy the nonnegativity requirement for the y_h can be written as:

$$x'(C-G) - y^+ - y^- = 0$$

where y^+ and y^- are 1 by s vectors of the y_h^+ and y_h^-. In matrix notation the problem becomes:

Minimize $\quad sA = (y^+ - y^-)'i$

Subject to: $\quad x'(C-G) - y^+ - y^- = 0$

$\qquad\qquad c'x = \lambda \qquad (\lambda$ varied from 0 to unbounded)

$\qquad\qquad Ax <= b$, and

$\qquad\qquad x, y^+, y^- >= 0$

If the problem is not formulated to minimize deviations from average net returns, the chosen trend or estimated time path of net returns for each activity can be inserted into G. Therefore, the

process of whitening the original time-series of net returns does not alter the problem formulation. Whatever the formulation of G, A remains an unbiased estimator of returns variance, although its degree of efficiency will vary. If the returns vector exhibits a trend or has autoregressive or moving average components, use of procedures to remove these elements will improve the efficiency of A.

These matrices and vectors are easily constructed and facilitate solution of the problem. As λ is parametrically varied from zero to unbounded, a set of risk-efficient choice sets can be generated as with mean-variance (E-V) type quadratic programming. In the absence of a measurable mean-absolute deviation (E-A) utility function, the utility-maximizing choice within this set cannot be mathematically determined. However, choices among E-A risk-efficient sets can be made in the same way as with E-V sets, so the choice cannot be more difficult. MOTAD models are also, as with quadratic programming models, suitable for application of the theory of separation.

C. Marginal Risk Constrained Linear Programming

The central proposition of MRCLP is that if an enterprise enters the optimal farm plan, it should enter to a level such that the expected marginal utility of that enterprise is zero, in the absence of other more binding constraints. The contribution to total variance of each enterprise can be written as:

$$2\left(\sum_{k=1}^{n} s_{jk}x_k\right) \qquad \text{for } j=1 \text{ to } n$$

where x_j is the level of enterprise j and s_{jk} is the covariance between activities j and k. Where j=k, s_{jk} represents the variance of the enterprise.

Because each s_{kk} must be positive, the total variance of a solution must increase as x_k increases, holding all other activity levels constant (Heady, 1952). If expected utility is written

$$E(U) = c'x - \alpha/2x'Wx$$

where:

W = nxn variance-covariance matrix

α = risk-aversion coefficient

x = nx1 vector of activities

c = nx1 vector of returns)

then $$\frac{\partial E(U)}{\partial x} = c' - \alpha x'W$$

or $$\frac{\partial E(U)}{\partial x_j} = c_j - \alpha \sum_{k=1}^{n} s_{jk}x_j$$

which, at the optimum, must be greater than or equal to zero.

In a linear programming format, the problem becomes

Maximize $c'x$

Subject to: $c'/\alpha - x'W >= 0$

$Ax <= b$

$x >= 0$

where:

A = mxn matrix of technical coefficient

b = mx1 vector of resources

which is solvable by any linear programming algorithm. By parametrically varying α between zero and infinity, the E-V risk-efficient

set of choices may be constructed. However, if the QP equivalent problem is formulated as

Maximize $c'x - \alpha/2x'Wx$

Subject to: $Ax <= b$

$x >= 0$

the similarity of the two methods can be seen. When the QP problem is solved for the Kuhn-Tucker conditions, the first set of constraints of the problem becomes

$$x'\frac{\partial L}{\partial x} >= 0 \qquad \text{(where L is the Lagrangian)}$$

which can be written as

$$c'x - \alpha x'Wx >= 0$$

If x is constrained by nonnegativity to be greater than or equal to zero, then

$$c'/\alpha - x'W >= 0$$

which is directly comparable to the MRCLP constraint. Further,

$$\frac{\partial L}{\partial \delta} = Ax - b$$

which is the linear constraint set, where δ is an mx1 vector of Lagrangian Multipliers. When this second constraint group is set equal to zero, it becomes equivalent to the second MRCLP constraint. Chen and Baker (1974) report some differences in basis changes for the two models. These differences can occur if enterprises not in the basis have shadow prices greater than zero. Consequently, improvement in the value of the objective function will occur when these enterprises are removed from the problem, even though they are not currently in the solution. For the MRCLP solutions to duplicate the QP solutions, the

problem must be adjusted at every basis change to eliminate those enterprises not in the basis but with shadow prices greater than zero. The data requirements for MRCLP models are the same as those for the QP formulation. The same assumptions about expected utility maximization are also required for both.

The procedure for establishing MRCLP solutions to a problem closely followed that previously outlined for QP because of the similarity in data requirements. The theoretical basis for MRCLP is the assumption that the decision maker seeks to maximize returns subject to a marginal risk constraint. This constraint provides that the marginal contribution of each activity to the total variance of the farm does not exceed the marginal expected return of the activity divided by the risk-aversion coefficient of the decision maker.

The linear programming problem written in matrix notation is

Maximize $\quad c'x$

Subject to: $\quad c'/\alpha >= x'W$

$\quad Ax <= b$

$\quad x >= 0$

where:

c is a vector of expected returns for alternative activities

x is a vector of activity levels to be discovered

W is a matrix of variances and covariances

A is a matrix of technical coefficients

b is a vector or available resources, and

α is the risk-aversion coefficient of the decision maker

By parametrically varying α from 0 to unbounded a risk-efficient frontier of choice sets was constructed without knowledge of the specific risk-aversion coefficient of the farmer. The mathematical similarity between MRCLP and QP has been previously described, and resulting solutions from each model may be very close.

D. Single-Index Portfolio Model

The procedure followed in constructing the single-index portfolio model involved selection of a suitable regressor on which to regress the time-series of returns for each possible activity to provide the necessary measure of risk for that activity or enterprise. Based on the suggestion of Collins and Barry (1986), net returns from each enterprise were regressed on net farm income for Tennessee as published in Agricultural Statistics (USDA, 1954-1984).

A basic premise for the single-index model is the assumption that the net return of each activity is linearly related to some common factor as well as to random elements. For example, the returns to some enterprise "i" is expressed as

$$r_i = a_i + B_i * r_m + e_i$$

where r_i and r_m are the returns to activity "i" and the common factor discussed above, respectively, and a_i and B_i are estimates of intercept and slope parameters, respectively. The variance of returns for any enterprise can then be expressed as

$$\begin{aligned} Var(r_i) &= E[a_i + B_i * r_m + e_i - E(a_i + B_i * r_m + e_i)]^2 \\ &= B_i^2 * \sigma_m^2 + \sigma_{ei}^2 \end{aligned}$$

The variance of returns is thus expressed in two parts. The first part is a measure of the correlation to the variability of the general measure of each activity, while the second is a measure of the unique variability of each activity. In some applications the single-index model may include the assumption that in a well diversified portfolio the portion of variation in net returns of each enterprise that are not correlated with the variation of the general measure are also uncorrelated with each other. The result of this assumption is that the expected value over all possible activities of this portion of the total variance is zero, or

$$E \sum_{i=1}^{n} \sigma_{ei}^2 = 0$$

and $E(\sigma_{ei}\sigma_{ej}) = 0$

thus $\sigma_i^2 = (B_{i\sigma m})^2$

or $\sigma_i = B_i\sigma_m$

In this study, after the time-series of returns for selected farm activities were regressed on net farm income, the resulting estimated parameters were included in the underlying quadratic programming model as

$$\text{Maximize} = [x'a + R_m(x'B) - [x'\sigma x + x'B\sigma_m{}^2]$$

$$\text{Subject to: } Ax <= b$$

$$x >= 0$$

where:

x = an (nx1) vector of activity levels to be discovered

a = an (nx1) vector of estimated intercept parameters

R_m = the mean value of the general measure

B = an (nx1) vector of estimated slope parameters

λ = a scalar varied parametrically from zero to unbounded

σ = an (nxn) diagonal matrix of the σ_{ei}^2 from the regression of each activity on the general index

σ_m^2 = estimated variance of the general measure

A = an (nxm) matrix of technical coefficients, and

b = an (mx1) vector of resource levels

Examination of the objective function reveals that in this model both expectations of future returns as well as estimates of the variances of possible activities are formed in a completely different way from any other model. The objective function consists of two terms. The first could be termed a forecast of income based on the regression parameters discovered in the regression stage of the problem. One flaw in this procedure lies in the use of R_m, which requires, if time-series data are used, that decision makers be unable to distinguish trends in returns to the possible activities. The use of detrended data is required to circumvent this problem if the full single-index model is used. Alternately, the c' vector of expected net returns can be applied to the vector of enterprise levels, leaving only the variances of the enterprises to be estimated by use of the regression parameters. The second term of the original objective function involves estimates of returns variability for the farm. The two parts of the second term are estimates of nonsystematic and systematic returns variances, respectively.

While this is a quadratic programming problem, the fact that σ is a diagonal matrix allows significant improvement in computational efficiency, as well as assuring that the solution set is convex. The only restriction is that the chosen r_m index generally move with the activities. Because covariances are not directly estimated, one must assume that they are approximately equal between all activities.

ESTIMATION OF DEGREE OF RISK-AVERSION

If some form of risk planning is to be considered superior to currently used farm planning techniques, it should result in farm plans that are more useful to users of these techniques. The resulting plans should more closely resemble potential or planned organizations of any particular farm. This premise assumes that the model is successful in estimating the risk perception of the farmer. Because models are by definition abstractions and simplifications of reality, no model can capture all facets of a real situation. However, models that include risk in making decisions must be considered superior to those that do not in applications where the risky nature of decisions is to be examined.

These techniques of planning are by their nature somewhat static, because they do not encompass the sequential nature of many decisions. Nevertheless, they do contain elements of risk that are important at the early stages of planning such as at the beginning of the cropping season. Sequential models may allow in some cases for alternatives that are not available in single-stage models, or for other sources of risk. However these static models do reasonably well in describing the initial

step in the planning process, just as the nonrisk static models do in describing problems they are designed to address.

If some point on the frontier of risk-efficient choices can be identified that approximates the actual organization of the farm without use of constraints that do not reflect the resource complement, the degree of risk-aversion of the decision maker will have been estimated. If several farmers with similar resource complements can be identified, their level of risk-aversion may be ranked by differences in farm organization. Finally, farmers may be identified as landlords, owner/operators or sharecroppers by assignment of some characteristic level of risk-aversion. All types of farm ownership arrangements should not have the same resource set, but the identified level of risk-aversion is ordinally comparable across solutions for the same formulation of the problem. So long as returns and variances are calculated by the same method, the levels of risk-aversion identified for different farmers should be on the same ordinal scale (Turvey and Driver, 1986).

The identification of a general range of risk-aversion for any general type of farm business organization would be a valuable farm management tool. In such a case, construction of the full set of risk-efficient choices would not need to be attempted. In the presence of relatively riskless alternatives, this range of risk-aversion parameters could be applied to the optimal mix of risky alternatives and to the riskless alternatives. Hence, the relevant range on the E-V frontier could be identified by application of Tobin's theory of separation.

DESCRIPTION AND APPLICATION OF FINPACK

The FINPACK farm financial planning package was developed by the Center for Farm Financial Management, University of Minnesota (University of Minnesota, 1985). Released for general use in 1986, it was adopted by several states including Tennessee as an important farm financial management tool. FINPACK is currently being used by the Extension Service in Tennessee to provide intensive farm management assistance to individual farmers.

FINPACK is composed of several divisions (Figure 3), each concerned with a separate segment of financial planning. FINAN is used to analyze the current financial position of the farm by analyzing the farm business performance of the previous year. Actual farm records are used to generate beginning and ending financial statements for the year.

The second section of FINPACK, FINLRB (Financial Long Range Budgeting), is used to examine alternative plans that might be implemented in the future. FINLRB compares three such possible long-range plans in each computer run. The speed at which solutions are obtained make the examination of a large number of alternatives feasible. Plans are compared as to projected profitability, liquidity and solvency. The effects of a prolonged depression of prices and production are examined from the standpoint of returns on investments, asset to capital ratios, short-term solvency and rate of debt retirement. Finally, FINFLO is used to project a monthly cash flow for any plan for the succeeding year, and FINTRAN projects an annual cash flow for a two- to three-year transition period for the farm business.

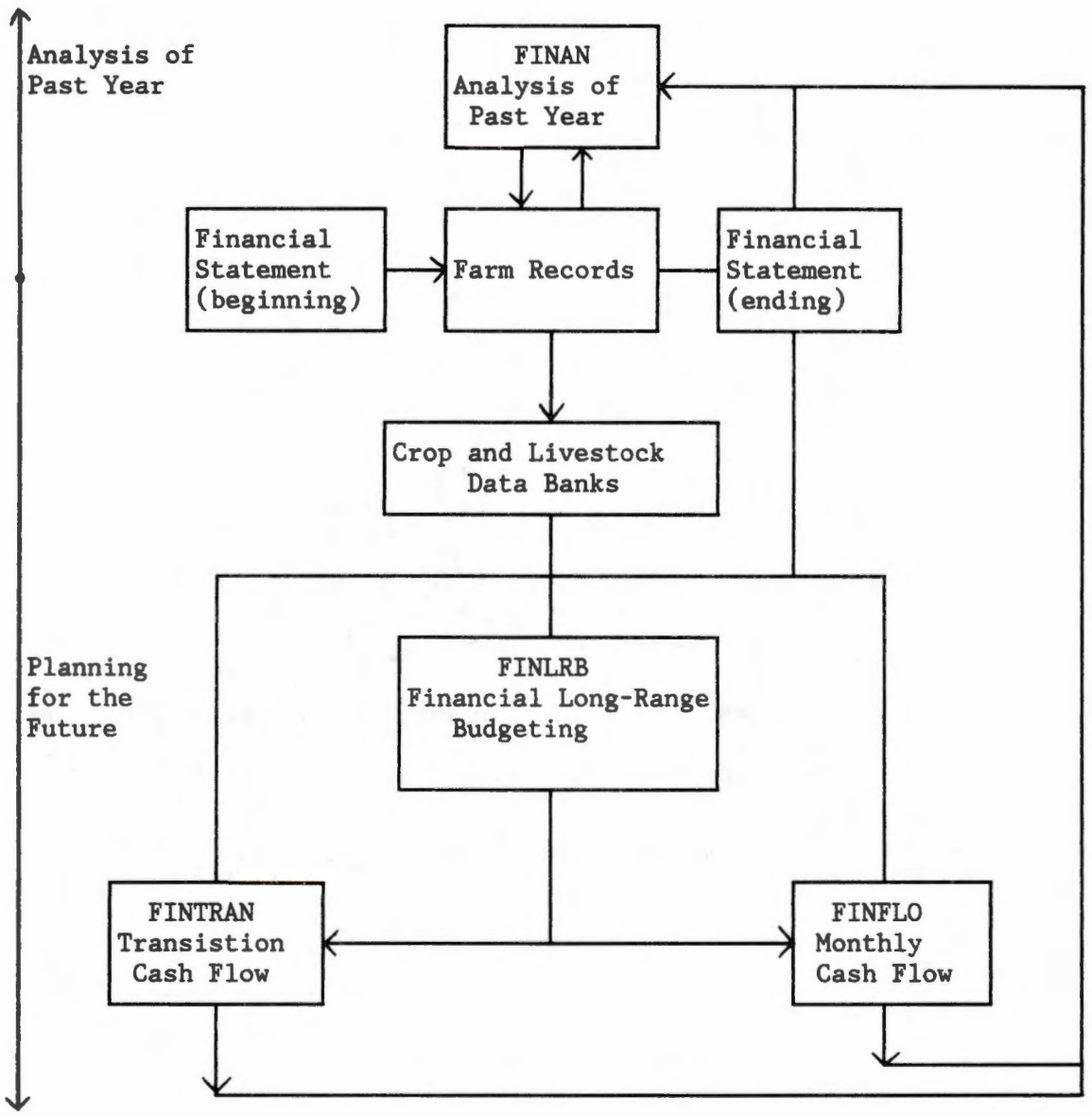


FIGURE 3

SCHEMATIC DIAGRAM OF THE FINPACK FARM FINANCIAL PLANNING PACKAGE

QP and MOTAD risk programming procedures were applied to a typical farm using data supplied from the FINAN section of FINPACK. A set of risk-efficient farm plans were generated that varied in total exposure to risk. These alternatives were subjected to long-range financial and sensitivity analysis by application of FINLRB. Selected alternatives were further examined by application of FINFLO and FINTRAN.

ANALYSIS

Given enough observations, statistical tests could be applied to the first two of the stated objectives of this study. Both types and levels of selected enterprises, as well as net returns and their variances could be tested for conformity across the several models, given enough data. Such was not the case, however, for this study. There were enough observations to test the time-series of net returns and the residuals of the series after application of "whitening" procedures for the type of distribution each represented. However, even here confidence intervals were very large. For this reason, and because of better conformity with the stated objectives, the analysis was limited, in most cases, to a more general, and perhaps more useful, less quantitative level. Comparisons among risk measures and models were left at a more subjective level.

Direct statistical comparisons among estimates of variances and covariances of alternative residuals vectors of the time-series of net returns were not possible. However, the major importance of differences among risk models using alternative estimates of net return variation was not in the absolute estimates of risk levels but in the comparisons

of enterprise mix and levels at various levels of total net returns (McCarl and Apland, 1986). If alternative measures of risk when applied in a farm programming problem yielded generally equivalent farm plans, then the areas of comparison among the alternative methods of risk estimation centered on how well each method conformed to Young's criteria as well as on the degree of complexity of the estimation technique. Also important was the simplicity of application, depth of data requirements and the ability of the procedure to rank activities as to relative riskiness and the effect on net returns of changes in various combinations of risky activities.

The same methods of comparison that were used to evaluate usefulness of various techniques for estimating net returns variation were also applied to the analysis of the alternative risk models examined. The critical area of evaluation was the identification of the enterprise mix selected by each model at various levels of returns. Also important to the analysis was the identification of data requirements necessary in the initial formulation of each model and the sensitivity of the results from each model to changes in the level of risk-aversion of the decision maker.

Finally, alternative risk-efficient farm plans were examined by application of the FINPACK farm financial planning package. One deficiency of this package that has been noted is the limited extent to which the effects of variation in prices and production can be examined for long-range planning purposes (Garland, 1987). Currently, FINPACK limits sensitivity analysis of alternative long-range plans to an examination of the effects of a 10 percent reduction in value of produc-

tion. While this procedure does provide some indication of the relative stability of a plan and the changes in farm solvency resulting from such a decline, it does have limitations. Such a procedure offers no information regarding the expected frequency of such price declines and fails to consider covariances between net returns of enterprises. Thus, the procedure offers no direct advantage to stability for diversification. Because risk models must by definition make some estimate of the expected variation in net returns for various farm enterprises, the effect of a given percentage of standard deviation decline in total farm profitability might be a more aeaningful measure of farm stability. In this research FINLRB was used to examine the farm financial position under alternative plans. The sensitivity of these alternative plans to changes in value of production as provided by FINPACK was compared to the variance of returns predicted from the risk models.

CHAPTER IV

RESULTS AND INTERPRETATIONS

REVIEW OF RESEARCH HYPOTHESES

An important hypothesis of this study was that when the time-series of net returns for enterprises were affected by the same exogenous variables, removal of all but random deviations were not necessary for the generation of useful risk measures. Although some of the simpler measures were not expected to fare well in comparison to Young's criteria, this agricultural application of risk programming was expected to be a case where strict compliance with these criteria was not essential to the generation of useful farm management information. In other words, the correlations among estimates of variation in net returns using various econometric whitening techniques were expected to be high.

The comparison of alternative risk models was hypothesized to demonstrate that several risk models are suitable for agricultural applications. The applications of alternative models in representative farm applications were expected to demonstrate that a high degree of correlation among models existed in terms of enterprise selection and levels at all levels of returns. The application of alternative risk models across such a wide range of farm types was also expected to reveal areas where particular models might be expected to be exceptionally appropriate. Further, any problems encountered in model development, application or data collection were expected to be demonstrated by these applications.

The application of the FINPACK package to farm data was expected to demonstrate that measures of risk, and risk programming models are currently available that offer advantages to farm management practitioners over currently used sensitivity analysis procedures. Techniques in farm planning that consider risk were expected to be shown to be useful in providing alternatives for long-range planning considerations. Measures of sensitivity and methods of sensitivity analysis that more accurately reflect actual exposure to risk were to be suggested.

COMPARISON OF RISK MEASURES BY MODEL RESULTS

The optimal organizations of each representative farm using QP farm planning were similar regardless of the formulation of the risk measure, as shown in Appendix Tables 14 through 21. Enterprise size was not the only variable in evaluation of the ability of these measures to allow demonstration of risk management principles. In other words, although model results specified in some cases impractical enterprise sizes, the demonstration of the principle of changes in size of enterprise as level of risk aversion varied was most important to the analysis. Further, the representative farms modelled were not large. Some could be classified as part-time farms in that the resources controlled were not capable of generating an adequate family income. Feasible enterprise size on such farms may be considerably smaller than that for larger farms. While specific levels of various enterprises were not in most cases exactly the same across all the risk measures for a given farm at a specific income level, a large difference in the organization of the farm never existed, especially among the major income-producing

enterprises. For example, at the $6,000 return level the organization of the large tobacco farm under owner/operator tenancy but allowing a beef enterprise and sharecropped tobacco, consisted of beef, tobacco, hay production and sale and, in some cases, a row-crop enterprise (Appendix Table 16). The average size of the beef herd was 5.6 cows with a range from 1.02 to 20.6. The average acreage of tobacco for this farm at this level of returns was just over two acres, ranging from about two acres (2.04 acres as owner/operator) to close to 2.2 acres (1.84 acres as owner/operator, .48 acre as sharecropper). Other enterprises and farms showed even less variation. The lack of major differences in many of the QP solutions resulting from the use of different measures of risk indicated that for some problems the application of elaborate and time consuming processes to eliminate nonrandom deviations from each time-series of net returns were not necessary. For problems where the profitability of enterprises were all affected by the same underlying variables, such as GNP growth, weather or rate of inflation, risk efficient management strategies could be identified using less sophisticated risk measuring techniques. Furthermore, the lack of major differences among the QP solutions resulting from the use of different risk measures at widely differing levels of risk aversion also suggested that the availability of farm-specific data may not be necessary for farm planning purposes. In cases where the optimized farm plans are to be evaluated by the farmer and adjusted for farm-specific enterprise size constraints reflecting farmer preferences, no risk measure of those evaluated could be said to be without merit. This is not to say that choices among these alternative measures of risk could not be made, only

that any choice must be made on more theoretical grounds, not solely on the evaluation of programming results. Choices among risk measures must be made on the basis of assumptions about the decision-making process, in particular the ability of the model to perform as if the decision maker were able to recognize nonrandom patterns of stochastic events.

Although differences among risk measures were not large in terms of enterprise selection and levels, examination of the results across several representative farms and at varying levels of returns offered insights into characteristics of the individual risk measures. In most cases, use of the nominal variance-covariance matrix of net returns in calculation of risk measures (NOM) resulted in farm organizations that consisted of larger than average beef herds and fewer row-crop enterprises other than tobacco (Appendix Tables 14-21). A possible explanation for this result was that the nominal time-series of net returns for the beef enterprise exhibited a high degree of negative correlation to the tobacco enterprises (Appendix Table 13). A large percentage of this negative correlation was removed by most of the time-series analysis techniques used in construction of the remaining risk measures. The other characteristics of solutions produced by the nominal risk measure were a result of the typically larger size of the beef herd. For example, more hay was produced and less sold, and on farms where dairy and hog enterprises were available, less of these other livestock enterprises were included. However, total resource use was not greatly affected by use of the NOM risk measure. The amount of labor used, both family and hired, was about the same as for the other risk measures.

Results with the deflated (DEF), simple moving average (SMA), weighted moving average (WMA) and detrended (TRN) measures were quite similar both within each representative farm at various levels of returns as well as among representative farms at similar return levels. While much of the negative correlation between beef enterprises and other farm enterprises was removed in the construction of these measures, enough remained to allow for the inclusion of small beef cow-calf herds in solutions based on the tobacco enterprises, especially at low levels of returns. Production and sale of hay remained in the solutions for all farms, both a result of restrictions on alternative uses for pasture and the seasonality of labor use for this crop, as well as the low level of risk for this enterprise. Finally, with the DEF, SMA, WMA and TRN measures, the higher returning, generally riskier enterprises entered the basis at lower levels of net returns than with the NOM measure. For example, in these solutions, tobacco production was shifted out of the less risky sharecrop arrangement into owner/operator production at lower levels of net returns than with the NOM risk measure. Dairy and hog enterprises also entered the solutions at lower levels of returns than in solutions using the NOM risk measure. Solutions using these measures were also characterized by increased production of row-crop enterprises. While renting out row-cropland, except that needed for tobacco production, represented the best use for this resource in most cases, the DEF, SMA, WMA and TRN risk measures allowed soybeans, wheat or wheat-soybeans doublecrop to enter the basis at low levels of income. However, levels of these row-crop enterprises remained low, averaging about a tenth of total row-cropland until very

high levels of risk and net returns were reached. The variability of enterprise selection and levels within this set of risk measures was very small. For many representative farms, the solutions were identical across a wide range of returns. For example, for the representative large tobacco farm under sharecrop tenancy while allowing the dairy enterprise (Appendix Table 18), at the $28,000 returns level, the level of the dairy enterprise varied from 9.3 to 16.7 milking cows and tobacco production varied from 12.8 to 16.5 acres. The variability in enterprise selection and level was even less in QP results for other representative farms using these risk measures. For example, results for both the large and small tobacco farms allowing hog enterprises (Appendix Tables 21 and 22, respectively) show that enterprises and levels were identical at most low returns levels.

Programming solutions using the risk measure resulting from ARIMA whitening techniques were similar to the simpler DEF, SMA, WMA and TRN measures. One exception was that the farm plans resulting from the use of the ARIMA risk measure typically resulted in slightly more farm diversification. For example, for the small tobacco farm under owner/operator tenancy while allowing hog enterprises (Appendix Table 21), results above the $10,000 level were identical to those from the DEF, SMA, WMA and TRN measures with the addition of an increasing acreage devoted to wheat-soybeans doublecrop. A possible explanation for this difference may lie in the large number of enterprises exhibiting a negative correlation to the profitability of the tobacco enterprises with this measure (Appendix Table 13). In the variance-covariance matrix of net returns formed from forecast errors based on ARIMA white-

ning techniques, net returns of the tobacco enterprises were negatively correlated to soybeans, wheat, wheat-soybeans doublecropped, as well as the beef enterprise. This negative correlation was seen as facilitating the inclusion of these enterprises into the farm plans of farms that were based around the tobacco crop. While these enterprises were only marginally more profitable than the relatively riskless hay enterprise with the renting out of row-cropland, this negative correlation with the tobacco enterprise was considered to have a dampening effect on total variance of net returns. At net returns levels above a level representing returns from rental enterprises, these row-crop enterprises replaced hay production in use of spring and summer labor.

