QUADRATIC PROGRAMMING ANALYSIS
OF FARM ORGANIZATIONS IN
NORTHEASTERN ARKANSAS

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Submitted to the Faculty of the Graduate College
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in partial fulfillment of the requirements
for the Degree of
DOCTOR OF PHILOSOPHY
May, 1973

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PREFACE

This study is concerned with the development of efficient farm plans for a typical cash crop farm in Northeast Arkansas. Efficient farm plans are defined as those having minimum income variance for a given expected income. A set of efficient plans make up the farm's efficiency frontier. A quadratic programming model is used in deriving efficient plans for both an owner and tenant operation.

The author wishes to express his sincere appreciation to Dr. Vernon R. Eidman, the major professor, for his direction and assistance throughout the study. Utmost appreciation is also accorded Dr. James S. Plaxico and Dr. Y. C. Lu for their invaluable assistance toward the finalization of the study. Further, appreciation is accorded Dr. Robert D. Morrison, Professor of Mathematics and Statistics, for his keen assistance as a committee member. The unselfish assistance of these men has made this study possible. However, all omissions and errors committed are the direct responsibility of the author.

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CHAPTER I

INTRODUCTION

Commercial farming is a serious business and a financially precarious occupation. Low incomes are characteristic of farming with prosperous farmers in the minority. Low income reflects the inability of many farmers to organize and adjust their operations efficiently to changing economic conditions. This situation is largely the result of the atomistic nature of the industry and the high proportion of fixed resources adapted primarily to agriculture. Consequently the industry is plagued with excess capacity and abundant production. The burden of overproduction with an inelastic demand falls on the farmer in the form of low prices and uncertain income.[1]

Variability of prices and income have long been a major farm problem. Much of the instability has been caused by business cycles, commodity cycles and other factors that affect productivity. Monetary and fiscal policies along with a secular decline in the income elasticity of demand for farm commodities have largely removed business cycles as a serious source of commodity price variability. The supply of farm output continues to fluctuate because of weather and commodity cycles.[2]

Levels of efficiency in farming are diverse, and a relatively small proportion of farms yield a normal return on all resources.[3] The problem of inefficiency is largely the result of change and uncertainty. If the assumptions of static economics prevailed, the decision making problems of farm management would be a simple affair and inefficiency rare.

Static theory specifies the economic optimum resource allocation that will maximize returns. Variable resources, without risk discounting, are applied at the margin where added returns equal added costs. They are applied as long as they continue to pay for themselves, or the value of the marginal product exceeds the added cost.

Applying static theory to farm management problems presupposes the agricultural industry is characterized by perfect competition and perfect knowledge. Further, if constant returns to scale is also assumed, all resources are rewarded their exact contribution to output and total product is exactly exhausted.[4] In reality, when uncertainty replaces the assumption of perfect knowledge, anticipation rules economic activity. Once uncertainty is injected into the production scheme, some factor becomes a residual claimant. Physical factors tend to be rewarded their market price and the entrepreneur, which encompasses the intangible input-management, becomes the residual claimant.[5] The size of the residual depends upon the successful application of management decisions.

Risk and Uncertainty

Risk and uncertainty are different phenomena. A risk situation is one when parameters of the probability distribution of a given outcome can be empirically estimated. For a decision maker to be in a risk situation: (1) the outcome must be predictable, (2) the sample from which the outcome is estimated must be large enough to derive empirical probability, (3) events must be random, and (4) observations must be repeatable. That is, the future will be similar to the past.[6]

Uncertainty refers to unpredictable events. Parameters of the probability distribution cannot be empirically determined. But, enough unpredictable events may be pooled into a large enough group that outcome is predictable. Characteristically, the individual farm manager is in an uncertainty situation. However, it is useful to represent the decision maker's position as a risk situation for planning purposes.

The uncertainty involved in commercial farming makes the management input one of the most important factors of production. Alternative and satisfactory ways to meet conditions of risk and uncertainty in a logical manner can mean the difference between success or failure.

Farm Planning Techniques

A widely used planning technique is linear programming. A basic assumption for using this tool is complete certainty or perfect knowledge. The decision maker is assumed to have a single-dimension criterion function or goal; for example, maximum expected returns. Although different enterprises are known to have different degrees of risk, linear programming is unable to make use of this information.

Farm planning with single-value expectations may not be adequate nor is it realistic. The search for methods and tools to aid planners faced with uncertainty has become an important segment of agricultural economics research. Because variability of income is important in selecting a farm plan, the farm manager is in a better position to evaluate alternative plans if he is knowledgeable, not only of the expected outcome, but also the variance, range and probability of outcome.

A decision model that offers considerable potential in farm planning for risk situations is quadratic programming. The use of quadratic programming, as employed in farm management, recognizes that expected income is desirable while variance of income is undesirable. The model utilizes data on expected returns for each potential enterprise as well as data on variance and covariance of returns in selecting a series of efficient plans for a given farm. An efficient plan is one where income variance is a minimum for any given level of expected income. The range of efficient plans for a given farm is the farm's efficiency frontier.

Quadratic programming has found limited use in farm planning largely because data are not readily available to compute income variance for each potential enterprise. However, data are available to derive estimates of income variance for most crops typically grown in the Mississippi River Delta area of Arkansas. The total delta area is typified as being a high cost, highly mechanized cash crop type of agriculture. Further, subareas within the area can be delineated where farm characteristics are quite homogeneous over large areas.

Area of Study

The area selected for this study is referred to as the North Mississippi River Delta area of Arkansas. It is in the northeast part of the state and includes those parts of Craighead, Greene and Poinsett Counties east of Crowley's Ridge, excluding the rice area, and all of Mississippi County (Figure 1). The topography is relatively flat to gently rolling permitting the use of large size farm equipment. Average annual precipitation is 49 inches. The growing season or period without a killing frost averages 210 days.

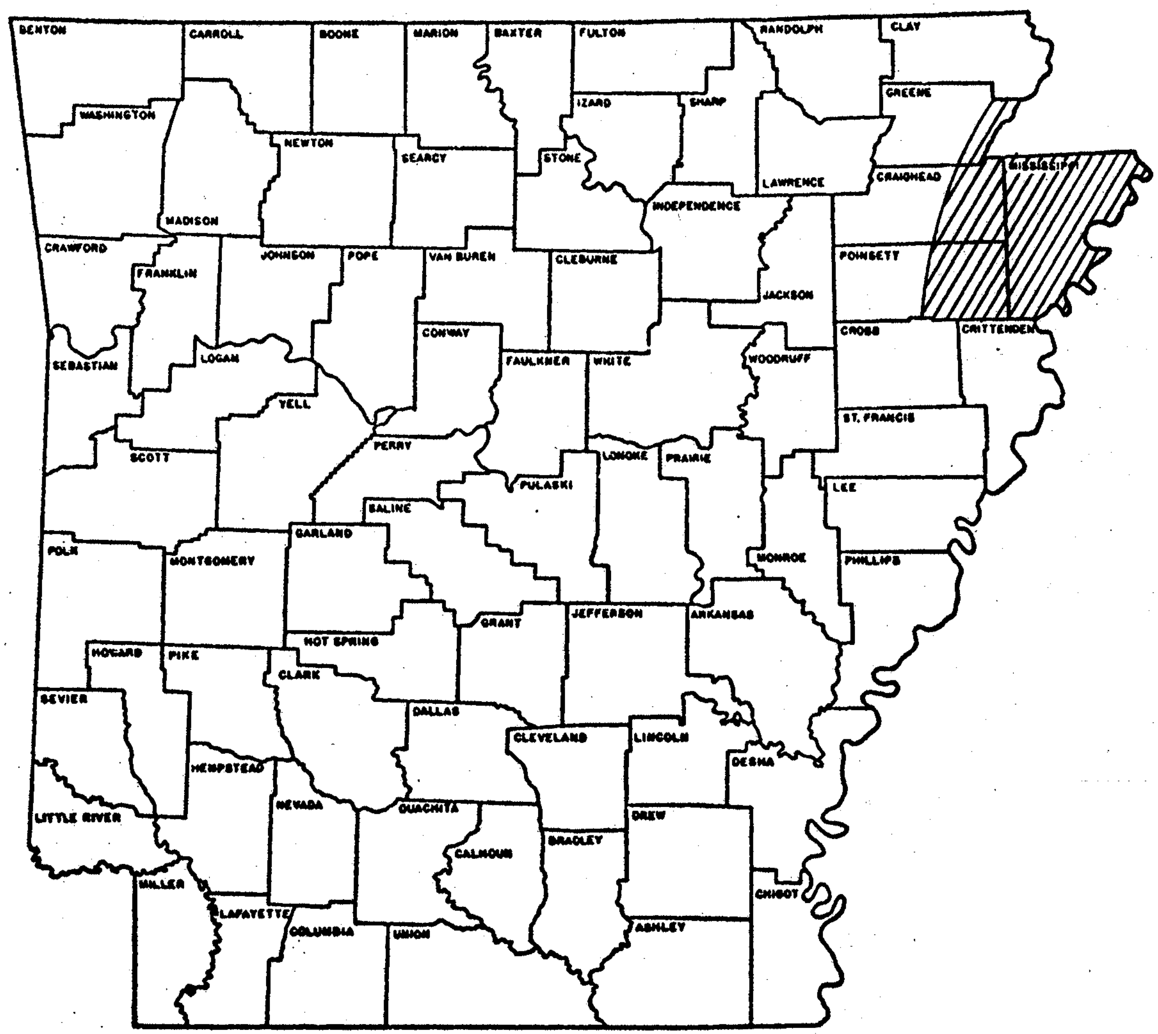

Figure 1. Area of Study

The soils are among the most fertile in the state. The area is part of the Bottomland and Terrace Soil Associations. They consist of broad alluvial plains with streams that have carried deposits from several soil areas. The soils are characterized by a mixture of sandy, loam and clay soils. The sandy and loam soils, which comprise approximately 62 percent of the area, are combined in this study and referred to as mixed soil. Clay soils comprise the other 38 percent.

The typical and predominate crops are cotton, soybeans and winter wheat. Cotton is grown under government programs and acreage will average less than one-third of total cropland. Winter wheat is grown primarily in a doublecrop rotation with soybeans.

A relatively high percentage of the total farms is operated by tenants. Tenure situations for the four counties are shown in Table I.

TABLE I

LAND TENURE IN STUDY AREA

Item	Full Owners	Part Owners	Managers	Tenants
Percent of Farms	27.6	20.2	.8	51.4
Percent of Total Land	22.1	36.9	6.8	34.2
Acres per Farm	130.4	298.4	1,346.2	108.4

Source: State Plan Inventory, Section 4, Agriculture, Department of Agricultural Economics and Rural Sociology, University of Arkansas, pp. 68 and 74.

Full tenant farms tend to be smaller than all other farms with part owner farms being by far the largest, excluding those operated by managers. Tenant operated farms in 1964 averaged 108 acres compared with 130 and 298 acres for owner and part owner farms, respectively.

This area was selected because of the homogeneity of the type of farming and technology used along with the availability of input and production data essential for quadratic programming. Therefore, the results of this study should have general applicability to the area delineated.

Objectives

The overall objective of this study is to determine efficient farm plans for representative farms in the study area. Efficient farm plans are defined as those having a minimum income variance for a given expected income, or alternately maximum expected income for a given variance. Specific objectives are:

1. To estimate expected net returns, the standard deviation of net returns and the correlation of net returns for alternative crop enterprises in the study area.
2. To determine the relationship between expected net returns and variance of net returns for efficient farm plans for both owner and tenant operations.
3. Evaluate the efficient farm plans for each situation in terms of their relative net returns, variability and suitability.

The following chapter develops the model used to determine the efficiency frontier for both a tenant and owner operated farm. No attempt is made to specify which efficient plan is optimum. Individual farmers vary in their financial resources and their attitudes toward risk aversion. Farmers with limited capital and high fixed debt obligations may plan to reduce risk to avoid the possibility of bankruptcy should a run of years occur when crop yields or prices for the major enterprise are below average. These farmers may strive to reduce risk even though expected income is somewhat less than the amount attainable with alternative plans. Alternatively, farmers in a strong financial position may strive for maximum expected income even though income varies considerably from year to year. Other farmers may select plans between the extremes of minimum income variance and maximum expected income that coincides with the individual's aversion to risk.

Data required to estimate the efficiency frontier for both tenant and owner operated farms are developed in Chapter III. The representative resource situations are specified, cost and return data for alternative enterprises are developed and the variance of net returns is estimated. A series of efficient farm plans are computed for each tenure situation which includes levels of expected income of $10,000 up to the maximum expected income for the given farm. The results are presented in both graphic and tabular form in Chapters IV and V.

FOOTNOTES

[1] Luther Tweeten, Foundations of Farm Policy, (University of Nebraska Press, 1970), pp. 153-170.

[2] Ibid, p. 153.

[3] Ibid, p. 164.

[4] Harold T. Davis, The Theory of Econometrics, (Bloomington, Indiana, 1941), p. 150.

[5] George J. Stigler, Production and Distribution Theories, (New York, 1941), p. 386.

[6] Vernon R. Eidman, Lecture notes for Agricultural Economics 6403, Advanced Production Economics, Department of Agricultural Economics, (Oklahoma State University, Fall, 1969).

CHAPTER II

THE PLANNING MODEL

It is generally accepted that farmers maximize expected utility in decision making.[1] A single-dimension objective function, as used in linear programming, presupposes: Utility = F (expected returns). A more realistic assumption, upon which this study is based, is: Utility = F (expected returns, income variance).

A two dimensional utility function based on expected returns and income variance may be depicted in terms of a risk indifference curve. Risk indifference curves are classified into three types: the risk averter -- sometimes referred to as a diversifier, the plunger and the risk lover (Figures 2, 3 and 4). Risk indifference curves are based on the assumption that investors have preferences between expected returns, E[Y], and variance of returns, σ_Y^2. The investor is indifferent between all pairs of (E[Y], σ_Y^2) that lie on a given indifference curve. Points on indifference curve I_2 are preferred to I_1. That is, for a given risk, the investor prefers a greater to a smaller expectation of returns. Risk averters, as well as plungers, are not willing to accept more risk without receiving a greater expected return. Their indifference curves are positively sloped with the exception that the plunger may have a point of zero slope.[2]

Risk indifference curves for the diversifier are normally characterized as being convex downward (Figure 2). Diversifiers are not

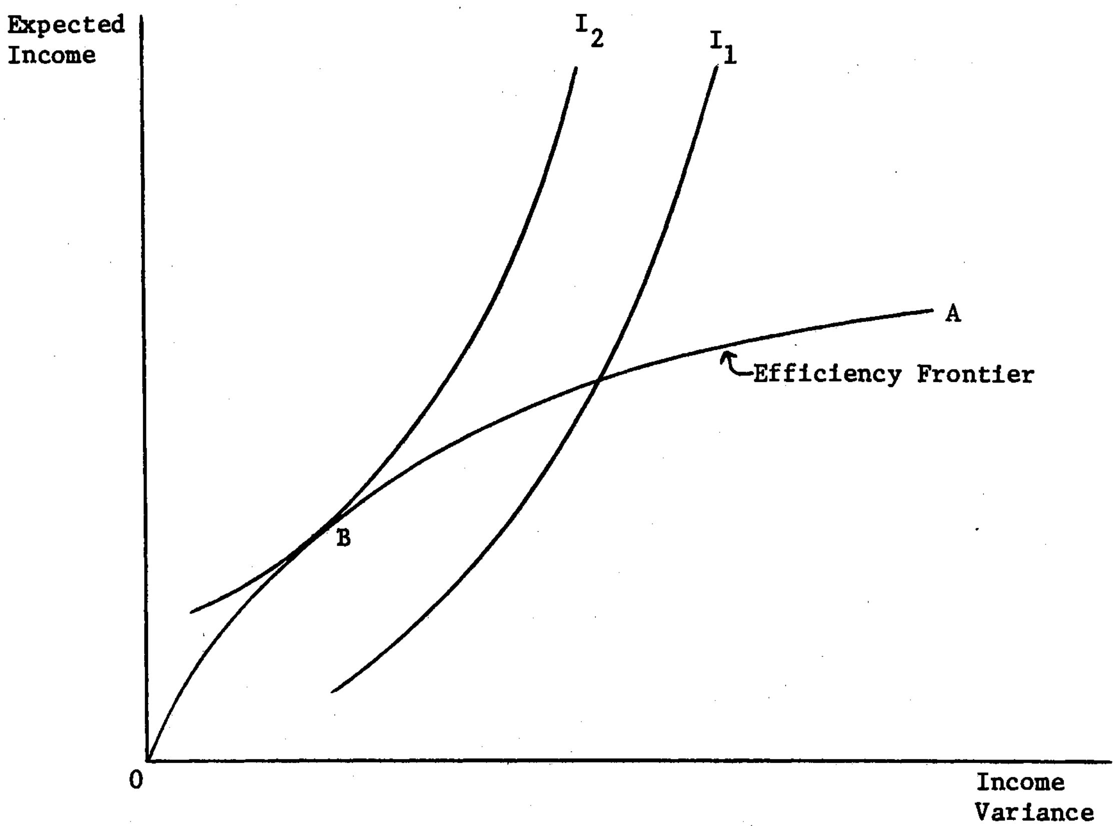

Figure 2. Hypothetical Risk Indifference Curves for a Risk Averter

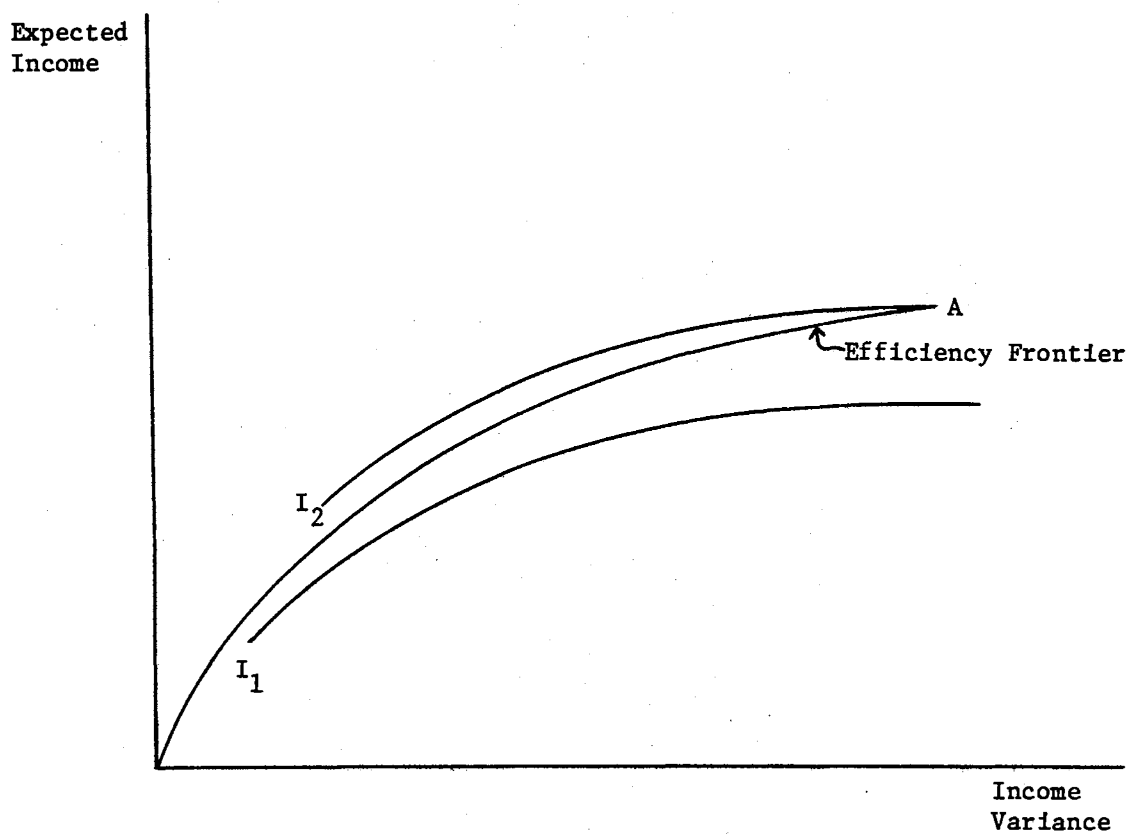

Figure 3. Hypothetical Risk Indifference Curves for a Plunger

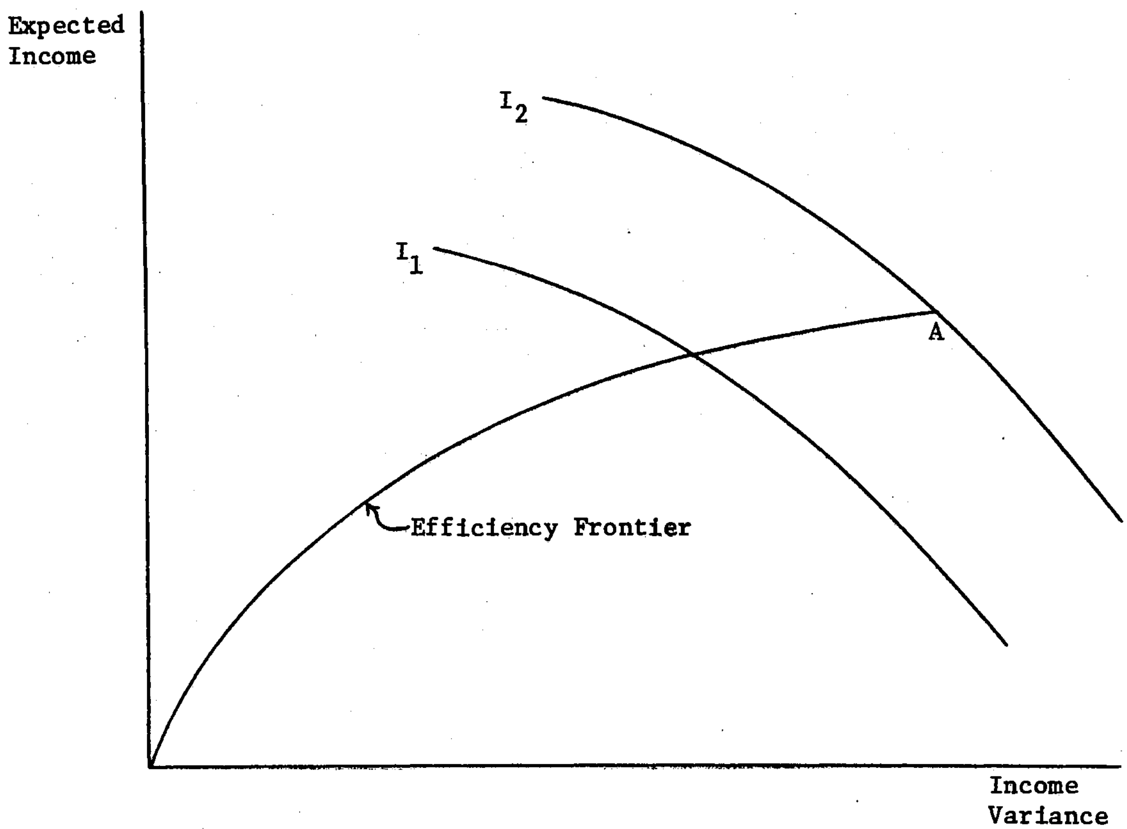

Figure 4. Hypothetical Risk Indifference Curves for a Risk Lover

willing to accept more risk without accepting a relatively larger increase in expected returns. The plunger's risk indifference curves are also upward sloping but may be either linear or concave downward (Figure 3). They are not willing to accept a greater risk without accepting a greater expected return, but they are willing to accept a realtivély larger increase in risk to achieve a given increase in expected returns. The indifference curves for risk lovers have negative slopes (Figure 4). Such individuals are willing to accept the possibility of receiving a low return or even negative return in order to have a chance for a high return which is associated with the higher variance.[3]

Relative degree of risk implies that a measure of elasticity of the risk indifference curve may be used to distinguish between diversifiers and plungers. Elasticity of the indifference curve may be defined as the percent change in expected income divided by the percent change in variance. If a measure of elasticity can be used to distinguish between the diversifier and plunger, each indifference curve, whether convex upward or downward, may demonstrate attributes of both a diversifier and a plunger. For example, if a tangent to the indifference curve has a positive E[Y] intercept, its elasticity at the point of tangency is less than one.[4] If it has a zero intercept elasticity is one and if it has a negative intercept elasticity is greater than one. An indifference curve can be convex downward with a range that has tangents with positive ordinate intercepts. If this is classed in the category of a diversifier, there may be an area on the indifference curve where the decision maker is willing to accept relatively large increases in risk to attain a given increase in expected returns. This would appear to place him in the classification of a plunger.