COMPARISON OF RISK MEASURES BY DESIRABLE CHARACTERISTICS

The aggregate risk measures developed in this research were described in terms of their conformity to characteristics of desirable risk measures as described by D. L. Young (1980), among other characteristics (Table 5). While lack of conformity to any given desirable characteristic did not preclude the validation of any risk measure within the context of this research, risk measures that were more conformable to these characteristics were preferred to measures that were less, given roughly equivalent ease of calculation and evaluation of validity. In other words, while conformity to these characteristics was in general preferred in risk measures, conformity was not considered in all cases as a necessary condition to the formulation of valid risk measures. For example, one might find that one measure conformed to the characteristic that the decision maker should recognize the effects of

TABLE 5

CHARACTERIZATION OF RISK MEASURES BY CONFORMITY TO DESIRABLE CHARACTERISTICS

Risk Measure[a]	Avail. Info.[b]	Limited Time[b]	Recent Weight[b]	Mean-Sq. Fcst Er[b]	Recog. Infl.[c]	Recog. Trend[c]	Recog. Cycle[c]
NOM	X[d]	X					
DEF	X	X			X		
SMA	X	X		X	X	X	X
WMA	X	X	X	X	X	X	X
TRN	X	X		X	X	X	
ARIMA	X	X		X	X	X	X

[a]Risk measures are as described in the text:

NOM - net returns in nominal dollars

DEF - net returns in constant dollars (deflated)

SMA - residuals of a simple moving average forecast of net returns

WMA - residuals of a weighted moving average forecast of net returns

TRN - residuals of a second-order trend forecast of net returns

ARIMA - residuals of an integrated autoregressive moving average forecast of net returns

[b]Desirable characteristics of risk measures described by D. L. Young (1980):

Avail. Info. - calculated only from information available to the decision maker

Limited Time - information used from a limited time frame

Recent Weight - recent information is weighted more than older information

Mean-Sq. Fcst Er - risk measure is formed as mean-squared forecast errors from residuals of net returns forecasts

TABLE 5 (continued)

[c]Additional characteristics of risk measures as described in the text:

Recog. Infl. - decision maker is able to recognize the effects of inflation on enterprises

Recog. Trend - decision maker is able to recognize trends in net returns of enterprises

Recog. Cycle - decision maker is able to recognize cycles in net returns of enterprises

[d]An "X" denotes that the measure conformed to the particular desirable characteristic, while no entry means that the measure did not conform.

inflation while another did not. In the event that inflation affected all possible enterprises equally, use of the measure that considered inflation would have no advantage over use of the one that did not. The fact that inflation affected one measure considered and not the other would not affect the solution of the farm planning problem, while holding other variables constant. This same qualification had similar application across all the desirable characteristics in comparisons among risk measures.

The risk measure calculated using net returns in nominal terms (NOM) was the simplest measure but conformed to the fewest number of desirable characteristics. The NOM measure was based on available information over a limited time horizon but did not conform to any other characteristic. With NOM, risk models contained the assumption that the decision makers did not recognize the effects of inflation, trends or cycles in net returns. Furthermore, estimates of variability were not based on forecast errors of expected future returns. Because of these limitations, the NOM measure was considered the least desirable measure of risk of those considered based on conformity to desirable characteristics.

The risk measure calculated from deflated net returns (DEF) was considered superior to the NOM in that farmers were able to recognize the effects of inflation at least to the extent that it affected all enterprises to the same degree. No price indices were available for the deflation of net returns for individual enterprises; thus, a general measure, the index of prices received by farmers, was used for all enterprises. The time-series procedures used in construction of the DEF

measure were not as sophisticated as those used in construction of the SMA, WMA, TRN and ARIMA measures. For example, with the DEF risk measure, the presumption was that farmers were not able to distinguish trends or cycles in net returns among the various enterprises. For any time-series where such trends or cycles in the profitability of each enterprise closely follow price index movements, such a simple measure may be valid. Such a special case may be representative of the enterprises considered here. The general inflation trend over the past 30-year time-series may partially explain the similarity between results obtained with the DEF measure and those with more sophisticated measures, especially the TRN measure (Appendix Table 12).

The remaining risk measures were similar in conformity to desirable characteristics. Only the WMA risk measure resulted from the weighting of recent information, and the TRN risk measure did not allow for the recognition of cycles in net returns. These two risk measures, as well as the SMA risk measure, could be described as similar in conformity to desirable characteristics. These measures also produced very similar farm plans for all representative farms, perhaps as a result of their success in removing a very large percentage of the nonrandom variation in the parent time-series of net returns (Appendix Tables 14-21). The similarity of results for the TRN, SMA and WMA suggested that for the time-series of net returns for all considered enterprises, a large proportion of the nonrandom variation was of relatively low order. Of course, as higher order techniques were applied to this series, more nonrandom variation was removed, but results suggested that an average of 40 percent of total variance was

removed by simple deflation and that about 90 percent of total variance of net returns was removed by the SMA, WMA and TRN techniques.

The ARIMA measure was in this research usually less statistically efficient at removing nonrandom variation than the SMA, WMA or TRN techniques. The low number of observations in the original time-series and the loss of a larger number of degrees of freedom in construction of the measure perhaps contributed to this result. However, the ARIMA measure was successful in conforming to most of the characteristics found desirable for risk measures. It did not weigh recent information more heavily on a year-by-year basis as did the WMA measure but did conform to the remaining desirable characteristics.

COMPARISON OF RISK MODELS

The comparison of risk models across the representative farms at different levels of risk and income showed several similarities as well as differences among the models. The models could be grouped into two sets: those that considered correlations or covariances among net returns for alternative enterprises and those that did not. Programming results were very similar within each set; however, some important differences were found to exist between sets. These differences were judged to be a result of whether the particular model in question considered covariances among net returns for considered enterprises.

The two models in which covariances were not considered were the MOTAD models and the single-index portfolio models. Representative farm planning results for the MOTAD and single-index models were similar for all representative farms (Appendix Tables 22-29). For example, farm

plans resulting from these models for the large tobacco farm under owner/operator tenancy allowing a beef enterprise (Appendix Table 24) consisted solely of a tobacco enterprise and hay production for sale. At the $7,000 level of net returns, the difference in farm plans was that the MOTAD plan resulted in all tobacco being produced as owner/operator (2.2 acres) while the single-index model resulted in a mix of sharecropped tobacco with owner/operator produced tobacco (2.3 acres as owner/operator, 1.25 as sharecropper). Also, slightly less hay was produced under the single index plan to reflect the lessened labor availability resulting from the slightly larger total acreage of tobacco (7.8 acres with the MOTAD model, 5.5 with the single-index). For many of the representative farms, results were identical. For example, results for the small tobacco farm under owner/operator tenancy were identical at all levels of returns. Throughout the feasible range of returns, the farms were organized around tobacco production with additional family labor utilized in the production of hay. Basis changes in the solutions for these farms also occurred at the same net income levels for both models.

A major difference between these models lies in the estimation of the expected variation of net returns for alternative enterprises. For the MOTAD models, mean-absolute deviations were used as an alternative measure to mean-squared deviations in measuring net returns variability. With this method, estimates of deviations in net returns were calculated directly from the appropriate time-series of net returns for each enterprise. Risk measures for this model were thus formulated in such a way as to conform to the various desirable characteristics of risk

measures in the same way as those for the QP models as previously noted. The single-index portfolio models required the use of a general variation index to calculate the expected variation in net returns for each enterprise based on the degree of correlation with a general measure. Some problems existed regarding the conformability of the single-index model measure of risk to desirable characteristics of risk measures in general. For example, no method existed to formulate single-index risk measures that conformed to Young's criteria without time-series analysis of the general measure as well as analysis of the time-series of net returns for each enterprise. If the same time-series procedures were not applied to the general measure as were applied to the time-series of net returns for possible enterprises, the degree of correlation between the two might vary. While any of these procedures could be applied to both the general measure and to net returns for each enterprise, the necessity of their application adds to the computational complexity of the risk measure. Therefore, this more complicated procedure generally must be less preferred to the MOTAD models. However, measures of risk can be derived from this procedure that are based on the correlation between mean-squared forecast errors for the general measure and mean-squared forecast errors of net returns for each enterprise. Special cases might exist where, for example, a long time-series of net returns for a particular enterprise is not available. Thus, such a procedure may be necessary to generate estimates of net returns variability.

These results indicated that the mean-absolute deviations and the single-index measures were successful in measuring net returns variability for each enterprise. Correlation between the E-A measure and the

single-index measure was very high, at .98834 for this data. Both the high degree of correlation between the measures and the similarity of results indicated that either model was applicable in cases where covariances among returns were not to be considered and choice between the models must be made on the basis of data availability. For problems where accurate estimates of net returns could be made on the basis of a long time-series of data, the MOTAD model was preferred, if only for computational simplicity. However, for problems where such data were not available and information about net returns variability was limited, the single-index method could be used to provide estimates of net returns variability.

Less similarity between results was exhibited between the QP and the MRCLP models (Appendix Tables 22-29). A difference was that for a given level of expected income the levels of risky enterprises were greater with the MRCLP model. Also, resources, especially hired labor, were employed more extensively in the MRCLP solutions. For example, results for the small tobacco farm, under owner/operator tenancy allowing hog enterprises (Appendix Table 29) at the $13,000 net return level, were similar for these two models. The farm was organized around a substantial tobacco crop with 2.4 acres grown as owner/operator and 1.5 acres grown as sharecropper to utilize the tobacco barn capacity of the landlord. Additionally, the farm plan consisted of an approximately 10-sow farrow-to-finish swine unit (10.6 sows with the QP model, 9.6 with the MRCLP) and hay production for sale of seven acres for both models. The difference in farm plans for this farm was in the inclusion of a 60-acre soybean crop with the MRCLP model that was not included in

the farm plan produced by the QP model. Other representative farms plans were similar in terms of enterprise selection and levels. Some representative farms were identically organized at some levels of returns. For example, both models for the small tobacco farm under owner/operator tenancy allowing beef enterprises (Appendix Table 25) at the $3,000 level of returns resulted in farm plans with tobacco grown as owner/operator to the limit of existing barn capacity (1.3 acres). Hay was produced for sale and as feed for the small beef enterprise on three acres, and the beef herd was limited by available labor to a single cow.

Although the possibility for MRCLP solutions to mirror QP solutions existed, it was small for models with large numbers of enterprises. The reasons for this dissimilarity were in the construction of the MRCLP model and the possibility of slack in the marginal risk constraints (MRC) representing the contribution to total risk of each enterprise. The MRCLP model was designed by Chen and Baker as a linear approximation of the QP model. Because of the way the MRC were written, xW <= c/ , the QP and MRCLP solutions were only identical if the dual values or shadow prices for the MRC of all enterprises not in the basis were zero. If the shadow prices of the MRC for enterprises not in the basis were zero, the contribution to total net returns variation was also zero. However, if no slack existed at any particular level of risk aversion for any of the constraints representing the contribution to risk of enterprises not in the current solution set, the solution could be "improved" by deleting those enterprises not in the basis from the problem. Improvement in the objective function value was possible without a decrease in level or risk aversion. For small problems, such

a procedure may be practical. Even for larger problems where extreme accuracy is desired, adjusting the problem at every basis change may be feasible. However, for general applications, such iterative adjustments may be too time consuming and offer too much room for error. Given the current availability of computing capability, QP must be preferred over MRCLP because of this consideration. However, despite these differences, MRCLP remains an efficient alternative to the MOTAD and single-index models for use with small computers where covariances between enterprises should be considered.

APPLICATION OF THE THEORY OF SEPARATION

The results from the QP model, as well as its approximation, the MRCLP model, indicated that for large portions of the E-V frontier developed for each representative farm, application of the theory of separation could be made. In other words, for a wide range of total farm risk, the E-V frontier for many farms was either linear or nearly so (Appendix Figures 1-8).

Although the E-V frontier of risk efficient choices was closely approximated by the QP models, the QP algorithm prevents easy identification of basis changes in the solutions to farm planning problems. For this reason, evaluations of the range of applicability of the theory of separation were made using the linear models: the MOTAD, single-index and MRCLP models. These models allowed parametric analysis of the E-V frontier to identify basis changes in the problem solution as risk and income levels rose. Application of the theory of separation to the farm planning problem was provided by examination of representative farm

problems at basis changes to identify the variation in proportions of enterprises.

As an example of this principle, parametric programming results using the MRCLP model for the large tobacco farm under the sharecrop tenancy arrangement while allowing hog enterprises identified only nine basis changes (Appendix Table 30 and Appendix Figure 8). The first few involved establishment of the optimal mix of almost riskless enterprises: hay production and sale and renting out row-cropland. This farm was capable of generating approximately $5,000 in net returns to these relatively riskless enterprises. After this level of returns was reached, several enterprises exhibiting a higher level of risk entered the basis. No additional basis changes occurred until net returns doubled to $10,895. Within this range of returns, the proportion of each less risky enterprise was not constant within the set of relatively riskless enterprises. Only the renting out of row-cropland did not compete with the incoming riskier enterprises for labor and capital as did the production and sale of hay. The risky enterprises in the basis between $5,000 and $18,000 in net returns were beef cow-calf, sharecrop tobacco and farrow-to-finish hogs. Within this range of net returns, these risky enterprises increased in size as net returns increased, but they remained roughly in the proportion of 13.3 cows to 2.8 acres of tobacco to one sow. In other words, as net returns increased in this range, each additional acre of tobacco was accompanied by an increase of 2.4 cows and .4 sow. Above $17,950 in net returns, tobacco quota was leased into the operation and proportions within the set of risky enterprises changed. Between $17,950 and $19,628 the proportional

increase of beef, tobacco (quota leased in and sharecrop) and hogs was about two cows to 2.5 acres of tobacco to one sow. Here, as net returns increased, each additional acre of tobacco was accompanied by .8 cow and .4 sow. The decreased proportional increase for the beef enterprise was typical for all representative farms. As net returns increased, the lower returning enterprises at first increased in size less rapidly than the higher returning ones, then were among the first to decrease in size and to leave the basis as they were replaced by riskier but higher returning enterprises. Thus, at return levels above $19,628, the level of the beef enterprise began to decline and tobacco remained constant as soybeans replaced the beef cow-calf enterprise. Between $19,628 and $21,920, enterprise selection for the farm was stable after the beef enterprise left the basis at $21,109, leaving the soybean, tobacco and hog enterprises the only risky enterprises in the basis. Because the upper limit of the acreage of tobacco grown as owner/operator and amount of quota that could be leased in was limited by existing barn capacity, the level of the tobacco enterprises remained constant throughout this range of returns and throughout the remaining feasible range of returns. There were no basis changes above $21,920, and the tobacco and soybean enterprises remained proportional at 1 to 26 as they decreased in size while the hog enterprise increased to supply the bulk of net returns.

In summary, this particular example E-V frontier could be divided into several segments for practical planning purposes. First, below $5,000 the farmer could be characterized as more risk averse, employing owned resources only in relatively riskless activities. Between $5,000 and $18,000 the farmer was less risk averse but still employed a large

proportion of resources in riskless enterprises in addition to a well diversified portfolio of risky activities including beef, sharecrop tobacco and farrow-to-finish hogs. Between $18,000 and $22,000 the farm plan shifted toward less diversification, and above $22,000 throughout the feasible range to $54,000 the farm plan consisted only of soybeans, burley tobacco and farrow-to-finish hogs. As net returns increased in this range, the size of the soybean and tobacco enterprises decreased, and the farrow-to-finish hog enterprise increased in size with only excess resources employed in riskless enterprises. Wide ranges in net returns and risk-aversion were demonstrated in this example where the basis of the solution remained unchanged and proportions of enterprises within each set remained constant.

Application of the theory of separation for these farms was complicated by the large number of enterprises and available resources. However, the wide ranges of net returns without basis changes suggested that substantial adjustments to generated plans could be made by holding proportions within sets of enterprises constant, varying only the proportions between sets of risky, less risky and riskless enterprises. The problem with the general application of this principle did not involve its validity but was in the identification of these sets of enterprises in large problems with many alternative enterprises that compete for a wide range of available resources. In the demonstrated example, survey information indicated that the reported organization from the 1984 survey for this particular representative farm most resembled some point on the E-V frontier between the $22,000 and $54,000 level of returns. Within this range of net returns, the risky set of

farm enterprises included only the hog enterprise, the less risky set included soybeans and tobacco and the riskless enterprises included rental activities and hay production and sale. By holding the proportions of soybeans to tobacco constant, the farm plan could be adjusted for any income level in this range simply by changing the level of the hog enterprise relative to soybeans and tobacco and applying unused resources to riskless activities.

Similar results were found for other farms. In general, the allowance of more diversification in the model resulted in more identifiable sets with more enterprises within each set. However, the characteristic of large changes in net returns between most basis changes remained common to all the representative farms in this study.

ESTABLISHMENT OF LEVEL OF RISK-AVERSION

Comparison of risk programming results to reported production for the representative farms was made in an effort to demonstrate that risk programming results may by used to establish a level or range of risk-aversion for farmers. Differences in levels of risk-aversion were determined by evaluating subjectively the importance of differences between calculated production for each representative farm and QP risk model results, then selecting the risk programming solution that minimized these differences. Attempts to establish levels of risk-aversion are not common in risk research based on an observed economic behavior (OEB) approach for several reasons. First, in order to compare accurately reported production to results of risk programming models, very detailed information concerning farm production must be available to the

researcher. Such was not the case in this study. While reported production data from the 1984 survey of Tennessee burley producers were adequate for construction of representative farms, the degree of detail required for accurate assessment of risk-aversion levels was not present. Second, and more important, establishment of risk-aversion level requires the assumption that the existing organization of the farm in question is entirely a result of the degree of risk-aversion of the farmer. This is perhaps an unrealistic assumption. However, it may be no more unrealistic than the primary assumption of an alternative method of establishing risk-aversion level, the direct elicitation of utility (DEU) approach. The assumption in studies that the level of risk-aversion discovered by elicitation of responses to hypothetical gaming situations (DEU) is applicable to real management decisions may be at least as unrealistic. However, as a result of the inherent subjectivity of the OEB approach, differences are probable between evaluations of risk-aversion levels among different researchers using the same data set.

Evaluations as to level of risk-aversion were made by comparison of reported production as presented in Table 2 with programming results across income levels as presented in Appendix Tables 15-22. Possible differences in levels of risk-aversion were considered for large farmers, small farmers, owner/operators, sharecroppers and for each type of farm--row-crop, beef cow-calf, hog and dairy.

For all farmers in these representative farms, and perhaps because no landlords, as defined by the establishment of representative farms, were identified in the survey, levels of risk-aversion were very

low. No representative farm organization as reported was similar to the farm organization developed by any risk model below approximately the top third of the respective E-V frontier. However, some differences in general level of risk-aversion were noted. Further, some representative farms had production that closely matched a QP solution, while some were less accurately modelled.

First, no differences in level of risk-aversion could be established between large and small farms. In this study, size differences between large and small farms did not reflect the wide range of farm sizes in Tennessee. Although size of farm may be a factor in determining the level of risk-aversion of a farmer, such a correlation could not be established from this data.

Second, very little difference was obvious in the comparison between sharecrop farmers and owner/operators. Farms with both types of tenancy of the tobacco crop reported production on representative farms that most closely matched model results near the upper bound of the E-V frontier.

Finally, differences in levels of risk-aversion were noted between farm types. The highest level of risk-aversion was exhibited by the farmers representing tobacco farms with large beef cow-calf enterprises. The beef enterprise was shown to be a relatively stable enterprise with negative correlations of net returns to many other enterprises. Thus, the operators of tobacco farms with large numbers of beef cattle were shown to be slightly more risk averse than those of the other types of representative farms. The remaining farm types had production that was much closer to the LP solution for the farm planning

problem, representing a lower level of risk-aversion. Representative hog farmers were perhaps more risk averse than the dairy or row-crop farmers. Row-crop farmers were at a somewhat lower level of risk-aversion. The results of the QP risk models for these farms shifted production from corn, as reported in the survey, to soybeans and wheat-soybeans doublecrop, but this change was not considered a major difference in farm organization. Again, as with the hog and beef farmers, the major difference between the point on the E-V frontier chosen as most closely resembling reported production and the LP solution representing risk neutrality, was the presence on these farms of a significant beef cow-calf enterprise. Dairy farmers were the least risk averse type of farmer. Reported enterprises and production levels on these dairy farms were very close to the LP solutions for each farm.

APPLICATION OF FINPACK

The FINPACK farm management program was applied to representative farms to examine the performance of the risk programming models with the sensitivity analysis procedures in the FINLRB section of the program. The reported farm production was used as the "base plan" for the program, and likely alternative organizations were selected from the risk programming results. No attempt was made to evaluate changes in levels of farm assets or liabilities. No attempt was made to determine loan repayment ability with the alternative plans as the farm plans were generated with levels of assets fixed at current levels. In other words, the farm plans were developed around assets already on the farm, and no plans were allowed that required additional investments or

changes in the distribution of types of assets. Thus, in the examination of differences between the alternative plans and the base plan, no balance sheet changes were considered. Only changes in expected net income and net income variability were examined.

When FINLRB was applied to the small tobacco farm under owner/operator tenancy while allowing hog enterprises, the reported organization of the farm was shown to be capable of producing about $6,000 more in annual net returns than the best alternative as suggested by the risk programming results. The difference in net returns remained in proportion throughout the sensitivity analysis as calculated by the FINLRB package. However, the effects of a constant percentage change in prices of products was not seen as an accurate estimation of expected net returns variability. On this particular farm, only a small tobacco crop was produced under the base plan that was examined by FINLRB, while a much larger percentage of total farm income on the alternative organization that was suggested by the risk programming model was from tobacco enterprises. The price protection resulting from the price support program reduced the chance of drastic declines in the profitability of tobacco. Thus, the stability of farm income on farms containing a relatively large proportion of tobacco was not accurately depicted by sensitivity measures based on percentage changes in all product prices as used in the FINLRB package.

Two other sources of error in sensitivity analysis as calculated by FINLRB of potential farm organizations were apparent in the analysis of tobacco farms that included a dairy enterprise. While reported production on dairy farms seldom included substantial beef enterprises,

the risk programming results for these farms usually contained at least a small beef cow-calf enterprise. The sensitivity analysis of the FINLRB package did not consider the effects of the illustrated negative correlation between the beef enterprises and other farm activities. Also, in the FINLRB analysis, no consideration was given to the stability of the dairy enterprise resulting from the marketing orders and agreements program.

In summary, with FINLRB the effects of percentage changes in product prices were accurate in ranking the relative riskiness of farm organizations in some cases. When the alternative organizations suggested by risk programming models represented minor deviations from the base plan, when the farm in question was well diversified among row-crop and livestock enterprises or when alternative plans represented minor changes in those enterprises with controlled markets, a constant percentage change in prices was an effective method for ranking the relative risk of alternative farm plans. For example, the sensitivity analysis by FINLRB for the small tobacco farm when no livestock enterprises other than beef were considered was successful in ranking several alternative farm plans that were suggested by risk programming models. Thus, constant percentage reductions in product prices produced a higher percentage variation in net returns for farm plans with higher expected net returns than did farm plans for lower returning, more stable organizations.

The use of risk programming to identify possible alternative farm organizations requires that every effort be made to accurately specify the risk programming problem. The completed FINPACK package contained

all the information needed to construct such problems, but small discrepancies between the data bank information, especially enterprise budgets, and the data used to construct the risk planning problem were often magnified by the FINLRB sensitivity analysis. For example, if objective function values used for risk programming purposes were not accurately reflected in the crop and livestock budgets used in the FINPACK analysis, serious and misleading discrepancies often resulted.

The deficiencies of the sensitivity analysis as performed by the FINLRB package suggested that an alternative measure of riskiness should be applied to farm organizations to be compared under some situations. While expected net returns and cash flow requirements were accurately depicted by FINLRB, an alternative sensitivity analysis could be conducted by calculation of variances or standard deviations of total farm net returns using an aggregate time-series of data. Thus, the effects of a given percentage standard deviation decline in farm profitability could then be examined for its effects on the farm balance sheet and cash flow.

These results suggest that the FINPACK farm planning program is an excellent management tool for examining the long-range consequences of several possible farm organizations. However, its usefulness in examining the stability of the plans depends on the type of farm and the enterprise mix on that farm. As a planning tool, its practicality might also be augmented by a farm programming section that would include some type of risk modelling as a format for generating possible alternative organizations for the farm being examined.

CHAPTER V

SUMMARY, CONCLUSIONS AND IMPLICATIONS FOR FURTHER RESEARCH

RESEARCH JUSTIFICATION AND OBJECTIVES

Because farmers may differ in their response to perceived risk, agricultural professionals must look to methods of analysis that consider risk as an important element in the planning process. Commonly used methods of risk analysis consist of two important segments. Researchers must first select an appropriate model and, second, must develop a suitable measure of risk for the particular problem at hand. Several mean-variance type risk models are available, but little research has attempted to evaluate and compare the applicability of these models for specific problems. Further, while much research effort has been directed at developing measures of risk based on aggregate historical net returns data, few comparisons among these alternative measures have been made.

One hypothesis of this study was that measures of risk for farm enterprises could be developed from aggregate data. Also hypothesized was that these measures could provide valid results for farm planning purposes when applied in existing mean-variance type risk programming models. Three objectives were formulated to test these hypotheses. The first involved the calculation of alternative risk measures from aggregate data and the validation of these measures by applications to representative burley tobacco-producing farms. The second objective involved incorporation of a valid measure of risk as previously ident-

ified in several mean-variance type risk programming models and the evaluation of relative strengths and weaknesses of the models. The final objective involved the application of risk modelling to representative farm situations in conjunction with a computerized farm planning aid with a view toward suggesting improvements in the sensitivity analysis performance of such aids.

PROCEDURE

A. Comparison of Risk Measures

A time-series of net returns was generated for common farm enterprises by applying costs calculated from modern enterprise budgets to historical state-level prices and yields for Tennessee. Various econometric time-series analysis procedures were applied to these series in an effort to remove nonrandom net return variation and to provide risk measures that conformed to identified desirable characteristics of risk measures. Six types of risk measures were developed that varied in conformation to the identified desirable characteristics, amount of nonrandom net return variation removed and in computational complexity. The six measures included a measure based on net returns in nominal terms only (NOM), one based on the deflated time series of net returns (DEF) and one each from residuals of mean-squared forecast errors from the detrended time-series (TRN), a simple moving average forecast (SMA), a weighted moving average forecast (WMA) and an integrated autoregressive and moving average forecast (ARIMA). These risk measures were applied in mean-variance type quadratic risk programming models to eight representative burley tobacco producing farms. Each

measure was characterized as to validity based on the "validation by results" principle described for linear programming type problems by McCarl (1986). The measures were also characterized as to conformity with the identified desirable characteristics of risk measures.

B. Comparison of Risk Models

Four mean-variance risk programming models were applied to the eight representative farm situations using a common risk measure (WMA). Types of models constructed for each farm included quadratic programming, marginal risk constrained linear programming, minimization of total absolute deviations and the single-index portfolio model. Solutions were compared on the basis of enterprise selection and levels at selected points along the E-V frontier of each representative farm. The resulting solutions were compared across various net return levels for each farm with each model. Solutions were also compared across models for each representative farm at equivalent levels of returns.

C. Application of FINPACK

Application of a computerized farm planning aid was made to several representative farm situations. Demonstrations of the use of such programs in providing the necessary data for risk planning problems and of the use of risk programming procedures in identifying potential alternative farm organizations were provided. Potential problems with farm applications of risk programming procedures using such data were identified and evaluated. Problems and deficiencies in the currently used sensitivity analysis sections of FINPACK were described.

RESULTS AND INTERPRETATIONS

Results of the analysis in general supported the hypotheses of the study. While very little quantitative analysis of the results could be accomplished due to the limited number of observations, farm risk planning results were compared on the basis of enterprise selection and levels for the representative farms across the range of risk aversion.

The results indicated that all the measures of risk were successful in providing useful farm planning information for the representative farms to which they were applied. Each risk measure was successful in identifying relatively risky enterprises and in providing realistic farm plans at varying levels of risk-aversion. Further, each risk measure was successful in demonstrating how farm plans varied with level of risk-aversion from low risk and returns to high risk and returns. Some risk measures were more successful than others in conforming to the characteristics thought to be desirable for risk measures to possess. Of the risk measures evaluated, the measure formed by the mean-squared errors from a series of weighted moving average one-step-ahead forecasts was judged as being most conformable to the desirable characteristics for risk measures as described by D. L. Young (1980). There were no significant differences in computational complexity among the risk measures evaluated. Differences in farm plans generated for farms using different risk measures were seen as resulting from differences in the amount of nonrandom variation in net returns removed by each measure. Differences in farm plans also resulted from differences in the number

of enterprises that were negatively correlated with the tobacco enterprises from measure to measure.

The results also indicated that all the evaluated risk planning models were successful in generating realistic farm plans for the representative farms. Farm plans generated by these models did not represent "corner solutions" characteristic of plans generated by linear programming models. Models that were more appropriate for specific applications were described. Models were divided into two groups: those that considered covariances among net returns for enterprises and those that did not. Major differences in enterprise selection and levels among models were described as a function of whether the model in question considered these covariances.

Results from application of a risk programming model in conjunction with an example computerized farm planning aid, FINPACK, to three representative farms suggested that planning of actual farms involving such aids can be an important data source for applied risk programming techniques. However, careful evaluation of the data to be used, especially the enterprise budgets provided by the planning aid, was found to be essential in avoiding serious discrepancies between the evaluation of farm profitability as performed with such packages and the estimation of net returns provided by the risk programming model used. Further, results indicated that risk programming models can be superior in providing estimates of expected future variation in farm net returns to the currently used sensitivity analysis techniques provided by the FINPACK package.

CONCLUSIONS

Several general conclusions may be made from the results of this study that augment the earlier interpretation of results presented in Chapter IV. The availability of a wide range of risk management tools suggests that no single method of risk analysis has been identified or will likely be identified as superior in all applications. Choice among risk measures and programming algorithms must be made on the bases of theoretical relevance to the problem, availability of data and type of information that is desired from the results.

One hypothesis of this study was that valid measures of risk for construction of risk efficient farm plans could be formulated from historical data without removal of all nonrandom variation in net returns. Analysis of results based on enterprise selection and levels supported this hypothesis. However, because of the general conformity of programming results and the lack of any method of establishing some standard of comparison for the various measures, conformity to desirable characteristics was described as the major concern of the programmer in choices among risk measures. While all risk measures possessed these characteristics to some degree, the relative simplicity of computer calculation rendered computational complexity essentially irrelevant. Thus, based on conformity to desirable characteristics, risk measures formed by the residuals of weighted moving average forecasts of net returns were shown to be suited for applications to E-V risk models.

The second hypothesis of this study concerned the similarity of programming results from a variety of risk programming models and an

evaluation of their validity based on enterprise selection and levels. Results indicated that in choices among risk models, those that considered covariances between enterprises should be considered superior for most applications, a conclusion due to the characteristic that these models better demonstrate the advantages of diversification. Exceptions were for problems that considered alternatives whose covariances were small or approximately equal or for extremely large problems. The major advantage of models that did not consider covariances was computational simplicity, an advantage for the most part removed by advances in computational capacity of small computers. For large problems, quadratic programming (QP) on mainframe computers was described as the model of choice, in that for these problems, solutions represented global optimums without adjustment, measures of risk were more statistically efficient and that other models were developed as approximations of QP. For smaller problems, either QP or marginal risk constrained linear programming (MRCLP) could be performed by microcomputers. Minimization of total absolute deviations models (MOTAD) performed well in problems where covariances were of lesser importance and were considered superior to the single-index portfolio models except where deficiencies in data precluded the calculation of the deviations vectors required by the MOTAD algorithm. One possible exception that was suggested by the high correlation of programming results between the single-index and MOTAD models was considered. In cases where sufficient data for some enterprises were not available, the single-index risk measure could be constructed for such enterprises and, based on the degree of correlation to the MOTAD deviations vector, converted into a

measure of expected deviations. These expected deviations could then be inserted into a MOTAD model, and the advantages of the MOTAD model would be preserved. Such a hybrid risk model has not been previously described, thus the practicality and performance of such a model might be explored in future research.

Results from the application of the theory of separation indicated that generated mean-variance frontiers for many of the representative farms were linear through wide ranges in net returns. However, easy application of this theory was complicated by the large number of alternative enterprises and the wide range of relative riskiness among these enterprises. Applications of this principle will likely be made on a subjective level and in situations involving only small changes in farm organization.

Similar difficulty was encountered in establishment of levels of risk-aversion for the representative farms. No clearly definable differences were obvious as a result of comparing reported farm organizations to generated risk efficient farm plans for farms of different type, size or organization. Results indicated that the representative farms examined were organized near the upper bound in the feasible range of net returns. The result that these farms represented a low level of risk-aversion has been supported by other research (Brink and McCarl, 1978 and Just, 1975).

Conclusions resulting from the application of the FINPACK farm financial planning package were that the package was successful in ranking the relative riskiness of alternative farm organizations in some situations. However, situations peculiar to specific farms rendered

sensitivity analysis as calculated by the package less effective. Users of the package should be aware of inaccuracies which may result in ranking relative riskiness of farm plans with large differences in the production levels of products sold in protected markets. In such cases, the use of risk programming techniques may prove useful in both providing alternative farm organizations and in more accurately ranking the relative riskiness of those farm plans. The degree of complimentarity of these computerized farm planning aids to risk programming models has not been fully utilized. Computerized farm planning aids may be developed that internally calculate variances or standard deviations in net returns as a measure of farm net returns stability. The utility of risk programming models in providing insights into the risk component of decisions concerning prospective alternative farm organizations has been clearly demonstrated by this research.

IMPLICATIONS

A wide range of problem areas exist in which farm planning models that incorporate some form of risk may be applicable. Their usefulness is indicated by their prevalence in publications directed toward a diverse clientele ranging from individual farm operators to extension personnel to other professional agricultural researchers in industry and academia.

The results of this study may be of interest to individual farmers who, as they move toward more professional and businesslike management of their farming operations, look to more advanced and accurate planning tools. Farmers may be able to use computer planning

methods, but they cannot be expected to have the expertise in research necessary to discover which of many procedures available for any given objective will yield the desired results without providing unnecessary information and without undue complication and expense.

Additionally, the research may have further implications for research and extension work at the farm level. While the primary objectives of this study have been accomplished, the research process itself has suggested areas for additional research.

First, as suggested by previous work, representative farm research was not found to be conducive to establishment of risk-aversion levels of farmers. Attractive theoretically as the advantages of observed economic behavior studies are for this type of research, specific levels of risk-aversion could not be quantitatively established as with an elicited response approach. While subjective differences in risk-aversion were described for the various farm types examined, equally valid alternative rankings could be made.

Second, while no practical applications of the theory of separation are likely to be made, the principle remains attractive. Just as the classic "L-shaped" long-run average cost curve concept facilitated production economics research using LP models, the establishment of linear E-V frontiers for many farms should facilitate future research in the area of risk management and response.

Also, further research is needed to explore the relationship between aggregate state-level data on net returns variation, farm-specific data on net returns variation and the subjective and expectational estimates on net returns variation that mean-variance risk models

require for the most accurate estimation of risk response. While farmers must use both individual and aggregate data in the formulation of these estimates of future variability, there are no indications as to the relative importance of each data source. The assumption that all farmers assign the same weights to each data source may not be realistic. If aggregate data are to be widely used for farm planning purposes, their use may be validated by such basic research.

Problems with estimating net returns variability for unconventional farming alternatives suggest an additional area where research may be useful for practical farm management purposes. An examination of the potential for using the single-index risk measure to develop measures of risk for enterprises where lengthy time-series data on price and yield variability are not available may be useful. However, regressing net returns for these enterprises on general indicators such as net farm income or annual rainfall data may not provide the most accurate estimates of net returns variability. Structurally based econometric net returns forecasts could provide the basis for improved efficiency of these variability estimates. In other words, forecasts of net returns based on either production or demand characteristics of alternative enterprises could provide the estimates of net return variability required for application of mean-variance type risk programming models to these problems.

Finally, further research is needed through use of risk models to describe and evaluate potential alternative enterprises for farmers. Identification of such alternatives for farmers experiencing financial difficulty or operating in markets with high potential for change could

be an important contribution to the agricultural community. Research procedures that consider farmer attitudes will become more important to researchers in their efforts to identify these potential alternatives, as well as in their efforts to identify farmer characteristics that may be important in insuring the continued success of the farming operation. Thus, an important extension of this research could be the examination of alternative enterprises for the farming community.

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APPENDICES

APPENDIX TABLES

APPENDIX TABLE 1

DEFINITIONS OF SELECTED TERMS USED IN APPENDIX TABLES AND FIGURES

I. Available Enterprises (see budgets, Appendix Tables 1-10)

CORN:	Conventional corn cultivated for grain or silage, per acre.
DAIRY:	Grade A dairy based on a 60-cow herd.
TOB.O/OP:	Burley tobacco grown under owner/operator tenancy, per acre.
TOB.SHR:	Burley tobacco grown under a sharecrop tenancy, per acre.
WHEAT:	Conventional wheat grain, per acre.
SOY:	Conventional soybeans, per acre.
WHT-SOY:	Wheat-soybeans no-till, per acre.
BEEF:	Beef cow-calf based on a 30-cow herd.
FDER PIG:	Market hogs based on purchased feeder pigs.
SOW F/F:	Market hogs based on a 40-sow herd, farrow to finish.
HAY PROD:	Grass hay for sale or feed.
HAY SOLD:	Produced hay for sale.
RNTRC:	Cash rental out of row cropland.
RNTTQ:	Cash rental out of tobacco quota.
TOB.LSE:	Cash rental in of tobacco quota.
HL1-6:	Hired labor by 60-day period beginning January 1.

II. Risk Measure or Whitening Procedure

NOMINAL:	Net returns in nominal terms only.
DEFLATED:	Net returns in constant dollars (1977=100).
DETRENDED:	Residuals of second-order trends removed.
SIM MOV A:	Residuals of a simple moving average.
WTD MOV A:	Residuals of a weighted moving average.
ARIMA RES:	Residuals of an integrated autoregressive moving average.

III. Risk Model

QUAD.PROG or QP:	Quadratic Programming.
MOTAD:	Minimization of Total Absolute Deviations.
SIN.INDEX:	Single-Index Portfolio Model.
MAR.RISK:	Marginal Risk Constrained Linear Programming.

IV. Miscellaneous

TYPE SOL:	Type of risk measure or model used a problem.
STD. ERR:	Standard Error of net returns.
TYPE MOD:	Type of risk model.

APPENDIX TABLE 2

CORN: ESTIMATED RETURNS AND EXPENSES PER ACRE

ITEM	DESCRIPTION	UNIT	QUANTITY	PRICE (DOLLARS)	AMOUNT (DOLLARS)
REVENUE CORN	GRAIN	BU.	80	2.6	208.00
VARIABLE EXPENSES -					
SEED	12-14 TH.	BAG	0.2	74.00	14.80
FERTILIZER	N	LB.	90	0.23	20.70
	P2O5	LB.	60	0.24	14.40
	K2O	LB.	60	0.13	7.80
LIME	AG LIMESTONE	TON	0.4	12.00	4.80
	BORON				1.39
ASTRAZINE 4L	4#/GAL.	QT.	1.25	2.40	3.00
LASSO	4#/GAL.	QT.	1.75	5.04	8.82
MACHINERY	FUEL	AC.	1	8.50	8.50
MACHINERY	REPAIRS	AC.	1	18.75	18.75
TOTAL VARIABLE EXPENSES				102.96	
RETURN ABOVE VARIABLE EXPENSES					105.04
FIXED EXPENSES -					
MACHINERY		AC.	1	31.51	31.51
TOTAL FIXED EXPENSES					31.51
TOTAL VARIABLE AND FIXED EXPENSES					134.47
NET RETURN TO LAND, LABOR, CAPITAL AND MANAGEMENT				73.53	
INTEREST -					
OPERATING CAPITAL	6 MONTHS	AC.	102.96	0.14	7.21
FIXED CAPITAL	MACH. & EQUIP.	AC.			18.67
TOTAL					25.88
NET RETURN TO LAND, LABOR AND MANAGEMENT				47.65	
LABOR		HR.	2.76	4.00	11.04
NET RETURN TO LAND AND MANAGEMENT					36.61

APPENDIX TABLE 3

BURLEY TOBACCO: ESTIMATED RETURNS AND EXPENSES PER ACRE

ITEM	DESCRIPTION	UNIT	QUANTITY	PRICE (DOLLARS)	AMOUNT (DOLLARS)
REVENUE -					
TOBACCO		LB.	2,400	1.85	4,440.00
EXPENSES, VARIABLE (PLANT BED) -					
SEED[a]	HYBRID 1/12 OZ.	PK	2	5.00	10.00
FERTILIZER	4-16-4	CWT.	0.5	10.50	5.25
GAS COVER	103' X 10 1/2', 3 MI		1	10.49	10.49
BED COVER	100' X 9', POLYESTER		1	18.50	18.50
INSECTICIDE	DISYSTON	OZ.	1	2.25	2.25
HERBICIDE[b]	ENIDE 90 W.P.	LB.	0.25	6.09	1.52
FUNGICIDE[b]	RIDOMIL	QT.	0.03	33.50	1.01
FUMIGANT	METHYL BROMIDE	LB.	6	1.54	9.24
APPLICATOR	PRORATED 3 YEAR	1	3	0.75	2.25
TOTAL					60.51
EXPENSES, VARIABLE (FIELD AND OTHER)[c]					
COVER CROP	WHEAT, RYE, BAR	BU.	2	5.00	10.00
FERTILIZER	5-10-15	CWT.	15	8.10	121.50
	NITROGEN	LB.	90	0.23	20.70
LIME		TON	0.4	12.00	4.80
INSECT CONTROL	FURADAN 15G	LB.	25	1.41	35.25
	ORTHENE 75 W.P.	LB.	2	7.20	14.40
DISEASE CONTROL	RIDOMIL	QT.	4	15.20	60.80
HERBICIDE	PROWL 4 E.C.	PT.	2.5	4.18	10.45
SUCKER CONTROL	ROYAL MH-30	GAL.	1.9	7.35	13.97
MARKET FEES[d]	4.5% + $1/CWT				357.00
HAULING	TO MARKET	CWT.	24	1.00	24.00
MACHINERY	FUEL	AC.	1	41.25	41.25
MACHINERY	REPAIRS	AC.	1	59.66	59.66
TOTAL VARIABLE EXPENSES					834.28
RETURN ABOVE VARIABLE EXPENSES					3,605.72
FIXED EXPENSES -					
MACHINERY		AC.	0.5	435.00	217.50
TOBACCO STICKS	PRORATED OVER 8 YRS.		1,600	0.20	40.00
BARN[e]					115.58
TOTAL FIXED EXPENSES					373.08
TOTAL VARIABLE AND FIXED EXPENSES					1,207.36
NET RETURN TO QUOTA, LAND, LABOR, CAPITAL AND MANAGEMENT					3,232.64
INTEREST -					
OPERATING CAP.	6 MONTHS	AC.	834.28	0.14	58.40
FIXED CAPITAL	EQUIP. & BARN	AC.			380.08
TOTAL					438.48
NET RETURN TO QUOTA, LAND, LABOR AND MANAGEMENT					2,794.16
LABOR		HR.	318.40	4.00	1,273.60
NET RETURN TO QUOTA, LAND AND MANAGEMENT					1,520.56

APPENDIX TABLE 3 (continued)

[a]Seed cost for those who do not grow hybrid tobacco will be about $5.00.

[b]This is a rate of four teaspoon per 100-foot bed.

[c]Assumes two applications of orthene 75 W.P. Other insecticides may be needed for specific insect problems.

[d]A quota charge is not included. Marketing charges included are warehouse charges of 4.5 percent of gross and $1 per cwt marketed. Also included is a $5 per cwt assessment for the "no net cost" program, and a grading fee of $.55 per cwt.

[e]Depreciation and repairs on tobacco barn are based on a $9,000 barn depreciated over 30 years and used for tobacco six months per year. Repairs at 1.5 percent of new cost. Interest on barn charged at 15 percent.

APPENDIX TABLE 4

SHARECROP BURLEY TOBACCO, TENANT:[a] ESTIMATED RETURNS AND EXPENSES PER ACRE

ITEM	DESCRIPTION	UNIT	QUANTITY	PRICE (DOLLARS)	AMOUNT (DOLLARS)
REVENUE -					
TOBACCO		LB.	1,200	1.85	2,220.00
EXPENSES, VARIABLE (PLANT BED) -					
SEED[b]	HYBRID 1/12 OZ.	PK	2	5.00	5.00
FERTILIZER	4-16-4	CWT.	0.5	10.50	2.63
GAS COVER	103' X 10 1/2', 3 MI		1	10.49	5.25
BED COVER	100' X 9', POLYESTER		1	18.50	9.25
INSECTICIDE[c]	DISYSTON	OZ.	1	2.25	1.13
HERBICIDE	ENIDE 90 W.P.	LB.	0.25	6.09	0.76
FUNGICIDE	RIDOMIL	QT.	0.03	33.50	0.50
FUMIGANT	METHYL BROMIDE	LB.	6	1.54	4.62
APPLICATOR	PRORATED 3 YEAR	1	3	0.75	1.13
TOTAL					30.25
EXPENSES, VARIABLE (FIELD AND OTHER) -					
COVER CROP	WHEAT, RYE, BAR	BU.	2	5.00	5.00
FERTILIZER	5-10-15	CWT.	15	8.10	60.75
	NITROGEN	LB.	90	0.23	10.35
LIME		TON	0.4	12.00	2.40
INSECT CONTROL[d]	FURADAN 15G	LB.	24	1.41	16.92
	ORTHENE 75 W.P.	LB.	2	7.20	7.20
DISEASE CONTROL	RIDOMIL	QT.	2	15.50	15.50
HERBICIDE	PROWL 4 E.C.	PT.	2.5	4.18	5.23
SUCKER CONTROL	ROYAL MH-30	GAL.	2.2	7.35	8.09
MARKET FEES[e]	4.5% + $1/CWT				178.50
HAULING	TO MARKET	CWT.	12	1.00	6.00
MACHINERY	FUEL	AC.	1	41.25	41.25
MACHINERY	REPAIRS	AC.	1	59.66	59.66
TOTAL VARIABLE EXPENSES					447.09
RETURN ABOVE VARIABLE EXPENSES					1,772.91
FIXED EXPENSES -					
MACHINERY		AC.	1	89.15	89.15
TOBACCO STICKS	PRORATED OVER 8 YRS.		1,600	0.15	15.00
BARN[f]					108.75
TOTAL FIXED EXPENSES					212.90
TOTAL VARIABLE AND FIXED EXPENSES					659.99
NET RETURN TO TENANT LABOR, CAPITAL AND MANAGEMENT					1,560.01
INTEREST -					
OPERATING CAP.	6 MONTHS	AC.	447.09	0.14	15.65
FIXED CAPITAL	EQUIP. & BARN	AC.			167.52
TOTAL					183.17
NET RETURN TO TENANT LABOR AND MANAGEMENT					1,376.84
LABOR		HR.	318.40	4.00	1,273.60
NET RETURN TO TENANT MANAGEMENT					103.24

APPENDIX TABLE 4 (continued)

[a]Sharecrop budget assumes producer pays 50 percent of variable expenses, 50 percent of barn costs and all machinery and related expenses.

[b]Seed cost for those who do not grow hybrid tobacco will be about $5.

[c]This is a rate of four teaspoon per 100-foot bed.

[d]Assumes two applications of orthene 75 W.P. Other insecticides may be needed for specific insect problems.

[e]A quota charge is not included. Marketing charges included are warehouse charges of 4.5 percent of gross and $1 per cwt marketed. Also included is a $5 per cwt assessment for the "no net cost" program and a grading fee of $.55 per cwt.

[f]Depreciation and repairs on tobacco barn are based on a $9,000 barn depreciated over 30 years and used for tobacco six months per year. Repairs at 1.5 percent of new cost. Interest on barn charged at 15 percent.

APPENDIX TABLE 5

SOYBEANS (CONVENTIONAL TILLAGE - 36-INCH ROW): ESTIMATED RETURNS AND EXPENSES PER ACRE

ITEM	DESCRIPTION	UNIT	QUANTITY	PRICE (DOLLARS)	AMOUNT (DOLLARS)
REVENUE -					
SOYBEANS	BEANS	BU.	28	6.80	190.40
VARIABLE EXPENSES -					
SEED	8-10 PLANTS/FT.	LB.	40	0.17	6.80
SEED TREATMENT	VITAVAX-M	BU.	0.33	0.45	0.15
FERTILIZER	P2O5	LB.	60	0.24	14.40
	K2O	LB.	60	0.13	7.80
LIME	3 TONS EVERY 4	TON	0.75	12.00	9.00
WEED CONTROL	SENCOR	PT.	0.75	10.9	8.18
PREPLANT	TREFLAN 4#/GAL.	PT.	1.50	3.78	5.67
PRE-EMERGE	BASAGRAN	PT.	1.5	9.32	13.98
MACHINERY	FUEL	AC.	1	8.89	8.89
MACHINERY	REPAIRS	AC.	1	16.88	16.88
TOTAL VARIABLE EXPENSES					91.74
RETURN ABOVE VARIABLE EXPENSES					98.66
FIXED EXPENSES -					
MACHINERY		AC.	1	28.83	28.83
TOTAL FIXED EXPENSES					28.83
TOTAL VARIABLE AND FIXED EXPENSES					120.57
NET RETURN TO LAND, LABOR, CAPITAL AND MANAGEMENT					69.83
INTEREST -					
OPERATING CAP.	6 MONTHS	AC.	92	0.14	6.42
FIXED CAPITAL	MACH. & EQUIP.	AC.			17.32
TOTAL					23.74
NET RETURN TO LAND, LABOR AND MANAGEMENT					46.08
LABOR		HR.	2.82	4.00	11.28
NET RETURN TO LAND AND MANAGEMENT					34.80

APPENDIX TABLE 6

WHEAT: ESTIMATED RETURNS AND EXPENSES PER ACRE

ITEM	DESCRIPTION	UNIT	QUANTITY	PRICE (DOLLARS)	AMOUNT (DOLLARS)
REVENUE -					
WHEAT		BU.	40	3.20	128.00
VARIABLE EXPENSES -					
SEED	TREATED/FUNGICI	BU.	1.50	7.75	11.63
FERTILIZER	N	LB.	60	0.23	13.80
	P2O5	LB.	60	0.24	14.40
	K2O	LB.	20	0.13	2.60
LIME		TON	0.40	12.00	4.80
MACHINERY	FUEL	AC.	1	4.73	4.73
MACHINERY	REPAIRS	AC.	1	13.32	13.32
TOTAL VARIABLE EXPENSES					65.28
RETURN ABOVE VARIABLE EXPENSES					62.73
FIXED EXPENSES -					
MACHINERY		AC.	1	22.91	22.91
TOTAL FIXED EXPENSES					22.91
TOTAL VARIABLE AND FIXED EXPENSES					88.19
NET RETURN TO LAND, LABOR, CAPITAL AND MANAGEMENT					39.82
INTEREST -					
OPERATING CAP.	6 MONTHS	AC.	65	0.14	4.57
FIXED CAPITAL	MACH. & EQUIP.	AC.			13.57
TOTAL					18.14
NET RETURN TO LAND, LABOR AND MANAGEMENT					21.68
LABOR		HR.	2.05	4.00	8.20
NET RETURN TO LAND AND MANAGEMENT					13.48

APPENDIX TABLE 7

WHEAT-SOYBEANS (NO-TILL): ESTIMATED RETURNS AND EXPENSES PER ACRE

ITEM	DESCRIPTION	UNIT	QUANTITY	PRICE (DOLLARS)	AMOUNT (DOLLARS)
REVENUE -					
WHEAT	GRAIN	BU.	40	3.20	128.00
SOYBEANS	BEANS	BU.	24	6.80	163.20
TOTAL					291.20
VARIABLE EXPENSES -					
SEED, WHEAT	TREATED/FUNGICI	BU.	1.50	7.75	11.63
SEED	SOYBEANS	LB.	40	0.17	6.80
FERTILIZER	N	LB.	60	0.23	13.80
	P2O5	LB.	100	0.24	24.00
	K2O	LB.	60	0.13	7.80
LIME	3 TONS EACH 4 Y	TON	0.75	12.00	9.00
WEED CONTROL(1)	BASAGRAN	PT.	1.5	9.32	13.98
PREPLANT	GRAMOXONE SUPER	PT.	1	5.02	5.02
	LOROX +	LB.	1.50	5.25	7.88
	PROWL +	QT.	2.25	5.04	11.34
	SURFACTANT(2)	AC.			0.30
MACHINERY	FUEL	AC.	1	11.09	11.09
MACHINERY	REPAIRS	AC.	1	25.77	25.77
TOTAL VARIABLE EXPENSES					148.40
RETURN ABOVE VARIABLE EXPENSES					142.80
FIXED EXPENSES -					
MACHINERY		AC.	1	44.28	44.28
TOTAL FIXED EXPENSES					44.28
TOTAL VARIABLE AND FIXED EXPENSES					192.68
NET RETURN TO LAND, LABOR, CAPITAL AND MANAGEMENT					98.52
INTEREST -					
OPERATING CAP.	12 MONTHS	AC.	148	0.14	20.78
FIXED CAPITAL	MACH. & EQUIP.	AC.			26.11
TOTAL					46.89
NET RETURN TO LAND, LABOR AND MANAGEMENT					51.63
LABOR		HR.	3.83	4.00	15.32
NET RETURN TO LAND AND MANAGEMENT					36.31

APPENDIX TABLE 8

BEEF COW-CALF, FED HAY OVER WINTER, SPRING CALVING 30 COW HERD-35-ANIMAL UNITS ESTIMATED RETURNS AND EXPENSES

ITEM	DESCRIPTION	UNIT	QUANTITY	PRICE (DOLLARS)	AMOUNT (DOLLARS)
REVENUE -					
FEEDER HEIFERS[a]	MED. GRD. 2 OR UP	CWT.	41.85	52.00	2,176.20
FEEDER STEERS	MED. GRD. 2 OR UP	CWT.	66.3	62.00	4,110.60
CULL COWS	900 LBS. UTILITY	CWT.	45	37.00	1,665.00
DEATH LOSS	2 PERCENT				-52.50
TOTAL REVENUE					7,899.30
VARIABLE EXPENSES -					
FEED[b,c]	HAY	TON	39.9	75.00	2,992.50
	PASTURE 1.5 AC.	AC.	52.5	45.48	2,387.70
SALT & MINERALS		AN.UN	35	1.75	61.25
VET & MED		HD.	30	9.40	282.00
MARKETING	AUCTION FEES	HD.	5	10.00	50.00
TRUCK		HD.	22	7.50	165.00
MACHINERY	FUEL				20.00
MACHINERY	REPAIRS				37.00
TOTAL VARIABLE EXPENSES					5,995.45
RETURN ABOVE VARIABLE EXPENSES					1,903.85
FIXED EXPENSES -					
DEPRECIATION	BLDGS., EQUIP.[d]	HD.	30	7.30	219.00
REPAIR	BLDGS., EQUIP.	HD.	30	2.19	65.70
DEPRECIATION	BULL[e]	HD.	30	3.33	99.90
DEPR & REPAIR	FENCES[f]	HD.	30	3.68	110.40
TRACTOR	34 HP				31.40
TOTAL FIXED EXPENSES					526.40
TOTAL VARIABLE AND FIXED EXPENSES					6,521.85
NET RETURN TO LAND, LABOR, CAPITAL AND MANAGEMENT					1,377.45
INTEREST -					
COW & SIRE	$383 @ 14%				1,608.60
BLDGS. & EQUIP.	1/2 OF $146 @ 14%				306.60
FIXED CAPITAL	MACH. & EQUIP.				20.60
TOTAL					1,935.80
NET RETURN TO LAND, LABOR AND MANAGEMENT					-558.35
LABOR		HR.	270	4.00	1,080.00
NET RETURN TO LAND AND MANAGEMENT					-1,638.35
NET RETURN PER COW					-54.61

[a]Assumes a 90 percent calf crop and a 16 2/3 percent replacement rate. Cows calve in January, February and March, average calving date, February 15, average selling date, October 15. Average daily gain, 1.75 pounds. Thirteen steers and nine heifers will be sold 60 percent grading choice and 40 percent good.