This suggests that risk indifference curves have the following characteristics:

1. The elasticity of the indifference curve for a diversifier is equal to or greater than one. Any tangent will have a zero or negative ordinate intercept. A risk indifference curve that is convex downward demonstrates characteristics of a plunger if the elasticity is less than one. It demonstrates characteristics of a diversifier if the elasticity is equal to or greater than one.
2. The elasticity of the indifference curve for a plunger is greater than zero but less than one. Any tangent has a positive ordinate intercept.
3. The elasticity of the indifference curve for a risk lover is less than zero.

Linear programming, with its single-dimension objective function, may be a suitable tool for the plunger or risk lover. For the plunger, the point of tangency between the indifference curve and efficiency frontier may occur at or near maximum expected income, depending on the relative slope of the two functions (point A, Figure 3). The point of tangency for the risk lover will occur at maximum expected income on the efficiency frontier because of the downward slope of the indifference curves (point A, Figure 4).[5] This is somewhat similar to an all or nothing situation in a game of chance because the risk lover is willing to accept a high probability of a low or even negative return to have a chance at the possible higher return associated with the higher variance.

The diversifier's preference for an efficient plan along the efficiency frontier will be less than maximum expected income. The risk averter requires increased expected returns if he is to accept greater variance and remain on the same indifference curve. Thus, he is willing to accept a trade-off in expected income, within reason (or the limitations dictated by his utility function), to avoid a high risk situation.

Risk Planning

Early efforts at risk planning in agricultural economics dealt primarily with the problem of diversification to achieve minimum absolute or relative variance. Diversification of farm activities may be used to reduce income variability when net returns for competitive enterprises have unequal coefficient of variations or are less than perfectly positively correlated. What is a good year for one crop may not be an equally good year for another. Yield data reveal that correlation is somewhat less than perfect even for similar crops that have identical growing seasons and cultural practices, thus allowing a reduction in income variance by diversification.[6]

Farm planning by budgeting methods can be used to determine the organization with the highest expected income for a given resource situation. If variability is also an important consideration, budgeting and non-stochastic programming methods fall short. Farmers with sufficient capital resources may not be as concerned about income variability as those with more limited resources. Farmers who are strong financially are in a better position to select enterprise combinations that yield the highest expected returns. Those with more limited capital may be interested in income stability because years of below average income may jeopardize the solvency of the farm business.

When income stability is also a goal in farm planning, the problem is no longer which enterprise combinations will yield the greatest expected income. Rather, the relevant question is which enterprise combinations will also yield a more stable income.

Diversification to obtain a higher degree of income certainty is somewhat analogous to insuring or contracting, usually something must be sacrificed to reduce income variability. The premium for a reduced income variance is usually a lower expected income. Those farmers whose financial position is vulnerable to bankruptcy from a run of low income years may well afford the premium. The decision maker who is a risk averter is a diversifier. The point of tangency between his risk indifference curve and the efficiency frontier is somewhat to the left of maximum expected returns (point B, Figure 2).

Diversification

Some of the earlier models to reduce income variance through diversification are presented by Earl O. Heady.[7] Diversification is achieved by either of two methods, (1) by adding more resources, e.g., land, so additional enterprises can be added or (2) by adding enterprises with existing resources. The main concern here involves the latter.

The method suggested for minimizing the absolute variance of income, using an example of two enterprises A and B, is based on the definition:

$$\sigma_Y^2 = q^2\,\sigma_A^2 + (1 - q)^2\,\sigma_B^2 + 2q(1 - q)r_{AB}\sigma_A\sigma_B \qquad (2\text{-}1)$$

where σ_Y^2 is variance of returns, q is the proportion of resources devoted to the production of enterprise A, 1 - q is the proportion of resources devoted to enterprise B, σ_A^2 is the variance of income from producing A, σ_B^2 is the variance of income from producing enterprise B, r_{AB} is the correlation coefficient for the two enterprises and $\sigma_A\sigma_B$ is the product of the standard deviation of each enterprise.

Income variance is minimized by differentiating with respect to q, setting the results equal to zero and solving for q. Minimum variance is achieved when:

$$q = \frac{\sigma_B^2 - r_{AB}\sigma_A\sigma_B}{\sigma_A^2 + \sigma_B^2 - 2r_{AB}\sigma_A\sigma_B}\,. \qquad (2\text{-}2)$$

The major criticism of using this method to select the combination of enterprises is that it minimizes income variance without considering the effects on expected income. The equation does impose one restriction -- that total land resources are used. If this restriction were not imposed, minimum variance could occur at zero production. The minimum variance organization, however, is an efficient plan located on the efficiency frontier and is the lowest variance possible for total utilization of the land resource.

An alternative method of diversification analysis is to minimize relative income variability. Again using the example of two enterprises, A and B, expected total farm income I is expressed as:

$$I = qI_A + (1 - q)I_B. \tag{2-3}$$

The coefficient of variation of expected farm income by definition is:

$$CV = \frac{\sigma_I}{I} = \frac{[q^2\sigma_A^2 + (1 - q)^2\,\sigma_B^2 + 2q(1 - q)r_{AB}\sigma_A\sigma_B]^{\frac{1}{2}}}{qI_A + (1 - q)I_B}\,. \tag{2-4}$$

Minimum relative variability is achieved by differentiating with respect to q, setting the results equal to zero and solving for q:

$$q = \frac{I_A\sigma_B^2 - r_{AB}I_{AB}\sigma_A\sigma_B}{I_B\sigma_A^2 + I_A\sigma_B^2 - r_{AB}\sigma_A\sigma_B(I_A - I_B)}. \tag{2-5}$$

This method can also be critized because it does not impose a minimum level of income and because it selects only one point on the efficiency frontier, that point having the minimum relative variability.

Quadratic Programming

A more complete method of diversification analysis is one that associates minimum variance with alternative levels of income. This method was popularized by Markowitz.[8] The method is quadratic programming and was first used in portfolio analysis. Portfolio selection is similar to enterprise selection in farm planning. Portfolio selections are based on expected future performance of available securities. Markowitz argues that quadratic programming implies the rejection of they hypothesis that investors try to maximize anticipated returns. Maximization of expected returns suggests that the investor may specialize in only one security. The accepted hypothesis is that investors view expected returns as desirable and variance of returns as undesirable. This is pointed out in the quotation:[9]

> The hypothesis (or maxim) that the investor does (or should) maximize discounted return must be rejected. If we ignore market imperfections the foregoing rule never implies that there is a diversified portfolio which is preferable to all nondiversified portfolios. Diversification is both observed and sensible; a rule of behavior which does not imply the superiority of diversification must be rejected both as a hypothesis and as a maxim.

Quadratic programming solutions derive a set of efficient plans which as a group is the firm's efficiency frontier. For any given feasible level of income, variance is at a minimum or for a given variance income is maximum. Any organization not on the efficiency frontier is not an efficient plan.

Quadratic programming is concerned with problems of either maximizing or minimizing a quadratic objective subject to linear inequality constraints. It is assumed the decision maker views future returns of alternative activities or enterprises in probabilistic terms. That is, the return of each activity is assumed to be normally distributed with an expected rate of return E[Y] and variance, σ_{ij} for $i = j$, where i is row and j is column in the variance-covariance matrix or net returns of activities. When $i = j$; variance is σ_{ii}.[10]

Variance is a measure of risk and indicates how realized returns deviate from expected returns. An activity with a high variance is usually risky. Risk may also be measured in relative terms using the coefficient of variation. The covariance of the returns of two activities, i and j, is σ_{ij} when $i \neq j$. This measure provides an indication of the correlation between the two activities. When covariance is positive the returns of both activities tend to move up and down together. A high positive correlation will tend to maintain risk of large fluctuations in year to year returns because a favorable return on one activity will usually be associated with a favorable return on the other activity; and likewise for unfavorable returns. It is easier to decrease variability of net returns when unfavorable returns on one activity are offset by favorable returns on the other activity.[11]

For those activities where E[Y] σ_{ij} can be estimated, the decision maker has a choice of alternative efficient plans. The return-variance rule states that the decision maker should select a plan which is efficient. It is necessary, through statistical techniques, to estimate E[Y] and σ_{ij} usually by time series analysis. From these the efficient combinations are derived. The decision maker, being informed of the E[Y] and σ_{ij} combinations which lie on the efficiency frontier, can select the desired combination.[12] Even if two decision makers agree on the same values for E[Y] and σ_{ij} for all activities taken into consideration they need not agree upon the same efficient plan. The plan the decision maker prefers depends on his attitude toward risk and the marginal utility of money. These attributes are reflected in the shape of the manager's indifference curves discussed above.[13]

Two conditions must be satisfied before it is practical to use an efficiency frontier: (1) the investor must choose to act according to the E[Y] and σ_{ij} maxim, and (2) it must be possible to derive reasonable estimates of E[Y] and σ_{ij}.[14]

Solutions to quadratic programming problems are thus based on the assumption that the return Y for a given enterprise is a random variable. E[Y] for a given enterprise can be estimated from time series data and can take on a finite number of values. The variance of Y is defined as σ_Y^2, the average squared deviation of Y from its expected value.

The decision problem is to choose activities that have minimum variance for the level of expected income. The set may be composed of a number of jointly distributed random variables: $Y_1, Y_2, \ldots Y_n$ representing returns for activities Y_1 through Y_n. E[Y] for the set is a weighted sum of the activities included in the efficient plan. E[Y] is also a random variable. Although $Y_1, Y_2, \ldots Y_n$ are random variables, they are not necessarily independent.[15] The assumption of independence implies zero covariance; however, the converse is not true in general.[16]

In the quadratic programming problem, as formulated by Markowitz, let Y_i be the expected return of the i^{th} activity and σ_{ij} the covariance between the i^{th} and j^{th} activities (σ_{ii} is the variance of the i^{th} activity). Also, let X_i be the proportion of resources or assets allocated to the i^{th} activity. Total expected returns are $E[Y] = \sum X_i Y_i$. The E[Y] and Y_i are considered to be random variables. The X_i's are not random variables because they are determined by the decision maker. The $\sum X_i = 1$ because X_i represents proportions. Also $X_i \geq 0$ for all i because negative values are excluded.

The expected return E[Y] is a weighted sum of random variables with weights chosen by the decision maker. The expected return E[Y] = $\sum_{i=1}^{n} X_i Y_i$ and variance is $\sigma_Y^2 = \sum_{i=1}^{n} \sum_{j=1}^{m} \sigma_{ij} X_i X_j$.

Basic to quadratic programming solutions of Markowitz's portfolio analysis is: (1) make estimates of the future expectations of the mean and variance of returns for selected alternatives; (2) determine a set of efficient portfolios; and (3) select the portfolio best suited to the risk and utility characteristics of the individual.

A refinement of the Markowitz analysis is presented by Sharpe who included a risk variable in the problem formulation:[17]

$$\phi = \lambda\ E[Y] - \sigma_Y^2. \qquad (2\text{-}6)$$

Of all possible portfolios, one will maximize the value of ϕ (ϕ_2, Figure 5). The selected plan is an efficient plan and will be on the efficiency frontier at this point, point A. Since this function is of the form $\phi = \lambda\ E[Y] - \sigma_Y^2$, the slope of the efficiency frontier at this point is λ. By varying λ from 0 to ∞ every solution of the problem can be obtained.

For any given value of λ the problem requires the maximization of the quadratic function ϕ, subject to the linear constraint, with the variables restricted to non-negative values. $\lambda = \infty$ is the no risk solution and is analogous to the linear programming maximum return solution. Therefore, λ is a risk variable.

Researchers in production economics, feeling the need for risk programming, soon adapted the portfolio analysis to decision problems in agriculture. Some of the earlier work was conducted by Freund.[18] An interesting part of his analysis was the inclusion of the risk aversion coefficient and the maximization of expected utility.

A logical objection to the inclusion of a risk aversion factor and maximization of utility is the inability of estimating objective values for these elements of the problem.

Solving decision problems where a risk factor is included presupposes a knowledge of the individual's utility function. Risk problems have generated a strong interest in utility analysis among agricultural economists. Consequently, utility analysis needs further emphasis. It is concluded that farmers have a nonlinear utility function and in general have an aversion to uncertainty. Further, they are expected

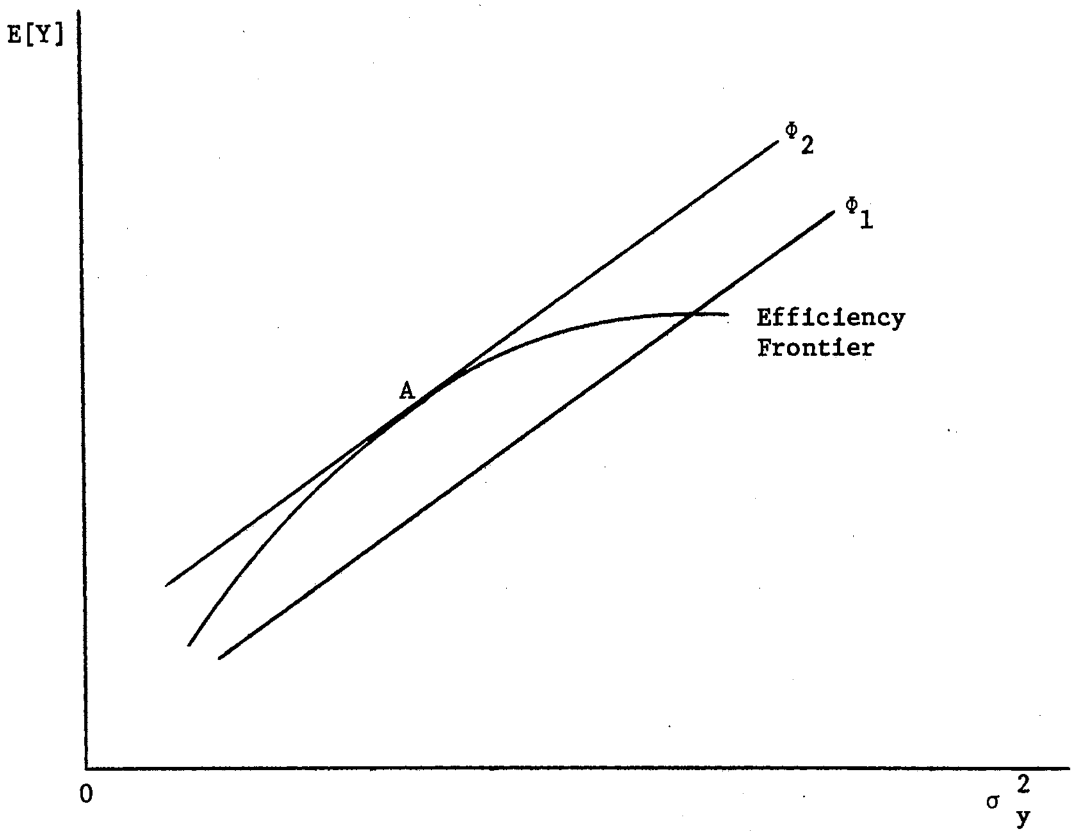

Figure 5. Efficiency Frontier With Maximization of the Objective Function

utility maximizers or behave as if they are.[19] Unlike the Freund analysis, no attempt is made in this study to estimate a risk indifference function or utility of money because the utility function is not known for farmers in the area of study. Given a set of efficient plans the decision maker is in a position to select that plan best suited to his own risk and utility characteristics.

Programming Model

The quadratic formulation used in the analysis is a minimization of variance in net returns subject to linear inequality constraints. The constraints reflect the limit on resources available and require expected income to equal or exceed a specified level. The problem is to determine enterprise organizations that minimize income variance for the given level of income. It may be beneficial to first solve, by linear programming, the no risk solution to determine the maximum expected income. This serves as a check on the maximum expected income derived by quadratic programming.

The quadratic programming model used is a restricted basis dual simplex method. The problem formulation is to:

A. Minimize income variance

$$\sigma_Y^2 = \sum_{i-1}^{m} \sum_{j=1}^{n} X_i \sigma_{ij} X_j . \tag{2-7}$$

B. Subject to:

$$\sum_{j=1}^{n} a_{ij} X_j \leq b_i \tag{2-8}$$

$$-\sum_{j=1}^{n} C_j X_j \leq -NR, \tag{2-9}$$

where NR is the specified level of net return.

$$X_j \geq 0; \tag{2-10}$$

$i = 1, 2, \ldots, m$

$j - 1, 2, \ldots, n.$[20]

Unlike the Markowitz formulation, the X_j values are levels of activities in acres; the a_{ij} are resource requirements per unit of j^{th} activity, the b_i values are resource restrictions, and the C_j are net income per unit of activity. The program is written such that expected income is entered as equal to or less than a specified amount. Entering all C_j values and NR as negative values imposes the desired constraint that expected income be greater than or equal to the minimum level of specified income. A solution can be derived for any specified income as long as specified income does not exceed the maximum attainable with the activities and constraints.

FOOTNOTES

[1]R. R. Officer and A. N. Halter, "Utility Analysis in a Practical Setting," American Journal of Agricultural Economics, Vol. 50, No. 2, May 1958, p. 274.

[2]M. G. Mueller, ed., Readings in Macroeconomics, "Liquidity Preference as Behavior Toward Risks," by J. Tobin (New York, 1966), pp. 180-181.

[3]Ibid., p. 181.

[4]R. F. Fowler, "The Diagrammatical Representation of Elasticity of Supply," Economica, Vol. 5, 1938, pp. 213-229.

[5]It is conceivable that a point of tangency may occur to the right of the maximum point on the efficiency frontier if the maximum variance solutions extend to the right of this point.

[6]Daniel F. Capstick, "Winter Oats Vs. Barley for North Central Oklahoma," Oklahoma Current Farm Economics, Vol. 30, No. 1 (Oklahoma State University, 1957), pp. 18-24.

[7]Earl O. Heady, "Diversification in Resource Allocation and Minimization of Income Variability," Journal of Farm Economics, Vol. 34, No. 4 (The American Farm Economic Association, November, 1952), pp. 482-496.

[8]Harry Markowitz, "Portfolio Selection," Journal of Finance, Vol. 7, No. 1, The American Finance Association (University of Chicago Press, 1952), pp. 77-91.

[9]Ibid., p. 77.

[10]John C. G. Boot, Quadratic Programming, Vol. 2 (Chicago, 1964), p. 1.

[11]Ibid, p. 2.

[12]Markowitz, p. 82.

[13]Boot, p. 2.

[14]Markowitz, p. 83.

[15]Harold J. Larson, Introduction to Probability Theory and Statistical Inference (John Wiley and Sons, 1969), p. 178-179.

[16]Jan Kmenta, Elements of Econometrics, (New York, 1971), p. 65.

[17]William F. Sharpe, "A Simplified Model for Portfolio Analysis," Management Science, Vol. 9 (October-July, 1962-63), pp. 277-292.

[18]Rudolf J. Freund, "The Introduction of Risk Into a Programming Model," Econometrics, Vol. 24, No. 3 (July, 1956), pp. 253-263.

[19]R. R. Officer and A. N. Halter, "Utility Analysis in a Practical Setting," American Journal of Agricultural Economics, Vol. 50, No. 2 (May, 1968), pp. 257-258.

[20]Allen Shurmann, Quadratic Programming, Department of Agricultural Economics and Rural Sociology, University of Arkansas.

CHAPTER III

DEVELOPING THE PLANNING DATA AND METHOD OF ANALYSIS

The type of data needed for quadratic programming is similar to that necessary for linear programming. In addition, variances and co-variances are required. Thus, the input data required include (1) the resource situation, (2) cost and return information and (3) the vari-ance-covariance matrix of net returns.

To use quadratic programming in decision making it is necessary to derive estimates of the mean and variance for each enterprise and covariance between enterprises. The future cannot be known with cer-tainty; therefore, the true Y_i (mean) and σ_{ij} (variance) is not known but statistical estimates can be made by analysis of a selected past period using time series analysis. The period selected is the 20 years from 1950 to 1969. Although the past may not be representative of the future, it provides the best estimates available. Also, the more recent the period, the closer it is to the future and consequently the probability of reliable estimates are considered greater.

Annual net income data are developed for major crops deemed fea-sible or adapted to this area (Figure 1). Those crops which may be feasible are alfalfa; corn; cotton; grain sorghum; winter oats; soy-beans, group IV (very early season maturing varieties), group V (early season maturing varieties), group VI (midseason maturing varieties), and group VII (late season maturing varieties) and winter wheat. Income data are estimated for each of these crops for mixed soil. Income data for clay soil do not include corn and winter oats because the clay soil of the area is not well suited for these two crops. In addition to these crop activities income data are also derived for several rotations which includes a doublecrop activity. The doublecrop activities include winter oats and winter wheat for the mixed soil and winter wheat for the clay soil. Other crops included in the doublecrop rotations are corn, for mixed soil only, grain sorghum, and group V and group VI soybeans.

Source of Data

The data used in the analysis are from (1) interviews with farmers in the area, (2) interviews with machinery dealers and other suppliers of agricultural resources, (3) consultations with experiment station personnel and (4) published data necessary for the analysis.

Crop production and input data are developed from 907 schedules obtained by personal interviews with farmers. Interview data relate specifically to farm acreage and organization, crop production practices, effects of weather on farming operations and machinery use and cost. Supplemental input data are also derived from published information for the area.[1]

Annual crop yield data are from variety tests that have been conducted in the area. Annual yields for individual crops are the highest one-third yielding varieties each year.

Resource Situation

The selected farm size is 640 acres with 596 acres of cropland (Table II). The soil inventory includes 370 acres of mixed soil cropland and 226 acres of clay soil cropland. Cotton allotment averaged 32.5 percent of cropland or 194 acres per farm.

TABLE II

LAND RESOURCES OF SELECTED FARM

Land	Percent	Acres
Cropland	93.1	596
Other land	6.9	44
Total	100.0	640
Cotton Allotment	32.5	194
Mixed Cropland	62.0	370
Clay Cropland	38.0	226

Labor restrictions are set at both a two-man and a three-man operation on an annual basis with day labor for weed chopping available as needed. Labor requirements are divided into four periods for each activity (Table III). The four periods are: (1) December-April which includes most of the post harvest and preplant operations, (2) May-June which includes most of the planting operations, (3) July-September which includes most of the operations between planting and harvest and (4) October-November which includes much of the harvesting season. Labor restrictions are based on average weather conditions.

TABLE III

LABOR RESTRICTIONS FOR SELECTED FARM SITUATION

Labor Period	Total Hours	
	Two Men	Three Men
December-April	854	1,281
May-June	614	921
July-September	874	1,311
October-November	548	822

Two tenure situations are programmed, full owner and full tenant. Annual net returns for the owner situation includes returns to land and management. Land returns are a gross value because no land costs, such as taxes, are deducted. Tenant situations are based on a crop-share rent of one-fourth for cotton and one-third for other crops. The landlord shares in cost in the same proportion that he shares in production for inputs of fertilizer, insecticides, ginning charges and drying of grain when necessary.

Development of Enterprise Cost and Returns

Derivation of Yield Data

Estimates of yields for the 20 year period are derived from variety test data. All yield data are from test plots either within the Northeast Arkansas study area or locations in close proximity. Location of text plots are Cotton Branch Experiment Station, Marianna; Delta Substation, Clarksdale; and Northeast Branch Experiment Station, Keiser. Variety yield data are averages of three or four replications. The yield selected is the average of the one-third highest yielding varieties each year. Yield data are by soil type -- mixed and clay cropland -- for alfalfa; cotton; grain sorghum; group IV, group V, group VI and group VII soybeans; and winter wheat. Yields for corn and winter oats are for mixed soil only. Grain sorghum yields are available for only the last 12 years of the period because comparable data do not exist prior to 1958. This method is used in estimating annual yields because the resulting yields tend to approximate the variability experienced by individual farmers better than county averages or individual plot data.

First degree linear equations are fit to all yield series by least squares regression analysis to test for trend. The resulting equation is used to remove trend from those series having significant trend values at the 10 percent level (Table IV). When trend is removed from the data the expected yield selected for the planning model is the average of the last half of the period (Table V). Variety test yields, as adjusted for trend, are the yields used for all single crop activities.

TABLE IV

REGRESSION ANALYSIS OF YIELD DATA FOR SELECTED CROPS[a]

Item	T-Test	F-Test	b_0[b]	b_1	Mean Yield	Standard Deviation	Coefficient of Determination	Number of Observations
Cotton[c]								
Mixed Soil	-0.0041	0.0000	676.437	-0.037	676.050	272.235	.000	20
Clay Soil	0.3764	0.1417	577.474	3.883	618.250	328.482	.008	20
Soybeans[d]								
Mixed Soil								
Group IV	2.8359[d]	8.0426	21.698	0.610	28.105	6.496	.309	20
Group V	0.5825	0.3393	29.659	0.016	31.305	6.818	.019	20
Group VI	0.3990	0.1592	31.822	0.121	33.095	7.662	.009	20
Group VII	1.1103	1.2327	27.954	0.372	31.860	8.694	.064	20
Clay Soil								
Group IV	-0.1392	0.0194	24.562	-0.035	24.195	6.308	.001	20
Group V	-0.5080	0.2580	29.557	-0.110	28.400	5.485	.014	20
Group VI	-0.4399	0.1935	32.707	-9.114	31.510	6.539	.011	20
Group VII	0.6125	0.3752	26.975	0.147	28.515	6.073	.020	20
Corn[d]								
Mixed Soil	-0.5052	0.2552	89.005	-0.602	82.685	30.117	.014	20
Grain Sorghum[d]								
Mixed Soil	1.7767[f]	3.1566	29.898	3.284	51.242	24.170	.240	12
Clay Soil	2.1712[f]	4.7142	23.394	3.588	46.717	22.856	.320	12
Oats								
Mixed Soil	1.3464[f]	1.8127	66.035	0.902	75.505	17.640	.091	20

TABLE IV (CONTINUED)

Item	T-Test	F-Test	b_0[b]	b_1	Mean Yield	Standard Deviation	Coefficient of Determination	Number of Observations
Wheat[d]								
Mixed Soil	1.5533[f]	2.4127	28.720	0.799	47.105	13.742	.118	20
Clay Soil	3.6301[f]	13.1775	20.092	1.445	35.265	13.150	.423	20
Alfalfa[e]								
Mixed Soil	0.7588	0.5757	5.389	0.053	5.946	1.780	.031	20
Clay Soil	0.7584	0.5752	4.029	0.040	4.444	1.330	.031	20

[a] $\hat{y} = b_0 + b_1 X$. $\hat{y}$ is yield per acre and X is year.

[b] The year enumeration begins with 1950 equal to 1.

[c] Pounds of lint per acre.

[d] Bushels per acre.

[e] Tons per acre.

[f] Significant at the 10 percent level.

TABLE V

EXPECTED YIELD PER ACRE FOR SELECTED CROPS, NORTH MISSISSIPPI RIVER DELTA AREA OF ARKANSAS

Enterprise		Unit	Production	
			Mixed Soil	Clay Soil
1.	Alfalfa	ton	5.95	4.44
2.	Corn	bu.	82.7	
3.	Cotton	lb.	676.0	618.2
4.	Grain Sorghum	bu.	61.6	57.5
5.	Oats	bu.	80.0	
6.	Soybeans, Group IV[a]	bu.	31.2	24.2
7.	Soybeans, Group V[a]	bu.	31.3	28.4
8.	Soybeans, Group VI[a]	bu.	33.1	31.5
9.	Soybeans, Group VII[a]	bu.	31.9	28.5
10.	Wheat	bu.	51.1	42.5
11.	Corn[b]	bu.	41.4	
	Oats[b]	bu.	40.0	
	Grain Sorghum[b]	bu.	25.2	
12.	Corn[b]	bu.	41.4	
	Oats[b]	bu.	40.0	
	Soybeans, Group VI[b]	bu.	12.6	
13.	Corn[b]	bu.	41.4	
	Wheat[b]	bu.	25.6	
	Grain Sorghum[b]	bu.	25.2	
14.	Corn[b]	bu.	41.4	
	Wheat[b]	bu.	25.6	
	Soybeans, Group VI[b]	bu.	13.6	
15.	Grain Sorghum[b]	bu.	30.8	
	Oats[b]	bu.	37.4	
	Grain Sorghum[b]	bu.	25.2	
16.	Grain Sorghum[b]	bu.	30.8	
	Oats[b]	bu.	37.4	
	Soybeans, Group VI[b]	bu.	12.6	
17.	Grain Sorghum[b]	bu.	30.8	28.8
	Wheat[b]	bu.	25.6	21.2
	Grain Sorghum[b]	bu.	25.2	23.4
18.	Grain Sorghum[b]	bu.	30.8	28.8
	Wheat[b]	bu.	25.6	21.2
	Soybeans, Group VI[b]	bu.	13.6	12.6
19.	Soybeans, Group V[b]	bu.	15.6	
	Oats[b]	bu.	34.7	
	Grain Sorghum[b]	bu.	25.2	
20.	Soybeans, Group VI[b]	bu.	16.6	
	Oats[b]	bu.	32.0	
	Grain Sorghum[b]	bu.	25.2	
21.	Soybeans, Group V[b]	bu.	15.6	
	Oats[b]	bu.	34.7	
	Soybeans, Group VI[b]	bu.	13.6	

TABLE V (CONTINUED)

Enterprise	Unit	Production	
		Mixed Soil	Clay Soil
22. Soybeans, Group VI[b]	bu.	16.6	
Oats[b]	bu.	32.0	
Soybeans, Group VI[b]	bu.	13.6	
23. Soybeans, Group V[b]	bu.	15.6	14.2
Wheat[b]	bu.	23.9	19.8
Grain Sorghum[b]	bu.	25.2	23.4
24. Soybeans, Group VI[b]	bu.	16.6	15.8
Wheat[b]	bu.	21.9	18.0
Grain Sorghum[b]	bu.	25.2	23.4
25. Soybeans, Group V[b]	bu.	15.6	14.2
Wheat[b]	bu.	23.9	19.8
Soybeans, Group VI[b]	bu.	13.6	12.6
26. Soybeans, Group VI[b]	bu.	16.6	15.8
Wheat[b]	bu.	21.9	18.0
Soybeans, Group VI[b]	bu.	13.6	12.6

[a]Group IV: Very early season maturing varieties; Group V: Early season maturing varieties; Group VI: Midseason maturing varieties; Group VII: Late season maturing varieties.

[b]One-half acre each.

Yields for doublecrop rotations are adjusted for estimated date of planting. Planting dates for doublecrop activities often deviate from the optimum and the realized yield may deviate from the yields normally expected for singlecrop operations. Therefore, weather data are used to estimate when one crop can be harvested and planting accomplished for the following crop for each year of the period. Soil moisture is also a factor in determining when doublecrop soybeans can be planted. Estimates for the yield adjustments are based on experimental data (Table IV). Soybeans and winter wheat, which are often used in doublecrop rotations, appear favored for these activities because they do not demonstrate a substantial reduction in yields as planting date is delayed past the optimum. Planting date is much more critical for cotton.

By the procedure described, estimates of annual yields are derived for single and doublecrop activities for both mixed and clay soils.[2] To be meaningful, doublecrop activities must fit into a rotation. The winter crops that have a doublecrop potential in the area are small grains. Oat and wheat yields are available, thus, they are considered possible alternatives. To bring these crops into a doublecrop activity it is necessary to associate them with the preceding and succeeding crops; thereby, combining three crop activities into one rotation activity. The rotation for each year consists of one-half acre of each crop. The crop preceding the winter small grain is grown in the normal manner of a single crop activity except a winter crop is planted following its harvest in the fall.

Machinery and Labor Requirements

Machinery costs, which include both fixed and variable costs, and labor requirements are based on six-row equipment.[3] Machinery and equipment are not considered a limiting factor in the analysis. Crop production practices with respect to particular operations are those typically performed by farmers or deemed acceptable for the individual activities. Total labor requirements are summarized for each activity and distributed on a monthly basis.[4] In the linear and quadratic programming analysis, annual labor requirements are grouped into four periods. The December through April period includes primarily post harvest and preplant operations; the May through June period includes most of the spring planting operations; the July through September period includes most of those operations between planting and harvesting as well as some of the harvesting operations; and the October through November period primarily includes harvesting and the planting of winter small grains.

The number of days suitable for field work exhibits considerable variability over the 20 year period. The variability exists even when viewed on a weekly, monthly or annual basis. It is deemed necessary in the analysis to use a constant weather or work permissibility factor. Therefore, average weather conditions are used with the average number of days and hours suitable for field work calculated on a monthly basis (Table VI).

Cost Data

Production costs for individual activities are based on 1969 prices paid by Arkansas farmers. All costs except interest on land investment

TABLE VI

AVERAGE NUMBER OF DAYS AND HOURS AVAILABLE FOR FIELD WORK FOR THE 20 YEAR PERIOD, 1950-69

Month	Number of Days	Number of Hours[a]
January	13.3	80
February	11.4	69
March	11.8	95
April	12.5	100
May	14.0	140
June	16.7	167
July	17.1	137
August	18.8	156
September	18.0	144
October	20.2	162
November	14.0	112
December	13.7	83

[a]Number of days includes all days without allowance for weekends and holidays. Number of hours are computed on the basis of 6 hours per day for December through February, 10 hours per day for May and June and 8 hours per day for all other days.

and land real estate taxes are included in the crop budgets (Appendix, Tables XXXVII through LXXVI). Labor is charged at $1.50 per hour in the activity budgets because it is necessary to derive a net return per acre on an annual basis for quadratic programming analysis.

Cost of production per acre of activity is estimated for 1969 prices. It is necessary, therefore, to compute costs on an annual basis for each of the 20 years, 1950-69. An index of the cost of production per acre is derived for cotton. These index data are based on the U.S. Department of Agriculture estimates of cost of cotton production per unit for large Mississippi River Delta area farms (Table VII). For the analysis that follows, the assumption is asserted that the index of the cost per acre for the production of cotton is the same for other crops. With this assumption, the 1969 input cost data are estimated on an annual basis for each of the 20 years for each activity.

Product Prices

Annual net returns also entail the derivation of product prices for each of the 20 years. Product prices used are those received by Arkansas farmers for each of the crops (Table VIII). These prices are adjusted according to the index of wholesale price of farm products with 1969 equal to 100 (Tables IX and X). The adjusted prices are tested for trend using linear least squares regression (Table XI). All commodities show trend influence at the 10 percent level except alfalfa and cottonseed. Trend is removed from the prices of those commodities showing trend at the 10 percent level of significance. Trend adjustments are based on the estimated price computed at the midpoint of the last half of the period (Table XII).

TABLE VII

INDEX OF COST OF PRODUCTION PER ACRE FOR COTTON IN MISSISSIPPI RIVER DELTA AREA OF ARKANSAS

Year	Index of Cost Per Unit of Product[a]	Wholesale Price of all Commodities[b]	Yield of Lint in Pounds Per Acre[c]	Index of Cost Per Unit of Product 1969=100	Index of Cost of Production Per Acre[d]
1950	100	81.8	370	82.0	62.2
1951	118	81.9	288	96.7	57.1
1952	107	88.6	335	87.7	60.2
1953	93	87.4	350	76.2	54.6
1954	100	87.5	427	82.0	71.8
1955	82	87.8	601	67.2	82.8
1956	91	90.7	535	74.6	81.8
1957	111	93.3	454	91.0	84.7
1958	105	94.6	412	86.1	72.7
1959	84	94.8	554	68.9	78.2
1960	90	94.9	471	73.8	73.9
1961	88	94.5	501	72.1	74.0
1962	88	94.8	514	72.1	75.9
1963	84	94.5	576	68.9	81.3
1964	84	94.7	642	68.9	90.6
1965	92	96.6	541	75.4	83.6
1966	109	99.8	424	89.3	77.6
1967	126	100.0	340	103.3	72.0
1968	114[e]	102.5	475	93.4	90.9
1969	122[e]	106.5	488	100.0	100.0

[a]Large scale farms 1957-59 = 100.

[b]1967 = 100.

[c]Arkansas Crop Reporting District 6.

[d]1969 = 100.

[e]Estimated with estimating equation of $y = -1150.4900 + 13.2652 x_1 + 2.0441 x_2 - 0.0219 x_1 x_2$ where x_1 = wholesale cost of all commodities and x_2 = pounds of lint per acre for Crop Reporting District 6. $R^2 = 0.9900$. Data for estimating equation included 1960-1967.

Source: (1) <u>Statistics on Cotton and Related Data, 1930-67</u>, Statistical Bulletin No. 417, U.S. Department of Agriculture, Economic Research Service, Washington D.C., p. 205, and <u>Supplement for 1968 to Statistics on Cotton and Related Data 1930-67, Supplement for 1968 to Statistical Bulletin No. 417</u>, U.S. Department of Agriculture, Economic Research Service, Washington, D.C., p. 88; (2) <u>Agricultural</u>

TABLE VII (CONTINUED)

Statistics for Arkansas, Crop Reporting Service, Statistical Reporting Service, U.S. Department of Agriculture, Little Rock, Arkansas, in Cooperation with Agricultural Experiment Station, University of Arkansas, Fayetteville, Arkansas; and (3) Federal Reserve Bulletin, Board of Governors, The Federal Reserve System, Washington, D.C., September 1958, p. 112; September 1961, p. 1100; June 1971, p. A66.

TABLE VIII

PRICE OF FARM CROPS IN ARKANSAS, 1950-69

Year	Alfalfa Hay	Corn	Cotton Lint	Cotton Seed	Grain Sorghum	Oats	Soybeans	Wheat
	($/ton)	($/bu.)	(¢/lb.)	($/ton)	($/bu.)	($/bu.)	($/bu.)	($/bu.)
1950	24.80	1.42	39.76	79.60	1.19	.94	2.27	1.96
1951	30.00	1.70	38.06	67.90	1.46	1.03	2.63	2.09
1952	40.20	1.73	34.78	69.50	1.47	1.00	2.67	2.09
1953	32.30	1.48	32.70	51.70	1.37	.87	2.48	2.18
1954	30.10	1.48	33.56	60.00	1.25	.80	2.47	2.11
1955	28.00	1.13	32.80	54.10	1.00	.70	2.03	1.91
1956	23.10	1.23	32.18	50.30	1.12	.65	2.17	1.88
1957	25.00	1.19	31.16	50.60	1.00	.68	2.07	1.81
1958	25.50	1.15	34.70	45.00	1.01	.68	1.94	1.76
1959	24.00	1.10	32.83	38.00	.99	.69	1.98	1.70
1960	26.00	1.10	30.89	41.10	.94	.70	2.13	1.74
1961	26.00	1.16	34.00	51.40	1.01	.70	2.29	1.72
1962	27.00	1.19	31.80	47.00	1.07	.73	2.34	1.99
1963	30.00	1.25	32.78	50.30	1.10	.81	2.60	1.79
1964	30.00	1.24	30.17	47.10	1.13	.71	2.65	1.28
1965	27.00	1.27	28.48	47.00	1.11	.76	2.56	1.28
1966	26.50	1.35	21.74	65.60	1.18	.74	2.80	1.55
1967	27.50	1.25	28.95	55.60	1.08	.75	2.49	1.41
1968	27.00	1.20	24.10	50.00	1.00	.76	2.45	1.16
1969	28.00	1.26	21.50	42.10	1.04	.70	2.40	1.16

Source: Agricultural Statistics for Arkansas, Crop Reporting Service, Statistical Reporting Service, U.S. Department of Agriculture, Little Rock, Arkansas, in cooperation with Agricultural Experiment Station, University of Arkansas, Fayetteville, Arkansas; Agricultural Prices, U.S.D.A., Statistical Reporting Service, Crop Reporting Board, Washington, D.C.

TABLE IX

INDEX OF WHOLESALE PRICE OF FARM PRODUCTS, 1950-69

Year	Index[a]
1950	98.2
1951	114.2
1952	107.7
1953	97.6
1954	96.2
1955	90.2
1956	89.0
1957	91.5
1958	95.5
1959	89.7
1960	89.3
1961	88.5
1962	90.1
1963	88.2
1964	86.9
1965	90.7
1966	97.3
1967	91.9
1968	94.2
1969	100.0

[a]1969 = 100.

Source: Federal Reserve Bulletin, Board of Governors, The Federal Reserve System, Washington, D.C., 1950-52, September 1958, p. 1120; 1953-60, September 1961, p. 1100; and 1960-69, June 1971, p. A66.

TABLE X

PRICE OF FARM CROPS IN ARKANSAS ADJUSTED TO 1969 PRICE LEVEL,[a] 1950-69

Year	Alfalfa Hay	Corn	Cotton Lint	Cotton Seed	Grain Sorghum	Oats	Soybeans	Wheat
	($/ton)	($/bu.)	(¢/lb.)	($/ton)	($/bu.)	($/bu.)	($/bu.)	($/bu.)
1950	25.25	1.45	40.49	8.06	1.21	0.96	2.31	2.00
1951	26.27	1.49	33.33	59.46	1.28	0.90	2.30	1.83
1952	37.33	1.61	32.29	64.53	1.36	0.93	2.48	1.94
1953	33.09	1.52	33.50	52.97	1.40	0.89	2.54	2.23
1954	31.29	1.54	34.89	62.37	1.30	0.83	2.57	2.19
1955	31.04	1.25	36.36	47.78	1.11	0.78	2.25	2.12
1956	25.96	1.38	36.16	56.52	1.26	0.73	2.44	2.11
1957	27.32	1.30	34.05	55.30	1.09	0.74	2.26	1.98
1958	26.70	1.20	36.34	47.12	1.06	0.71	2.03	1.84
1959	26.76	1.23	36.60	42.36	1.10	0.77	2.21	1.90
1960	29.12	1.23	34.59	46.02	1.05	0.78	2.39	1.95
1961	29.38	1.31	38.42	58.08	1.14	0.79	2.59	1.94
1962	29.97	1.32	35.29	52.16	1.19	0.81	2.60	2.21
1963	34.01	1.42	37.17	57.03	1.25	0.92	2.95	2.03
1964	34.52	1.43	34.72	54.20	1.30	0.82	3.05	1.47
1965	29.77	1.40	31.40	51.82	1.22	0.84	2.82	1.41
1966	27.24	1.39	22.34	67.42	1.21	0.76	2.88	1.59
1967	29.92	1.36	31.50	60.50	1.18	0.82	2.71	1.53
1968	28.66	1.27	25.58	53.08	1.06	0.81	2.60	1.23
1969	28.00	1.26	21.50	42.10	1.04	0.70	2.40	1.16

[a]Adjustment is based on the index of prices received by Arkansas farmers.

TABLE XI

REGRESSION ANALYSIS OF COMMODITY PRICES FOR 20 YEAR PERIOD, 1950-69, ADJUSTED TO 1969 PRICE LEVEL[a]

Item	T-Test	F-Test	b_0[b]	b_1	Mean Price	Standard Deviation	Coefficient of Determination
Alfalfa	.0016	.0000	29.68	.00021	29.58	1.276	.0000
Corn	-2.2140	4.9020	1.46	-.00902	1.36	.041	.2140
Cotton Lint	-3.3001	10.8904	38.74	-.51514	33.33	1.561	.3770
Cottonseed	-1.6778	2.8149	61.56	-.56779	55.59	3.384	.1352
Grain Sorghum	-2.0989	4.4054	1.27	-.00804	1.19	.038	.1966
Oats	-2.1075	4.4417	.87	-.00557	.81	.026	.1979
Soybeans	2.6508	7.0269	2.27	.02388	2.52	.090	.2808
Wheat	-4.7119	22.2024	2.26	-.04069	1.83	.086	.5523

[a] $\hat{Y} = b_0 + b_1X$. $\hat{Y}$ is the index of wholesale price for farm products and X is the year.

[b] The year enumeration begins with 1950 equal to 1.