[b]Pasture cost equals establishment and maintenance cost. Assumes 1.5 acres of permanent pasture per animal unit.

APPENDIX TABLE 8 (continued)

[c]Approximately one ton of grass and clover hay will be fed per animal unit from late November to April 1. Assumes enough clover to eliminate feeding supplement, and cows will have access to stalk fields, and mature grasses from permanent sods.

[d]Assumes one building for hay storage and sorting per 1,000 square feet at $1.50--depreciated over 20 years with repairs at 1 percent of cost.

[e]Assumes a $650 bull replaced every four years and sold for $375.

[f]Assumes four strands of barbed wire and posts spaced 10 feet apart. Total cost was $2.10 per rod, excluding labor. Repairs and depreciation were computed to be $.14 per rod annually. Fifty two and one-half acres of pasture will have approximately 210 rods per side or 840 rods of circumference.

APPENDIX TABLE 9

DAIRY GRADE A LARGE BREEDS--1,250 POUND COWS, DRYLOT 60-COW UNIT 15,000 POUND 3.7 PERCENT MILK, PER COW ESTIMATED RETURNS AND EXPENSES

ITEM	DESCRIPTION	UNIT	QUANTITY	PRICE (DOLLARS)	AMOUNT (DOLLARS)
REVENUE -					
MILK[a,b]	15,000 LBS./COW	CWT.	9,000	12.40	111,600.00
CALVES	2-3 DAYS OLD	HD.	40	40.00	1,600.00
COWS-CULL	25% CULL RATE	HD.	14	462.50	6,475.00
NONBRED HEIFERS	YRLNGS @ .40	HD.	2	400.00	800.00
TOTAL REVENUE					120,475.00
VARIABLE EXPENSES -					
DAIRY FEED	2.2T 18% CON.	TON	170	200.00	34,000.00
SILAGE CORN[c]	11T/COW+2T/HEF.	TON	784	25.00	19,600.00
ALFALFA HAY	1.5T/MILK COW	TON	60	110.00	6,600.00
GRASS-CLOVER HAY	1T/HEIFER	TON	32	75.00	2,400.00
PASTURE	1.5AC./REP.AN.U	AC.	35	45.48	1,591.80
SALT		CWT.	9	5.70	51.30
BONE MEAL		CWT.	18	11.80	212.40
MILK REPLACER	ALL MILK	CWT.	7.5	54.75	410.63
CALF STARTER		CWT.	27	12.75	344.25
BREEDING FEES	ARTIFICIAL	HD.	72	21.00	1,512.00
DHIA[d]		HD.	60	14.00	840.00
DUES	ADA	CWT.	9,000	0.36	3,240.00
MILK HAULING		CWT.	9,000	0.50	4,500.00
VET & MED.	INCLUDES REP. S	HD.	60	19.00	1,140.00
DAIRY SUPPLIES		HD.	60	8.00	480.00
BEDDING	INCLUDES REP. S	HD.	60	10.00	600.00
ELECTRICITY		KWH	45,000	0.06	2,790.00
MARKETING FEES[e]	14 COWS - 2 HEIF	HD.	16	6.88	110.00
TRUCKING FEES[f]	14 COWS - 2 HEIF	HD.	16	2.88	46.00
MACHINERY	FUEL	HR.	0	1.02	0.00
	REPAIRS	HR.	0	1.83	0.00
TOTAL VARIABLE EXPENSES				80,468.38	
RETURN ABOVE VARIABLE EXPENSES					40,006.63
FIXED EXPENSES -					
DEPR. & REPAIRS[g]					
BLDG., EQUIP., FEN.		HD.	60	118.78	7,126.80
MACH.		HR.	0	1.57	0.00
TOTAL FIXED EXPENSES					7,126.80
TOTAL VARIABLE AND FIXED EXPENSES					87,595.18
NET RETURN TO LAND, LABOR, CAPITAL AND MANAGEMENT					32,879.83
NET RETURNS PER COW					548.00
INTEREST -					
LIVESTOCK	$800 @ 14%				6,720.00
BLDGS. & EQUIP.	1/2 OF $2,177 @ 11%				7,232.40
FIXED	MACH. & EQUIP.				463.50
TOTAL					14,415.90
NET RETURN TO LAND, LABOR AND MANAGEMENT					18,463.93
NET RETURN PER COW					307.73

APPENDIX TABLE 9 (continued)

ITEM	DESCRIPTION	UNIT	QUANTITY	PRICE (DOLLARS)	AMOUNT (DOLLARS)
LABOR	60 HRS./COW	HR.	3,600	4.00	14,400.00
NET RETURN TO LAND AND MANAGEMENT					4,063.92
NET RETURN PER COW					67.73

[a]This budget assumes the enterprise has been operating at capacity of 60 cows. A 25 percent replacement rate requires 15 bred heifers and 17 yearling heifers to maintain a herd of 60 milk cows. A 5 percent death loss for calves and a 1.67 percent loss for cows leaves 40 calves and 14 cull cows to be sold.

[b]The average blend price of 3.5 percent milk used is $12.10 per cwt. There was a $.15 differential for each .1 percent butterfat.

[c]Forage requirements were based on the Tennessee DHIA pasture summary.

[d]Includes the supervisor's fee and travel allocation costs plus fat test and machine processing costs.

[e]Marketing fees are $7 per cow and $2 per yearling heifer. Most two-three day old calves were assumed sold directly to buyers on the farm.

[f]Transportation costs were $3 per cow and $2 per yearling heifer.

[g]Complete breakdown of building and equipment repairs and depreciation are published in the Tennessee Farm Planning Manual. A direct spread manure disposal system with 30 days storage is assumed. The value of the manure will offset the cost of equipment and labor needed.

APPENDIX TABLE 10

FARROW-TO-FINISH HOGS, 16 PIGS PER SOW PER UNIT (40-SOW UNIT), ESTIMATED RETURNS AND EXPENSES

ITEM	DESCRIPTION	UNIT	QUANTITY	PRICE (DOLLARS)	AMOUNT (DOLLARS)
REVENUE -					
MARKET HOGS[a]	15.5 HD. @ 230 LBS.	CWT.	35.65	48.00	1,711.20
CULL SOW	.5 OF A SOW	CWT.	2.25	42.00	94.50
DEATH LOSS	1.5% OF 16 MKT HOGS				-16.56
TOTAL REVENUE					1,789.14
VARIABLE EXPENSES -					
FEED					
CORN[b,c]	SHELLED	BU.	186.7	3.50	653.45
SUPPLEMENT	SOYBEAN MEAL	CWT.	25.38	12.75	323.60
PREMIX		CWT.	4.05	21.30	86.27
PASTURE		AC.	0.17	45.48	7.73
VET. & MED.[d]		SOW	1	41.10	41.10
ELECTRICITY		HD.	1	6.00	6.00
TRUCK	SLAUGHTER	HD.	16	1.50	24.00
TOTAL VARIABLE EXPENSE					1,142.14
RETURN ABOVE VARIABLE EXPENSES					647.00
FIXED EXPENSES -					
DEPR.[e]	BOAR	SOW	1	11.25	11.25
DEPR.[f]	BLDGS., EQUIP.	SOW	1	78.15	78.15
REPAIRS[f]	BLDGS., EQUIP.	SOW	1	23.37	23.37
TOTAL FIXED EXPENSES					112.77
TOTAL VARIABLE AND FIXED EXPENSES					1,254.91
NET RETURN TO LAND, LABOR, CAPITAL AND MANAGEMENT					534.23
INTEREST -					
LIVESTOCK	$158.75 @ 14%				22.26
BLDGS. & EQUIP.	1/2 OF $1,563 @ 1				109.41
TOTAL					131.67
NET RETURN TO LAND, LABOR AND MANAGEMENT					402.56
LABOR		HR.	28	4.00	112.00
NET RETURN TO LAND AND MANAGEMENT					290.56

[a]Expenses are based on a 40-sow unit, with five groups of eight sows each. Sows will farrow twice each year and wean eight pigs per litter. Sows will be kept for four litters then sold.

[b]All feed, including creep feed, is ground and mixed on the farm. Formulations are for an 18 percent creep feed, a 15 percent lactating ration, a 14 percent dry sow ration, a 16 percent growing ration fed to 100 pounds and a 14 percent finishing ration fed to market weight.

[c]Corn requirements are 45.38 bushels for sow, replacement, boar and creep, plus 141.32 bushels for market hogs.

APPENDIX TABLE 10 (continued)

[d]Veterinary expenses consist of two vaccinations for erysipelas and leptospiosis ($2.65), atrophic rhinitis vaccination ($1.60), feed additives for creep and sow feed ($10.45) and one vet trip per year for each 20 sows ($2.50). Expenses for pigs are for two iron shots at $.10 each ($3.64) and $1.00 per pig for feed additives from weaning to market weight ($18.20). Total = $41.10.

[e]Three boars will cost $450 each and sell for $150 after two years. Depreciation is $450 or $11.25 per sow annually.

[f]Complete building and equipment costs are published in the Tennessee Farm Planning Manual.

APPENDIX TABLE 11

MARKET HOG--300-HEAD UNIT, FINISHING PURCHASED FEEDER PIGS ON FINISHING FLOOR, ESTIMATED RETURNS AND EXPENSES

ITEM	DESCRIPTION	UNIT	QUANTITY	PRICE (DOLLARS)	AMOUNT (DOLLARS)
REVENUE -					
MARKET HOGS[a]	230 LBS.	CWT.	2.3	48.00	110.40
DEATH LOSS	3%				-3.01
TOTAL REVENUE					107.39
VARIABLE EXPENSES -					
FEEDER PIG	45 LBS.	HD.	1	35.00	35.00
CORN[b]	SHELLED	BU.	9.7	3.50	33.95
SUPPLEMENT	SOYBEAN MEAL	CWT.	1.15	12.75	14.66
PREMIX		CWT.	0.17	21.30	3.62
FEED ADDITIVES		HD.	1	0.00	0.00
VET. & MED.[c]		HD.	1	1.65	1.65
TRUCK	SLAUGHTER HOGS	HD.	1	1.50	1.50
TRUCK	FEEDER PIGS	HD.	1	0.45	0.45
TOTAL VARIABLE EXPENSES					90.83
RETURN ABOVE VARIABLE EXPENSES					16.56
FIXED EXPENSES -					
DEPR.[d]	BLDGS., EQUIP.	HD.	1	1.83	1.83
REPAIRS	BLDGS., EQUIP.	HD.	1	0.55	0.55
TOTAL FIXED EXPENSES					2.38
TOTAL VARIABLE AND FIXED EXPENSES					93.21
NET RETURN TO LAND, LABOR, CAPITAL AND MANAGEMENT					14.18
INTEREST -					
FEEDER PIG	$45 @14% FOR 3.5 M				1.83
BLDGS. & EQUIP.	1/2 OF $37 @ 14%				2.59
TOTAL					4.42
NET RETURN TO LAND, LABOR AND MANAGEMENT					9.76
LABOR		HR.	0.8	4.00	3.20
NET RETURN TO LAND AND MANAGEMENT					6.56

[a]This enterprise is based on the all-in all-out concept. Efficiency and sanitation is improved if each finishing building is emptied completely before a new group of pigs is moved in from the nursery. Each purchased group of 180 pigs is put in the nursery, then moved to the feeding floors as they become empty.

[b]A feed efficiency of 3.8 pounds feed per pound of gain was used. Rations are 16 percent for pigs up to 100 pounds and 14 percent up to market weight.

APPENDIX TABLE 11 (continued)

[c]Purchased pigs will require $1.65 per head for medications as compared with $1.00 per head for home raised feeder pigs. Expenses for purchased pigs include high level medication for the first two weeks, a preventive level for the following two weeks, then 100 grams of a broad spectrum antibiotic to market weight. Also included are costs for worming the pig twice, for lice control and for veterinary trips and injections of medication at the preventive level then finished with 50 grams of broad based antibiotics.

[d]Depreciation and repairs on buildings, equipment and fences are based on 2.8 fill-ups or 2,016 head per year.

APPENDIX TABLE 12

NET RETURNS FOR SELECTED FARM ENTERPRISES FOR TENNESSEE, 1954 TO 1984[a]

YEAR	NOMINAL DOLLARS PER UNIT ENTERPRISE									
	CORN	DAIRY	TOB.O/OP	TOB.SHR	SOY	BEEF	FDER PIG	SOW F/F	WHEAT	WHT-SOY
1954	10.36	15,337.9	238.91	120.96	10.48	827.75	21.55	550.50	-4.41	-2.74
1955	11.76	16,457.71	341.22	172.08	6.78	690.95	7.31	268.58	3.46	2.33
1956	16.21	17,817.91	418.36	210.65	9.68	582.95	5.96	242.12	2.31	3.50
1957	7.63	18,252.62	384.75	193.88	9.30	723.52	13.00	382.92	8.48	9.21
1958	12.11	16,744.18	505.89	254.48	8.80	1,122.79	16.43	453.16	9.08	9.26
1959	7.68	16,207.31	439.02	221.08	5.58	1,122.71	3.44	201.48	-5.47	-8.02
1960	7.67	17,035.65	2.00	290.55	10.46	974.60	6.76	263.53	5.38	6.89
1961	20.57	16,013.00	650.39	326.77	16.75	615.35	9.07	311.73	-5.17	1.22
1962	24.39	14,944.27	644.50	323.82	16.15	949.40	8.39	298.50	14.89	20.80
1963	26.25	14,213.09	671.04	337.12	19.88	490.94	4.63	227.62	-2.34	6.40
1964	25.52	15,332.9	754.37	378.75	19.26	416.93	5.02	232.35	-4.15	4.24
1965	36.49	15,184.66	756.10	379.65	20.87	730.81	17.45	478.99	-1.47	8.06
1966	38.44	19,163.1	786.26	394.80	26.73	699.25	21.17	557.73	-0.12	13.79
1967	29.75	21,689.19	869.50	436.42	17.89	646.50	12.40	385.74	-2.22	4.62
1968	32.63	23,386.94	840.28	421.84	21.12	790.84	10.88	358.97	-3.52	5.76
1969	42.98	24,062.04	877.49	440.52	18.87	1,043.10	17.98	503.86	-3.30	3.87
1970	38.60	24,005.95	982.24	493.00	27.70	848.20	17.26	498.50	-7.65	6.12
1971	34.53	23,366.92	1,007.79	505.87	32.28	1,076.51	3.72	241.76	-1.40	15.59
1972	87.50	22,676.81	1,090.55	547.39	66.93	1,295.96	18.36	540.37	11.55	55.64
1973	158.62	27,074.95	1,046.11	525.48	95.42	1,931.92	42.75	1,044.66	71.58	137.10
1974	132.49	32,782.2	1,418.39	711.96	86.09	1,083.42	27.15	768.07	42.27	98.79
1975	126.45	31,207.67	1,152.22	579.15	63.87	1,012.44	49.01	1,219.76	44.56	82.09
1976	87.83	36,244.84	1,326.92	656.57	94.14	12.30	39.02	1,041.45	5.54	66.37
1977	78.91	33,366.19	1,330.44	668.63	91.93	-86.06	27.17	823.77	0.30	58.59
1978	114.38	36,455.2	1,679.89	843.63	100.76	1,003.34	38.45	1,068.19	11.34	75.49
1979	145.31	40,546.85	1,347.02	667.57	93.35	2,154.96	18.43	719.45	15.42	71.34
1980	137.88	40,752.21	1,545.20	777.31	79.17	1,303.54	0.66	414.80	3.90	46.19
1981	115.49	40,916.5	2,074.46	1,042.35	49.80	281.56	6.55	565.34	7.33	24.31
1982	139.30	34,535.18	2,252.60	1,131.66	41.08	-31.71	21.15	871.81	16.19	25.11
1983	96.04	31,661.54	1,533.29	772.10	63.82	-399.92	6.93	601.85	5.97	32.63
1984	115.36	28,153.87	2,266.11	1,138.83	28.55	-252.06	5.15	578.53	7.70	5.53

[a]See Appendix Table 1 for definition of terms and abbreviations.

APPENDIX TABLE 13

VARIANCE-COVARIANCE MATRICES OF NET RETURNS FOR SELECTED FARM ENTERPRISES USING ALTERNATIVE WHITENING PROCEDURES

WHITENING PROCEDURE[a]	ENTER-PRISE	VARIANCE-COVARIANCES									
		CORN	DAIRY	SOY	BEEF	WHEAT	WHT-SOY	TOB.O/OP	TOB.SHR	FDER PIG	SOW F/F
NOMINAL	CORN	2,581.6									
	DAIRY	388,997.1	77,818,628								
	SOY	1,402.8	236,904	1,061.2							
	BEEF	3,084.2	-131,989	2,885.3	314,469.5						
	WHEAT	559.1	50,191	298.5	3,670.3	283.8					
	WHT-SOY	1,428.7	193,734	1,029	7,180.3	499.6	1,243.9				
	TOB.O/OP	22,894.6	33,996,952	10,873.7	-97,064.3	2,382.7	7,941.9	298,051.9			
	TOB.SHR	11,468.1	1,999,530	5,427.3	-49,023.6	1,194.8	1,961.4	149,525.9	75,019.8		
	FDER PIG	308.1	40,234	250.5	1,329.1	133.5	326.8	1,285.6	635.86	156.3	
	SOW F/F	10,864.6	1,667,031	7,172.3	3,093.4	3,056.4	7,913.8	85,181.1	42,557.26	3,197.3	79,488.1
DEFLATED	CORN	2,140									
	DAIRY	-6,072.5	49,445,434								
	SOY	1,275.6	31,162.8	1,015.4							
	BEEF	-472.6	3,528,341.	-249.9	668,964						
	WHEAT	771.9	3,370.5	426.8	4,985.3	545.6					
	WHT-SOY	1,792.4	28,300.7	1,239.2	4,785.4	887.1	1,878.4				
	TOB.O/OP	6,621.3	588,312.1	4,336.4	-5,015.9	277.5	3,746.6	1,006,003			
	TOB.SHR	3,274.6	293,030.1	2,113.5	1,675.4	139.9	1,830.7	53,124.2	26,651.8		
	FDER PIG	325	49,396.8	247.8	4,406.4	179.8	378	565	273.6	251.6	
	SOW F/F	6,369.1	968,177	4,857.4	86,365	3,523.5	7,409.4	11,074.6	5,362.8	4,932.3	96,673.3
SECOND ORDER TRENDS REMOVED	CORN	1,054.8									
	DAIRY	20,441.3	19,592,451								
	SOY	579.3	21,509.5	544.3							
	BEEF	8,859.7	498,772.3	3,180.3	319,966.3						
	WHEAT	612.8	7,443.7	325	6,371.1	522.3					
	WHT-SOY	1,076.2	24,651.3	760.4	8,915.3	782.2	1,390.5				
	TOB.O/OP	-1,140.7	-81,981.1	-1,429.3	-20,758.4	-854.6	-1,998.1	25,166.5			
	TOB.SHR	-568.2	-45,845.4	-747.4	-10,143.5	-420.6	-1,018.5	12,897.1	6,632.2		
	FDER PIG	273.8	17,846.8	198.3	1,574.8	175.4	334.1	-609.2	-315.5	215	
	SOW F/F	5,758.4	349,797.2	3,887.3	30,866.4	3,438.1	6,547.9	-11,940.9	-6,184	4,214.1	82,596.7

APPENDIX TABLE 13 (continued)

WHITENING PROCEDURE[a]	ENTER-PRISE	VARIANCE-COVARIANCES									
		CORN	DAIRY	SOY	BEEF	WHEAT	WHT-SOY	TOB.O/OP	TOB.SHR	FDER PIG	SOW F/F
SIMPLE MOVING AVERAGE	CORN	891									
	DAIRY	-19,639	15,200,000								
	SOY	358	-6,850.7	314.4							
	BEEF	8,468.7	381,442.7	2,581.6	351,644						
	WHEAT	526.8	-11,292.5	185.6	5,499.6	453.3					
	WHT-SOY	813.2	-16,773.1	437.1	7,564.9	601.8	951.5				
	TOB.O/OP	-230.2	33,476	-232.8	-10,585.5	-182.8	-369.1	23,300.1			
	TOB.SHR	-95.3	12,058.5	-128.9	-5,037.4	-71.9	-175	11,826	6,025.5		
	FDER PIG	165.5	263	80.9	462.4	118	182.7	-460.9	-237.5	168.8	
	SOW F/F	3,242.9	5,155.2	1,585.1	9,062.1	2,312.4	3,580.5	-9,034.6	-4,654.4	3,309.2	64,861.3
WEIGHTED MOVING AVERAGE	CORN	701.8									
	DAIRY	-549.8	6,693,067								
	SOY	275.3	695.8	234.3							
	BEEF	8,028.7	-39,718.6	2,121.2	265,795.9						
	WHEAT	391.5	466	141.8	5,410	336.4					
	WHT-SOY	611.8	1,022.6	329.3	7,106.9	449.8	713.3				
	TOB.O/OP	-335.2	61,594.3	-18.4	-20,871.6	-326.2	-340.9	19,632.8			
	TOB.SHR	-158.8	27,945.6	-19.7	-10,584.7	-150.9	-166.6	10,096.1	5,220.7		
	FDER PIG	195.5	-123.7	75	1,995.1	137.7	197.7	-17.1	-11.4	161.7	
	SOW F/F	3,831.9	-2,425.3	1,469.1	39,104	2,699.3	3,874.6	-336	-223	3,169.6	62,124.5
ARIMA MODEL	CORN	755.4									
	DAIRY	-6,830.6	10,900,000								
	SOY	116.8	5,179.7	293.5							
	BEEF	-226.7	-36,312.6	1,429.1	346,125.7						
	WHEAT	-221.7	399.6	74.3	6,143.3	459.4					
	WHT-SOY	-82.4	4,666.6	326.4	9,402.7	545	886.3				
	TOB.O/OP	1,215.7	176,740.3	-150.9	-10,687.7	-1,077.4	-1,176.3	39,747			
	TOB.SHR	623.5	81,385.7	-104.4	-5,159.9	-527.1	-586.3	20,085.8	10,192.9		
	FDER PIG	177.2	496.3	48.4	-770.5	-13.6	25.2	519.2	281.2	219.6	
	SOW F/F	3,472.3	9,726.8	949.2	-15,102.4	-265.9	494.3	10,176.1	5,511	4,304.4	84,366.4

[a]See Appendix Table 1 for explanation of abbreviations.

APPENDIX TABLE 14

COMPARISON OF RISK MEASURES USING QUADRATIC PROGRAMMING - LARGE TOBACCO FARM, SHARECROP TENANCY, ROW-CROP ENTERPRISES[a]

		Enterprise Levels									
	VAR	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	HL6 (HRS.)
NET RETURNS - $3,000											
TYPE SOL:											
1. NOMINAL	1,849		0.17		1.74		0.28	1.40	2.60	125.0	
2. DEFLATED	824				0.12		0.30	1.16	2.84	125.0	
3. SIM MOV A	181			0.15	4.56		0.30	1.16	2.84	124.8	
4. WTD MOV A	145				0.39		0.30	1.20	2.80	125.0	
5. DETRENDED	163			0.40	0.21		0.30	1.17	2.80	124.6	
6. ARIMA RES	296	0.25	0.02	0.21	0		0.30	1.14	2.80	124.7	
AVERAGE		0.04	0.03	0.13	1.17	0	0.30	1.20	2.78	124.8	0
AVERAGE 2-6		0.05	0.004	0.15	1.06	0	0.30	1.17	2.82	124.8	0
STD ERR 2-6		0.220	0.017	0.333	3.876	0	0.004	0.044	0.044	0.358	0
NET RETURNS - $4,000											
TYPE SOL:											
1. NOMINAL	34,108				6.06		1.06	2.10	1.90	125.0	50
2. DEFLATED	15,054				0.33		1.15	1.19	2.81	125.0	53
3. SIM MOV A	3,259			0.83	0.39		1.13	1.20	2.80	124.1	51
4. WTD MOV A	2,648			0.20	1.41		1.13	1.35	2.65	124.8	52
5. DETRENDED	2,899			1.63	0.66		1.11	1.24	2.76	123.0	48
6. ARIMA RES	5,247	1.16			0		1.11	1.14	2.80	123.8	48
AVERAGE		0.19	0	0.44	1.48	0	1.12	1.37	2.62	124.3	50
AVERAGE 2-6		0.23	0	0.53	0.56	0	1.13	1.22	2.76	124.1	50.4
STD ERR 2-6		1.038	0	1.405	1.062	0	0.033	0.158	0.133	1.610	4.60
NET RETURNS - $5,000											
TYPE SOL:											
1. NOMINAL	183,284				12.00		2.33	1.40	2.60	125.0	267
2. DEFLATED	80,086				0.69		2.50	1.20	2.80	125.0	275
3. SIM MOV A	17,339			1.82	0.87		2.47	1.27	2.70	123.0	268
4. WTD MOV A	14,085			0.43	3.06		2.46	1.60	2.39	124.5	271
5. DETRENDED	15,422			3.58	1.44		2.42	1.36	2.64	121.4	262
6. ARIMA RES	27,915	2.54					2.43	1.14	2.86	122.5	262
AVERAGE		0.42	0	0.97	3.01	0	2.44	1.33	2.66	123.6	267.5
AVERAGE 2-6		0.51	0	1.17	1.21	0	2.46	1.31	2.68	123.3	267.6
STD ERR 2-6		2.272	0	3.085	2.308	0	0.064	0.360	0.365	2.944	11.367

APPENDIX TABLE 14 (continued)

		Enterprise Levels									
	VAR	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	HL6 (HRS.)
NET RETURNS - $6,000											
TYPE SOL:											
1. NOMINAL	UNBND?										
2. DEFLATED	856,273	25.80				3.22	1.14	2.86	99.20	35	400
3. SIM MOV A	UNBND?										
4. WTD MOV A	223,578	18.30		13.80		3.20	1.14	2.90	93.00	43	400
5. DETRENDED	448,818	9.40		30.40		3.22	1.14	2.86	85.20	54	400
6. ARIMA RES	252,889	17.10		16.10		3.22	1.14	2.86	91.80	45	400
AVERAGE		11.77	0	10.05	0	2.14	0.76	1.91	61.50	29.5	266.7
AVERAGE 2-6		14.12	0	12.06	0	2.57	0.91	2.30	73.84	35.4	320
STD ERR 2-6		19.607	0	25.428	0	2.876	1.020	2.567	83.15	41.823	357.771
NET RETURNS - $6,054.59											
LINEAR PROG.		81.17				3.07	1.14	2.86	43.8	108	400

[a]See Appendix Table 1 for definition of terms and abbreviations.

APPENDIX TABLE 15

COMPARISON OF RISK MEASURES USING QUADRATIC PROGRAMMING - SMALL TOBACCO FARM, OWNER/OPERATOR TENANCY, ROW-CROP ENTERPRISES[a]

		Enterprises										
	VAR	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	HL5 (HRS.)	HL6 (HRS.)
NET RETURNS - $4,000												
TYPE SOL:												
1. NOMINAL	14,830		0.17		4.44			0.71	2.10	2.90		
2. DEFLATED	6,610				0.03			0.76	1.47	3.53		
3. SIM MOV A	1,450			0.38	0.33			0.76	1.48	3.52		
4. WTD MOV A	1,162				1.02			0.75	1.60	3.40		
5. DETRENDED	1,311			1.00	0.51			0.75	1.50	3.49		
6. ARIMA RES	2,370	0.13		0.21				0.75	1.60	3.50		
AVERAGE		0.02	0.03	0.27	1.06	0	0	0.75	1.62	3.39	0	0
AVERAGE 2-6		0.02	0	0.32	0.38	0	0	0.75	1.53	3.49	0	0
STD ERR 2-6		0.116	0	0.827	0.834	0	0	0.010	0.130	0.103	0	0
NET RETURNS - $6,000												
TYPE SOL:												
1. NOMINAL	192,051				13.74			2.40	3.50	1.50		146
2. DEFLATED	84,765				0.72			2.60	1.50	3.50		155
3. SIM MOV A	18,352			1.89	0.90			2.56	1.57	3.40		149
4. WTD MOV A	14,908			0.44	3.18			2.56	1.90	3.10		152
5. DETRENDED	16,323			3.70	1.50			2.50	1.60	3.34		142
6. ARIMA RES	29,545	2.64						2.53	1.40	3.60		142
AVERAGE		0.44	0	1.00	3.34	0	0	2.52	1.91	3.07	0	147.7
AVERAGE 2-6		0.53	0	1.21	1.26	0	0	2.55	1.59	3.39	0	148.0
STD ERR 2-6		2.361	0	3.191	2.398	0	0	0.075	0.375	0.378	0	11.747
NET RETURNS - $8,000												
TYPE SOL:												
1. NOMINAL	959,418				23.43	1.91		1.42	5.00			317
2. DEFLATED	408,894				1.17	1.78		2.00	1.60	3.40		350
3. SIM MOV A	86,848			4.10	1.83	1.74		2.00	1.70	3.30		343
4. WTD MOV A	73,246	0.22		1.00	6.18	1.80		1.90	2.40	2.60		341
5. DETRENDED	76,361			7.80	3.15	1.70		1.98	1.90	3.10		335
6. ARIMA RES	139,844		5.70			1.70		2.02	1.40	3.60		336
AVERAGE		0.04	0.95	2.15	5.96	1.77	0	1.89	2.33	2.67	0	337
AVERAGE 2-6		0.04	1.14	2.58	2.47	1.74	0	1.98	1.80	3.20	0	341
STD ERR 2-6		0.197	5.098	6.736	4.736	0.091	0	0.094	0.762	0.762	0	12.083

APPENDIX TABLE 15 (continued)

		Enterprises										
	VAR	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	HL5 (HRS.)	HL6 (HRS.)
NET RETURNS - $9,000												
TYPE SOL:												
1. NOMINAL	1,756,525				23.19	3.26	1,592	0.49	4.96	0.04	29	385
2. DEFLATED	700,443					3.26	1,592	0.78	1.43	3.57	15	386
3. SIM MOV A	146,375	0.04		6.11	0.90	3.26	1,592	0.56	1.57	3.43	6.3	355
4. WTD MOV A	125,561	1.21		1.30	6.36	3.26	1,592	0.60	2.39	2.60	15	371
5. DETRENDED	127,214			10.70	2.88	3.26	1,592	0.41	1.87	3.13	2	335
6. ARIMA RES	232,807	8.07				3.26	1,592	0.42	1.43	3.57	1	331
AVERAGE		1.55	0	3.02	5.55	3.26	1,592	0.54	2.28	2.72	11.4	360
AVERAGE 2-6		1.86	0	3.62	2.03	3.26	1,592	0.55	1.74	3.26	7.9	355
STD ERR 2-6		7.017	0	9.376	5.384	0	0	0.301	0.813	0.821	13.631	46.81
NET RETURNS - $9,929.91												
LINEAR PROG.		51.20				3.26	1,591	0.72	1.43	3.57	85	400

[a]See Appendix Table 1 for definition of terms and abbreviations.

APPENDIX TABLE 16

COMPARISON OF RISK MEASURES USING QUADRATIC PROGRAMMING - LARGE TOBACCO FARM, OWNER/OPERATOR TENANCY, BEEF ENTERPRISES[a]

		Enterprise Levels											
	VAR	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (AC.)	RNTRC (AC.)	RNTTQ (LBS.)	HL6 (HRS.)
NET RETURNS - $4,000													
TYPE SOL:													
1. NOMINAL	208,347				8.58			1.36	11.00	23.0	7.0	6,000	
2. DEFLATED	12,635				0.57			1.47	9.80	24.2	7.0	6,000	
3. SIM MOV A	2,771			0.74	0.66			1.46	9.80	24.2	6.2	6,000	
4. WTD MOV A	2,223				1.95			1.46	10.00	24.0	7.0	6,000	
5. DETRENDED	2,505			1.96	0.99			1.45	9.90	24.1	5.0	6,000	
6. ARIMA RES	4,544	1.21	0.09		2.82			1.46	9.70	24.3	5.6	6,000	
AVERAGE		0.20	0.02	0.45	2.60	0	0	1.44	10.03	24.0	6.3	6,000	
AVERAGE 2-6		0.24	0.02	0.54	1.40	0	0	1.46	9.84	24.2	6.2	6,000	0
STD ERR 2-6		1.082	0.083	1.713	1.930	0	0	0.014	0.228	0.228	1.727	0	0
NET RETURNS - $5,000													
TYPE SOL:													
1. NOMINAL	210,144				13.11	0.82		6.81	11.50	22.1	6.2	4,023	
2. DEFLATED	60,136				0.57	0.22		2.13	9.80	24.2	6.8	5,479	92
3. SIM MOV A	11,944			0.65	1.14	0.39		1.80	9.89	24.1	6.0	5,074	66
4. WTD MOV A	15,194				3.15	0.34		1.86	10.20	23.8	6.6	5,174	72
5. DETRENDED	16,239			2.54	1.92	0.81		0.95	10.00	24.0	3.7	4,049	
6. ARIMA RES	20,863	1.64			0.12	0.69		1.20	9.70	24.3	4.7	4,341	18
AVERAGE		0.27	0	0.53	3.34	0.54	0	2.46	10.18	23.8	5.7	4,690	41
AVERAGE 2-6		0.33	0	0.64	1.38	0.49	0	1.59	9.92	24.1	5.6	4,823	49
STD ERR 2-6		1.467	0	2.200	2.393	0.501	0	0.984	0.385	0.385	2.673	1,203.302	77.635
NET RETURNS - $6,000													
TYPE SOL:													
1. NOMINAL	581,446				20.67	2.04			9.80	13.5	4.96	1,092	81
2. DEFLATED	188,989				1.02	1.84		0.48	9.87	24.1	5.20	1,583	88
3. SIM MOV A	38,874			0.83	1.95	2.06		0.03	10.00	24.0	4.10	1,044	54
4. WTD MOV A	42,384				5.04	2.04		0.05	10.50	23.5	5.00	1,108	58
5. DETRENDED	49,655			3.40	3.27	2.12			8.00	18.3	1.50	904	61
6. ARIMA RES	80,491	0.71			1.59	2.08			10.00	24.0	4.20	1,003	51
AVERAGE		0.12	0	0.70	5.59	2.03	0	0.09	9.70	21.2	4.16	1,122	65
AVERAGE 2-6		0.14	0	0.846	2.57	2.03	0	0.11	9.67	22.8	4.00	1,128	62
STD ERR 2-6		0.635	0	2.945	3.215	0.218	0	0.415	1.933	5.031	2.956	529	29.62

APPENDIX TABLE 16 (continued)

	VAR	Enterprise Levels WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (AC.)	RNTRC (AC.)	RNTTQ (LBS.)	HL6 (HRS.)
NET RETURNS - $7,000													
TYPE SOL:													
1. NOMINAL	1,163,077				29.25	2.89	939		6.40	0.4	3.73		235
2. DEFLATED	469,433				1.14	2.92	1,013		7.80	18.8	3.60		186
3. SIM MOV A	101,665				2.82	2.92	1,008		7.70	17.7	3.70		189
4. WTD MOV A	87,527				7.14	2.50		0.87	5.90	10.9	4.50		270
5. DETRENDED	99,932			3.55	4.95	2.98	1,156		4.80	9.3			203
6. ARIMA RES	177,445				2.91	2.92	1,008		7.70	17.7	3.70		189
AVERAGE		0	0	0.59	8.03	2.86	854	0.14	6.72	12.5	3.20	0	212
AVERAGE 2-6		0	0	0.71	3.79	2.85	837	0.17	6.78	14.9	3.10	0	207
STD ERR 2-6		0	0	3.175	4.616	0.393	944	0.779	2.725	8.84	3.541	0	71
NET RETURNS - $7,492.77													
LINEAR PROG.						3.13	1,531	0.44	5.5	13.8	3.25		290

[a]See Appendix Table 1 for definition of terms and abbreviations.

APPENDIX TABLE 17

COMPARISON OF RISK MODELS USING QUADRATIC PROGRAMMING - SMALL TOBACCO FARM, OWNER/OPERATOR TENANCY, BEEF ENTERPRISES[a]

		Enterprise Levels											
	VAR	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	RNTTQ (LBS.)	HL6 (HRS.)
NET RETURNS - $1,500													
TYPE SOL:													
1. NOMINAL	3,488	4.00						0.54				2,640	
2. DEFLATED	1,797				0.20			0.51	2.88	7.1	4.00	2,640	
3. SIM MOV A	394			0.25	0.23			0.50	2.89	7.1	3.74	2,640	
4. WTD MOV A	316				0.66			0.50	2.96	7.1	4.00	2,640	
5. DETRENDED	356			0.68	0.33			0.50	2.91	7.1	3.30	2,640	
6. ARIMA RES	646	0.42	0.03					0.50	2.86	7.1	3.55	2,640	
AVERAGE		0.74	0.005	0.16	0.24	0	0	0.51	2.42	5.9	3.10	2,640	0
AVERAGE 2-6		0.08	0.006	0.19	0.28	0	0	0.50	2.90	7.1	3.72	2,640	0
STD ERR 2-6		0.372	0.029	0.591	0.484	0	0	0.007	0.076	0.104	0.602	0	0
NET RETURNS - $2,000													
TYPE SOL:													
1. NOMINAL	18,068				5.52			0.96	3.69	6.3	4.00	2,640	61
2. DEFLATED	7,975				0.29			1.05	2.90	7.1	4.00	2,640	64
3. SIM MOV A	1,727			0.76	0.36			1.03	2.91	7.1	3.20	2,640	62
4. WTD MOV A	1,403			0.18	1.29			1.03	3.05	6.9	3.80	2,640	63
5. DETRENDED	1,536			1.49	0.60			1.01	2.95	XX?	XX?	2,640	59
6. ARIMA RES	2,780	1.06						1.02	2.86	7.1	2.90	2,640	59
AVERAGE		0.18	0	0.40	1.34	0	0	1.02	3.06	5.8	2.98	2,640	61
AVERAGE 2-6		0.21	0	0.49	0.51	0	0	1.03	2.934	5.6	2.78	2,640	61
STD ERR 2-6		0.948	0	1.285	0.974	0	0	0.030	0.145	6.317	3.232	0	4.6
NET RETURNS - $2,500													
TYPE SOL:													
1. NOMINAL	90,099				9.21	0.86			4.30	5.7	3.1	588	51
2. DEFLATED	30,449				0.46	0.50		0.80	2.90	7.1	3.5	1,445	106
3. SIM MOV A	8,018			0.42	0.81	0.52		0.74	2.98	7.1	3.0	1,378	100
4. WTD MOV A	7,771				2.16	0.50		0.77	3.19	6.8	3.5	1,430	104
5. DETRENDED	7,418			2.05	1.26	0.90			3.00	6.9	1.0	478	43
6. ARIMA RES	13,579	1.12			0.09	0.74		0.32	2.87	7.1	2.1	861	66
AVERAGE		0.19	0	0.41	2.33	0.67	0	0.44	3.21	6.8	2.7	1,030	78
AVERAGE 2-6		0.22	0	0.49	0.96	0.63	0	0.53	2.99	7.0	2.6	1,118	83
STD ERR 2-6		1.002	0	1.777	1.598	0.360	0	0.707	0.250	0.294	2.142	864.6	56

APPENDIX TABLE 17 (continued)

		Enterprise Levels											
	VAR	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	RNTTQ (LBS.)	HL6 (HRS.)
NET RETURNS - $3,000 TYPE SOL:													
1. NOMINAL	160,100	0.14			1.02	1.29	471		3.00	6.98	2.3		106
2. DEFLATED	68,200				0.30	1.30	492		2.90	7.10	2.5		106
3. SIM MOV A	17,450			0.21	0.99	1.29	471		3.00	7.00	2.3		106
4. WTD MOV A	11,123	0.14			1.02	1.29	471		3.00	7.00	2.3		106
5. DETRENDED	22,203			0.23	0.96	1.29	472		3.00	7.00	2.3		106
6. ARIMA RES	33,200	0.14			1.02	1.29	471		3.00	7.00	2.3		106
AVERAGE		0.07	0	0.07	0.88	1.29	475	0	2.98	7.01	2.3	0	106
AVERAGE 2-6		0.06	0	0.09	0.86	1.29	475	0	2.98	7.02	2.3	0	106
STD ERR 2-6		0.157	0	0.238	0.626	0.009	18.6	0	0.089	0.089	0.179	0	0
NET RETURNS - $3,007.83 LINEAR PROG.		0.31				1.3	499		2.86	7.14	2.18		106

[a]See Appendix Table 1 for definition of terms and abbreviations.

APPENDIX TABLE 18

COMPARISON OF RISK MEASURES USING QUADRATIC PROGRAMMING - LARGE TOBACCO FARM, SHARECROP TENANCY, DAIRY ENTERPRISES[a]

		Enterprise Levels									
	VAR	DAIRY (COWS)	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (AC.)	RNTRC (AC.)	HL6 (HRS.)
NET RETURNS - $4,000											
TYPE SOL:											
1. NOMINAL	35,012					6.60	1.04	2.44	2.56	113.0	
2. DEFLATED	15,313	0.26					1.06	1.43	3.57	112.9	
3. SIM MOV A	3,134	0.39	0.10		0.60	0.16	1.02	1.45	3.55	112.0	
4. WTD MOV A	2,485	0.54				1.35	0.96	1.63	3.37	112.7	
5. DETRENDED	2,816	0.34			1.20	0.48	1.02	1.50	3.50	111.6	
6. ARIMA RES	5,228	0.54	0.71	0.14		0.04	0.97	1.43	3.56	111.8	
AVERAGE		0.34	0.14	0.02	0.30	1.44	1.01	1.65	3.35	112.3	0
AVERAGE 2-6		0.41	0.16	0.03	0.36	0.41	1.01	1.49	3.51	112.2	0
STD ERR 2-6		0.247	0.618	0.125	1.073	1.120	0.082	0.169	0.166	1.14	0
NET RETURNS - $12,000											
TYPE SOL:											
1. NOMINAL	1,357,721					26.40	6.30	4.36		113.0	
2. DEFLATED	567,141	1.50					6.18	1.43	3.57	112.1	
3. SIM MOV A	116,091	2.28	0.60		3.48	0.93	5.89	1.57	3.43	107.6	
4. WTD MOV A	92,030	3.12				7.74	5.60	2.60	2.39	111.2	
5. DETRENDED	104,281	1.98			7.00	2.82	5.93	1.86	3.14	104.9	
6. ARIMA RES	193,615	3.12		0.81		0.23	5.63	1.46	3.54	106.3	
AVERAGE		2.00	0.10	0.13	1.75	6.35	5.92	2.21	2.68	109.2	0
AVERAGE 2-6		2.40	0.12	0.16	2.10	2.34	5.85	1.78	3.21	108.4	0
STD ERR 2-6		1.427	0.541	0.724	6.257	6.427	0.477	0.974	0.982	6.23	0
NET RETURNS - $20,000											
TYPE SOL:											
1. NOMINAL	4,793,487					46.80	11.80			113.0	
2. DEFLATED	1,910,678	2.76					11.29	1.43	3.57	111.4	
3. SIM MOV A	391,106	4.14	1.11		6.35	1.71	10.77	1.69	3.31	103.2	
4. WTD MOV A	310,047	5.76				14.10	10.23	3.59	1.41	109.7	
5. DETRENDED	351,319	3.54			12.8	5.16	10.80	2.21	2.79	98.2	
6. ARIMA RES	652,281	5.70	7.52	1.48		0.42	10.29	1.49	3.51	100.7	
AVERAGE		3.65	1.44	0.25	3.19	11.36	10.86	1.74	2.43	106.0	0
AVERAGE 2-6		4.38	1.73	0.296	3.83	4.28	10.68	2.08	2.92	104.6	0
STD ERR 2-6		2.65	6.549	1.324	11.438	11.706	0.866	1.794	1.794	11.42	0

APPENDIX TABLE 18 (continued)

		Enterprise Levels									
	VAR	DAIRY (COWS)	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (AC.)	RNTRC (AC.)	HL6 (HRS.)
NET RETURNS - $28,000											
TYPE SOL:											
1. NOMINAL	16,086,643	17.40				23.40	12.30	5.00		103.0	69
2. DEFLATED	5,184,375	12.78					15.15	1.43	3.57	105.7	426
3. SIM MOV A	1,030,031	11.64	4.92		10.40		15.36	1.42	3.57	91.0	452
4. WTD MOV A	760,633	16.68			1.63	17.46	12.81	4.09	0.91	101.8	121
5. DETRENDED	958,976	9.30			19.30	3.99	16.47	2.04	2.96	88.4	614
6. ARIMA RES	1,527,490	17.76	11.78				12.20	1.43	3.57	91.1	
AVERAGE		14.26	2.78	0	5.22	7.48	14.05	2.57	2.43	96.8	280
AVERAGE 2-6		13.63	3.34	0	6.27	4.29	14.40	2.08	2.92	95.6	322
STD ERR 2-6		7.056	10.354	0	16.941	15.125	3.625	2.307	2.304	15.29	507
NET RETURNS - $36,000											
TYPE SOL:											
1. NOMINAL	37,002,356	27.60				23.40	18.10	5.00		97.2	1,088
2. DEFLATED	11,740,227	19.20					10.98	1.43	3.57	102.0	1,725
3. SIM MOV A	2,332,548	17.46	7.39		15.60		23.10	1.43	3.57	80.0	1,764
4. WTD MOV A	1,725,412	25.26			3.35	23.43	19.17	5.00		95.2	1,252
5. DETRENDED	2,171,639	13.98			29.00	6.00	24.70	2.30	2.66	76.0	2,008
6. ARIMA RES	3,457,599	28.20					17.49	1.43	3.57	79.6	974
AVERAGE		21.95	1.23	0	8.00	8.80	18.92	2.76	2.23	88.3	1,468
AVERAGE 2-6		20.82	1.48	0	9.59	5.89	19.09	2.32	2.67	86.6	1,545
STD ERR 2-6		11.614	6.610	0	25.214	20.291	10.765	3.092	3.092	22.716	841
NET RETURNS - $44,000											
TYPE SOL:											
1. NOMINAL	67,484,513	42.60				23.40	17.20	5.00		84.0	1,198
2. DEFLATED	23,979,917	42.60					21.60			88.6	1,786
3. SIM MOV A	5,675,724	42.60					21.60			88.6	1,786
4. WTD MOV A	3,349,404	44.34				22.41	20.70			87.6	1,696
5. DETRENDED	6,107,882	42.60					21.60			88.6	1,786
6. ARIMA RES	649,311	45.30				8.28	20.10	1.76		87.1	1,578
AVERAGE		43.34	0	0	0	9.02	20.47	1.13	0	87.4	1,638
AVERAGE 2-6		43.49	0	0	0	6.14	21.12	0.35	0	88.1	1,726
STD ERR 2-6		2.525	0	0	0	19.555	1.381	1.574	0	1.414	183
NET RETURNS - $48,939.38											
LINEAR PROG.		81.60					8.12			66.3	

[a]See Appendix Table 1 for definition of terms and abbreviations.

APPENDIX TABLE 19

COMPARISON OF RISK MEASURES USING QUADRATIC PROGRAMMING - SMALL TOBACCO FARM, OWNER/OPERATOR TENANCY, DAIRY ENTERPRISES[a]

		Enterprise Levels											
	VAR	DAIRY (COWS)	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	RNTTQ (LBS.)	HL6 (HRS.)
NET RETURNS - $4,000														
TYPE SOL:														
1. NOMINAL	68,835								1.45	2.80	2.2	31.0	5,040	
2. DEFLATED	30,105	0.36				0.18			1.47	1.43	3.57	31.0	5,040	
3. SIM MOV A	6,162	0.54	0.14		0.827	0.27			1.40	1.46	3.54	29.7	5,040	
4. WTD MOV A	4,885	0.72				0.36			1.33	1.70	3.3	30.6	5,040	
5. DETRENDED	5,535	0.48			1.66	0.24			1.41	1.53	3.47	29.1	5,040	
6. ARIMA RES	10,278	0.72	0.98	0.19		0.36			1.34	1.44	3.56	29.4	5,040	
AVERAGE		0.47	0.187	0.03	0.41	0.24	0	0	1.40	1.73	3.27	30.1	5,040	
AVERAGE 2-6		0.56	0.225	0.039	0.50	0.28	0	0	1.39	1.51	3.49	30.0	5,040	
STD ERR 2-6		0.313	0.853	0.173	1.484	0.156	0	0	0.114	0.224	0.224	1.616	0	
NET RETURNS - $6,000														
TYPE SOL:														
1. NOMINAL	280,895	0.72				0.36			2.52	3.70	1.30	31.0	5,040	
2. DEFLATED	109,375	0.84				0.42			2.69	1.43	3.57	31.0	5,040	
3. SIM MOV A	22,409	1.02	0.27		1.55	0.51			2.62	1.49	3.50	28.6	5,040	
4. WTD MOV A	17,765	1.38				0.69			2.50	1.95	3.00	30.2	5,040	
5. DETRENDED	20,129	0.84			3.11	0.42			2.64	1.92	3.38	27.4	5,040	
6. ARIMA RES	37,374	1.38	1.83	0.36		0.69			2.51	1.44	3.56	28.0	5,040	
AVERAGE		1.03	0.35	0.06	0.78	0.52	0	0	2.58	1.99	3.05	29.4	5,040	
AVERAGE 2-6		1.09	0.42	0.07	0.93	0.55	0	0	2.59	1.65	3.40	29.0	5,040	
STD ERR 2-6		0.546	1.594	0.322	2.781	0.273	0	0	0.167	0.530	0.474	3.025	0	
NET RETURNS - $8,000														
TYPE SOL:														
1. NOMINAL	1,034,462	2.58				1.29			4.17	5.00		29.5	5,040	302
2. DEFLATED	364,972	3.48				1.74			4.08	1.43	3.57	29.0	5,040	253
3. SIM MOV A	72,513	3.12	1.30		2.80	1.56			4.14	1.43	3.57	25.1	5,040	260
4. WTD MOV A	53,547	4.50			0.44	2.25			3.45	2.14	2.85	27.9	5,040	170
5. DETRENDED	67,510	2.52			5.20	1.26			4.44	1.59	3.41	24.4	5,040	303
6. ARIMA RES	107,487	5.04				2.52			3.14	1.43	3.57	25.0	5,040	118
AVERAGE		3.54	0.22	0	1.41	1.77	0	0	3.90	2.17	2.83	21.8	5,040	234
AVERAGE 2-6		3.73	0.26	0	1.69	1.87	0	0	3.85	1.60	3.39	26.3	5,040	220
STD ERR 2-6		2.051	1.163	0	4.564	1.026	0	0	1.072	0.615	0.624	4.073	0	150

APPENDIX TABLE 19 (continued)

		Enterprise Levels												
	VAR	DAIRY (COWS)	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	RNTTQ (LBS.)	HL6 (HRS.)
NET RETURNS - $10,000														
TYPE SOL:														
1. NOMINAL	2,342,391	6.78				3.39			4.71	5.00		27.0	5,040	434
2. DEFLATED	813,649	5.94				2.97	0.47		4.64	1.43	3.57	27.0	3,907	445
3. SIM MOV A	162,214	5.10	2.27		4.01	2.55	0.76		4.40	1.43	3.57	21.0	3,225	445
4. WTD MOV A	116,701	6.78			0.72	3.39			4.98	2.46	2.54	26.4	5,040	445
5. DETRENDED	152,347	4.02			7.48	2.01	1.32		3.89	1.64	3.36	19.9	1,872	445
6. ARIMA RES	234,089	7.44	4.56			3.72			4.60	1.43	3.57	22.2	5,040	379
AVERAGE		6.01	1.14	0	2.04	3.00	0.42	0	4.54	2.23	2.77	23.9	4,021	432
AVERAGE 2-6		5.86	1.37	0	2.44	2.93	0.51	0	4.50	1.68	3.32	23.3	3,816	431
STD ERR 2-6		2.704	4.076	0	6.536	1.352	1.113	0	0.801	0.893	0.893	6.43	2,671	59
NET RETURNS - $12,000														
TYPE SOL:														
1. NOMINAL	4,359,161	12.72				23.43	0.78		2.92	5.00		23.0	3,175	331
2. DEFLATED	1,496,017	8.10					2.54	1,048	2.44	1.43	3.57	23.0		445
3. SIM MOV A	300,555	7.56	3.37		4.47		2.66	1,347	2.29	1.43	3.57	15.6		438
4. WTD MOV A	219,048	10.26			1.31	7.77	1.68		2.75	2.60	2.39	22.2	996	395
5. DETRENDED	295,233	7.56			8.00		2.66	1,347	2.34	1.42	3.57	15.5		445
6. ARIMA RES	429,385	10.92	4.35			0.02	1.30		3.10	1.45	3.55	19.1	1,917	383
AVERAGE		9.52	1.29	0	2.30	5.20	1.94	624	2.64	2.22	2.78	19.7	1,015	406
AVERAGE 2-6		8.88	1.54	0	2.76	1.56	2.17	748	2.58	1.66	3.33	19.1	582	421
STD ERR 2-6		3.187	4.285	0	6.908	6.946	1.270	1,388	0.679	1.044	1.051	7.07	1,723	59
NET RETURNS - $15,151.17														
LINEAR PROG.		20.82					2.66	1,347	0.35			15.9		202

[a] See Appendix Table 1 for definition of terms and abbreviations.