TABLE XII

PRICE OF FARM PRODUCTS ADJUSTED FOR TREND AND PRICE LEVEL, 1950-69[a]

Year	Alfalfa	Corn	Cotton Lint	Cotton-Seed	Grain Sorghum	Oats	Soybeans	Wheat
	($/ton)	($/bu.)	(¢/lb.)	($/ton)	($/bu.)	($/bu.)	($/bu.)	($/bu.)
1950	25.25	1.33	33.02	81.06	1.09	.88	2.66	1.41
1951	26.27	1.38	26.38	59.46	1.17	.82	2.62	1.28
1952	37.33	1.51	25.85	64.53	1.26	.86	2.78	1.43
1953	33.09	1.43	27.58	52.97	1.31	.83	2.81	1.76
1954	31.29	1.45	29.48	52.37	1.22	.77	2.82	1.76
1955	31.04	1.17	31.47	47.78	1.03	.73	2.48	1.73
1956	25.96	1.31	31.78	56.52	1.19	.68	2.64	1.76
1957	27.32	1.24	30.19	55.30	1.03	.70	2.44	1.67
1958	26.70	1.14	32.99	47.12	1.01	.67	2.19	1.58
1959	26.76	1.18	33.77	42.36	1.06	.74	2.34	1.68
1960	29.12	1.19	32.27	46.02	1.01	.75	2.50	1.77
1961	29.38	1.28	36.62	58.08	1.11	.77	2.67	1.80
1962	29.97	1.30	34.00	52.16	1.17	.80	2.66	2.11
1963	34.01	1.41	36.40	57.03	1.24	.91	2.99	1.97
1964	34.52	1.43	34.46	54.20	1.30	.82	3.06	1.45
1965	29.77	1.40	31.66	51.82	1.22	.84	2.81	1.43
1966	27.24	1.40	23.11	67.42	1.22	.77	2.84	1.65
1967	29.92	1.38	32.79	60.50	1.20	.83	2.65	1.63
1968	28.66	1.30	27.38	53.08	1.09	.83	2.52	1.37
1969	28.00	1.30	23.82	42.10	1.08	.73	2.29	1.34

[a]Trend adjustment is based on the midpoint of the last half of the period. Trend adjustment is made for those commodities that showed significant trend values at the 10 percent level (all commodities except alfalfa and cottonseed). Price level is adjusted to base of 1969.

Net Return Data

At this point it is possible to estimate net returns per acre on an annual basis for each enterprise. However, one step remains. That is the computation of Government program payments for participation in the cotton program. Two budgets are necessary for cotton on each of the two soils -- mixed soil and clay soil. Cotton produced under terms of the Government program is designated allotment cotton. Cotton grown outside the Government program is designated free market cotton. The provisions of the 1972 farm program requires participating farmers to idle an acreage equivalent to 20 percent of the farm's base acreage allotment. The idle land is called set-aside. For each acre of allotment cotton grown, 1.2 acres of cropland are required. A farmer who meets the set-aside requirements can plant all the cotton he wishes and receive full Government support payment on his cotton acreage base. Cotton grown outside the allotment must be sold at market price without the benefit of support payments.

Farm payment yields for each of the 20 years are based on the method specified for computing farm payment yield for 1972. The 1972 farm payment yield is calculated by adding the 1970 projected yield, the 1971 payment yield and the 1971 actual or adjusted yield and dividing by three. Payment yields for the 20 year series are calculated by averaging the projected yield (average yield) the preceding payment yield and the preceding actual yield. If for a given year the actual yield is less than 90 percent of the payment yield, the county Agricultural Stabilization and Conservation Service Committee can adjust it upward to 90 percent of the payment yield if it is determined actual yield was reduced because of bad weather. Such adjustments are made for 1968 and 1969 because of adverse weather for the 1967 and 1968 crops (Table XIII). Cotton payments per acre are figured on the estimated farm payment yields at the rate of 15 cents per pound of lint. Thus, net returns are estimated for cotton for each of the 20 years based on the current 1972 farm program. This estimate of net returns is judged a better measure of future cotton program payments than the actual programs in force over the historical period.

Net return data are the results of multiplying yield per acre times price per unit less operating cost per acre.[5] The resulting net return series approximate the random variable requirements necessary to estimate the variance and covariance of net returns for the crop alternatives.

All 42 single and doublecrop activities, 27 for mixed soil and 15 for clay soil, are considered possible alternatives for the owner operator situation. All show positive expected returns. Not all of the 42 activities are feasible for the tenant situation under the assumptions imposed. After deducting the appropriate share rent the mixed soil singlecrop activities alfalfa, grain sorghum, and soybean, groups V and VII show negative expected returns. The clay soil singlecrop activities alfalfa, grain sorghum and soybean, groups IV, V and VII also show negative expected returns.

The feasible crop activities (processes) are designated P_1 through P_{42} for identification and programming purposes (Tables XIV, XV, XVII and XVIII). All activities P_1 through P_{27} are for mixed soil and P_{28} through P_{42} are for clay soil. Those activities which are not feasible (P_1, P_5, P_8, P_{10}, P_{28}, P_{31}, P_{32}, P_{33}, and P_{35}) are omitted for the tenant situation. Tables XVI and XIX show the coefficient of

TABLE XIII

GOVERNMENT PROGRAM PAYMENTS PER ACRE FOR COTTON
BASED ON THE 1972 FARM PROGRAM

Year	Farm Payment Yield		Cotton Payment Per Acre[a]	
	Mixed Soil	Clay Soil	Mixed Soil	Clay Soil
	(lb.)	(lb.)	(dollars)	(dollars)
1950	676[b]	618[b]	101.40	92.70
1951	631	538	94.65	80.70
1952	643	590	96.45	88.50
1953	651	661	97.65	99.15
1954	693	629	103.95	94.35
1955	594	613	89.10	91.15
1956	734	511	101.10	76.65
1957	692	572	103.80	85.80
1958	630	539	94.50	80.85
1959	708	599	106.20	89.85
1960	781	799	117.15	119.85
1961	699	646	104.85	96.90
1962	739	606	110.85	90.90
1963	675	674	101.25	101.10
1964	661	639	99.15	95.85
1965	730	718	109.50	107.70
1966	719	731	107.85	109.65
1967	806	710	120.90	106.50
1968	736[c]	656[c]	110.40	98.40
1969	691[c]	621[c]	103.65	93.15

[a]Computed at the rate of 15 cents per pound.

[b]Average or projected yield used to start the series. Following payment yields are the average of the projected yield, the preceding payment yield and the preceding actual yield.

[c]Actual yield is adjusted to 90 percent of the payment yield because of adverse weather for the 1967 and 1968 crops.

TABLE XIV

RETURNS TO LAND AND MANAGEMENT PER ACRE BY CROP ENTERPRISE FOR MIXED SOIL, NORTH MISSISSIPPI RIVER DELTA AREA OF ARKANSAS, 1950-69

Year	P_1 Alfalfa	P_2 Corn	P_3 Allotment Cotton	P_4 Free Market Cotton	P_5 Grain Sorghum	P_6 Oats	P_7 Soybeans Group IV	P_8 Soybeans Group V	P_9 Soybeans Group VI	P_{10} Soybeans Group VII	P_{11} Wheat	P_{12} Corn-Oats-Grain Sorghum	P_{13} Corn-Oats-Soybeans, Group VI	P_{14} Corn-Wheat-Grain Sorghum	P_{15} Corn-Wheat-Soybeans, Group VI
	Dollars														
1950	34.84	27.78	126.83	25.43		-4.77	10.72	49.52	13.08	16.89	14.23		22.45		32.85
1951	-60.39	27.10	78.07	-16.58		-11.27	-14.52	2.47	-12.20	-8.28	-2.24		10.18		16.18
1952	-58.90	-22.08	93.55	-2.90		38.93	-11.33	-.79	2.27	-38.20	10.71		5.44		-5.50
1953	-79.09	36.07	117.12	19.47		33.54	15.68	-31.01	4.40	5.04	45.87		50.35		53.86
1954	-22.19	5.83	78.57	-25.38		38.05	19.21	38.09	54.44	28.11	58.25		50.35		61.68
1955	137.80	76.94	274.64	185.54		15.96	47.41	35.47	61.51	33.18	35.78		79.72		81.85
1956	74.34	81.51	196.80	95.70		26.95	28.38	3.01	30.20	-18.57	110.85		70.62		115.05
1957	64.76	90.63	142.50	38.70		24.76	45.50	41.81	64.51	62.77	49.00		90.13		103.92
1958	3.53	24.95	230.21	135.71	-5.81	4.58	18.40	.42	-8.13	4.75	78.35	15.18	18.64	83.62	56.87
1959	94.85	104.19	309.48	203.28	-8.04	24.38	21.62	14.10	33.75	26.63	40.88	61.29	84.32	98.42	95.08
1960	57.82	93.11	184.98	67.83	16.88	24.48	26.41	27.63	20.38	1.79	66.80	64.43	72.87	135.32	96.68
1961	33.87	99.87	291.02	186.17	-20.99	33.31	11.98	.47	-16.35	50.49	96.88	58.58	65.16	119.06	99.75
1962	47.82	72.13	185.62	74.77	-16.64	35.43	28.60	15.80	45.60	44.70	59.15	44.12	79.65	75.48	92.54
1963	72.89	54.57	212.64	111.39	14.05	41.43	40.03	38.81	47.18	13.80	52.47	51.17	69.70	99.03	78.36
1964	98.08	51.37	299.60	200.45	62.39	16.80	53.19	48.89	33.89	42.89	42.38	59.29	53.93	136.25	68.40
1965	101.31	11.74	236.03	126.53	35.84	44.97	60.33	49.34	54.40	54.70	26.94	41.47	54.04	84.31	48.22
1966	85.31	57.37	247.42	139.57	39.45	20.34	24.29	57.50	49.54	61.89	42.87	56.68	64.93	126.66	78.37
1967	16.48	47.88	-10.62	-131.52	3.21	23.76	27.05	43.71	30.73	27.02	20.22	42.10	51.24	82.25	51.66
1968	-22.30	21.90	80.13	-30.27	31.06	33.69	14.11	26.93	28.70	17.31	35.17	45.18	43.05	100.42	46.53
1969	106.35	9.80	226.12	122.47	-26.57	17.52	12.35	27.21	41.64	29.69	47.23	3.72	35.00	30.69	51.57
Average	39.36	48.63	180.04	76.32	10.40	24.14	23.97	24.47	28.98	22.83	46.59	45.27	53.36	97.63	66.20
Standard Deviation	60.47	34.67	86.24	88.44	26.48	14.48	18.59	22.51	24.11	26.11	26.95	17.84	84.24	28.59	30.07
Coefficient of Variation (percent)	153.64	71.29	47.90	115.88	254.61	60.00	77.55	92.01	83.21	114.37	57.84	39.41	45.43	29.28	45.43

TABLE XIV (CONTINUED)

Year	P_{16} Grain Sorghum-Oats-Grain Sorghum	P_{17} Grain Sorghum-Oats-Soybeans, Group VI	P_{18} Grain Sorghum-Wheat-Grain Sorghum	P_{19} Grain Sorghum-Wheat-Soybeans, Group VI	P_{20} Soybeans, Group V-Oats-Grain Sorghum	P_{21} Soybeans, Group V-Oats-Soybeans, Group VI	P_{22} Soybeans, Group V-Wheat-Grain Sorghum	P_{23} Soybeans, Group V-Wheat-Soybeans, Group VI	P_{24} Soybeans, Group VI-Oats-Grain Sorghum	P_{25} Soybeans, Group VI-Oats-Soybeans, Group VI	P_{26} Soybeans, Group VI-Wheat-Grain Sorghum	P_{27} Soybeans, Group VI-Wheat-Soybeans, Group VI
	Dollars											
1950						32.70		41.71		12.46		21.95
1951						-2.66		3.00		-11.18		-5.99
1952						14.47		4.04		11.38		2.44
1953						8.92		17.71		24.34		32.16
1954						63.11		75.40		68.30		79.31
1955						57.51		68.63		68.72		78.84
1956						30.05		71.35		41.18		78.58
1957						64.04		77.45		72.61		84.60
1958	-.75	3.68	37.51	40.95	2.00	5.46	38.42	41.88	-4.64	-1.26	27.10	30.62
1959	4.71	27.72	15.49	38.51	15.00	30.04	24.80	47.82	23.11	46.06	32.23	55.32
1960	25.81	34.23	59.63	58.07	29.84	38.29	51.33	59.77	24.98	33.34	45.12	53.63
1961	-2.29	4.28	32.33	38.89	6.77	13.37	38.62	45.20	-4.21	2.29	24.53	31.18
1962	-.63	34.89	12.29	47.81	12.62	48.16	26.43	61.96	24.23	59.68	36.22	71.81
1963	30.38	48.90	39.07	57.58	41.02	59.56	48.58	67.11	42.99	61.45	49.96	68.55
1964	64.33	58.95	78.82	73.45	57.06	51.71	70.79	65.43	51.13	42.70	60.78	55.47
1965	53.01	65.57	47.21	59.78	59.00	71.58	53.26	65.83	58.82	71.32	53.17	65.80
1966	47.23	55.47	60.69	68.93	55.92	64.19	68.53	76.78	50.16	58.33	61.68	70.00
1967	19.31	28.44	19.76	28.89	36.74	45.90	37.13	46.27	30.45	39.51	30.71	39.92
1968	49.41	47.27	52.91	50.77	46.59	44.46	49.55	47.41	44.99	42.79	47.49	45.42
1969	-14.78	16.49	1.81	33.08	10.82	42.11	25.85	57.13	17.53	48.75	31.92	63.25
Average	22.98	35.49	37.29	49.73	31.12	39.15	44.44	52.09	29.96	39.64	41.74	51.14
Standard Deviation	24.99	19.65	21.33	13.54	20.19	21.48	14.78	21.74	19.81	25.09	12.42	25.25
Coefficient of Variation (percent)	108.74	55.36	57.21	27.23	64.87	54.86	33.27	41.73	66.12	63.30	29.77	49.37

TABLE XV

RETURNS TO LAND AND MANAGEMENT PER ACRE BY CROP ENTERPRISE FOR CLAY SOIL, NORTH MISSISSIPPI RIVER DELTA AREA OF ARKANSAS, 1950-69

Year	P_{28} Alfalfa	P_{29} Allot-ment Cotton	P_{30} Free Market Cotton	P_{31} Grain Sorghum	P_{32} Soybeans Group IV	P_{33} Soybeans Group V	P_{34} Soybeans Group VI	P_{35} Soybeans Group VII	P_{36} Wheat	P_{37} Grain Sorghum-Wheat-Grain Sorghum	P_{38} Grain Sorghum-Wheat-Soybeans, Group VI	P_{39} Soybeans, Group V-Wheat-Grain Sorghum	P_{40} Soybeans, Group V-Wheat-Soybeans, Group VI	P_{41} Soybeans, Group VI-Wheat-Grain Sorghum	P_{42} Soybeans, Group VI-Wheat-Soybeans, Group VI
	Dollars														
1950	-1.79	66.05	-26.65		22.29	30.36	-12.84	23.39	21.82				23.73		.51
1951	-77.55	80.28	-.42		-40.11	-10.11	-1.58	-.75	-2.11				-1.95		1.01
1952	-72.75	147.96	59.46		5.43	14.99	35.72	-35.40	26.59				27.07		26.23
1953	-90.87	91.97	-7.18		18.38	13.52	31.37	12.61	30.61				41.92		48.49
1954	-40.68	146.47	52.12		-2.58	1.85	40.67	42.40	43.64				42.46		58.53
1955	82.09	64.71	-26.44		36.34	27.11	36.95	22.36	4.23				36.86		40.28
1956	34.34	156.76	80.11		-2.16	24.54	39.77	-.07	70.47				65.57		68.41
1957	27.84	104.03	18.23		28.24	45.04	53.98	35.72	36.07				67.26		68.00
1958	-21.20	165.74	84.89	-23.13	2.32	2.33	7.93	11.69	8.43	-9.43	4.93	.65	15.01	.47	14.83
1959	48.67	389.29	299.44	8.16	-3.43	31.69	37.92	30.94	32.63	29.41	44.63	37.88	53.10	38.76	53.99
1960	19.80	158.53	38.68	13.84	6.35	17.63	23.29	18.58	44.30	33.03	43.20	33.60	43.76	34.49	44.66
1961	1.86	177.51	80.61	28.59	12.93	8.98	2.75	-.42	54.01	59.78	51.07	45.14	36.43	38.27	29.56
1962	12.90	251.72	160.82	-45.49	-2.05	3.45	47.78	40.64	40.62	-16.54	25.04	4.04	45.62	22.61	64.19
1963	33.21	223.09	121.99	14.96	17.02	34.30	42.29	22.29	51.13	42.31	55.49	47.36	60.54	48.81	61.99
1964	54.26	324.05	228.20	37.36	43.95	52.35	48.29	43.74	49.04	62.25	70.66	66.53	74.94	61.81	70.22
1965	55.01	284.37	176.67	-17.42	40.85	25.84	38.69	43.50	-1.05	-11.27	13.10	8.49	32.86	13.40	37.77
1966	41.49	192.64	82.99	5.89	9.78	3.03	20.83	30.25	54.74	39.07	46.60	33.80	41.33	39.61	47.14
1967	-11.83	-15.44	-121.94	11.86	25.46	42.77	55.40	24.17	34.45	39.04	49.14	48.42	58.52	54.81	64.91
1968	-35.75	47.70	-50.70	3.40	-3.49	16.78	10.91	30.09	22.30	22.62	23.57	26.60	27.55	21.38	22.34
1969	62.11	237.80	144.65	22.88	18.80	28.52	21.81	23.90	32.73	42.94	42.59	41.99	41.64	37.72	37.37
Average	6.06	164.76	69.78	5.08	11.67	20.75	29.10	20.98	32.73	27.77	39.17	32.88	41.71	34.34	43.02
Standard Deviation	48.29	97.49	97.78	22.38	18.82	16.00	18.79	18.84	19.14	25.56	18.04	19.03	18.17	16.70	21.25
Coefficient of Variation (percent)	796.80	59.17	140.13	440.50	161.27	77.12	64.56	89.80	58.46	92.03	46.07	57.89	43.55	48.64	49.39

TABLE XVI

CORRELATION MATRIX OF NET RETURNS FOR CROP ACTIVITIES ON OWNER-OPERATED FARMS, 1950-69[a]

Activity	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{19}	P_{20}	P_{21}	P_{22}	P_{23}	P_{24}	P_{25}	P_{26}	P_{27}	P_{28}	P_{29}	P_{30}	P_{31}	P_{32}	P_{33}	P_{34}	P_{35}	P_{36}	P_{37}	P_{38}	P_{39}	P_{40}	P_{41}	P_{42}
P_1	1.000	.490	.717	.690	.110	.032	.718	.589	.630	.549	.240	.065	.629	-.026	.584	.077	.254	.005	.239	.163	.618	.101	.748	.246	.593	.262	.688	.999	.490	.471	.172	.543	.527	.293	.484	.192	.143	.268	.201	.500	.243	.392
P_2		1.000	.474	.444	-.202	.000	.370	.014	.149	.353	.503	.679	.824	.506	.878	-.207	-.209	-.065	-.018	-.269	.098	-.129	.416	-.284	.183	-.184	.407	.480	.193	.184	.170	.060	.235	.187	.195	.455	.288	.407	.242	.485	.311	.433
P_3			1.000	.996	.019	.026	.444	.083	.147	.386	.425	.176	.435	.246	.521	-.064	-.025	.175	.356	-.156	.139	.122	.401	-.132	.176	.133	.359	.711	.740	.738	.174	.309	.152	-.004	.196	.169	.148	.182	.077	.237	-.016	.140
P_4				1.000	.018	-.004	.419	.051	.123	.351	.410	.147	.597	.236	.488	-.070	-.038	.184	.361	-.169	.105	.126	.366	-.147	.149	.131	.332	.683	.720	.724	.176	.297	.135	-.024	.159	.138	.147	.175	.074	.205	-.029	.119
P_5					1.000	.058	.328	.603	.328	.143	-.359	.436	-.005	.610	-.173	.980	.842	.910	.850	.915	.514	.922	.263	.813	.307	.906	.152	.115	.051	.005	.212	.412	.333	.204	.364	.009	.152	.212	.242	.250	.281	.179
P_6						1.000	.328	-.028	.364	.140	.280	.277	.403	.012	.232	.190	.345	-.027	.118	.251	.415	.001	.284	.324	.524	.164	.418	.054	.256	.217	-.122	.251	.110	.575	.108	.362	-.110	-.024	-.065	.430	.002	.544
P_7							1.000	.551	.711	.606	.222	.215	.676	.186	.548	.533	.604	.386	.506	.542	.752	.422	.772	.557	.740	.515	.755	.725	.319	.287	-.046	.738	.600	.595	.683	.118	-.112	.090	.052	.640	.135	.618
P_8								1.000	.678	.582	-.264	.175	.267	.161	.094	.613	.680	.392	.482	.731	.832	.552	.659	.721	.592	.663	.474	.595	.074	.029	.185	.484	.460	.202	.640	.052	.175	.283	.281	.308	.372	.215
P_9									1.000	.548	-.028	.036	.628	-.186	.384	.364	.675	.012	.338	.528	.933	.166	.800	.711	.979	.544	.876	.642	.201	.178	-.140	.455	.435	.650	.604	.143	-.129	.095	.027	.560	.199	.634
P_{10}										1.000	.070	.143	.560	.056	.439	.170	.253	.092	.204	.237	.646	.186	.638	.239	.564	.223	.556	.556	.265	.230	-.012	.489	.245	.212	.756	.086	.053	.119	.044	.328	.118	.322
P_{11}											1.000	.011	.455	.156	.756	-.396	-.506	-.053	-.094	-.512	-.035	-.144	.460	-.393	.066	-.346	.448	.255	.226	.238	.004	-.020	-.083	.082	-.005	.627	.049	-.043	-.113	.375	-.199	.378
P_{12}												1.000	.587	.890	.421	.473	.410	.480	.490	.397	.177	.434	.128	.329	.108	.403	.055	.047	.168	.117	.268	-.007	.129	.182	.074	.473	.348	.897	.366	.388	.468	.387
P_{13}													1.000	.303	.899	.037	.207	-.048	.166	.068	.568	-.032	.730	.154	.691	.127	.798	.632	.297	.271	.007	.298	.356	.553	.507	.465	.104	.312	.142	.690	.284	.730
P_{14}														1.000	.318	.580	.334	.784	.652	.421	.027	.706	.117	.234	-.143	.492	-.070	-.038	.038	-.007	.344	.048	.012	-.073	-.033	.418	.306	.417	.335	.222	.308	.132
P_{15}															1.000	-.185	-.136	-.051	.066	-.226	.331	-.084	.713	-.212	.444	-.087	.725	.588	.300	.892	.044	.132	.221	.342	.372	.598	.138	.241	.085	.635	.142	.631
P_{16}																1.000	.884	.869	.812	.954	.568	.886	.255	.862	.364	.895	.142	.084	-.014	-.063	.186	.404	.330	.218	.368	-.011	.129	.183	.222	.234	.219	.174
P_{17}																	1.000	.609	.789	.930	.779	.692	.364	.981	.671	.924	.363	.254	.216	.164	-.004	.378	.333	.432	.522	.022	-.030	.160	.118	.326	.224	.348
P_{18}																		1.000	.856	.721	.256	.955	.201	.537	.016	.782	-.001	.010	.004	-.034	.272	.304	.112	-.077	.153	.109	.228	.201	.218	.108	.134	.002
P_{19}																			1.000	.735	.497	.876	.378	.688	.338	.928	.270	.234	.348	.306	.088	.285	.057	.111	.324	.204	.085	.220	.116	.220	.143	.197
P_{20}																				1.000	.712	.821	.308	.945	.516	.901	.228	.166	-.048	-.109	.203	.466	.395	.326	.401	.019	.141	.242	.272	.299	.318	.362
P_{21}																					1.000	.418	.835	.799	.926	.679	.807	.633	.181	.135	-.028	.553	.442	.548	.724	.188	-.023	.157	.104	.332	.248	.595
P_{22}																						1.000	.289	.646	.153	.866	.089	.101	-.033	-.085	.319	.400	.154	.008	.183	.187	.297	.294	.293	.181	.254	.093
P_{23}																							1.000	.341	.804	.400	.937	.764	.277	.251	.005	.440	.361	.436	.698	.441	.032	.140	.057	.626	.131	.621
P_{24}																								1.000	.694	.888	.352	.248	.126	.074	.062	.385	.142	.450	.518	-.020	.028	.188	.186	.342	.282	.398
P_{25}																									1.000	.522	.902	.608	.250	.219	-.149	.466	.404	.696	.694	.205	-.139	.079	.006	.601	.170	.688
P_{26}																										1.000	.329	.262	.218	.166	.144	.348	.222	.233	.416	.148	.121	.256	.204	.285	.251	.259
P_{27}																											1.000	.704	.292	.275	-.112	.594	.339	.597	.659	.407	-.083	.074	-.022	.669	.087	.730
P_{28}																												1.000	.491	-.471	-.175	.544	.303	.303	.497	.203	.144	.257	.200	.513	.234	.404
P_{29}																													1.000	.994	-.006	.109	.138	.239	.294	.226	-.050	.162	.029	.315	.047	.313
P_{30}																														1.000	-.033	.069	.123	.228	.258	.210	-.075	.134	.004	.297	.015	.295
P_{31}																															1.000	.308	.568	-.077	-.182	.468	.961	.813	.927	.426	.754	.127
P_{32}																																1.000	.733	.398	.379	.032	.223	.280	.337	.512	.333	.353
P_{33}																																	1.000	.504	.316	.190	.479	.590	.700	.726	.693	.485
P_{34}																																		1.000	.324	.304	-.041	.295	.213	.766	.440	.894
P_{35}																																			1.000	.026	-.198	-.012	-.051	.389	.090	.422
P_{36}																																				1.000	.642	.738	.589	.702	.658	.640
P_{37}																																					1.000	.900	.953	.485	.839	.221
P_{38}																																						1.000	.949	.721	.968	.528
P_{39}																																							1.000	.650	.939	.398
P_{40}																																								1.000	.765	.922
P_{41}																																									1.000	.599
P_{42}																																										1.000

[a]See Table XXV for number of activities.