APPENDIX TABLE 20

COMPARISON OF RISK MEASURES USING QUADRATIC PROGRAMMING - LARGE TOBACCO FARM, SHARECROP TENANCY, HOG ENTERPRISES[a]

		Enterprise Levels										
	VAR	WHT-SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	SOW F/F (SOWS)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	HL5 (HRS.)	HL6 (HRS.)
NET RETURNS - $30,000 TYPE SOL:												
1. NOMINAL	370,227		5.49	1.02	2,449	8.26	31.7	1.69	1.30	248		829
2. DEFLATED	295,574			1.02	2,449	8.33	31.8	0.86	2.14	248		829
3. SIM MOV A	170,170			1.02	2,449	8.33	31.8	0.86	2.14	248		829
4. WTD MOV A	173,678			1.02	2,449	8.33	31.8	0.86	2.14	248		829
5. DETRENDED	215,461			1.02	2,449	8.33	31.8	0.86	2.14	248		829
6. ARIMA RES	226,183	57.50		1.02	2,449	8.25	28.9	0.86	2.14	190	34	829
AVERAGE		9.58	0.91	1.02	2,449	8.30	31.3	1.00	2.00	238	6	829
AVERAGE 2-6		11.50	0	1.02	2,449	8.31	31.2	0.86	2.14	236	7	829
STD ERR 2-6		51.430	0	0	0	0.072	2.59	0	0	51.9	30.4	0
NET RETURNS - $35,000 TYPE SOL:												
1. NOMINAL	601,611		4.29	1.02	2,449	7.90	43.9	1.50	1.50	248		829
2. DEFLATED	539,992			1.02	2,449	8.00	43.9	0.86	2.14	248		829
3. SIM MOV A	326,977			1.02	2,449	8.00	43.9	0.86	2.14	248		829
4. WTD MOV A	327,724			1.02	2,449	8.00	43.9	0.86	2.14	248		829
5. DETRENDED	414,948			1.02	2,449	8.00	43.9	0.86	2.14	248		829
6. ARIMA RES	428,668	76.90		1.02	2,449	7.90	40.5	0.86	2.14	248	87	829
AVERAGE		12.82	0.71	1.02	2,449	7.97	43.3	0.97	2.03	248	14	829
AVERAGE 2-6		15.38	0	1.02	2,449	7.98	43.2	0.86	2.14	248	17	829
STD ERR 2-6		68.781	0	0	0	0.089	3.04	0	0	0	77.8	0
NET RETURNS - $40,000 TYPE SOL:												
1. NOMINAL	904,148		3.03	1.02	2,449	7.10	56.9	1.32	1.68	248		748
2. DEFLATED	860,027			1.02	2,449	7.65	56.3	0.86	2.14	248	31	829
3. SIM MOV A	534,811			1.02	2,449	7.65	56.3	0.86	2.14	248	31	829
4. WTD MOV A	530,492			1.02	2,449	7.65	56.3	0.86	2.14	248	31	829
5. DETRENDED	679,425			1.02	2,449	7.65	56.3	0.86	2.14	248	31	829
6. ARIMA RES	696,568	96.20		1.02	2,449	7.50	52.2	0.86	2.14	152	141	829
AVERAGE		16.03	0.50	1.02	2,449	7.53	55.7	0.93	2.06	232	44	815
AVERAGE 2-6		19.24	0	1.02	2,449	7.62	55.5	0.86	2.14	228	53	829
STD ERR 2-6		86.044	0	0	0	0.134	3.70	0	0	86	98	0

APPENDIX TABLE 20 (continued)

	VAR	Enterprise Levels: WHT-SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	SOW F/F (SOWS)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	HL5 (HRS.)	HL6 (HRS.)
NET RETURNS - $45,000 TYPE SOL:												
1. NOMINAL	1,271,970			1.02	2,449	6.34	69.8	0.86	2.14	248		677
2. DEFLATED	1,266,418			1.02	2,449	7.30	68.8	0.86	2.14	248	63	829
3. SIM MOV A	800,845			1.02	2,449	7.30	68.8	0.86	2.14	248	63	829
4. WTD MOV A	788,868			1.02	2,449	7.30	68.8	0.86	2.14	248	63	829
5. DETRENDED	1,018,024			1.02	2,449	7.30	68.8	0.86	2.14	248	63	829
6. ARIMA RES	1,029,881	115.50		1.02	2,449	7.10	63.8	0.86	2.14	132	195	829
AVERAGE		19.25	0	1.02	2,449	7.11	68.1	0.86	2.14	229	74	804
AVERAGE 2-6		23.10	0	1.02	2,449	7.26	67.8	0.86	2.14	225	89	829
STD ERR 2-6		103.306	0	0	0	0.179	4.47	0	0	103	118	0
NET RETURNS - $50,000 TYPE SOL:												
1. NOMINAL	1,704,290			1.02	2,449	5.50	82.7	0.86	2.14	248		600
2. DEFLATED	1,752,468			1.02	2,449	7.00	81.2	0.86	2.14	248	95	829
3. SIM MOV A	1,120,696			1.02	2,449	7.00	81.2	0.86	2.14	248	95	829
4. WTD MOV A	1,098,597			1.02	2,449	7.00	81.2	0.86	2.14	248	95	829
5. DETRENDED	1,425,167			1.02	2,449	7.00	81.2	0.86	2.14	248	95	829
6. ARIMA RES	1,425,091	122.00		1.02	2,449	6.80	75.9	0.86	2.14	126	234	829
AVERAGE		20.33	0	1.02	2,449	6.72	80.6	0.86	2.14	228	102	791
AVERAGE 2-6		24.40	0	1.02	2,449	6.96	80.1	0.86	2.14	224	123	829
STD ERR 2-6		109.120	0	0	0	0.179	4.74	0	0	109.1	124.3	0
NET RETURNS - $54,633.16 LINEAR PROG.		112		1.02	2,449		88.0			135		829

[a]See Appendix Table 1 for definition of terms and of abbreviations.

APPENDIX TABLE 21

QUADRATIC PROGRAMMING RESULTS - COMPARISON OF RISK MEASURES SMALL TOBACCO FARM, OWNER/OPERATOR TENANCY, HOG ENTERPRISES[a]

		Enterprise Levels												
	VAR	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	SOW F/F (SOWS)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	RNTTQ (LBS.)	HL6 (HRS.)
NET RETURNS - $4,000														
TYPE SOL:														
1. NOMINAL	5,066				4.68			0.74		7.57	16.4	78.0	4,560	
2. DEFLATED	2,247							0.78	0.08	6.86	17.1	78.0	4,560	
3. SIM MOV A	442				0.36			0.77	0.09	6.90	17.1	78.0	4,560	
4. WTD MOV A	394				0.99			0.79	0.02	7.00	17.0	78.0	4,560	
5. DETRENDED	439			0.74	0.48			0.78	0.05	6.90	17.0	77.2	4,560	
6. ARIMA RES	812	0.66	0.05					0.80		6.86	17.2	77.2	4,560	
AVERAGE		0.11	0.01	0.12	1.09	0	0	0.78	0.04	7.02	17.0	77.7	4,560	0
AVERAGE 2-6		0.13	0.01	0.15	0.37	0	0	0.78	0.05	6.90	17.1	77.7	4,560	0
STD ERR 2-6		0.588	0.046	0.659	0.818	0	0	0.017	0.078	0.115	0.17	0.88	0	0
NET RETURNS - $7,000														
TYPE SOL:														
1. NOMINAL	312,034				13.98			0.62	2.05	9.00	6.1	78.0	4,560	90
2. DEFLATED	119,479							3.23	0.86	6.86	17.1	78.0	4,560	208
3. SIM MOV A	23,360				1.29			3.40	0.54	7.00	17.0	78.0	4,560	236
4. WTD MOV A	22,634				3.48			3.54	0.25	7.40	16.6	78.0	4,560	262
5. DETRENDED	23,826			2.60	1.77			3.45	0.36	7.10	16.9	75.4	4,560	244
6. ARIMA RES	45,626	3.59						3.50	0.21	6.90	17.1	74.4	4,560	250
AVERAGE		0.60	0	0.43	3.42	0	0	2.96	0.71	7.38	15.1	77.0	4,560	215
AVERAGE 2-6		0.72	0	0.52	1.31	0	0	3.42	0.44	7.05	16.9	76.8	4,560	240
STD ERR 2-6		3.211	0	2.326	2.890	0	0	0.241	0.535	0.431	0.431	3.47	0	40.5
NET RETURNS - $10,000														
TYPE SOL:														
1. NOMINAL	1,897,501				22.47	0.28		3.23	6.32	10.30	13.7	77.7	3,897	320
2. DEFLATED	726,851					2.36	1,163	1.47	3.32	6.90	17.1	75.1		320
3. SIM MOV A	145,455					2.36	1,163	1.47	3.32	6.90	17.1	75.0		320
4. WTD MOV A	181,133					2.36	1,163	1.47	3.31	6.90	17.1	75.1		320
5. DETRENDED	160,521					2.36	1,163	1.47	3.31	6.90	17.1	75.1		320
6. ARIMA RES	326,778	11.77				2.36	1,163	1.46	2.66	6.90	17.1	63.4		320
AVERAGE		1.96	0	0	3.74	2.01	969	1.76	3.71	7.46	16.5	73.6	649	320
AVERAGE 2-6		2.35	0	0	0	2.36	1,163	1.47	3.18	6.89	17.1	72.74	0	320
STD ERR 2-6		10.527	0	0	0	0	0	0.009	0.586	0.036	0	10.44	0	0

APPENDIX TABLE 21 (continued)

	VAR	Enterprise Levels											
		WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	SOW F/F (SOWS)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	RNTTQ (LBS.)	HL6 (HRS.)
NET RETURNS - $13,000 TYPE SOL:														
1. NOMINAL	5,082,427				27.96	2.20	717	1.10	10.7	11.1	12.9	75.5		320
2. DEFLATED	3,185,777					2.38	1,163	1.27	10.6	6.9	17.2	75.1		320
3. SIM MOV A	1,525,992					2.38	1,163	1.27	10.6	6.9	17.2	75.1		320
4. WTD MOV A	1,646,304					2.38	1,163	1.27	10.6	6.9	17.1	75.1		320
5. DETRENDED	1,911,875					2.38	1,163	1.27	10.6	6.9	17.1	75.1		320
6. ARIMA RES	2,220,272	21.04				2.38	1,163	1.25	9.5	6.9	17.1	54.1		320
AVERAGE		3.51	0	0	4.66	2.35	1,089	1.24	10.43	7.6	16.4	71.7	0	320
AVERAGE 2-6		4.21	0	0	0	2.38	1,163	1.27	0.38	6.9	17.1	70.9	0	320
STD ERR 2-6		18.82	0	0	0	0	0	0.018	0.984	0	0.11	18.78	0	0
NET RETURNS - $16,000 TYPE SOL:														
1. NOMINAL	9,255,124				10.38	2.38	1,163	0.812	18.0	8.4	15.6	75.1		320
2. DEFLATED	8,288,827					2.38	1,163	1.07	17.9	6.9	17.1	75.1		320
3. SIM MOV A	4,695,478					2.38	1,163	1.07	17.9	6.9	17.1	75.1		320
4. WTD MOV A	4,817,121					2.38	1,163	1.07	17.9	6.9	17.1	75.1		320
5. DETRENDED	5,941,797					2.38	1,163	1.07	17.9	6.9	17.1	75.1		320
6. ARIMA RES	6,502,527	32.60				2.38	1,163	1.02	16.4	6.9	17.1	42.5		320
AVERAGE		5.43	0	0	1.73	2.38	1,163	1.02	17.7	7.2	16.8	69.7	0	320
AVERAGE 2-6		6.52	0	0	0	2.38	1,163	1.06	17.6	6.9	17.1	68.6	0	320
STD ERR 2-6		29.158	0	0	0	0	0	0.045	1.34	0	0	29.16	0	0
NET RETURNS - $16,692.13 LINEAR PROG.				52.5		2.38	1,163	1.07	18.0	6.9	17.1	22.5		320

[a]See Appendix Table 1 for definition of terms and abbreviations.

APPENDIX TABLE 22

COMPARISON OF RISK MODELS USING A WEIGHTED MOVING AVERAGE RISK MEASURE - LARGE TOBACCO FARM, SHARECROP TENANCY, ROW-CROP ENTERPRISES[a]

		Enterprise Levels										
	STD.DEV	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	HL5 (HRS.)	HL6 (HRS.)
NET RETURNS - $3,000												
TYPE SOL:												
1. QUAD.PROG	20.6				0.39		0.30	1.20	2.8	125		
2. MOTAD	21.8						0.30	1.14	2.9	125		
3. SIN.INDEX	21.8						0.30	1.14	2.9	125		
4. MAR.RISK	23.6				1.08		0.29	1.31	2.7	125		
AVERAGE		0	0	0	0.37	0	0.30	1.20	2.8	125	0	0
STD.ERR.		0	0	0	0.882	0	0.012	0.139	0.139	0	0	0
NET RETURNS - $4,000												
TYPE SOL:												
1. QUAD.PROG	78.5			0.20	1.41		1.13	1.35	2.6	125		52
2. MOTAD	83.1						1.15	1.14	2.9	125		54
3. SIN.INDEX	83.1						1.15	1.14	2.9	125		54
4. MAR.RISK	89.6				4.11		1.10	1.77	2.2	125		51
AVERAGE		0	0	0.05	1.38	0	1.10	1.35	2.6	125	0	52
STD.ERR.		0	0	0.169	3.356	0	0.049	0.514	0.51	0.2	0	2.6
NET RETURNS - $5,000												
TYPE SOL:												
1. QUAD.PROG	171.0			0.43	3.06		2.46	1.60	2.390	124		271
2. MOTAD	182.1						2.52	1.14	2.860	125		275
3. SIN.INDEX	182.1						2.52	1.14	2.860	125		275
4. MAR.RISK	195.9				9.00		2.38	2.51	1.49	125		269
AVERAGE		0	0	0.11	3.02	0	2.47	1.60	2.4	125	0	272
STD.ERR.		0	0	0.372	7.349	0	0.115	1.119	1.119	0.4	0	5.2

APPENDIX TABLE 22 (continued)

	STD.DEV	Enterprise Levels WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	HL5 (HRS.)	HL6 (HRS.)
NET RETURNS - $6,000												
TYPE SOL:												
1. QUAD.PROG	694	18.30		13.800	0.000		3.20	1.14	2.90	93		400
2. MOTAD	708	25.80					3.22	1.14	2.86	99		400
3. SIN.INDEX	708	25.80					3.22	1.14	2.86	99		400
4. MAR.RISK	785			47.90	5.28		3.17	1.94	2.05	77		400
AVERAGE		17.48	0	15.42	1.32	0	3.20	1.34	2.67	92	0	400
STD.ERR.		21.087	0	39.155	4.573	0	0.041	0.693	0.714	18	0	0
LINEAR PROG. SOL: $6,054.69												
LINEAR PROG.	2,160	81.17					3.07	1.14	2.86	43.8	199	400

[a]See Appendix Table 1 for definition of terms and abbreviations.

APPENDIX TABLE 23

COMPARISON OF RISK MODELS USING A WEIGHTED MOVING AVERAGE RISK MEASURE - SMALL TOBACCO FARM, OWNER/OPERATOR TENANCY, ROW-CROP ENTERPRISES[a]

		Enterprise Levels											
	STD.DEV.	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	HL5 (HRS.)	HL6 (HRS.)	RNTRC (AC.)
NET RETURNS - $4,000													
TYPE SOL:													
1. QUAD.PROG	5.2				1.02			0.75	1.60	3.4			78
2. MOTAD	5.5							0.77	1.43	3.6			78
3. SIN.INDEX	5.5							0.77	1.43	3.6			78
4. MAR.RISK	6.0				2.76			0.73	1.80	3.2			78
AVERAGE		0	0	0	0.94	0	0	0.75	1.56	3.4	0	0	78
STD.ERR.		0	0	0	2.255	0	0	0.032	0.305	0.344	0	0	0
NET RETURNS - $6,000													
TYPE SOL:													
1. QUAD.PROG	17.8			0.44	3.18			2.56	1.90	3.10		152	78
2. MOTAD	18.9							2.62	1.43	3.57		156	78
3. SIN.INDEX	18.9							2.62	1.43	3.57		156	78
4. MAR.RISK	20.3				9.33			2.47	2.85	2.15		150	78
AVERAGE		0	0	0.11	3.13	0	0	2.57	1.90	3.10	0	154	78
STD.ERR.		0	0	0.381	7.618	0	0	0.120	1.159	1.159	0	5.2	0.3
NET RETURNS - $8,000													
TYPE SOL:													
1. QUAD.PROG	37.5	0.22		1.00	6.18	1.80		1.90	2.40	2.60		341	75
2. MOTAD	39.7					1.78		2.05	1.43	3.57		352	76
3. SIN.INDEX	114.7			72.60		0.17		3.86	1.43	3.57	70.00	400	5
4. MAR.RISK	43.8				21.00	1.90		1.48	4.63	0.37		322	76
AVERAGE		0.06	0	18.40	6.80	1.41	0	2.32	2.47	2.53	17.50	353	58
STD.ERR.		0.191	0	62.590	17.186	1.435	0	1.824	2.614	2.614	60.622	57.6	61.1

APPENDIX TABLE 23 (continued)

		Enterprise Levels											
	STD.DEV.	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	HL5 (HRS.)	HL6 (HRS.)	RNTRC (AC.)
NET RETURNS - $9,000													
TYPE SOL:													
1. QUAD.PROG	48.5	1.21		1.30	6.36	3.26	1,592	0.60	2.39	2.60	15	371	74
2. MOTAD	51.3					3.26	1,592	0.78	1.43	3.57	15	386	74
3. SIN.INDEX	118.0			72.60		1.77		2.26	1.43	3.57	70	400	4
4. MAR.RISK	61.4			16.10	23.43	3.26	1,592		5.00		8	309	57
AVERAGE		0.30	0	22.50	7.45	2.89	1,194	0.91	2.56	2.44	27	366	52
STD.ERR.		1.048	0	59.217	19.172	1.290	1,378	1.662	2.922	2.921	50.0	69.5	57.8
NET RETURNS	$9,929.91												
LINEAR PROG.	1,415.0	51.20	0	0	0	3.26	1,591	0.72	1.43	3.57	85	400	23

[a]See Appendix Table 1 for definition of terms and abbreviations.

APPENDIX TABLE 24

COMPARISON OF RISK MODELS USING A WEIGHTED MOVING AVERAGE RISK MEASURE - LARGE TOBACCO FARM, OWNER/OPERATOR TENANCY, BEEF ENTERPRISES[a]

		Enterprise Levels											
	STD.DEV	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	RNTTQ (LBS.)	HL6 (HRS.)
NET RETURNS - $4,000 TYPE SOL:													
1. QUAD.PROG	101.2				1.95			1.46	10.00	24.0	7.0	6,000	
2. MOTAD	106.9							1.48	9.70	24.3	7.0	6,000	
3. SIN.INDEX	106.9							1.48	9.70	24.3	7.0	6,000	
4. MAR.RISK	115.9				5.31			1.41	10.50	23.5	7.0	6,000	
AVERAGE		0	0	0	1.82	0	0	1.46	10.00	24.0	7.0	6,000	0
STD.ERR.		0	0	0	4.338	0	0	0.057	0.654	0.654	0	0	0
NET RETURNS - $5,000 TYPE SOL:													
1. QUAD.PROG	174.9				3.15	0.34		1.86	10.20	23.80	6.6	5,174	72
2. MOTAD	185.2					0.19		2.20	9.70	24.30	6.8	5,549	96
3. SIN.INDEX	187.9							2.60	8.97	22.40	4.0	6,000	130
4. MAR.RISK	211.6				9.72			2.57	8.50	16.10	7.0	6,000	146
AVERAGE		0	0	0	3.22	0.13	0	2.31	9.34	21.65	6.1	5,680	111
STD.ERR.		0	0	0	7.937	0.288	0	0.605	1.308	6.558	2.45	691.4	57.7
NET RETURNS - $6,000 TYPE SOL:													
1. QUAD.PROG	277.1				5.04	2.04		0.05	10.50	23.50	5.0	1,108	58
2. MOTAD	293.4					1.79		0.60	9.70	24.30	5.2	1,709	96
3. SIN.INDEX	308.0					0.73		2.85	5.50	13.80	6.3	4,249	290
4. MAR.RISK	351.4				16.56	0.87		2.51	5.34	4.53	6.1	3,911	290
AVERAGE		0	0	0	5.40	1.36	0	1.50	7.76	16.53	5.7	2,744.2	183
STD.ERR.		0	0	0	13.53	1.132	0	2.401	4.715	16.137	1.13	2,715.6	214.7

APPENDIX TABLE 24 (continued)

	STD.DEV	Enterprise Levels WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	RNTTQ (LBS.)	HL6 (HRS.)
NET RETURNS - $7,000													
TYPE SOL:													
1. QUAD.PROG	395.6				7.14	2.50		0.87	5.90	10.9	4.5		270
2. MOTAD	409.1					2.92	1,016		7.80	19.6	3.7		184
3. SIN.INDEX	416.6					2.33		1.25	5.52	13.8	4.7	409	290
4. MAR.RISK	484.5				23.40	2.53	72	0.77	5.27	0.7	4.4		290
AVERAGE		0	0	0	7.64	2.57	272	0.72	6.12	11.2	4.3	102	258
STD.ERR.		0	0	0	19.11	0.432	861.2	0.908	1.988	13.706	0.744	354.2	87.6
NET RETURNS - $7,492.77													
LINEAR PROG.	470.3					3.13	1,531	0.44	5.50	13.8	3.250		290

[a]See Appendix Table 1 for definition of terms and abbreviations.

APPENDIX TABLE 25

COMPARISON OF RISK MODELS USING A WEIGHTED MOVING AVERAGE RISK MEASURE - SMALL TOBACCO FARM, OWNER/OPERATOR TENANCY, BEEF ENTERPRISES[a]

		Enterprise Levels											
	STD.DEV	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	RNTTQ (LBS.)	HL6 (HRS.)
NET RETURNS - $1,000													
TYPE SOL:													
1. QUAD.PROG	11.5				0.21			0.17	2.89	7.1	4.0	2,640	
2. MOTAD	12.2							0.17	2.86	7.1	4.0	2,640	
3. SIN.INDEX	12.2												
4. MAR.RISK	13.1				0.60			0.16	2.95	7.0	4.0	2,640	
AVERAGE		0	0	0	0.20	0	0	0.12	2.17	5.3	3.0	1,980	0
STD.ERR.		0	0	0	0.490	0	0	0.143	2.512	6.15	3.46	2,286	0
NET RETURNS - $1,500													
TYPE SOL:													
1. QUAD.PROG	34.7				0.66			0.50	2.96	7.1	4.0	2,640	
2. MOTAD	36.9							0.51	2.86	7.1	4.0	2,640	
3. SIN.INDEX	36.9							0.51	2.86	7.1	4.0	2,640	
4. MAR.RISK	39.9				1.83			0.48	3.14	6.9	4.0	2,640	
AVERAGE		0	0	0	0.62	0	0	0.50	2.96	7.0	4.0	2,640	0
STD.ERR.		0	0	0	1.495	0	0	0.021	0.229	0.23	0	0	0
NET RETURNS - $2,000													
TYPE SOL:													
1. QUAD.PROG	71.6			0.18	1.29			1.03	3.05	6.90	3.8	2,640	63
2. MOTAD	75.9							1.05	2.86	7.14	4.0	2,640	64
3. SIN.INDEX	75.9							1.05	2.86	7.14	4.0	2,640	64
4. MAR.RISK	81.7				3.75			0.69	0.99	3.43	6.6	2,640	62
AVERAGE		0	0	0.04	1.26	0	0	0.96	2.44	6.15	4.0	2,640	63
STD.ERR.		0	0	0.154	3.062	0	0	0.305	1.680	3.150	2.29	0	1.7

APPENDIX TABLE 25 (continued)

	STD.DEV	Enterprise Levels WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	RNTTQ (LBS.)	HL6 (HRS.)
NET RETURNS - $2,500													
TYPE SOL:													
1. QUAD.PROG	120.6				2.16	0.50		0.77	3.19	6.8	3.5	1,430	104
2. MOTAD	128.4					0.50		0.81	2.86	7.1	3.5	1,439	106
3. SIN.INDEX	127.8			0.44		0.49		0.82	2.86	7.1	3.1	1,465	106
4. MAR.RISK	145.6				6.93	0.53		0.69	3.09	4.0	3.5	1,359	106
AVERAGE		0	0	0.11	2.27	0.51	0	0.77	3.00	6.3	3.4	1,423	105
STD.ERR.		0	0	0.381	5.660	0.033	0	0.099	0.289	2.61	0.37	78.5	1.7
NET RETURNS - $3,000													
TYPE SOL:													
1. QUAD.PROG	176.4	0.14			1.02	1.29	471		3	7.0	2.3		106
2. MOTAD	182.2					1.30	496		2.86	7.1	2.5		106
3. SIN.INDEX	182.2			0.44		1.30	470		2.86	7.1	2.1		106
4. MAR.RISK	176.4	0.14			1.02	1.29	471		3	7.0	2.3		106
AVERAGE		0.07	0	0.11	0.51	1.30	477	0	2.93	7.1	2.3	0	106
STD.ERR.		0.143	0	0.377	1.02	0.010	22.0	0	0.14	0.14	0.30	0	0
NET RETURNS - $3,007.83													
LINEAR PROG.	181.6	0.31				1.30	499		2.86	7.14	2.18		106

[a]See Appendix Table 1 for description of terms and abbreviations.

APPENDIX TABLE 26

COMPARISON OF RISK MODELS USING A WEIGHTED MOVING AVERAGE RISK MEASURE LARGE TOBACCO FARM, SHARECROP TENANCY, DAIRY ENTERPRISE[a]

		Enterprise Levels										
	STD.DEV	DAIRY (COWS)	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	HAY PURCH (TONS)	RNTRC (AC.)	HL6 (HRS.)
NET RETURNS - $4,000												
TYPE SOL:												
1. QUAD.PROG	74.0	0.54				1.35	0.96	1.63	3.37		112.7	
2. MOTAD	82.4						1.14	1.43	3.56		113	
3. SIN.INDEX	82.4						1.14	1.43	3.56		113	
4. MAR.RISK	89.2					4.11	1.08	2.05	2.95		113	
AVERAGE		0.14	0	0	0	1.36	1.08	1.64	3.36	0	113	0
STD.ERR.		0.468	0	0	0	3.356	0.143	0.506	0.498	0	0.3	0
NET RETURNS - $12,000												
TYPE SOL:												
1. QUAD.PROG	429.1	3.12				7.74	5.60	2.60	2.39		111	
2. MOTAD	478.3						6.62	1.42	3.57		113	
3. SIN.INDEX	478.3						6.62	1.42	3.57		113	
4. MAR.RISK	518.2					23.82	6.29	4.92		0.4	113	
AVERAGE		0.78	0	0	0	7.89	6.28	2.59	2.39	0.1	112	0
STD.ERR.		2.702	0	0	0	19.450	0.833	2.858	2.915	0.35	1.6	0
NET RETURNS - $20,000												
TYPE SOL:												
1. QUAD.PROG	785.1	5.76				14.1	10.23	3.59	1.41		110	
2. MOTAD	874.3						12.10	1.43	3.57		113	
3. SIN.INDEX	874.3						12.10	1.43	3.57		113	
4. MAR.RISK	973.1					44.7	11.82	0.46		22.7	113	
AVERAGE		1.44	0	0	0	14.7	11.56	1.73	2.14	5.7	112	0
STD.ERR.		4.988	0	0	0	36.50	1.556	2.294	3.034	19.66	2.9	0

APPENDIX TABLE 26 (continued)

	STD.DEV	Enterprise Levels: DAIRY (COWS)	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	HAY PURCH (TONS)	RNTRC (AC.)	HL6 (HRS.)
NET RETURNS - $28,000												
TYPE SOL:												
1. QUAD.PROG	1,223.5	16.68			1.63	17.46	12.81	4.09	0.91		101.8	121
2. MOTAD	1,575.1						21.80	1.43	3.57		113.0	1,370
3. SIN.INDEX	1,575.1						21.80	1.43	3.57		113.0	1,370
4. MAR.RISK	1,584.9					46.80	21.75			25.0	71.4	1,460
AVERAGE		4.17	0	0	0.41	16.06	19.54	1.74	2.01	6.2	99.8	1,080
STD.ERR.		14.445	0	0	1.412	38.246	7.771	2.957	3.181	21.65	34.04	1,110.1
NET RETURNS - $36,000												
TYPE SOL:												
1. QUAD.PROG	1,840.8	25.26			3.35	23.43	19.17	5.00			95.2	1,252
2. MOTAD	2,030.0	13.26					25.80	1.43	3.57		105.4	2,162
3. SIN.INDEX	2,044.0	11.82	20.50				25.90	1.43	3.57		85.7	2,162
4. MAR.RISK	1,987.5	12.00	16.67			23.43	25.60	5.00			89.5	2,162
AVERAGE		15.58	9.29	0	0.84	11.72	24.12	3.22	1.79	0	94.0	1,934
STD.ERR.		11.227	18.781	0	2.901	23.430	5.717	3.570	3.57	0	14.85	788.1
NET RETURNS - $44,000												
TYPE SOL:												
1. QUAD.PROG	2,554.0	44.34				22.41	20.70			12.0	87.6	1,696
2. MOTAD	2,584.1	42.60					21.64				88.6	1,786
3. SIN.INDEX	2,584.1	42.60					21.64				88.6	1,786
4. MAR.RISK	2,584.1	42.60					21.64				88.6	1,786
AVERAGE		43.04	0	0	0	5.60	21.40	0	0	3.0	88.4	1,763
STD.ERR.		1.507	0	0	0	19.408	0.814	0	0	10.36	0.87	77.9
NET RETURNS - $48,939.38												
LINEAR PROG.	3,652	81.60					8.12				66.3	

[a]See Appendix Table 1 for description of terms and abbreviations.

APPENDIX TABLE 27

COMPARISON OF RISK MODELS USING A WEIGHTED MOVING AVERAGE RISK MEASURE SMALL TOBACCO FARM, OWNER/OPERATOR TENANCY, DAIRY ENTERPRISE[a]

		Enterprise Levels												
	STD.DEV	DAIRY (COWS)	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	RNTTQ (LBS.)	HL6 (HRS.)
NET RETURNS - $4,000														
TYPE SOL:														
1. QUAD.PROG	36.1	0.72				1.83			1.33	1.70	3.3	30.6	5,040	
2. MOTAD	113.4								1.57	1.43	3.6	31.0	5,040	
3. SIN.INDEX	113.4								1.57	1.43	3.6	31.0	5,040	
4. MAR.RISK	123.2					0.19			1.50	2.29	2.7	31.0	5,040	
AVERAGE		0.18	0	0	0	15.14	0	0	1.49	1.71	3.3	30.9	5,040	
STD.ERR.		0.624	0	0	0	29.301	0	0	0.196	0.702	0.69	0.35	0	
NET RETURNS - $6,000														
TYPE SOL:														
1. QUAD.PROG	191.3	1.38				3.45			2.50	1.95	3.0	30.2	5,040	
2. MOTAD	226.9								3.14	1.43	3.6	31.0	5,040	64
3. SIN.INDEX	226.9								3.14	1.43	3.6	31.0	5,040	64
4. MAR.RISK	243.7					11.19			2.96	3.14	1.9	31.0	5,040	56
AVERAGE		0.34	0	0	0	3.66	0	0	2.94	1.99	3.0	30.8	5,040	46
STD.ERR.		1.195	0	0	0	9.140	0	0	0.523	1.397	1.39	0.69	0	53.5
NET RETURNS - $8,000														
TYPE SOL:														
1. QUAD.PROG	329.7	4.5			0.44	4.71			3.45	2.14	2.8	27.9	5,040	170
2. MOTAD	427.1						0.45		5.04	1.43	3.6	30.6	3,962	445
3. SIN.INDEX	482.1				18.50				5.47	1.43	3.6	12.5	5,040	445
4. MAR.RISK	460.1					21.30	0.35		4.89	4.67	0.3	30.7	4,209	445
AVERAGE		1.12	0	0	4.74	6.50	0.20	0	4.71	2.42	2.6	25.4	4,563	376
STD.ERR.		3.897	0	0	15.899	17.514	0.405	0	1.519	2.665	2.67	15.08	970.3	238.2

APPENDIX TABLE 27 (continued)

		Enterprise Levels											
	STD.DEV	DAIRY (COWS)	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	RNTTQ (LBS.)	HL6 (HRS.)
NET RETURNS - $10,000														
TYPE SOL:														
1. QUAD.PROG	484.7	6.78			0.72	6.78			4.98	2.46	2.5	26.4	5,040	445
2. MOTAD	586.6	1.86					2.66		2.71	1.43	3.6	26.7		445
3. SIN.INDEX	644.6	1.02	12.70				2.66		2.73	1.43	3.6	14.5		445
4. MAR.RISK	681.4	1.08	8.19			23.43	2.66		2.46	5.00		18.3		445
AVERAGE		2.68	5.22	0	0.18	7.55	2.00	0	3.22	2.58	2.4	21.5	1,260	445
STD.ERR.		4.775	10.921	0	0.626	19.151	2.304	0	2.043	2.918	2.91	10.50	4,364.8	0
NET RETURNS - $12,000														
TYPE SOL:														
1. QUAD.PROG	654	10.26			1.31	7.77	1.68		2.75	2.6	2.4	22.2	996	395
2. MOTAD	683.5	7.86					2.66	1,347	2.33	1.43	3.6	23.3		445
3. SIN.INDEX	684.6	7.50	6.43				2.66	1,347	2.33	1.43	3.6	17		445
4. MAR.RISK	705	7.68	2.46			23.43	2.66	1,347	2.05	5.00		20.9		445
AVERAGE		8.32	2.22	0	0.33	7.80	2.41	1,010	2.36	2.61	2.4	20.8	249	432
STD.ERR.		2.249	5.257	0	1.134	19.130	0.849	1,166.6	0.500	2.915	2.91	4.76	862.6	43.3
NET RETURNS - $15,151.17														
LINEAR PROG.	1,041	20.82					2.66	1,347	0.35			15.9		202

[a]See Appendix Table 1 for description of terms and abbreviations.

APPENDIX TABLE 28

COMPARISON OF RISK MODELS USING A WEIGHTED MOVING AVERAGE RISK MEASURE - LARGE TOBACCO FARM, SHARECROP TENANCY, HOG ENTERPRISES[a]

		Enterprise Levels										
	STD.DEV	WHT-SOY (AC.)	SOY (AC.)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	SOW F/F (HD.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	HL5 (HRS.)	HL6 (HRS.)
NET RETURNS - $30,000 TYPE SOL:												
1. QUAD.PROG	7,952			1.02	2,449	8.33	31.8	0.86	2.14	248.0		829
2. MOTAD	7,952			1.02	2,449	8.33	31.8	0.86	2.14	248.0		829
3. SIN.INDEX	8,203	242.00		1.02	2,449	8.24	24.1	0.86	2.14	6.2	112	829
4. MAR.RISK	8,203	242.00		1.02	2,449	8.24	24.1	0.86	2.14	6.2	112	829
AVERAGE		121.00	0	1.02	2,449	8.28	28.0	0.86	2.14	127.1	56	829
STD.ERR.		242.000	0	0	0	0.090	7.70	0	0	241.80	112	0
NET RETURNS - $35,000 TYPE SOL:												
1. QUAD.PROG	10,957			1.02	2,449	8.00	43.9	0.86	2.14	248.0		829
2. MOTAD	10,957			1.02	2,449	8.00	43.9	0.86	2.14	248.0		829
3. SIN.INDEX	13,771	47.20	176.20	1.02	2,449	7.90	36.5	0.86	2.14	24.4	159	829
4. MAR.RISK	11,038	222.00		1.02	2,449	7.90	37.2	0.86	2.14	26.0	132	829
AVERAGE		67.30	44.05	1.02	2,449	7.95	40.4	0.86	2.14	136.6	73	829
STD.ERR.		182.742	152.594	0	0	0.100	7.07	0	0	222.80	146.8	0
NET RETURNS - $40,000 TYPE SOL:												
1. QUAD.PROG	14,041			1.02	2,449	7.65	56.3	0.86	2.14	248.0	31	829
2. MOTAD	14,041			1.02	2,449	7.65	56.3	0.86	2.14	248.0	31	829
3. SIN.INDEX	21,000	127.80	63.80	1.02	2,449	7.44	48.8	0.86	2.14	56.4	216	829
4. MAR.RISK	14,000		187.30	1.02	2,449	7.58	50.7	0.86	2.14	60.7	143	829
AVERAGE		31.90	62.78	1.02	2,449	7.58	53.0	0.86	2.14	153.3	105	829
STD.ERR.		110.678	152.934	0	0	0.171	6.69	0	0	189.47	157.2	0

APPENDIX TABLE 28 (continued)

		Enterprise Levels										
	STD.DEV	WHT-SOY (AC.)	SOY (AC.)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	SOW F/F (HD.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	HL5 (HRS.)	HL6 (HRS.)
NET RETURNS - $45,000 TYPE SOL:												
1. QUAD.PROG	17,153			1.02	2,449	7.30	68.8	0.86	2.14	248.0	63	829
2. MOTAD	17,153			1.02	2,449	7.30	68.8	0.86	2.14	248.0	63	829
3. SIN.INDEX	26,671	174.00		1.02	2,449	7.00	61.4	0.86	2.14	74.0	263	829
4. MAR.RISK	17,042		152.60	1.02	2,449	7.24	64.2	0.86	2.14	95.4	154	829
AVERAGE		43.50	38.15	1.02	2,449	7.21	65.8	0.86	2.14	166.4	136	829
STD.ERR.		150.688	132.155	0	0	0.247	6.32	0	0	164.00	164.7	0
NET RETURNS - $50,000 TYPE SOL:												
1. QUAD.PROG	20,241			1.02	2,449	7.00	81.2	0.86	2.14	248.0	95	829
2. MOTAD	20,241			1.02	2,449	7.00	81.2	0.86	2.14	248.0	95	829
3. SIN.INDEX	28,823	144.40		1.02	2,449	6.73	75.3	0.86	2.14	103.6	261	829
4. MAR.RISK	20,132		117.90	1.02	2,449	6.90	77.7	0.86	2.14	130.1	165	829
AVERAGE		36.10	29.48	1.02	2,449	6.91	78.8	0.86	2.14	182.4	106	829
STD.ERR.		125.054	102.104	0	0	0.221	5.00	0	0	132.48	223.6	0
NET RETURNS - $54,633.16 LINEAR PROG.	30,174	112		1.02	2,449		88.0			135.0		829

[a]See Appendix Table 1 for definition of terms and abbreviations.

APPENDIX TABLE 29

COMPARISON OF RISK MODELS USING A WEIGHTED MOVING AVERAGE RISK MEASURE - SMALL TOBACCO FARM, OWNER/OPERATOR TENANCY, HOG ENTERPRISES[a]

		Enterprise Levels												
	STD.DEV	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (HD.)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	SOW F/F (HD.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	RNTTQ (AC.)	HL6 (HRS.)
NET RETURNS - $4,000 TYPE SOL:														
1. QUAD.PROG	55.1				0.99			0.79	0.02	7.00	17.0	78	4,560	
2. MOTAD	58.3							0.81		6.86	17.1	78	4,560	
3. SIN.INDEX	58.3							0.81		6.86	17.1	78	4,560	
4. MAR.RISK	84.9				1.71			0.71	0.24	7.10	16.9	78	4,560	
AVERAGE		0	0	0	0.68	0	0	0.78	0.06	6.96	17.0	78	4,560	0
STD.ERR.		0	0	0	1.443	0	0	0.081	0.204	0.203	0.17	0	0	0
NET RETURNS - $7,000 TYPE SOL:														
1. QUAD.PROG	256.7				3.48			3.54	0.2	7.40	16.6	78	4,560	262
2. MOTAD	271							3.75		6.86	17.1	78	4,560	287
3. SIN.INDEX	271							3.75		6.86	17.1	78	4,560	287
4. MAR.RISK	360				7.26			3.02	1.0	7.96	16.0	78	4,560	188
AVERAGE		0	0	0	2.68	0	0	3.52	0.3	7.27	16.7	78	4,560	256
STD.ERR.		0	0	0	5.998	0	0	0.597	0.84	0.911	0.91	0	0	81.1
NET RETURNS - $10,000 TYPE SOL:														
1. QUAD.PROG	931					2.38	1,163	1.47	3.3	6.9	17.1	75		320
2. MOTAD	931					2.38	1,163	1.47	3.3	6.9	17.1	75		320
3. SIN.INDEX	1,141			60.25		2.38	1,163	1.46	1.1	6.9	17.1	14		320
4. MAR.RISK	994			33.50	11.49	2.38	1,163	1.33	2.0	8.6	15.4	41		320
AVERAGE		0	0	23.44	2.87	2.38	1,163	1.43	2.4	7.3	16.7	51	0	320
STD.ERR.		0	0	50.547	9.951	0	0	0.119	1.87	1.50	1.47	50.6	0	0

APPENDIX TABLE 29 (continued)

		Enterprise Levels												
	STD.DEV	WHT-SOY (AC.)	WHEAT (AC.)	SOY (AC.)	BEEF (HD.)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	SOW F/F (HD.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	RNTTQ (AC.)	HL6 (HRS.)
NET RETURNS - $13,000 TYPE SOL:														
1. QUAD.PROG	2,671					2.38	1,163	1.27	10.6	6.9	17.1	75.1		320
2. MOTAD	2,671					2.38	1,163	1.27	10.6	6.9	17.1	75.1		320
3. SIN.INDEX	2,664			61.26		2.38	1,163	1.25	8.5	6.9	17.1	13.9		320
4. MAR.RISK	2,664			61.26		2.38	1,163	1.25	8.5	6.9	17.1	13.9		320
AVERAGE		0	0	30.63	0	2.38	1,163	1.26	9.6	6.9	17.1	44.5	0	320
STD.ERR.		0	0	61.260	0	0	0	0.020	2.06	0	0	61.2	0	0
NET RETURNS - $16,000 TYPE SOL:														
1. QUAD.PROG	4,476					2.38	1,163	1.07	17.9	6.9	17.1	75.1		320
2. MOTAD	4,476					2.38	1,163	1.07	17.9	6.9	17.1	75.1		320
3. SIN.INDEX	4,461			59.90		2.38	1,163	1.05	16.1	6.9	17.1	13.9		320
4. MAR.RISK	4,461			59.90		2.38	1,163	1.05	16.1	6.9	17.1	15.2		320
AVERAGE		0	0	29.95	0	2.38	1,163	1.06	17.0	6.9	17.1	44.8	0	320
STD.ERR.		0	0	59.900	0	0	0	0.020	1.8	0	0	60.56	0	0
NET RETURNS - $16,692.13 LINEAR PROG.	4,865			52.5		2.38	1,163	1.07	18.0	6.9	17.1	22.5		320

[a]See Appendix Table 1 for definition of terms and abbreviations.

APPENDIX TABLE 30

REPRESENTATIVE FARM ORGANIZATIONS AND NET RETURNS LEVELS AT BASIS CHANGES OF MARGINAL RISK CONSTRAINED PROGRAMMING SOLUTIONS[a]

LARGE TOBACCO FARM, SHARECROP TENANCY, HOG ENTERPRISES ALLOWED

	Enterprises											
NET RETURNS (DOLLARS)	SOY (AC.)	CORN (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (LBS.)	TOB.SHR (AC.)	SOW F/F (SOWS)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	HL5 (HRS.)	HL6 (HRS.)
5,000										250		
5,044						0[b]	0	0.86	2.1	250		
10,885			8.5			3.51	1.2	2.1	0.9	250		
13,295			8.4			4.97	1.8	2.1	0.9	250		0
17,950			8.2	0	2	10.02	4.0	2.1	0.9	249		829
19,628	83.6		8.2	1.02	2,449	8.91	3.5	2.1	0.9	164		829
21,109	238.8			1.02	2,449	8.86	2.0	0.86	2.1	9	54	829
21,305	238.9			1.02	2,449	8.85	2.5	0.86	2.1	9	55	829
21,920	239.1			1.02	2,449	8.81	4.1	0.86	2.1	9	59	829
54,000	105.8			1.02	2,449	6.63	88.2	0.86	2.1	142	184	829

LARGE TOBACCO FARM, SHARECROP TENANCY, ALLOWING DAIRY ENTERPRISES

	Enterprises								
NET RETURNS (DOLLARS)	DAIRY (COWS)	CORN (AC.)	WHT-SOY (AC.)	BEEF (COWS)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	HL6 (HRS.)
2,333			0	0	0	1.43	3.6	113	
11,857				23.4	6.20	5.00	0	113	
20,818		0		46.8	12.39	0	0	113	
21,398		1.76		46.8	12.79			111	0
29,905		53.00		46.8	24.34			60	1,881
32,297			28.24	23.4	26.33	5.00	0	85	2,162
41,333	29.10		0	23.4	24.55	5.00	0	96	2,162
42,553	33.00				24.58	1.43	3.6	64	2,162
42,960	34.44				24.49	0	0	93	2,162
45,000	42.66				21.64			89	1,786

APPENDIX TABLE 30 (continued)

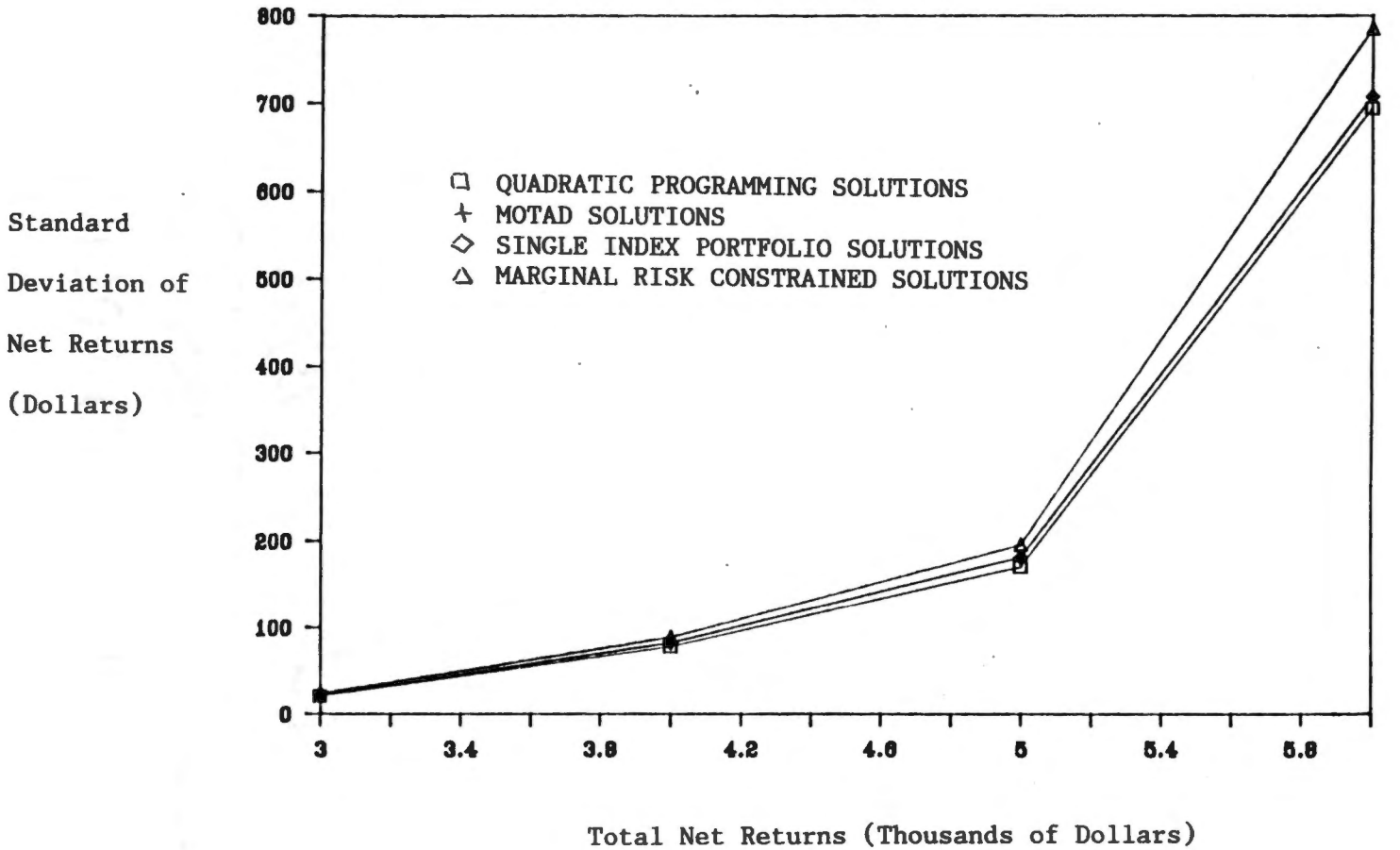
SMALL TOBACCO FARM, OWNER/ OPERATOR TENANCY, ROW-CROP ENTERPRISES

	Enterprises											
NET RETURNS (DOLLARS)	SOY (AC.)	CORN (AC.)	WHT-SOY (AC.)	BEEF (COWS)	TOB.O/OP (AC.)	TOB.LSE (AC.)	TOB.SHR (AC.)	HAY PROD (AC.)	HAY SOLD (TONS)	RNTRC (AC.)	HL5 (HRS.)	HL6 (HRS.)
2,880		0					0	1.43	3.6	78		
5,315				3.6			1.58	2.34	2.7	78		0
6,837				13.4			3.55	3.47	1.5	78		333
8,365				22.6	2.30		1.05	4.88	0.1	76		319
8,810	.16	3.64		23.4	3.26	1,592	0	5.00		70		313
8,850	4.46	2.77		23.4	3.26	1,592		5.00		67	0	307
9,070	21.30	0		23.4	3.26	1,592		5.00		53	11	310
9,475	35.85			23.4	3.26	1,592	0	5.00		38	60	400
9,700	60.26		6.07	16.5	3.26	1,592	0	3.94	1.05	8	79	400

[a]See Appendix Table 1 for definition of terms and abbreviations.