TABLE XVII

TENANT RETURNS PER ACRE FOR MANAGEMENT BY CROP ENTERPRISES FOR MIXED SOIL, NORTH MISSISSIPPI RIVER DELTA AREA OF ARKANSAS, 1950-69

Year	P_2 Corn	P_3 Allotment Cotton	P_4 Free Market Cotton	P_6 Oats	P_7 Soybeans, VI	P_{11} Wheat	P_{12} Corn-Oats-Grain Sorghum	P_{13} Corn-Oats-Soybeans, VI	P_{14} Corn-Wheat-Grain Sorghum	P_{15} Corn-Wheat-Soybeans, VI	P_{16} Grain Sorghum-Oats-Grain Sorghum	P_{17} Grain Sorghum-Oats-Soybeans, VI
1950	.07	66.83	-12.89	-14.83	-13.89	-1.57		-6.27		.94		
1951	-2.03	24.47	-46.51	-20.20	-32.77	-13.55		-16.34		-12.05		
1952	-33.78	37.83	-34.51	13.92	-21.86	-4.29		-18.31		-25.33		
1953	3.04	52.20	-21.04	9.09	-22.83	17.98		6.38		12.03		
1954	-12.09	31.82	-46.14	15.27	16.70	29.26		15.17		22.96		
1955	37.44	182.47	115.64	1.89	24.02	15.55		37.20		38.81		
1956	40.32	123.81	47.99	9.11	2.93	65.49		30.93		60.77		
1957	46.88	83.90	6.05	7.94	26.40	24.55		44.49		53.89		
1958	.85	145.88	75.01	-6.91	-24.77	42.77	-7.15	-5.74	38.71	19.98	-16.94	-18.63
1959	54.69	207.23	127.57	6.99	4.52	18.45	24.80	39.33	49.78	46.72	-12.15	2.23
1960	46.55	112.40	24.53	6.51	-5.45	35.22	25.96	30.71	73.45	46.82	1.02	5.63
1961	51.09	191.96	113.32	12.42	-29.91	55.29	22.08	25.59	62.63	48.88	-17.69	-14.32
1962	32.98	113.57	30.43	14.08	11.87	30.37	12.87	35.70	34.01	44.52	-16.17	6.52
1963	22.27	135.54	59.60	18.71	14.15	26.52	18.67	30.22	50.79	36.21	5.55	16.96
1964	21.58	203.22	128.85	3.20	7.06	20.66	25.67	21.38	77.16	31.21	29.69	25.28
1965	-5.89	153.74	71.61	21.32	19.44	9.73	12.62	20.23	41.39	16.56	21.04	28.51
1966	23.47	160.48	79.59	4.22	14.89	19.72	21.60	26.27	68.48	35.45	16.08	20.60
1967	15.99	-35.00	-125.67	5.78	.95	3.92	10.63	15.82	37.63	16.33	-3.72	1.32
1968	1.98	38.69	-44.11	14.49	1.66	15.88	16.30	14.17	53.32	16.68	19.79	17.54
1969	-4.94	150.13	72.39	4.43	13.69	24.61	-10.08	10.13	8,07	21.34	-21.81	-1.71
Average	17.03	108.91	31.09	6.37	.34	21.83	14.50	17.85	49.62	26.64	.39	7.49
Standard Deviation	23.90	66.69	68.32	10.15	18.12	18.53	11.49	17.79	18.63	21.60	17.09	14.27
Coefficient of Variation (percent)	140.35	61.23	219.74	159.42	5,328.65	84.87	79.25	99.69	37.55	81.10	4,380.86	190.13

TABLE XVII (CONTINUED)

Year	P_{18} Grain Sorghum-Wheat-Grain Sorghum	P_{19} Grain Sorghum-Wheat-Soybeans, VI	P_{20} Soybeans, V-Oats-Grain Sorghum	P_{21} Soybeans, V-Oats-Soybeans, VI	P_{22} Soybeans, V-Wheat-Grain Sorghum	P_{23} Soybeans, V-Wheat-Soybeans, VI	P_{24} Soybeans, VI-Oats-Grain Sorghum	P_{25} Soybeans, VI-Oats-Soybeans, VI	P_{26} Soybeans, VI-Wheat-Grain Sorghum	P_{27} Soybeans, VI-Wheat-Soybeans, VI
1950				-5.64		.63		-19.05		-12.62
1951				-27.04		-22.99		-32.74		-28.97
1952				-14.32		-21.00		-16.39		-22.07
1953				-20.48		-14.33		-10.21		-4.69
1954				21.98		30.40		25.43		33.01
1955				20.91		28.53		28.38		35.34
1956				2.40		30.13		9.81		34.96
1957				25.66		34.80		31.36		39.56
1958	11.68	10.06	-13.49	-16.20	10.34	8.29	-21.90	-20.70	2.43	.80
1959	-4.73	9.65	-7.50	6.91	-.76	13.64	-2.07	12.25	4.17	18.64
1960	17.15	21.76	1.38	6.00	15.92	20.54	-1.86	2.69	11.76	16.46
1961	5.63	8.99	-13.97	-10.58	7.47	10.86	-21.29	-17.98	-1.94	1.51
1962	-7.32	15.36	-9.61	13.10	-.20	22.51	-1.86	20.77	6.31	29.08
1963	11.55	22.98	10.52	21.96	15.75	27.19	11.85	23.21	16.65	28.16
1964	39.55	34.83	22.94	18.55	32.27	27.87	18.99	12.53	25.57	21.24
1965	17.39	24.87	22.96	30.46	19.33	26.83	22.85	30.28	19.25	26.81
1966	25.28	29.81	19.65	24.20	28.26	32.80	15.82	20.28	23.68	28.29
1967	-3.19	1.85	5.49	10.56	5.97	11.04	1.30	6.29	1.67	6.81
1968	22.32	20.06	16.01	13.77	18.16	15.92	14.95	12.65	16.77	14.59
1969	-10.57	9.52	-6.47	13.65	3.71	23.82	-1.99	18.07	7.74	27.91
Average	10.40	17.48	3.99	6.79	8.85	15.37	2.90	6.85	11.17	14.74
Standard Deviation	14.44	9.41	13.59	16.59	10.10	17.12	13.98	19.10	8.73	19.44
Coefficient of Variation (percent)	138.80	53.85	340.49	244.37	114.11	111.38	482.12	278.76	78.12	131.86

TABLE XVIII

TENANT RETURNS PER ACRE FOR MANAGEMENT BY CROP ENTERPRISES FOR CLAY SOIL, NORTH MISSISSIPPI RIVER DELTA AREA OF ARKANSAS, 1950-69

Year	P_{29} Allotment Cotton	P_{30} Free Market Cotton	P_{34} Soybeans, VI	P_{36} Wheat	P_{37} Grain Sorghum-Wheat-Grain Sorghum	P_{38} Grain Sorghum-Wheat-Soybeans, VI	P_{39} Soybeans, V-Wheat-Grain Sorghum	P_{40} Soybeans, V-Wheat-Soybeans, VI	P_{41} Soybeans, VI-Wheat-Grain Sorghum	P_{42} Soybeans, VI-Wheat-Soybeans, VI
1950	43.43	-26.10	-30.13	3.60				6.82		-22.29
1951	27.43	-33.09	-24.55	-13.33				-25.96		-23.98
1952	79.88	13.51	1.53	6.42				-5.34		-5.89
1953	34.71	-39.66	-3.66	7.93				2.16		6.54
1954	83.79	13.03	8.43	19.61				8.69		19.42
1955	25.94	-42.43	8.43	-5.41				7.57		9.86
1956	94.70	37.21	10.12	38.66				26.50		28.40
1957	55.93	-8.42	20.15	16.01				28.22		28.72
1958	98.57	37.94	-13.16	-3.75	-22.30	-14.02	-17.65	-9.36	-17.77	-9.47
1959	268.04	200.65	8.13	13.05	4.72	13.67	8.44	17.39	9.04	18.00
1960	93.57	3.68	-2.63	20.32	6.27	11.77	4.60	10.12	5.21	10.72
1961	107.85	35.17	-16.29	26.80	24.13	17.05	12.33	5.26	7.75	.68
1962	164.14	95.97	14.18	18.11	-26.36	.11	-14.63	11.86	-2.25	24.25
1963	144.29	68.47	11.69	25.72	13.89	21.52	15.40	23.04	16.38	24.02
1964	222.38	150.49	17.39	25.18	28.66	33.22	29.84	34.42	26.70	31.28
1965	190.90	110.12	9.74	-8.85	-21.43	-6.32	-10.07	5.06	-6.78	8.34
1966	120.37	38.13	-3.40	27.72	11.05	14.86	5.58	9.41	9.47	13.30
1967	-37.57	-117.44	18.30	13.51	9.86	15.29	14.02	19.45	18.28	23.72
1968	15.19	-58.61	-7.48	7.38	2.27	1.87	3.27	2.88	-.20	-.59
1969	159.64	89.77	1.13	15.01	16.99	15.81	14.85	13.68	12.01	10.84
Average	99.66	28.41	1.40	12.68	3.98	10.40	5.50	8.91	6.49	9.79
Standard Deviation	73.69	73.88	13.76	13.21	17.40	12.35	13.21	13.89	11.48	15.71
Coefficient of Variation (percent)	73.94	260.05	983.02	104.17	437.16	118.70	240.24	155.94	176.81	160.47

TABLE XIX

CORRELATION MATRIX OF NET RETURNS FOR CROP ACTIVITIES ON TENANT-OPERATED FARMS, 1950-69[a]

Activity	P_2	P_3	P_4	P_6	P_9	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{19}	P_{20}	P_{21}	P_{22}	P_{23}	P_{24}	P_{25}	P_{26}	P_{27}	P_{29}	P_{30}	P_{34}	P_{36}	P_{37}	P_{38}	P_{39}	P_{40}	P_{41}	P_{42}
P_2	1.000	.514	.484	.080	.250	.535	.603	.830	.447	.883	-.218	-.196	-.113	-.075	-.314	-.242	-.208	.482	.288	.279	-.255	.471	.233	.224	.273	.473	.250	.339	.187	.534	.240	.488
P_3		1.000	.997	.115	.254	.460	.189	.494	.247	.564	-.037	.004	.192	.364	.112	.281	.156	.471	-.085	.274	.175	.428	.752	.750	.120	.231	.163	.200	.103	.341	.016	.251
P_4			1.000	.087	.231	.446	.162	.458	.239	.533	-.041	.009	.205	.372	-.120	.246	.166	.438	-.098	.248	.180	.403	.734	.738	.102	.200	.164	.195	.102	.309	.005	.222
P_6				1.000	.453	.340	.261	.482	-.005	.327	.208	.376	-.029	.147	.241	.527	-.008	.424	.341	.606	.158	.524	.288	.250	.625	.413	-.074	.007	-.021	.509	.032	.601
P_9					1.000	.091	.058	.701	-.167	.491	.364	.653	.030	.372	.500	.954	.180	.849	.677	.978	.523	.900	.274	.252	.732	.247	-.057	.155	.101	.667	.250	.707
P_{11}						1.000	-.035	.504	.121	.772	-.383	-.482	-.054	-.115	-.484	.106	-.142	.519	-.553	.181	-.320	.505	.251	.261	.184	.653	.037	-.063	.122	.442	.214	.441
P_{12}							1.000	.508	.845	.351	.493	.451	.452	.477	.376	.192	.371	.106	.350	.119	.350	.055	.205	.154	.148	.448	.364	.495	.374	.339	.430	.299
P_{13}								1.000	.244	.914	.046	.224	-.070	.146	.037	.689	-.075	.795	.156	.754	.077	.841	.341	.316	.638	.517	.103	.276	.135	.760	.249	.781
P_{14}									1.000	.261	.578	.326	.764	.612	.407	.021	.660	.085	.229	-.126	.442	-.070	.055	.010	-.096	.391	.384	.397	.321	.177	.283	.093
P_{15}										1.000	-.168	-.104	-.070	.039	-.225	.480	.116	.767	-.182	.542	.107	.771	.339	.330	.453	.633	.123	.201	.069	.702	.108	.694
P_{16}											1.000	.878	.859	.825	.962	.517	.881	.253	.867	.367	.891	.164	.021	-.027	.233	.002	.168	.228	.270	.250	.266	.187
P_{17}												1.000	.577	.800	.921	.718	.668	.353	.984	.647	.901	.366	.250	.201	.438	.049	.063	.254	.222	.358	.319	.363
P_{18}													1.000	.842	.734	.211	.956	.186	.533	.035	.783	.019	.032	-.001	-.065	.083	.231	.199	.227	.103	.134	-.002
P_{19}														1.000	.768	.470	.873	.359	.727	.365	.941	.284	.386	.348	.137	.194	.140	.268	.187	.241	.201	.203
P_{20}															1.000	.625	.830	.297	.939	.484	.900	.233	-.008	-.062	.315	-.001	.179	.254	.299	.286	.330	.242
P_{21}																1.000	.348	.881	.729	.951	.597	.864	.307	.265	.681	.295	.035	.202	.166	.670	.282	.683
P_{22}																	1.000	.267	.646	.163	.870	.106	.013	-.030	.010	.141	.301	.285	.304	.166	.247	.072
P_{23}																		1.000	.337	.853	.375	.954	.347	.322	.592	.505	.064	.155	.098	.736	.150	.729
P_{24}																			1.000	.657	.882	.355	.169	.121	.448	.004	.093	.253	.261	.357	.346	.349
P_{25}																				1.000	.493	.926	.308	.279	.779	.300	-.068	.129	.076	.699	.212	.766
P_{26}																					1.000	.326	.264	.223	.230	.111	.160	.272	.249	.278	.272	.235
P_{27}																						1.000	.344	.326	.708	.473	-.030	.108	.037	.757	.123	.804
P_{29}																							1.000	.941	.288	.268	-.015	.201	.075	.374	.095	.353
P_{30}																								1.000	.275	.251	-.039	.175	.053	.356	.066	.334
P_{34}																									1.000	.376	-.001	.293	.231	.812	.422	.914
P_{36}																										1.000	.618	.700	.560	.719	.622	.670
P_{37}																											1.000	.907	.952	.459	.849	.225
P_{38}																												1.000	.952	.659	.970	.490
P_{39}																													1.000	.604	.944	.383
P_{40}																														1.000	.696	.936
P_{41}																															1.000	.552
P_{42}																																1.000

[a]See Table XVIII for names of activities.

correlation for all feasible activities.

Method of Analysis

The first step in the analysis is to find the linear programming solution for each of the four situations: owner operator situation with labor restricted to both two and three full-time employees and tenant situation with similar labor restrictions. The linear programming solution establishes the maximum expected income that can be obtained with the available resources and the production alternatives considered.

The linear programming solution establishes the maximum income variance of interest on the efficiency frontier. The following step is to determine by quadratic programming the organization that yields minimum income variance for specified levels of income up to the maximum. The linear programming solution is necessary to serve as a guide in developing the quadratic programming solutions.

The quadratic programming program used in the analysis minimizes income variance subject to the linear constraints. The linear constraints are the conventional linear programming input-output tableau (Table XX for the owner situation and Table XXI for the tenant situation) and minimum expected income. Efficient organizations are presented for owner and tenant situations in the next two chapters.

TABLE XX

RESOURCE SUPPLY AND RESTRICTIONS FOR THE OWNER-OPERATED FARM[a]

Resource Supply and Net Returns	Unit	Resource Supply P_0	Alfalfa (M.S.) P_1	Corn (M.S.) P_2	Allot-ment Cotton (M.S.) P_3	Free Market Cotton (M.S.) P_4	Grain Sorghum (M.S.) P_5	Oats (M.S.) P_6	Soybeans, IV (M.S.) P_7	Soybeans, V (M.S.) P_8	Soybeans, VI (M.S.) P_9	Soybeans, VII (M.S.) P_{10}	Wheat (M.S.) P_{11}
Average Net Returns	Dol.		39.36	48.63	180.04	76.32	10.40	24.14	23.97	24.47	28.98	22.83	46.59
Cropland	Acre	596.0	1.000	1.000	1.200	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Mixed Soil	Acre	370.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Clay Soil	Acre	226.0	--	--	.200	--	--	--	--	--	--	--	--
Cotton Allotment	Acre	194.0	--	--	1.000	--	--	--	--	--	--	--	--
Labor[b]													
December-April	Hour	1,281.0[c]	.530	2.053	1.419	1.419	1.473	.460	1.645	1.645	1.645	1.645	.460
May-June	Hour	921.0[c]	3.163	.448	1.551	1.551	.986	.580	1.517	1.517	1.257	1.317	.580
July-September	Hour	1,311.0[c]	4.191	1.170	1.143	1.143	.870	1.411	.870	.870	.260	.579	.843
October-November	Hour	822.0[c]	.033	--	2.676	2.676	.102	.210	.118	.118	.988	.988	.777

TABLE XX (CONTINUED)

Resource Supply and Net Returns	Unit	Corn-Oats-Grain Sorghum (M.S.) P_{12}	Corn-Oats-Soybeans, VI (M.S.) P_{13}	Corn-Wheat-Grain Sorghum (M.S.) P_{14}	Corn-Wheat-Soybeans, VI (M.S.) P_{15}	Grain Sorghum-Oats-Grain Sorghum (M.S.) P_{16}	Grain Sorghum-Oats-Soybeans, VI (M.S.) P_{17}	Grain Sorghum-Wheat-Grain Sorghum (M.S.) P_{18}	Grain Sorghum-Wheat-Soybeans, VI (M.S.) P_{19}	Soybeans, V-Oats-Grain Sorghum (M.S.) P_{20}	Soybeans, V-Oats-Soybeans, VI (M.S.) P_{21}	Soybeans, V-Wheat-Grain Sorghum (M.S.) P_{22}
Average Net Returns	Dol.	45.27	53.36	97.63	66.20	22.98	35.49	37.29	49.73	31.12	39.15	44.44
Cropland	Acre	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Mixed Soil	Acre	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Clay Soil	Acre	--	--	--	--	--	--	--	--	--	--	--
Cotton Allotment	Acre	--	--	--	--	--	--	--	--	--	--	--
Labor[b]												
December-April	Hour	1.256	1.256	1.256	1.256	.966	.966	.966	.966	1.056	1.054	1.054
May-June	Hour	1.068	1.051	.514	1.051	1.337	1.320	1.337	1.320	1.603	1.586	1.602
July-September	Hour	1.150	1.231	2.139	1.231	1.121	1.203	1.121	1.203	.894	.976	1.121
October-November	Hour	.831	.831	.396	.831	.696	.696	.696	.696	.930	.930	.704

TABLE XX (CONTINUED)

Resource Supply and Net Returns	Unit	Soybeans, V-Wheat-Soybeans, VI (M.S.) P_{23}	Soybeans, VI-Oats-Grain Sorghum (M.S.) P_{24}	Soybeans, VI-Oats-Soybeans, VI (M.S.) P_{25}	Soybeans, VI-Wheat-Grain Sorghum (M.S.) P_{26}	Soybeans, VI-Wheat-Soybeans, VI (M.S.) P_{27}	Alfalfa (C.S.) P_{28}	Allotment Cotton (C.S.) P_{29}	Free Market Cotton (C.S.) P_{30}	Grain Sorghum (C.S.) P_{31}	Soybeans, IV (C.S.) P_{32}
Average Net Returns	Dol.	52.09	29.96	39.64	41.74	51.14	6.06	164.76	69.78	5.08	11.67
Cropland	Acre	1.000	1.000	1.000	1.000	1.000	1.000	1.200	1.000	1.000	1.000
Mixed Soil	Acre	1.000	1.000	1.000	1.000	1.000	--	--	--	--	--
Clay Soil	Acre	--	--	--	--	--	1.000	1.200	1.000	1.000	1.000
Cotton Allotment	Acre	--	--	--	--	--	--	1.000	--	--	--
Labor[b]											
December-April	Hour	1.054	1.054	1.054	1.054	1.054	.530	1.142	1.142	1.402	.775
May-June	Hour	1.585	1.473	1.456	1.473	1.456	3.163	1.285	1.285	1.456	1.531
July-September	Hour	1.203	.456	.538	.456	.538	4.191	1.856	1.856	.870	1.062
October-November	Hour	.704	1.498	1.498	1.498	1.498	.033	2.176	2.176	.102	.073

TABLE XX (CONTINUED)

Resource Supply and Net Returns	Unit	Soybeans, V (C.S.) P_{33}	Soybeans, VI (C.S.) P_{34}	Soybeans, VII (C.S.) P_{35}	Wheat (C.S.) P_{36}	Grain Sorghum-Wheat-Grain Sorghum (C.S.) P_{37}	Grain Sorghum-Wheat-Soybeans, VI (C.S.) P_{38}	Soybeans, V-Wheat-Grain Sorghum (C.S.) P_{39}	Soybeans, V-Wheat-Soybeans, VI (C.S.) P_{40}	Soybeans, VI-Wheat-Grain Sorghum (C.S.) P_{41}	Soybeans, VI-Wheat-Soybeans, VI (C.S.) P_{42}
Average Net Returns	Dol.	20.75	29.10	20.98	32.73	27.77	39.17	32.88	41.71	34.34	43.02
Cropland	Acre	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Mixed Soil	Acre	--	--	--	--	--	--	--	--	--	--
Clay Soil	Acre	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Cotton Allotment	Acre	--	--	--	--	--	--	--	--	--	--
Labor[b]											
December-April	Hour	.775	.775	.775	.460	.931	.931	.618	.618	.618	.618
May-June	Hour	1.694	1.694	1.333	.580	1.572	1.555	1.691	1.674	1.510	1.494
July-September	Hour	1.089	.219	.579	.829	1.121	1.203	1.231	1.313	.616	.698
October-November	Hour	.073	.943	.943	.791	.696	.696	.681	.681	1.477	1.477

[a]M.S. and C.S. represent mixed soil and clay soil, respectively.

[b]Day labor for hauling hay and chopping weeds is not included. Labor input is for three full time men.

[c]For a two man labor supply, hours of labor are: December-April, 854; May-June, 614; July-September, 874; October-November, 548.

TABLE XXI

RESOURCE SUPPLY AND RESTRICTIONS FOR THE TENANT-OPERATED FARM[a]

Resource Supply and Net Returns	Unit	Resource Supply P_0	Corn (M.S.) P_2	Allotment Cotton (M.S.) P_3	Free Market Cotton (M.S.) P_4	Oats (M.S.) P_6	Soybeans, VI (M.S.) P_9	Wheat (M.S.) P_{11}	Corn-Oats-Grain Sorghum (M.S.) P_{12}	Corn-Oats-Soybeans, VI (M.S.) P_{13}	Corn-Wheat-Grain Sorghum (M.S.) P_{14}	Corn-Wheat-Soybeans, VI (M.S.) P_{15}	Grain Sorghum-Oats-Grain Sorghum (M.S.) P_{16}
Average Net Returns	Dol.		17.03	108.91	31.09	6.37	.34	21.83	14.50	17.85	49.62	26.64	.39
Cropland	Acre	596.0	1.000	1.200	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Mixed Soil	Acre	370.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Clay Soil	Acre	226.0	--	.200	--	--	--	--	--	--	--	--	--
Cotton Allotment	Acre	194.0	--	1.000	--	--	--	--	--	--	--	--	--
Labor[b]													
December-April	Hour	1,281.0[c]	2.053	1.419	1.419	.460	1.645	.460	1.256	1.256	1.256	1.256	.966
May-June	Hour	921.0[c]	.448	1.551	1.551	.580	1.257	.580	1.068	1.051	.514	1.051	1.337
July-September	Hour	1,311.0[c]	1.170	1.143	1.143	1.411	2.60	.843	1.150	1.231	2.139	1.231	1.121
October-November	Hour	822.0[c]	--	2.676	2.676	.210	.988	.777	.831	.831	.396	.831	.696

TABLE XXI (CONTINUED)

Resource Supply and Net Returns	Unit	Grain Sorghum-Oats-Soybeans, VI (M.S.) P_{17}	Grain Sorghum-Wheat-Grain Sorghum (M.S.) P_{18}	Grain Sorghum-Wheat Soybeans, VI (M.S.) P_{19}	Soybeans, V-Oats-Grain Sorghum (M.S.) P_{20}	Soybeans, V-Oats-Soybeans, VI (M.S.) P_{21}	Soybeans, V-Wheat-Grain Sorghum (M.S.) P_{22}	Soybeans, V-Wheat-Soybeans, VI (M.S.) P_{23}	Soybeans, VI-Oats-Grain Sorghum (M.S.) P_{24}	Soybeans, VI-Oats-Soybeans, VI (M.S.) P_{25}	Soybeans, VI-Wheat-Grain Sorghum (M.S.) P_{26}
Average Net Returns	Dol.	7.49	10.40	17.48	3.99	6.79	8.85	15.37	2.90	6.85	11.17
Cropland	Acre	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Mixed Soil	Acre	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Clay Soil	Acre	--	--	--	--	--	--	--	--	--	--
Cotton Allotment	Acre	--	--	--	--	--	--	--	--	--	--
Labor[b]											
December-April	Hour	.966	.966	.966	1.054	1.054	1.054	1.054	1.054	1.054	1.054
May-June	Hour	1.320	1.337	1.320	1.603	1.586	1.602	1.585	1.473	1.456	1.473
July-September	Hour	1.203	1.121	1.203	.894	.976	1.121	1.203	.456	.538	.456
October-November	Hour	.696	.696	.696	.930	.930	.704	.704	1.498	1.498	1.498

TABLE XXI (CONTINUED)

Resource Supply and Net Returns	Unit	Soybeans, VI-Wheat-Soybeans, VI (M.S.) P_{27}	Allotment Cotton (C.S.) P_{29}	Free Market Cotton (C.S.) P_{30}	Soybeans, VI (C.S.) P_{34}	Wheat (C.S.) P_{36}	Grain Sorghum-Wheat-Grain Sorghum (C.S.) P_{37}	Grain Sorghum-Wheat-Soybeans, VI (C.S.) P_{38}	Soybeans, V-Wheat-Grain Sorghum (C.S.) P_{39}	Soybeans, V-Wheat-Soybeans, VI (C.S.) P_{40}	Soybeans, VI-Wheat-Grain Sorghum (C.S.) P_{41}	Soybeans, VI-Wheat-Soybeans, VI (C.S.) P_{42}
Average Net Returns	Dol.	14.74	99.66	28.41	1.40	12.68	3.98	10.40	5.50	3.91	6.49	9.79
Cropland	Acre	1.000	1.200	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Mixed Soil	Acre	1.000	--	--	--	--	--	--	--	--	--	--
Clay Soil	Acre	--	1.200	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Cotton Allotment	Acre	--	1.000	--	--	--	--	--	--	--	--	--
Labor[b]												
December-April	Hour	1.054	1.142	1.142	.755	.460	.931	.931	.618	.618	.618	.618
May-June	Hour	1.456	1.285	1 285	1.694	.580	1.572	1.555	1.691	1.674	1.510	1.494
July-September	Hour	.538	1.856	1.856	.219	.829	1.121	1.203	1.231	1.313	.616	.698
October-November	Hour	1.498	2.176	2.176	.943	.791	.696	.696	.681	.681	1.477	1.477

[a]M.S. and C.S. represents mixed soil and clay soil, respectively.

[b]Day labor for chopping weeds is not included. Labor input is for three full time men.

[c]For a two man labor supply, hours of labor are: December-April, 854; May-June, 614; July-September, 874; October-November, 548.

FOOTNOTES

[1]Joseph Musick, James H. White and Waymon Halbrook, Estimated Production Items, Cost and Returns for Crop and Livestock Enterprises for Eastern Arkansas, MP 123, Part 1, North Delta (University of Arkansas).

[2]Daniel F. Capstick, Planning Data for Northeast Arkansas Farms - Six Row Equipment, Department of Agricultural Economics, University of Arkansas (1972).

[3]Ibid.

[4]Ibid.

[5]Ibid.

CHAPTER IV

EFFICIENT ORGANIZATIONS FOR OWNER-OPERATED FARMS

Efficient organizations are programmed for a 640-acre owner-operated farm. Organizations are presented for two levels of annual labor input -- a two-man and a three-man operation. Labor requirements are based on average weather conditions.

The efficiency frontier is a set of efficient plans whereby income variance is at a minimum for any given feasible expected income (or the highest expected income for a given variance). Any farm organization not on the efficiency frontier will lie to the right and is not an efficient plan. A comparison of plans on the efficiency frontier indicates the premium that must be paid to gain a more certain income or one with less variance. The premium is a sacrifice in level of expected income.

Farm plans that yield minimum income varinace are computed by $5,000 increments beginning at $10,000 up to the maximum expected annual income. Maximum income is determined by linear programming. The quadratic program problem as set up does not obtain solutions to the right of this point. Income variance has been transformed into standard deviation which is the square root of variance. Standard deviation is a measure of dispersion or variation in income. The range of one standard deviation from the mean includes approximately two-thirds or 68.27 percent of a normal distribution. In nearly seven out of 10 years, income is expected to fall within this range.

Two-Man Farm

Maximum income for the two-man farm is $58,574 (Figure 6 and Table XXII). This income represents returns to land and management. The part that is attributable to land is a gross return because land ownership costs are not deducted from the input budgets. The lower income levels on the efficiency frontier may not be either attractive nor rational alternatives. It is unlikely that one's risk aversion characteristics are so great that he is willing to sacrifice an excessive amount of income to gain certainty. It is helpful to consider the coefficient of variation in evaluating efficient farm plans. The coefficient of variation is a measure of relative variability usually expressed in percent. It is computed by dividing expected income into its standard deviation.

At the expected income levels of $10,000 and $15,000 the measure of income variation is $2,050 and $3,075, respectively. The relative variability is 20.50 percent for both. Consequently, a rational manager is not likely to prefer the lower income as a means of risk aversion because the coefficient of variation is identical for the first two levels of income shown. Expected income less one standard deviation is 79.5 percent of expected income for each level or $7,950 and $11,925 for the $10,000 and $15,000 expected income, respectively. These efficient plans lie on a straight line extending through the origin in Figure 6. Relative variability will be identical for all efficient plans that lie on any ray extending through the origin. Therefore, regardless how great one's risk aversion might be he should never

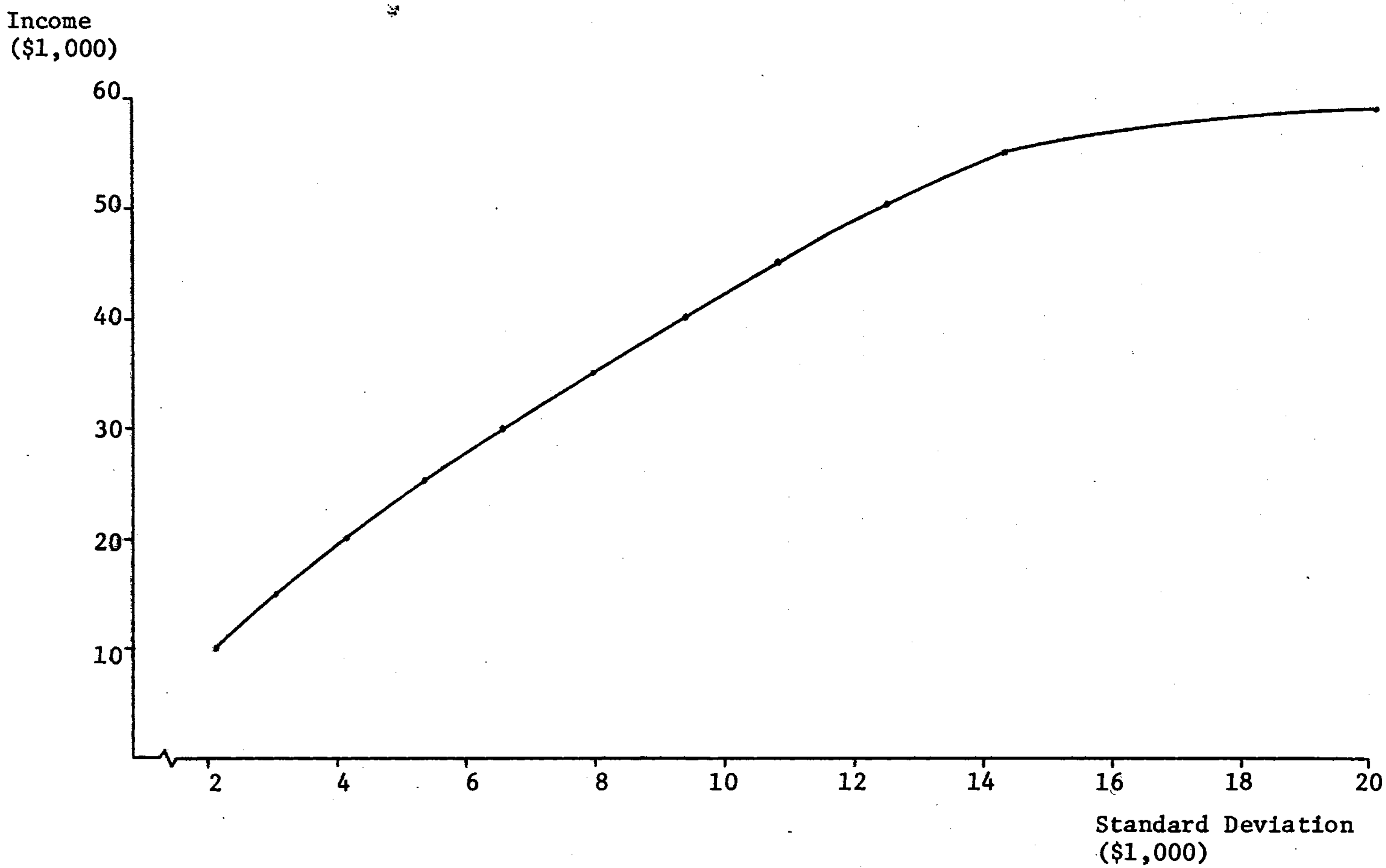

Figure 6. Income-Variance (Standard Deviation) Relationship for 640 Acre Owner Operated Two Man Farm

TABLE XXII

RELATIONSHIP OF INCOME TO VARIATION IN INCOME FOR THE OWNER-OPERATED 640 ACRE FARMS

Income	Standard Deviation[a]		Coefficient of Variation[b]	
	Two-Man Farm	Three-Man Farm	Two-Man Farm	Three-Man Farm
$10,000	$ 2,050.04	$ 2,050.04	.2050	.2050
15,000	3,075.06	3,075.06	.2050	.2050
20,000	4,112.05	4,106.82	.2056	.2084
25,000	5,306.55	5,226.07	.2123	.2090
30,000	6,594.98	6,431.95	.2198	.2144
35,000	7,949.07	7,668.81	.2271	.2191
40,000	9,323.69	8,927.96	.2331	.2232
45,000	10,757.86	10,297.11	.2391	.2288
50,000	12,494.63	11,902.97	.2498	.2381
55,000	14,235.35	13,968.35	.2588	.2540
58,574	20,109.31	--	.3433	--
60,000	--	16,649.70	--	.2775
65,000	--	19,819.23	--	.3049
67,527	--	21,707.20	--	.3216

[a]Square root of income variance.

[b]Standard deviation divided by average income.

accept anything lower than the highest income when the coefficient of variation is unchanged. It is very unlikely that two different efficient plans will ever lie on the same straight line or tangent that has a negative ordinate intercept. Should this be the case, relative variability will decrease as expected income increases. It would be rational to always seek the highest possible income regardless of risk aversion characteristics. The real choice is choosing between those plans which lie on a tangent with a positive ordinate intercept. The greater the ordinate intercept, or the more horizontal the tangent, the greater is the amount of variability that must be assumed in order to achieve an increase in expected income. Also, any straight line that has a positive intercept, relative variability will increase with movement to the right. That is, if two efficient plans lie on the same straight line with a positive intercept the plan to the right will have the higher relative variability. Consequently, the efficiency frontier may be viewed in terms of its elasticity. Elasticity of the efficiency frontier may be defined as the percent change in expected income divided by the percent change in standard deviation. Elasticity would be 1.0 for the first two levels of income in Figure 6 decreasing to zero at maximum expected income.

Beginning at the $15,000 income and moving to the right on the efficiency frontier indicates greater amounts of variance must be assumed to obtain a given increase in expected income. However, the relative increase is rather small between the $20,000 and $45,000 income levels. The increase in variability becomes noticeably greater above the $45,000 income and is much larger from $55,000 to the maximum of $58,574.

Income variance may become more critical to the decision maker at the upper income levels. At maximum expected income of $58,574 the standard deviation is $20,109 and the coefficient of variation is 34.33 percent. A much more stable income may be achieved if one is willing to sacrifice some income for more certainty. With an expected income of $55,000 the standard deviation is only $14,235 and the coefficient of variation falls to 25.68 percent. Income variance increases at a much higher relative rate as expected income exceeds $55,000.

The efficient plans change rather drastically between the expected incomes of $55,000 and $58,574 (Table XXIII). Activities P_{40} (soybeans, group V-wheat-soybeans, group VI, doublecrop rotation) and P_{34} (soybeans, group VI) both on clay soil are deleted in the maximum income organization. Activity P_2 (corn on mixed soil) is included at a level of 71 acres. P_3 (allotment cotton on mixed soil) increases from 62 to 73 acres and P_{29} (allotment cotton on clay soil) increases from 58 to 121 acres. Production of P_{14} (corn-wheat-grain sorghum, doublecrop rotation, on mixed soil) drops from 308 to 226 acres. Another interesting aspect is that total cropland is used at the $55,000 income level while 66 acres of clay soil is unused at the $58,574 level (Table XXIV). The total cotton allotment is utilized at the higher income level while 74 acres is not used at the $55,000 level. Unused cropland results from a shortage of labor during the July-September and October-November periods. Thus, labor becomes a limiting factor with the two-man labor restriction.

At the higher levels of income, activities with the highest expected income per unit of the most limiting resources are prime choices for inclusion in the organization. Expected income is

TABLE XXIII

MINIMUM VARIANCE ORGANIZATION FOR SELECTED LEVELS OF INCOME FOR THE OWNER-OPERATED 640 ACRE TWO-MAN FARM

Activity[a]	$10,000 (1)	$15,000 (2)	$20,000 (3)	$25,000 (4)	$30,000 (5)	$35,000 (6)	$40,000 (7)	$45,000 (8)	$50,000 (9)	$55,000 (10)	$58,573.87 (11)
	acres										
P_2	--	--	--	--	--	--	--	--	--	--	71.37
P_3	1.61	2.42	2.53	2.66	4.37	3.84	2.21	11.24	29.43	61.77	73.05
P_6	7.10	10.65	18.70	3.70	--	--	--	--	--	--	--
P_{11}	46.20	69.30	90.47	87.82	80.88	63.01	39.22	--	--	--	--
P_{14}	10.20	15.29	27.42	66.80	113.33	172.19	229.96	286.07	326.31	308.23	225.58
P_{19}	--	--	--	45.20	62.02	41.86	29.16	--	--	--	--
P_{26}	121.18	181.78	230.88	163.82	109.41	64.51	6.57	--	--	--	--
P_{27}	--	--	--	--	--	24.60	62.87	72.70	14.25	--	--
P_{29}	--	--	--	5.50	10.45	18.16	26.34	33.35	41.40	57.84	120.95
P_{34}	--	--	--	25.90	54.78	64.98	68.79	90.25	120.37	139.52	--
P_{35}	--	--	--	--	6.50	7.61	4.35	--	--	--	--
P_{40}	--	--	--	--	--	--	--	--	--	4.72	--
P_{41}	38.80	58.21	74.67	89.47	95.47	101.56	115.05	93.49	41.94	--	--
P_{42}	--	--	--	--	--	--	--	--	8.12	--	--
Set Aside[b]	.32	.48	.51	1.63	2.96	4.40	5.71	8.92	14.17	23.92	38.80
Total	225.41	338.13	445.18	492.50	540.17	566.72	590.23	596.02	595.99	596.00	529.75
	dollars										
Standard Deviation	2,050	3,075	4,112	5,307	6,595	7,949	9,324	10,758	12,495	14,235	20,109
	percent										
Coefficient of Variation	20.5	20.5	20.6	21.2	22.0	22.7	23.3	22.9	25.0	25.9	34.3

[a]See Table XX for crop designation.

[b]To participate in the Government price support program for cotton, cropland equivalent to 20 percent of the cotton allotment must be taken out of production.

TABLE XXIV

SLACK (UNUSED) RESOURCES BY LEVELS OF INCOME FOR THE 640 ACRE OWNER-OPERATED TWO-MAN FARM

Resource Restrictions	Unit	$10,000	$15,000	$20,000	$25,000	$30,000	$35,000	$40,000	$45,000	$50,000	$55,000	$58,574
Cropland	Acre	370.58	247.88	150.82	103.49	55.84	29.29	5.76	--	--	--	66.25
Mixed Cropland	Acre	183.71	90.56	--	--	--	--	--	--	--	--	--
Clay Cropland	Acre	186.87	167.31	150.82	103.49	55.84	29.29	5.76	--	--	--	66.25
Cotton Allotment	Acre	192.39	191.58	191.47	185.84	179.18	172.00	165.45	149.42	123.16	74.39	--
Labor												
December-April	Hour	662.68	567.02	476.26	426.24	374.61	329.18	284.76	236.33	215.86	202.12	182.37
May-June	Hour	338.25	200.37	79.82	35.43	--	--	--	6.79	47.30	41.19	197.36
July-September	Hour	722.22	646.33	558.53	448.75	339.96	240.27	137.28	70.91	--	--	--
October-November	Hour	263.42	121.13	--	--	--	--	--	--	41.12	--	--

relatively more important than income variance. Variability becomes relatively more important in the selection of activities when minimum income variance is the goal. Those activities which have lower relative variability tend to be the ones selected for the efficient plan at the lower levels of income (Appendix, Table LXXVII). However, covariance between activities is also important.

Realized Income

Realized income often deviates considerably from expected income. The greater the variance the greater the deviation. It may be easier to grasp the significance of variance by plotting the income a farmer would have realized over a period of years from following a selected efficient plan. Annual income is estimated for the $45,000; $55,000 and $58,547 plans to contrast the effects of variance from following each organization. Income variability is greatest for the maximum income level. For the last 12 years of the period, 1958-69, realized annual income ranged from a low of $17,255 in 1967 to a high of $88,663 in 1959 (Figure 7). The efficient plan for $55,000 expected income modifies the extreme somewhat. By comparison this income level shows a low of $29,633 in 1967 and a high of $80,431 in 1964 (Figure 8). The lowest income for this organization is $12,378 higher than for the lowest year of the maximum expected income organization.