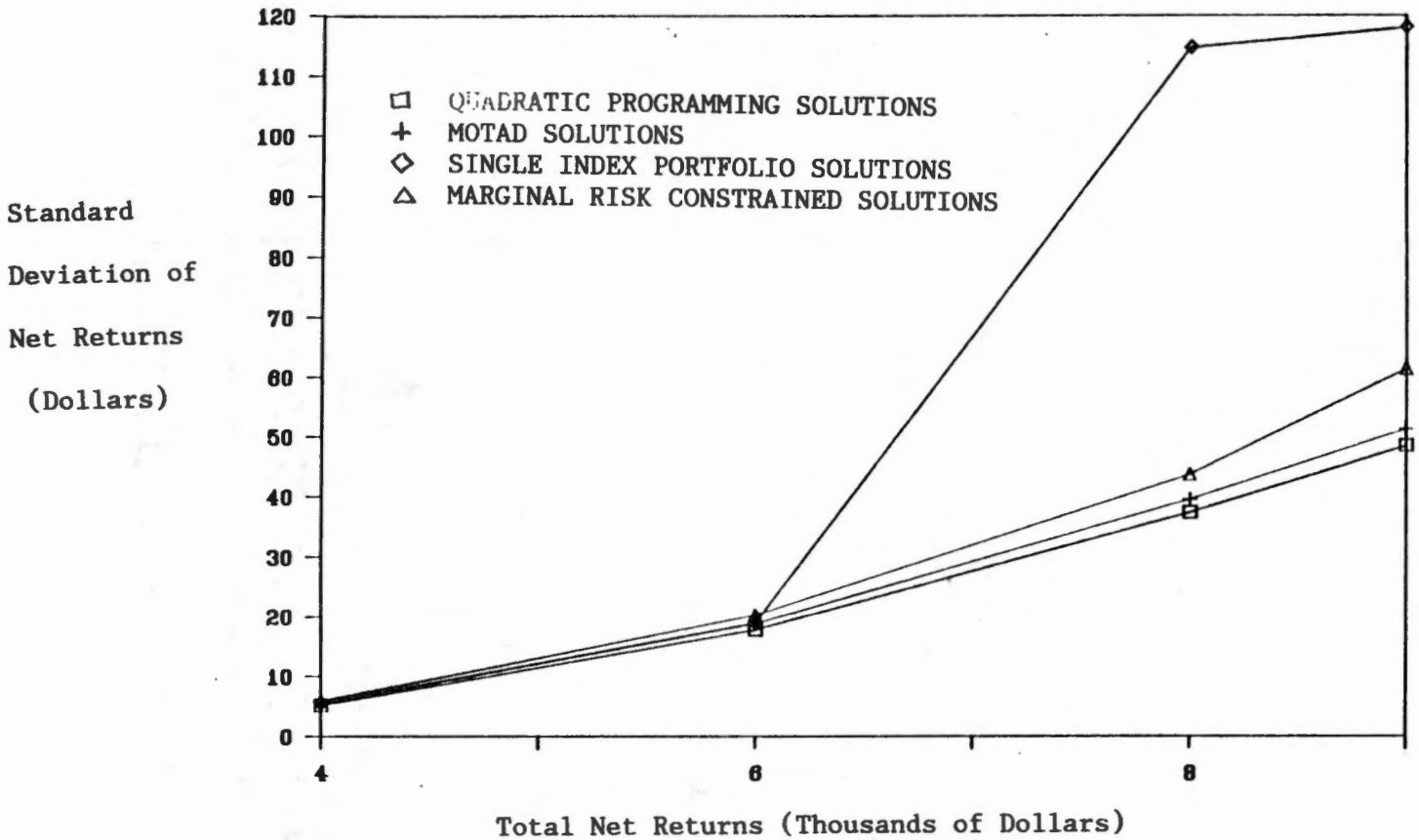
[b]"0" indicates the relevant enterprise is in the basis at the given level or returns, but is present at extremely low levels, signifying that it is either entering or leaving the basis at that basis change. No entry in any cell indicates that the enterprise is not in the basis at that solution level.

APPENDIX FIGURES



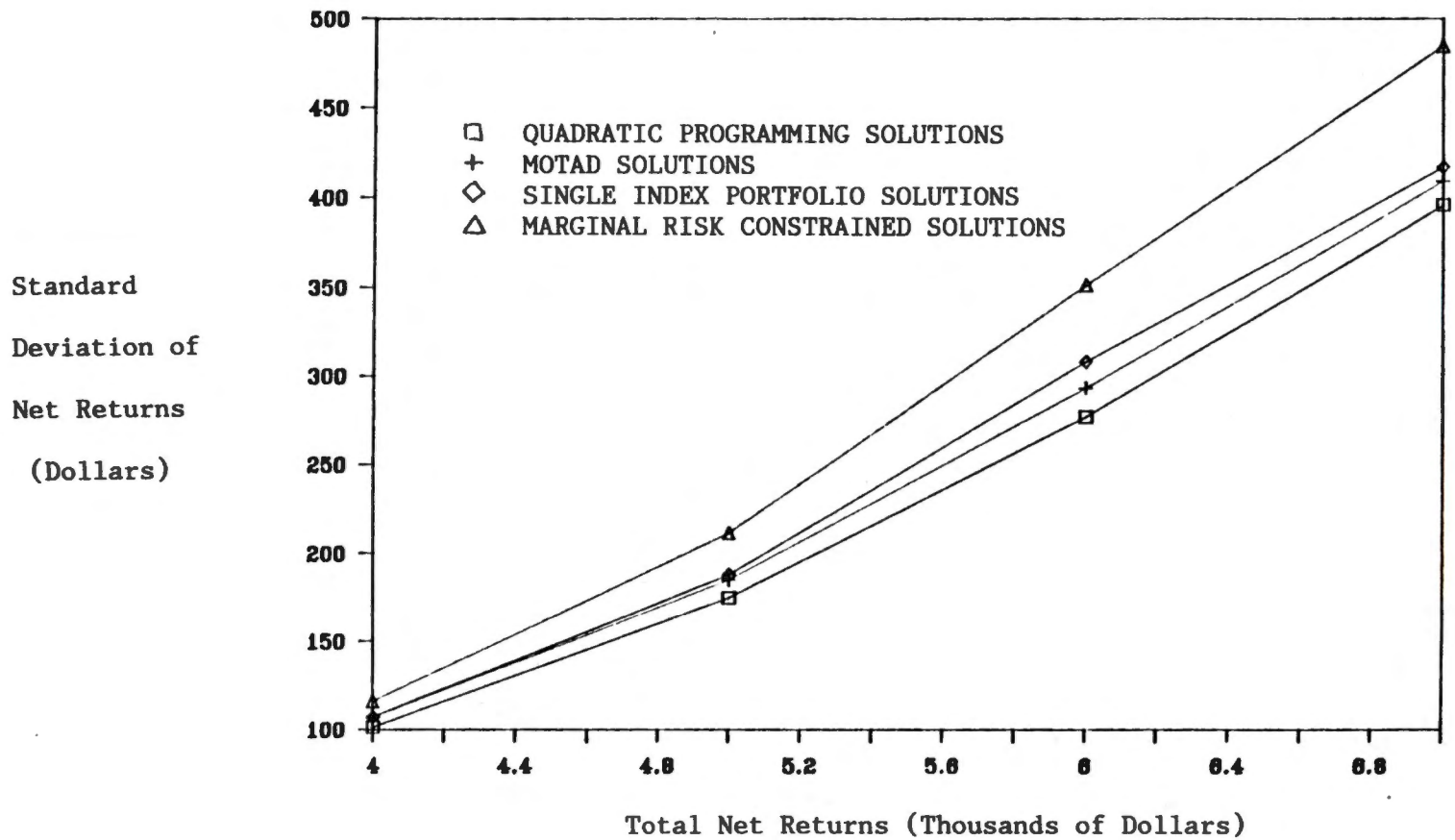
APPENDIX FIGURE 1

MEAN-VARIANCE FRONTIER
Large Tobacco Farm, Sharecrop Tenancy, Row Crop Enterprises



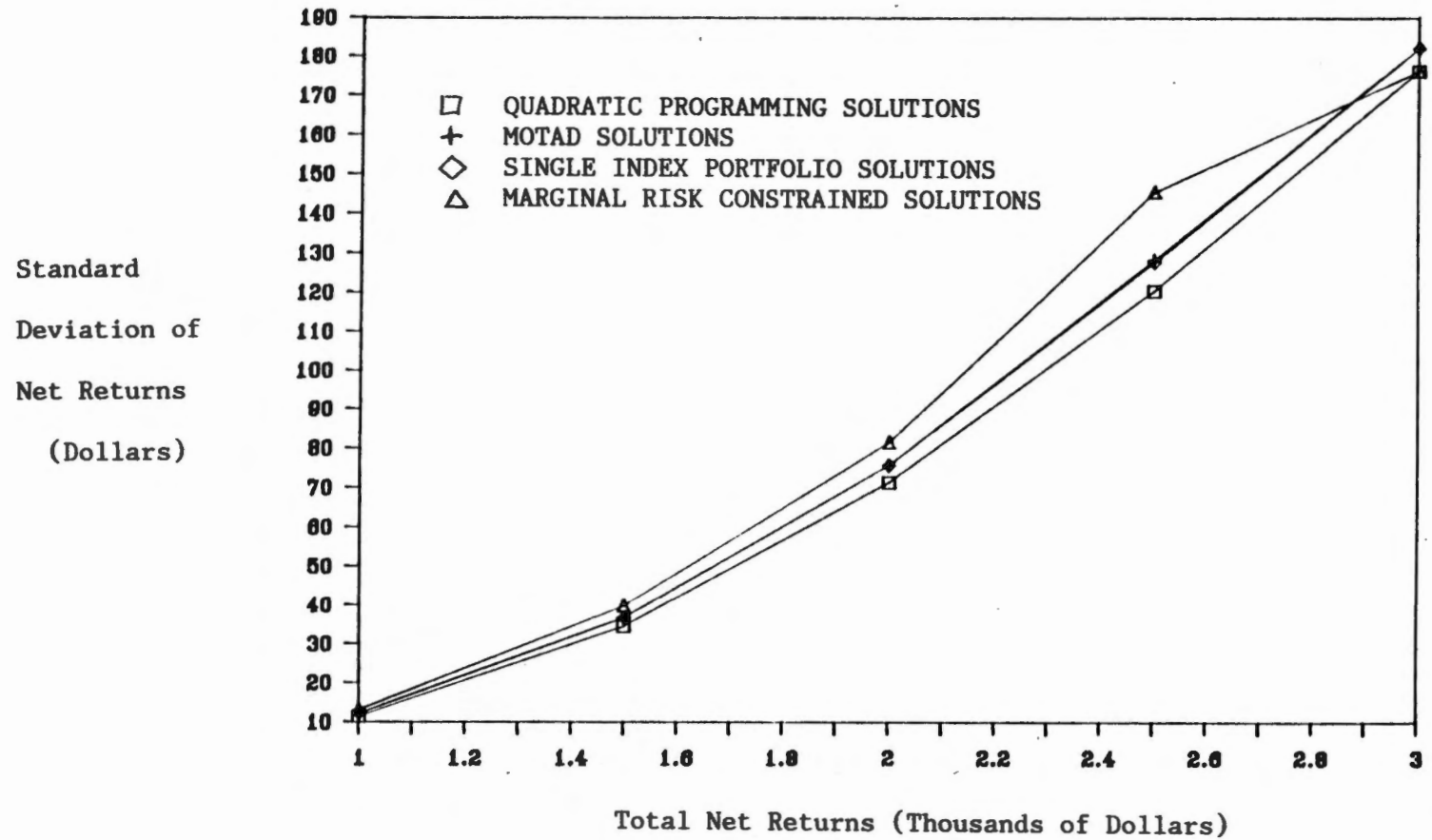
APPENDIX FIGURE 2

MEAN-VARIANCE FRONTIER
Small Tobacco Farm, Owner/Operator Tenancy, Row Crop Enterprises



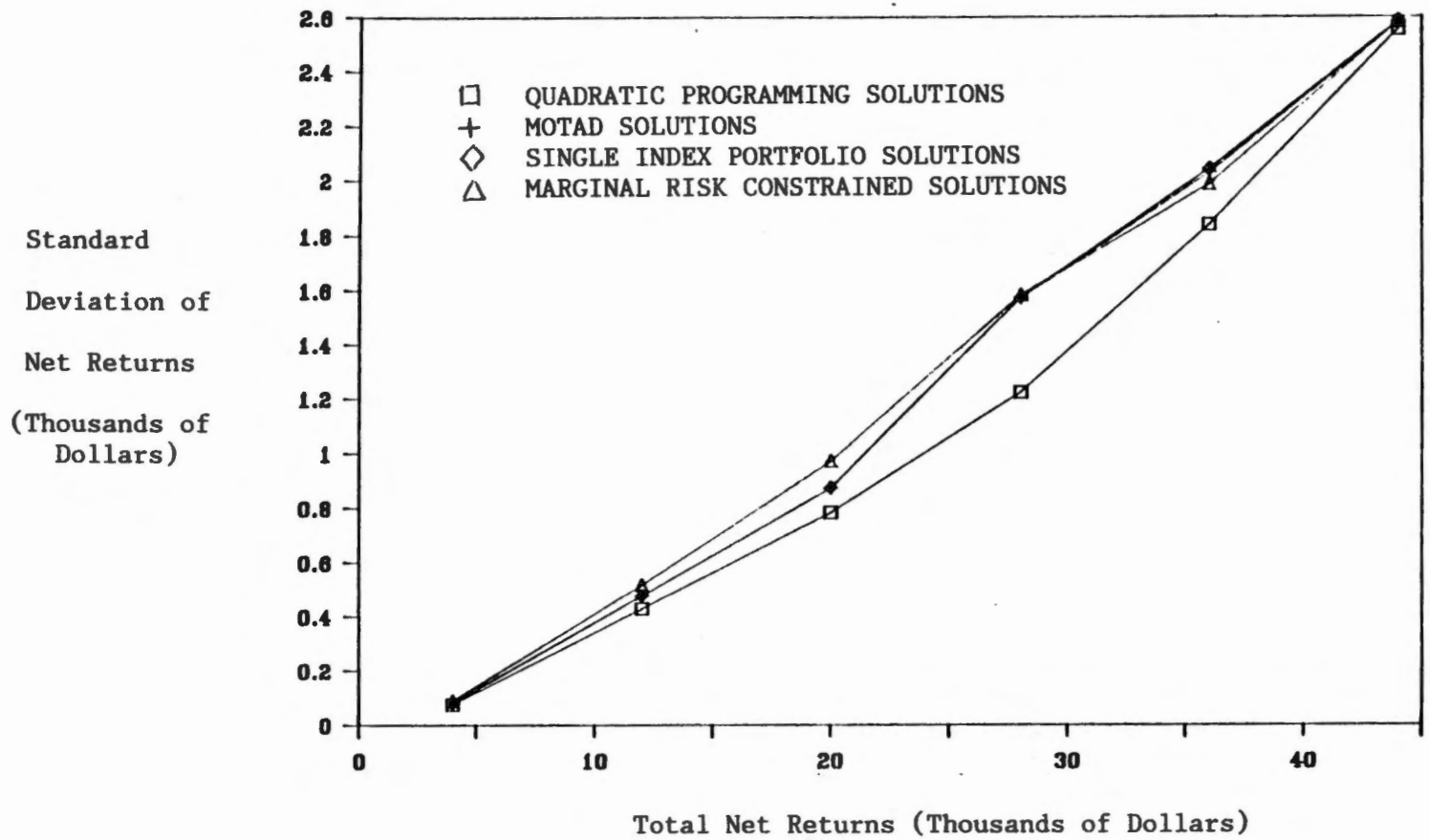
APPENDIX FIGURE 3

MEAN-VARIANCE FRONTIER
Large Tobacco Farm, Owner/Operator Tenancy, Beef Enterprise



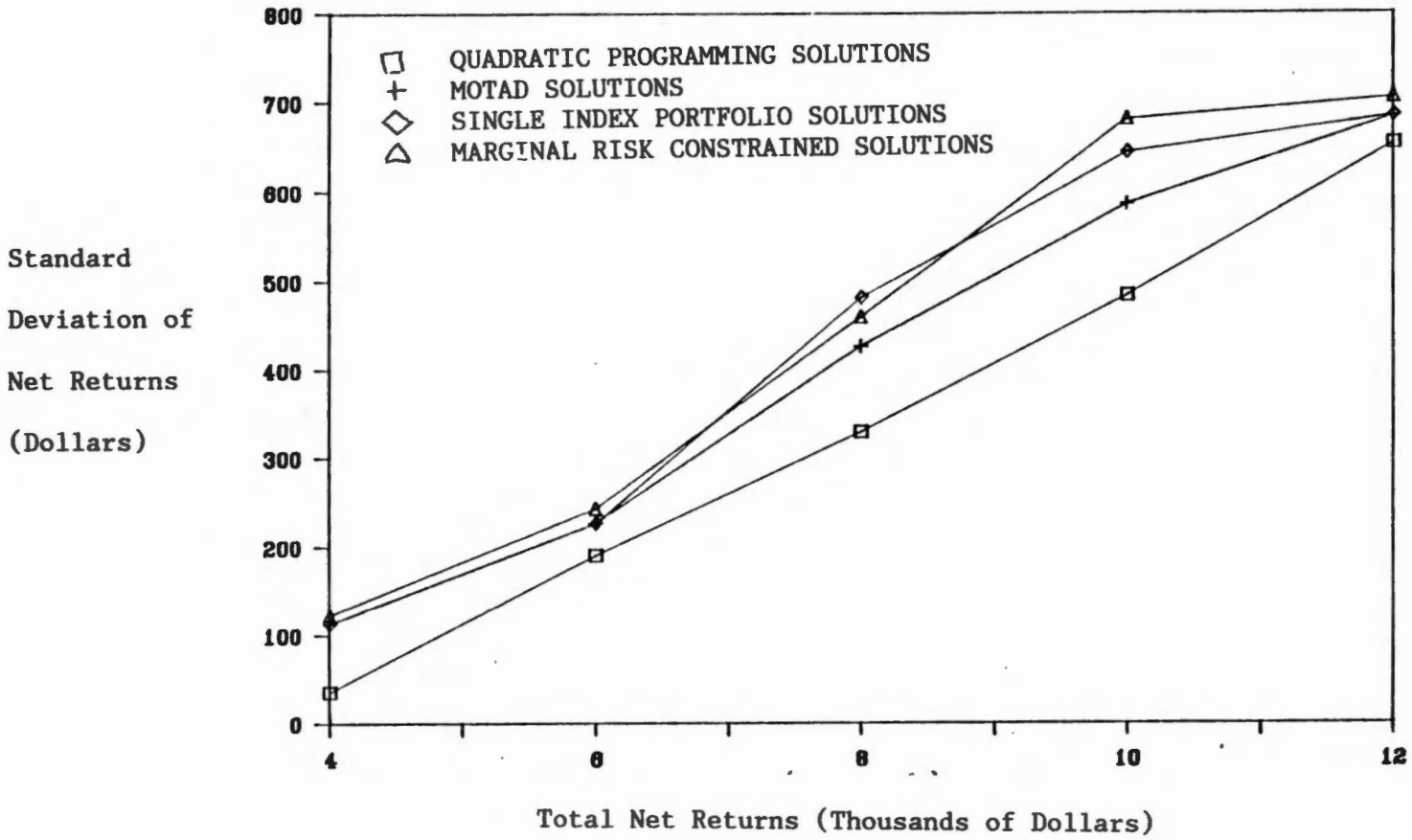
APPENDIX FIGURE 4

MEAN-VARIANCE FRONTIER
Small Tobacco Farm, Owner/Operator Tenancy, Beef Enterprise



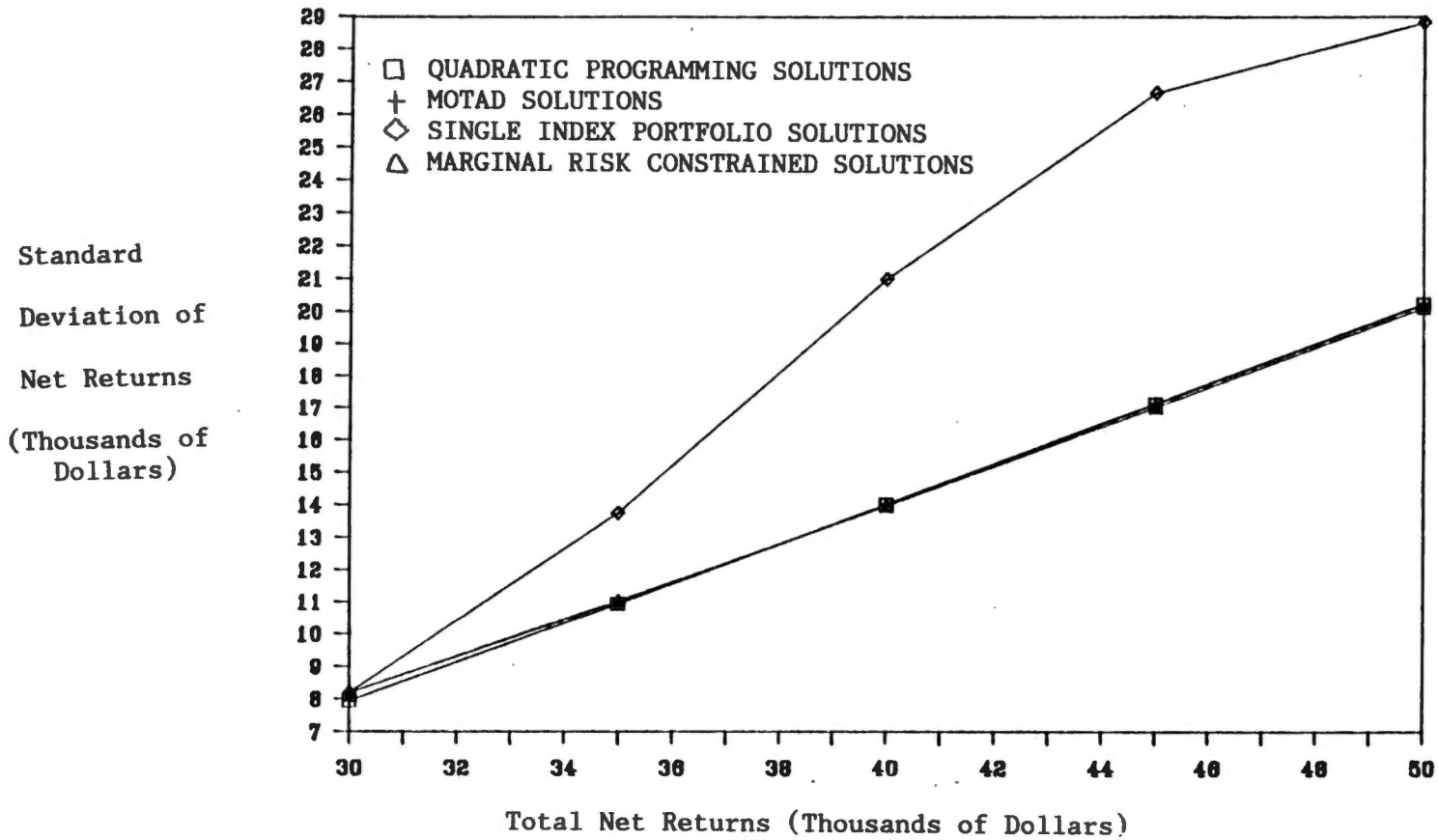
APPENDIX FIGURE 5

MEAN-VARIANCE FRONTIER
Large Tobacco Farm, Sharecrop Tenancy, Dairy Enterprise



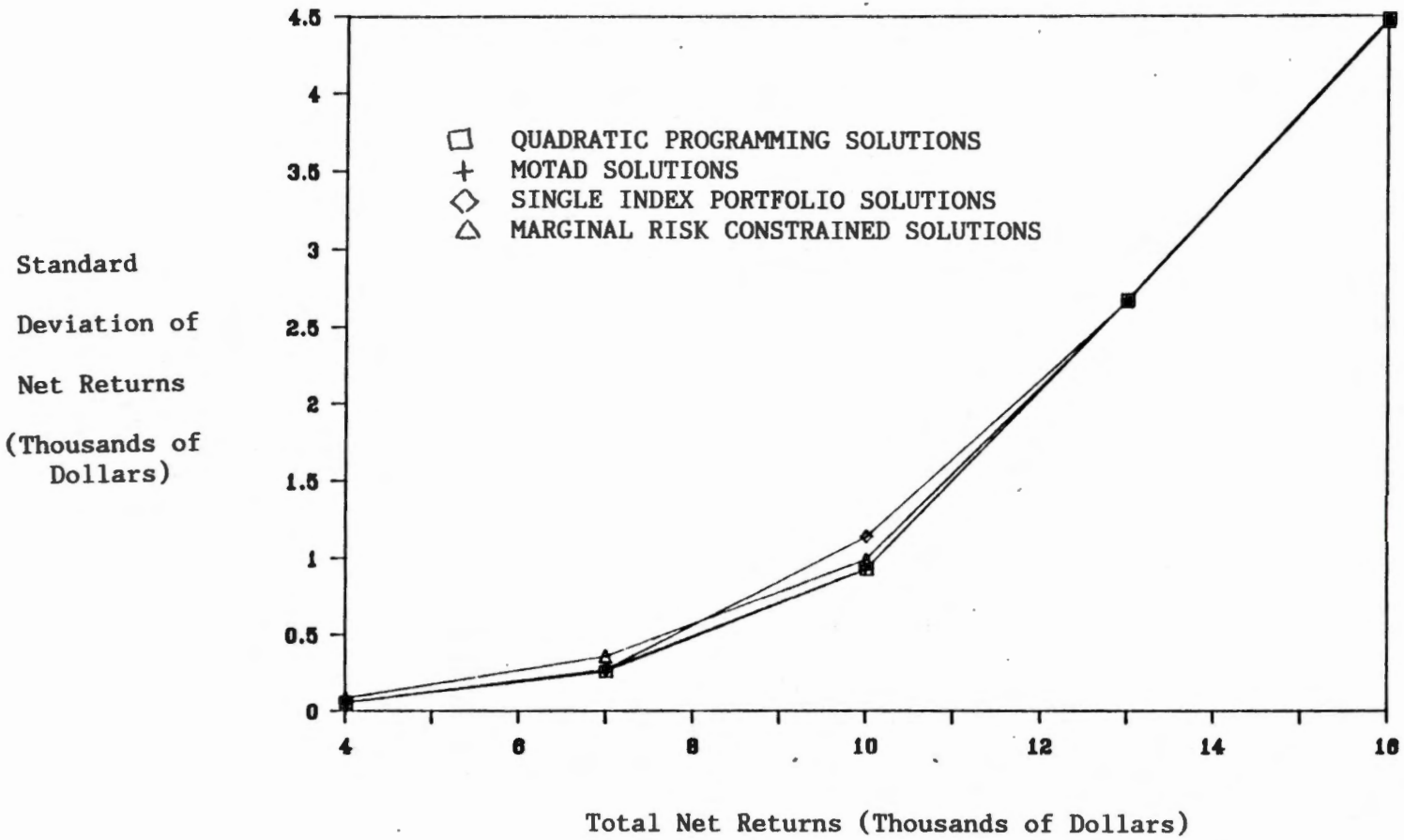
APPENDIX FIGURE 6

MEAN-VARIANCE FRONTIER
Small Tobacco Farm, Owner/Operator Tenancy, Dairy Enterprise



APPENDIX FIGURE 7

MEAN-VARIANCE FRONTIER
Large Tobacco Farm, Sharecrop Tenancy, Hog Enterprises



APPENDIX FIGURE 8

MEAN-VARIANCE FRONTIER
Small Tobacco Farm, Owner/Operator Tenancy, Hog Enterprises

VITA

William Robert Goodman was born in Birmingham, Alabama, on December 3, 1949. He is the middle son of Mr. and Mrs. William Lewis Goodman. He attended elementary school in Decatur and in Birmingham, Alabama, and graduated from Brentwood High School in Brentwood, Missouri. He entered Washington University in St. Louis, Missouri, in 1968, and transferred to Auburn University where he received a B.S. in Animal Science in 1975. He received an M.S in Agricultural Economics from Auburn University in 1976.

He was employed as an Area Farm Management Specialist by the University of Georgia Cooperative Extension Service in 1976. In 1978 he accepted a position as farm manager with M&M Farms in Red Bay, Alabama.

He was married to the former Susan Dianne Austin of Tifton, Georgia, on August 18, 1978.

In January, 1984, he accepted a graduate research assistantship at the University of Tennessee, Knoxville, in the Department of Agricultural Economics and Rural Sociology.