Income fluctuations become less and less as lower expected incomes are specified. For example, if a $45,000 income is selected all annual returns lie much closer to the average (Figure 9). Although an expected income of $45,000 may not be acceptable the degree of income certainty is much higher. Income levels below this amount would not be desirable

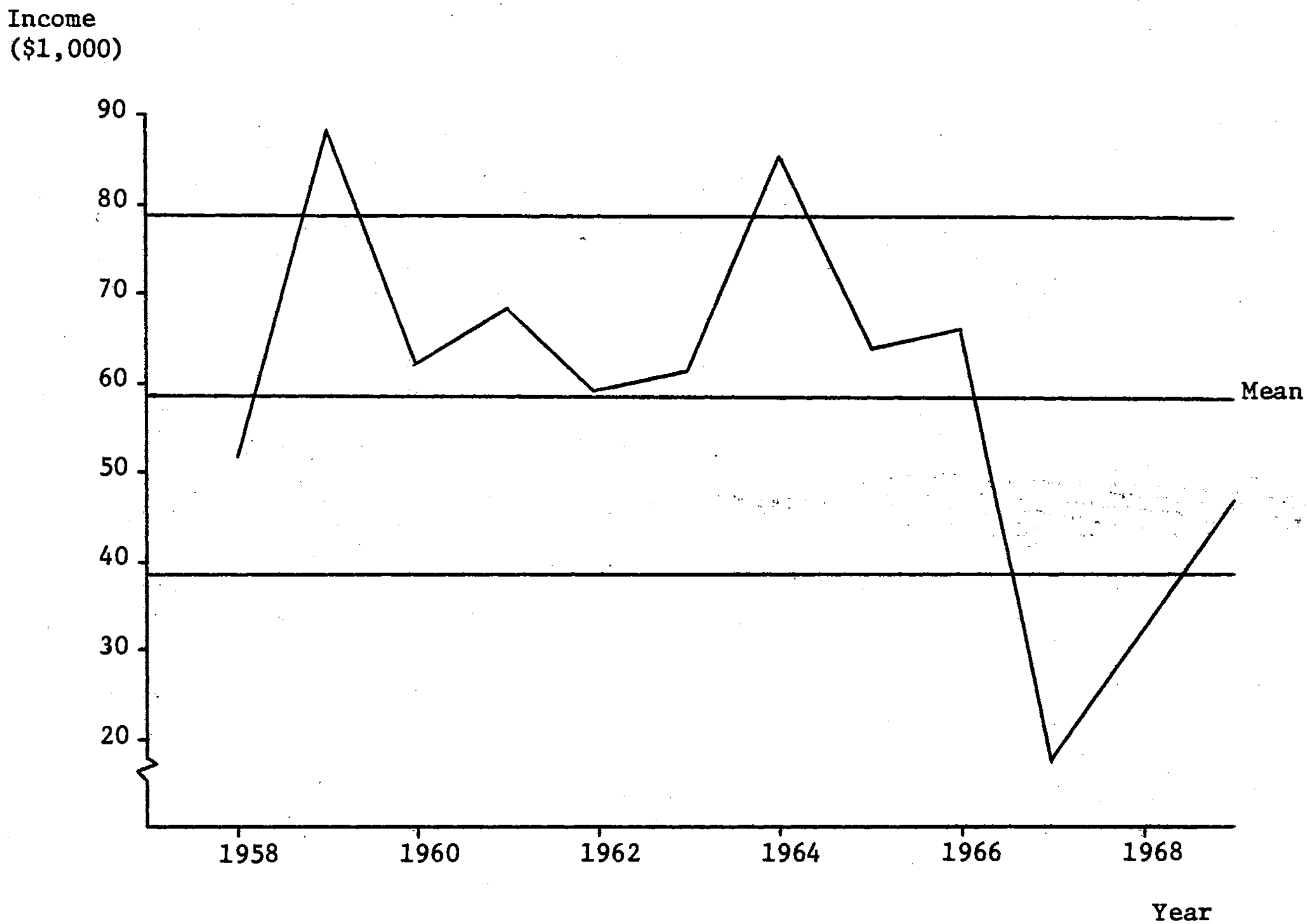

Figure 7. Annual Income and Range of One Standard Deviation From the Mean for 640 Acre Owner Operated Two Man Farm at Maximum Income, 1958-69

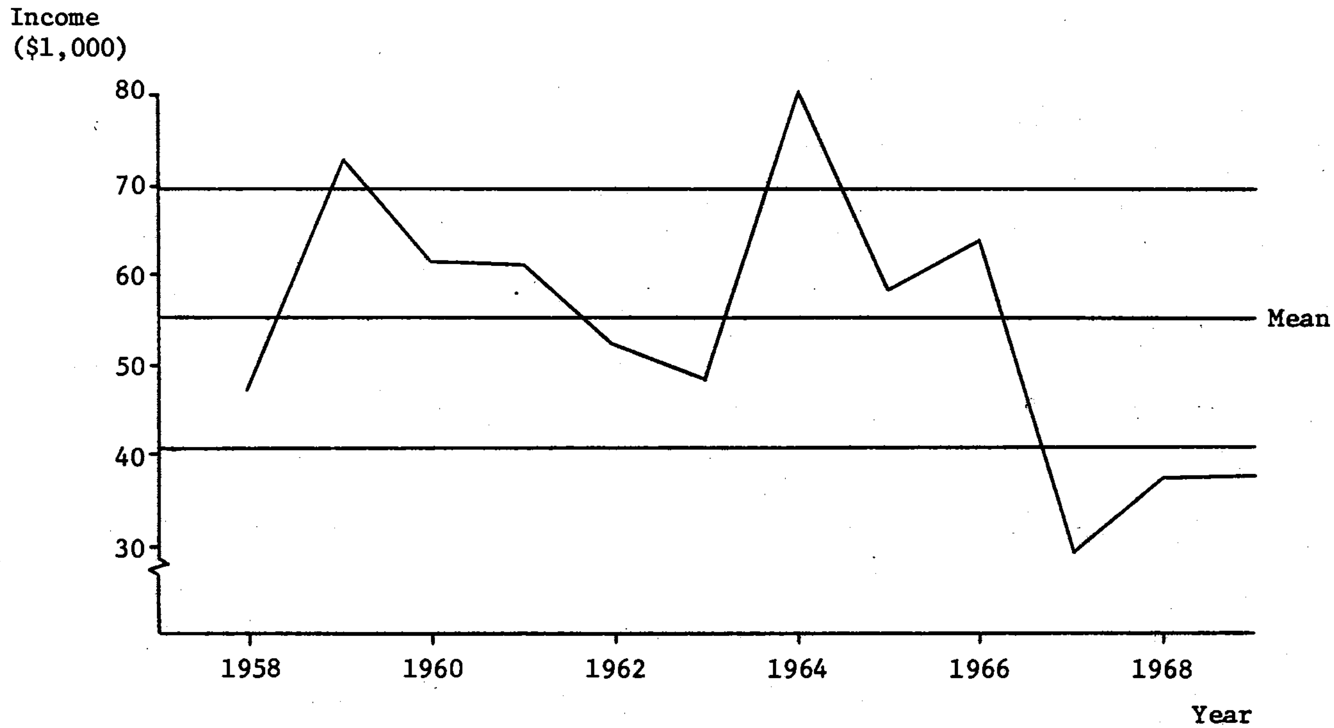

Figure 8. Annual Income and Range of One Standard Deviation From the Mean for 640 Acre Owner Operated Two Man Farm at $55,000 Income Level, 1958-69

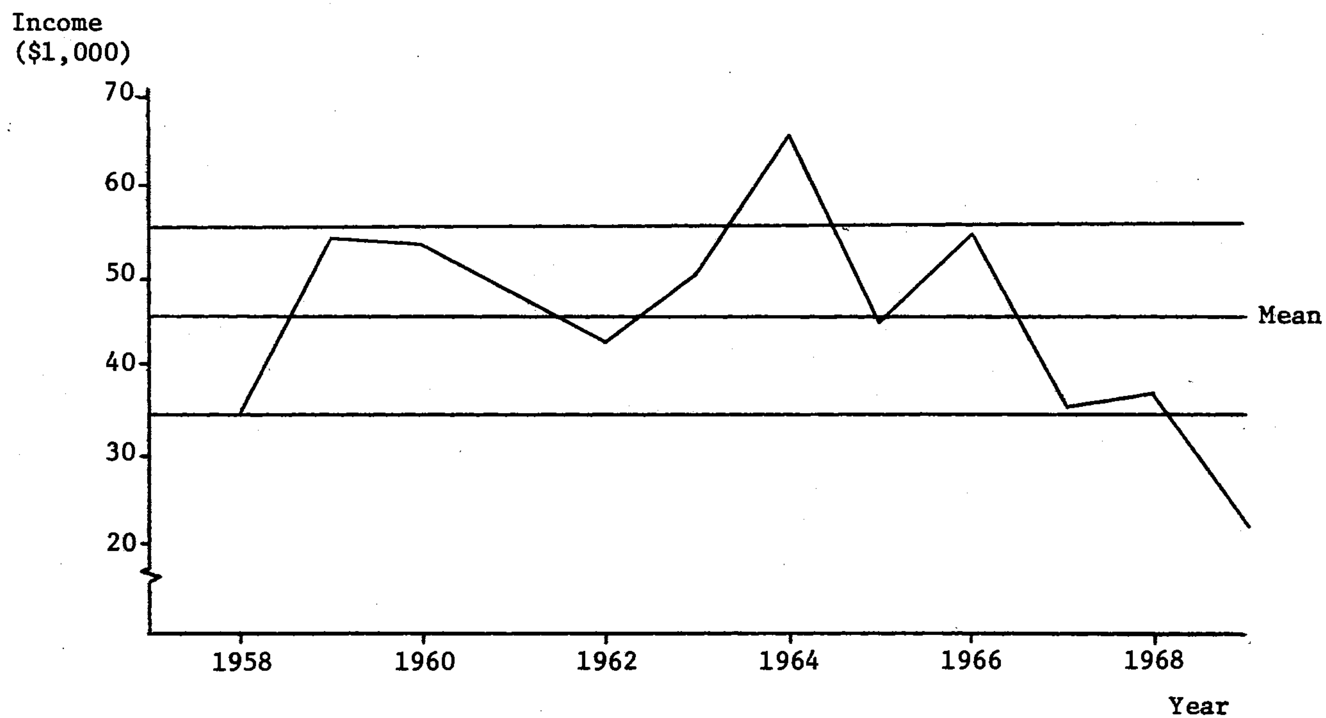

Figure 9. Annual Income and Range of One Standard Deviation From the Mean for 640 Acre Owner Operated Two Man Farm at $45,000 Income Level, 1958-69

unless the operator wishes to sell land or become a landlord. Efficient plans having lower expected income do not utilize total land resources.

Marginal Variance

The objective function for the quadratic programming analysis is minimization of income variance subject to linear constraints. Consequently, the change in income variance associated with one more unit of resource is of interest. Mixed cropland becomes limiting at $20,000 and its marginal value is $1,242. That is, a one acre change in mixed cropland will change total variance by $1,242 (Table XXV). This means that a one acre increase in mixed cropland will reduce total variance $1,242. Marginal variance becomes $615,469 for the $55,000 income. Also, at this level an hour change in July-September labor changes total variance $96,151, while a unit change in October-November labor has a marginal variance of $97,754. Clay cropland becomes limiting, or is completely utilized, at the $45,000 income but marginal variance is zero in all instances even when the clay slack is zero. The explanation for this phenomenon is that net returns for clay soil is less and variance greater than for mixed soil. Another acre of mixed soil would be used and reduce income variance. However, another acre of clay soil would not be used and hence not effect the variance for the farm organization.

Three-Man Farm

Income variance is similar for both two- and three-man labor situations at the lower levels (Table XXII). That is because the income

TABLE XXV

MARGINAL VARIANCE FOR CONSTRAINTS AT SPECIFIED LEVELS OF INCOME FOR THE 640 ACRE OWNER-OPERATED TWO-MAN FARM

Resource Restrictions	Unit	$10,000	$15,000	$20,000	$25,000	$30,000	$35,000	$40,000	$45,000	$50,000	$55,000	$58,574
Cropland	Acre	--	--	--	--	--	--	--	55,457	156,139	245,201	--
Mixed Cropland	Acre	--	--	1,242	17,532	32,294	47,022	63,338	96,806	158,821	615,469	a
Clay Cropland	Acre	--	--	--	--	--	--	--	--	--	--	--
Cotton Allotment	Acre	--	--	--	--	--	--	--	--	--	--	a
Labor												
December-April	Hour	--	--	--	--	--	--	--	--	--	--	--
May-June	Hour	--	--	--	--	4,074	8,854	11,546	--	--	--	--
July-September	Hour	--	--	--	--	--	--	--	--	23,785	96,151	a
October-November	Hour	--	--	3,840	6,501	6,852	5,362	2,966	2,412	--	97,754	a
Income	Dol.	841	1,261	1,791	2,655	3,506	4,347	5,150	6,703	9,694	16,668	a

[a] Value not estimated.

level was set so low that labor resources are not restricting in achieving these incomes. It is not until the $20,000 level that any resource is restricting. At this level mixed cropland is completely utilized for both labor situations (Tables XXIV and XXVII). The two-man farm has an additional limitation with respect to October-November labor. Even up through the $55,000 level, income variation and relative variability are similar but slightly lower for the three-man farm.

The higher labor supply for the three-man farm allows more freedom in crop choices and combinations resulting in $8,953 higher maximum expected income; $67,527 versus $58,574 for the three- and two-man farms, respectively. Labor is not a limiting factor for any income level on the three-man farm. However, labor may not always be excessive even with a three-man labor supply because these results are based on average weather conditions. Analysis indicates that two years out of 20 a labor shortage will occur even with three men. This compares with 13 years out of 20 for the two-man farm.[1]

Crop organization at maximum expected income is seven acres of P_3 (allotment cotton on mixed soil), 363 acres of P_{14} (corn-wheat-grain sorghum, doublecrop rotation, on mixed soil) and 187 acres of P_{29} (allotment cotton on clay soil). This organization has an expected income of $67,527 with a standard deviation of $21,707 and a 32.16 percent coefficient of variation (Tables XXII and XXVI).

The slope of the efficiency frontier decreases at a somewhat faster rate beginning with the $50,000 income level (Figure 10). The smaller the slope, the greater the variance that must be assumed to achieve a given increase in income. Because there is relatively little change in slope throughout the first eight or nine income levels programmed,

TABLE XXVI

MINIMUM VARIANCE ORGANIZATION FOR SELECTED LEVELS OF INCOME FOR THE OWNER-OPERATED 640 ACRE THREE-MAN FARM

Activity[a]	$10,000 (1)	$15,000 (2)	$20,000 (3)	$25,000 (4)	$30,000 (5)	$35,000 (6)	$40,000 (7)	$45,000 (8)	$50,000 (9)	$55,000 (10)	$60,000 (11)	$65,000 (12)	$67,527 (13)
	acres												
P_3	1.61	2.42	2.15	12.60	22.90	33.11	44.75	57.32	65.09	59.86	56.77	53.97	6.80
P_6	7.10	10.65	8.11	--	--	--	--	--	--	--	--	--	--
P_{11}	46.20	69.30	19.46	83.12	61.38	27.47	--	--	--	--	--	--	--
P_{14}	10.20	15.29	19.46	60.18	101.92	129.51	174.58	252.82	304.91	310.14	313.23	316.03	363.20
P_{15}	--	--	--	--	6.42	24.60	38.21	30.27	--	--	--	--	--
P_{19}	--	--	--	--	3.49	85.31	112.39	29.59	--	--	--	--	--
P_{26}	121.18	181.78	244.50	214.10	173.90	70.01	.07	--	--	--	--	--	--
P_{29}	--	--	--	--	--	--	--	--	14.44	42.67	88.07	134.09	187.20
P_{34}	--	--	--	29.46	67.42	99.01	129.92	161.27	139.58	--	--	--	--
P_{41}	38.80	58.21	82.98	92.90	94.61	100.20	88.03	53.26	39.22	10.53	--	--	--
P_{42}	--	--	--	--	--	--	--	--	16.85	152.29	108.96	54.29	--
Set Aside[b]	.32	.48	.43	2.52	4.58	6.62	8.95	11.46	15.91	20.51	28.97	37.61	38.80
Total	225.41	338.13	453.41	494.88	536.62	575.84	596.00	595.99	596.00	596.00	596.00	595.99	596.00
	dollars												
Standard Deviation	2,050	3,075	4,107	5,226	6,432	7,669	8,928	10,297	11,903	13,968	16,650	19,819	21,707
	percent												
Coefficient of Variation	20.5	20.5	20.8	20.9	21.4	21.9	22.3	22.9	23.8	25.4	27.8	30.5	32.2

[a] See Table XX for crop designation.

[b] To participate in the Government price support program for cotton, cropland equivalent to 20 percent of the cotton allotment must be taken out of production.

TABLE XXVII

SLACK (UNUSED) RESOURCES AT SPECIFIED LEVELS OF INCOME
FOR THE 640 ACRE OWNER-OPERATED THREE-MAN FARM

Resource Restriction	Unit	$10,000	$15,000	$20,000	$25,000	$30,000	$35,000	$40,000	$45,000	$50,000	$55,000	$60,000	$65,000	$67,527
Cropland	Acre	370.58	257.88	142.59	101.12	59.38	20.17	--	--	--	--	--	--	--
Mixed Cropland	Acre	183.71	90.56	--	--	--	--	--	--	--	--	--	--	--
Clay Cropland	Acre	186.87	167.31	142.59	101.12	59.38	20.17	--	--	--	--	--	--	--
Cotton Allotment	Acre	192.39	191.58	191.85	181.40	171.10	160.89	149.25	136.68	114.47	91.47	49.15	5.93	--
Labor														
December-April	Hour	1,089.68	994.02	896.73	843.40	786.82	732.97	687.20	657.62	646.35	657.17	639.11	620.79	601.63
May-June	Hour	645.25	507.37	361.96	316.77	272.92	226.54	221.75	277.65	323.92	370.49	395.99	421.43	482.37
July-September	Hour	1,159.22	1,083.33	1,012.13	936.50	850.64	724.75	621.67	563.72	491.10	387.21	336.60	286.55	180.35
October-November	Hour	537.42	395.13	243.60	214.16	201.09	234.72	271.34	292.00	283.21	205.66	193.46	180.44	251.56

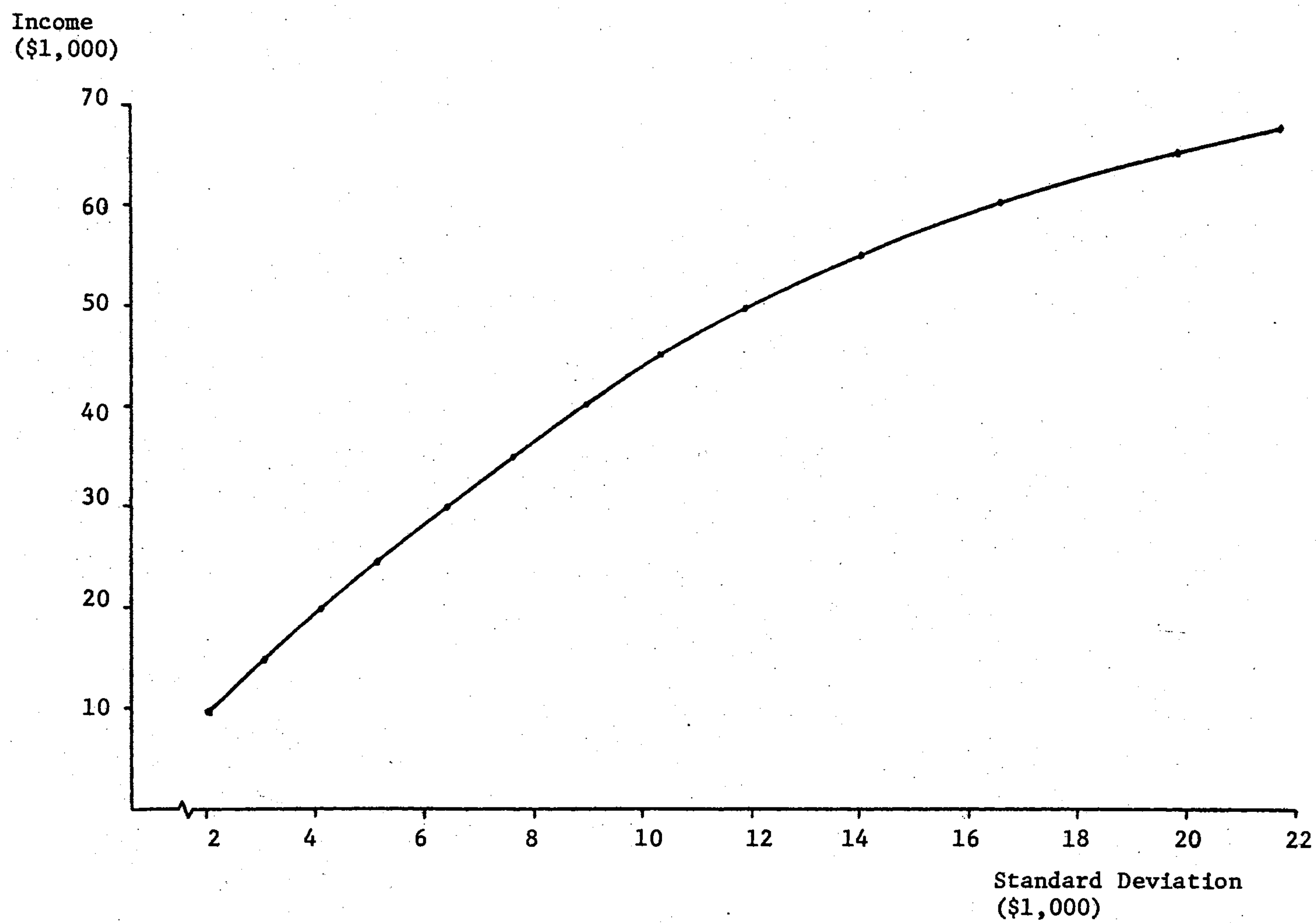

Figure 10. Income-Variance (Standard Deviation) Relationship for 640 Acre Owner Operated Three Man Farm

these income levels might be ruled out as being attractive alternatives. If the farm operator is a risk averter he may view income levels from \$55,000 and above with interest. Standard deviation at this level is \$13,968 and coefficient of variation is 25.40 percent.

Realized Income

Range in maximum expected income is from a low of \$24,265 in 1967 to a high of \$101,158 in 1964 for the 12 year period, 1968-69 (Figure 11). This compares with a low of \$28,607 to a high of \$80,975 for the \$55,000 expected income for the same period (Figure 12).

It is conceivable that few farmers would be willing to accept a \$12,527 sacrifice in expected income in order to achieve the degree of stability possible for the \$55,000 efficient plan. However, there are many risk averters involved in farming.

Marginal Variance

Mixed cropland becomes limiting at \$20,000 on the efficiency frontier and has a marginal variance of \$3,453. Marginal variance increases throughout the higher incomes to \$1,782,883 at the maximum expected income of \$67,527 (Table XXVIII). Thus, at this income level a one acre decrease in mixed cropland will increase total variance \$1,782,883 whereas a one acre increase will reduce total variance \$1,782,883.

Clay cropland is completely utilized for expected incomes of \$40,000 or more but does not have a marginal variance for any income level. Thus, clay cropland has no influence on decreasing income variance.

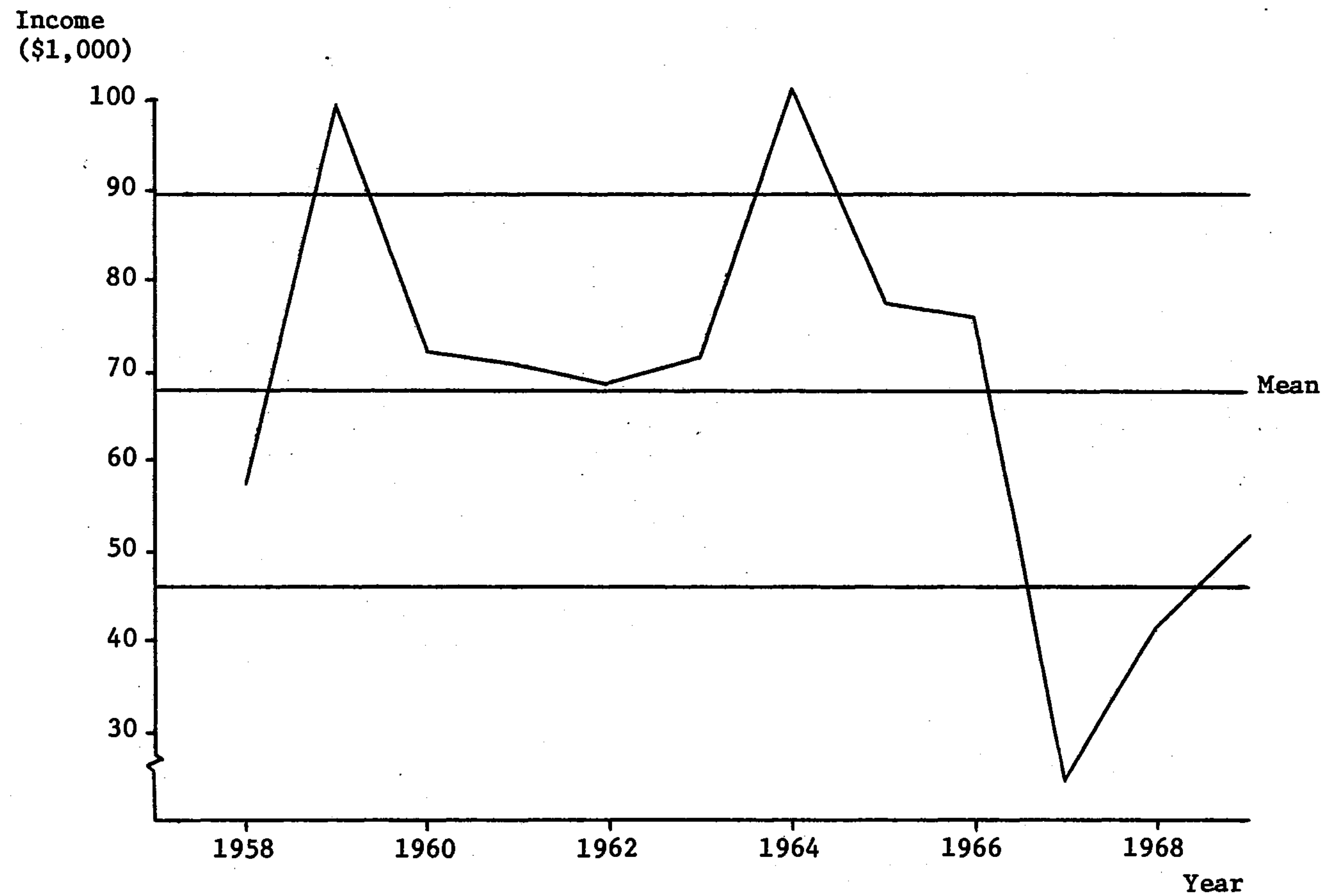

Figure 11. Annual Income and Range of One Standard Deviation From the Mean for 640 Acre Owner Operated Three Man Farm at Maximum Income, 1958-69

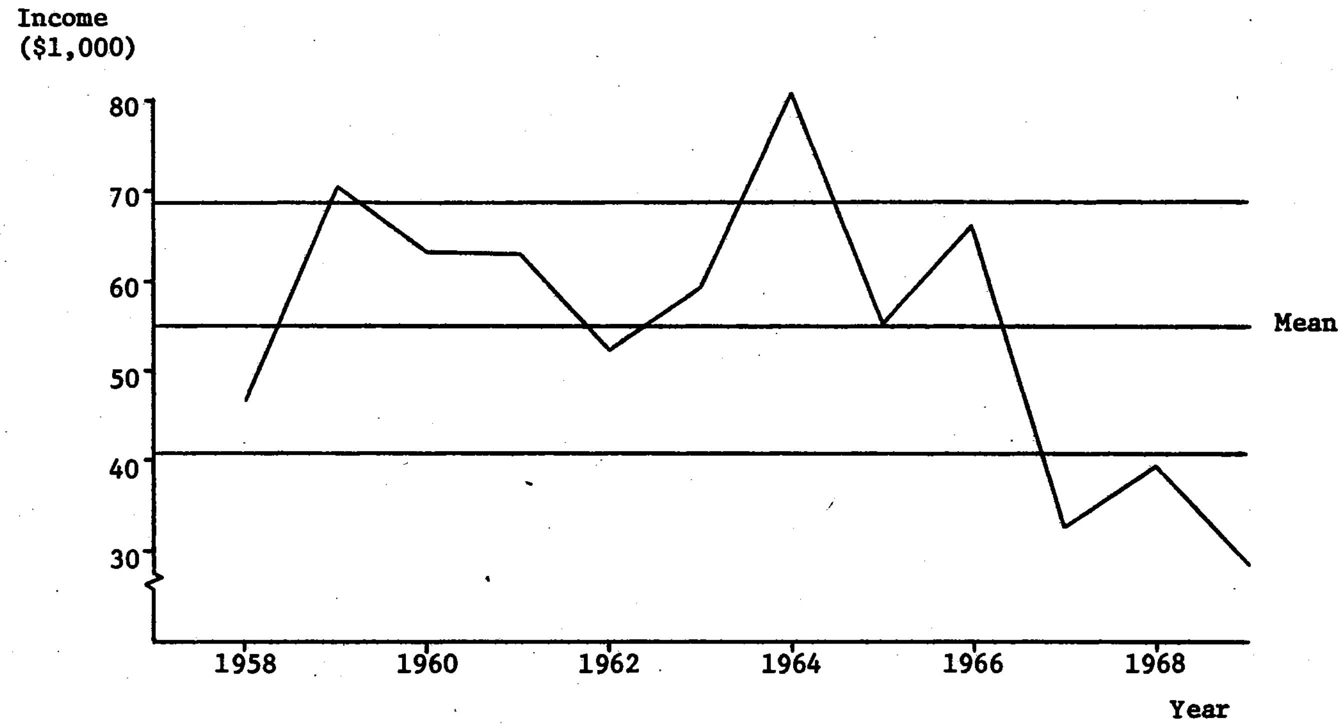

Figure 12. Annual Income and Range of One Standard Deviation From the Mean for 640 Acre Owner Operated Three Man Farm at $55,000 Income Level, 1958-69

TABLE XXVIII

MARGINAL VARIANCE FOR CONSTRAINTS AT SPECIFIED LEVELS OF INCOME FOR THE 640 ACRE OWNER-OPERATED THREE-MAN FARM

Resource Restrictions	Unit	$10,000	$15,000	$20,000	$25,000	$30,000	$35,000	$40,000	$45,000	$50,000	$55,000	$60,000	$65,000	$67,527
Cropland	Acre	--	--	--	--	--	--	13,502	49,315	152,432	285,173	556,486	835,700	1,359,311
Mixed Cropland	Acre	--	--	3,453	18,401	32,524	43,182	51,498	60,832	204,185	437,896	810,344	1,180,810	1,782,883
Clay Cropland	Acre	--	--	--	--	--	--	--	--	--	--	--	--	--
Cotton Allotment	Acre	--	--	--	--	--	--	--	--	--	--	--	--	1,024,826
Labor														
December-April	Hour	--	--	--	--	--	--	--	--	--	--	--	--	--
May-June	Hour	--	--	--	--	--	--	--	--	--	--	--	--	--
July-September	Hour	--	--	--	--	--	--	--	--	--	--	--	--	--
October-November	Hour	--	--	--	--	--	--	--	--	--	--	--	--	--
Income	Dol.	841	1,261	1,750	2,457	3,159	3,817	4,663	5,886	8,995	13,131	19,765	26,470	38,682

Cotton allotment is completely utilized only for the maximum expected income. Cotton production increases for all efficient plans proceeding up the efficiency frontier. That is because cotton has a relatively high expected return per acre and a high variance as compared with several other alternative activities.

FOOTNOTES

[1]Daniel F. Capstick, Economic Benefits of Land Grading With Respect to Timeliness, Paper presented at the 1971 Winter Meeting, American Society of Agricultural Engineers, Paper No. 71-706.

CHAPTER V

EFFICIENT ORGANIZATIONS FOR TENANT-OPERATED FARMS

The efficiency frontier is programmed for tenant-operated farms by $2,500 increments in expected income from $10,000 up to the maximum. The same resource restrictions are applied as for owner-operated farms. Expected income is that accruing principally to management. However, all labor costs may not be accounted for. Labor is charged at $1.50 per hour and only that labor cost is accounted for which is necessary for actual production. Idle time is not counted as a cost. Labor input is fixed at two levels, both a two-man and a three-man operation. Rent payments are based on crop share with the landlord receiving one-fourth of the cotton and one-third of other crops. The landlord shares in the cost of fertilizer, insecticides, ginning charges and grain drying when necessary in the same proportion in which he shares in production.

Two-Man Farm

Increases in the expected income, for the tenant operated two-man farm, from $10,000 through $17,500 on the efficiency frontier shows a corresponding increase in variance. Relative variability is unchanged at 33.35 percent (Table XXIX). This is because no specified resource is limiting within this range. Increases in income result from

TABLE XXIX

RELATIONSHIP OF INCOME TO VARIATION IN INCOME
FOR THE TENANT-OPERATED 640 ACRE FARMS

Income	Standard Deviation[a]		Coefficient of Variation[b]	
	Two-Man Farm	Three-Man Farm	Two-Man Farm	Three-Man Farm
$10,000	$ 3,334.63	$ 3,334.63	.3335	.3335
12,500	4,168.29	4,168.29	.3335	.3335
15,000	5,001.95	5,001.95	.3335	.3335
17,500	5,835.61	5,835.61	.3335	.3335
20,000	6,694.85	6,694.85	.3347	.3347
22,500	7,641.52	7,641.52	.3396	.3396
25,000	8,708.02	8,679.65	.3483	.3472
27,500	10,090.47	9,901.79	.3669	.3601
30,000	11,716.23	11,243.01	.3905	.3748
30,500	12,062.19	--	.3955	--
31,000	12,413.75	--	.4004	--
32,500	--	12,720.42	--	.3914
32,759	13,691.01	--	.4179	--
35,000	--	14,354.21	--	.4101
37,419	--	16,033.54	--	.4287

[a]Square root of income variance.

[b]Standard deviation divided by expected income.

proportionate increases in the efficient organization (Table XXX). Mixed cropland becomes limiting at \$20,000 (Table XXXI). The only limiting period for labor is July-September and this occurs for plans having expected income of \$25,000 or more.

The four lowest income plans on the efficiency frontier lie on a ray extending through the origin (Figure 13). The slope and relative rate of change is constant, therefore relative variability is unchanged. Beginning at the \$20,000 level, the slope of the efficiency frontier decreases. As the slope decreases a greater increase in variance must be assumed to achieve a given incremental increase in income. The curve has noticeably less slope after the \$27,000 income level is reached indicating variance is increasing at a relatively faster rate than income.

Maximum expected income is \$32,759. The crop organization is 88 acres of P_3 (allotment cotton mixed soil), 282 acres of P_{14} (corn-wheat-grain sorghum, doublecrop rotation, on mixed soil) and 92 acres of P_{29} (allotment cotton on clay soil). Slack resources include 98 acres of clay cropland and 14 acres of cotton allotment. Thus, the maximum amount of land that can be utilized is 487 acres of which 76 percent is mixed cropland and 24 percent clay cropland. The corresponding cotton allotment for 487 acres would be 159 acres. Therefore, there would be no unused cotton allotment because the efficient plan includes 180 acres of allotment cotton (P_3 and P_{29}).

It is unlikely that the tenant would be permitted to retain unused cropland because of a restricted labor input except in those areas where land is idled under conservation programs. However, it should not be

TABLE XXX

MINIMUM VARIANCE ORGANIZATION FOR SELECTED LEVELS OF INCOME
FOR THE TENANT-OPERATED 640 ACRE TWO-MAN FARM

Activity[a]	$10,000 (1)	$12,500 (2)	$15,000 (3)	$17,250 (4)	$20,000 (5)	$22,500 (6)	$25,000 (7)	$27,500 (8)	$30,000 (9)	$30,500 (10)	$31,000 (11)	$32,759 (12)
	acres											
P_3	--	--	--	--	--	1.08	19.57	41.74	63.91	63.34	72.77	88.37
P_6	2.12	2.65	3.18	3.71	--	--	--	--	--	--	--	--
P_{11}	25.37	31.72	38.06	44.40	40.04	25.91	--	--	--	--	--	--
P_{14}	154.32	192.90	231.48	270.06	307.10	343.01	350.43	328.26	306.09	301.66	297.23	281.63
P_{27}	21.78	27.22	32.67	38.11	22.86	--	--	--	--	--	--	--
P_{29}	14.59	18.24	21.89	25.54	35.63	48.13	54.99	66.89	78.78	81.16	83.54	91.91
Set Aside[b]	2.92	3.65	4.38	5.11	7.13	9.84	14.91	21.73	28.54	28.90	31.26	24.89
Total Acres	221.10	276.38	331.66	386.93	412.76	427.97	439.90	458.62	477.32	475.06	484.80	486.80
	dollars											
Standard Deviation	3,335	4,168	5,002	5,836	6,695	7,642	8,708	10,090	11,716	12,062	12,414	13,691
	percent											
Coefficient of Variation	33.4	33.4	33.4	33.4	33.5	34.0	34.8	36.7	39.0	39.6	40.0	41.8

[a]See Table XXI for crop description.

[b]To participate in the Government price support program for cotton, cropland equivalent to 20 percent of the cotton allotment must be taken out of production.

TABLE XXXI

SLACK (UNUSED) RESOURCES AT SPECIFIED LEVELS OF INCOME
FOR THE 640 ACRE TENANT-OPERATED TWO-MAN FARM

Resource Restrictions	Unit	$10,000	$12,500	$15,000	$17,500	$20,000	$22,500	$25,000	$27,500	$30,000	$30,500	$31,000	$32,759
Cropland	Acre	374.90	319.62	264.35	209.07	183.25	168.03	156.10	137.39	118.68	114.94	111.19	109.20
Mixed Cropland	Acre	166.41	115.51	64.62	13.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clay Cropland	Acre	208.49	204.11	199.73	195.35	183.25	168.03	156.10	137.39	118.68	114.94	111.19	109.20
Cotton Allotment	Acre	179.41	175.76	172.11	168.46	158.37	144.79	119.44	85.37	51.31	44.50	37.68	13.72
Labor													
December-April	Hour	607.91	546.39	484.87	423.34	385.08	354.77	323.29	306.09	288.89	285.45	282.01	269.91
May-June	Hour	468.27	431.84	395.41	358.98	353.86	359.14	332.86	294.59	256.31	248.66	241.00	214.08
July-September	Hour	480.73	382.41	284.10	185.78	104.93	27.90	0.00	0.00	0.00	0.00	0.00	0.00
October-November	Hour	402.35	365.94	329.53	293.11	283.51	284.41	237.20	160.77	84.34	69.05	53.77	0.00

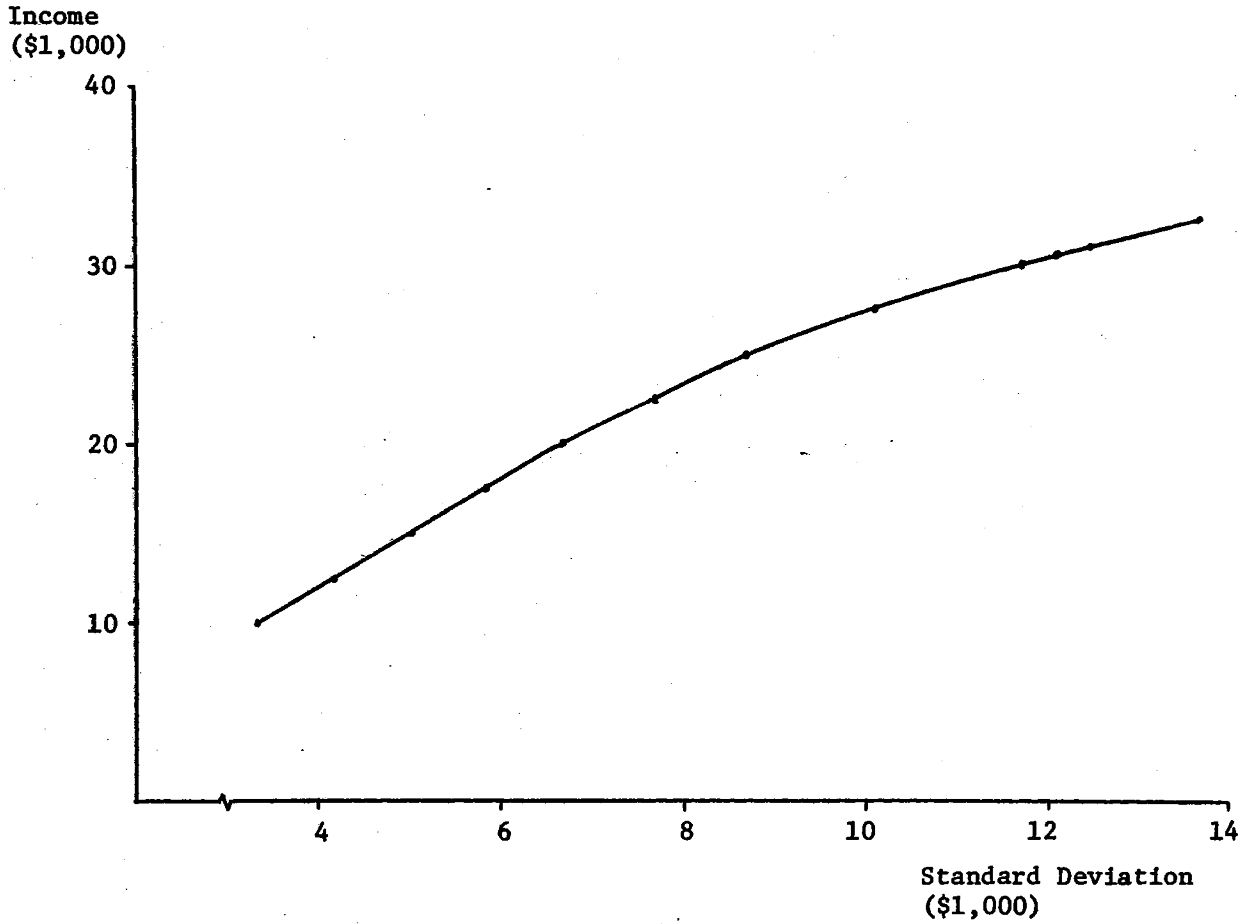

Figure 13. Income-Variance (Standard Deviation) Relationship for 640 Acre Tenant Operated Two Man Farm

difficult for a tenant to cut back the acreage of his operation to more closely conform with his labor capabilities. Therefore, a lower expected income might be more reasonable.

By accepting a $25,000 expected income relative variability would be only 34.83 percent rather than 41.79 percent for the $32,759 income. With a $25,000 income the tenant would need to rent only 440 acres of cropland rather than 596 acres. Organization for the efficient plan is 20 acres of P_3 (allotment cotton on mixed soil), 350 acres of P_{14} (corn-wheat-grain sorghum, doublecrop rotation, on mixed soil), and 55 acres of P_{29} (allotment cotton on clay soil). For 596 acres of cropland this would mean 119 acres of unused cotton allotment. For a 440 acre farm the proportionate cotton allotment would be 143 acres. This is an excess of 68 acres of cotton allotment because only 75 acres of cotton are included in the efficient plan. If the tenant places a high priority on reducing income variance, his goals may be in conflict with those held by the landlord. The landlord may be interested in utilizing total allotment in order to maximize his expected returns.

The tenant may not be unduly disadvantaged if he finds it advantageous to reduce the acres of cotton below the alloted acres for the farm. Cotton allotments can be transferred by the land owner or the tenant may choose to rent cropland without an allotment.

Realized Income

Minimum income variance for the $25,000 efficient organization yields a standard deviation of $8,708 and a relative variability of 34.83 percent (Tables XXIX and XXX). Standard deviation for the maximum expected income of $32,758 is $13,691 resulting in relative variability of 41.79 percent. By following the maximum income plan for the 12 year period 1958-69 annual income would have ranged from a low of $3,545 in 1967 to a high of $52,606 in 1964 (Figure 14). Range in income for the $25,000 level is from a low of $9,644 in 1967 to a high of $39,963 in 1964 (Figure 15).

Marginal Variance

Mixed cropland has considerable influence with respect to changes in income variance on the tenant-operated two-man farm. Clay land has no influence whatsoever in reducing income variance. The addition of an acre of cropland, with a fixed proportion of clay and mixed soil, will reduce income variance. Where mixed cropland first becomes limiting, at the $20,000 income level, marginal income variance for a unit change is $19,949 (Table XXXII). At the $31,000 level marginal variance of mixed cropland is $306,608. That is, if mixed cropland were increased by one acre total variance would decrease $306,608. The opposite is true for a one acre decrease. This suggests that if the tenant is seriously interested in reducing income variance he may concentrate his efforts in farming and renting as little clay land as possible.

The limitation imposed by the July-September labor supply also has considerable influence on total income variance. Marginal variance per hour for July-September labor is $28,140 for the $25,000 efficient plan. It increases to $141,403 at the $31,000 income level. A one hour change in the July-September labor supply will result in an opposite change of $141,403 in total income variance.

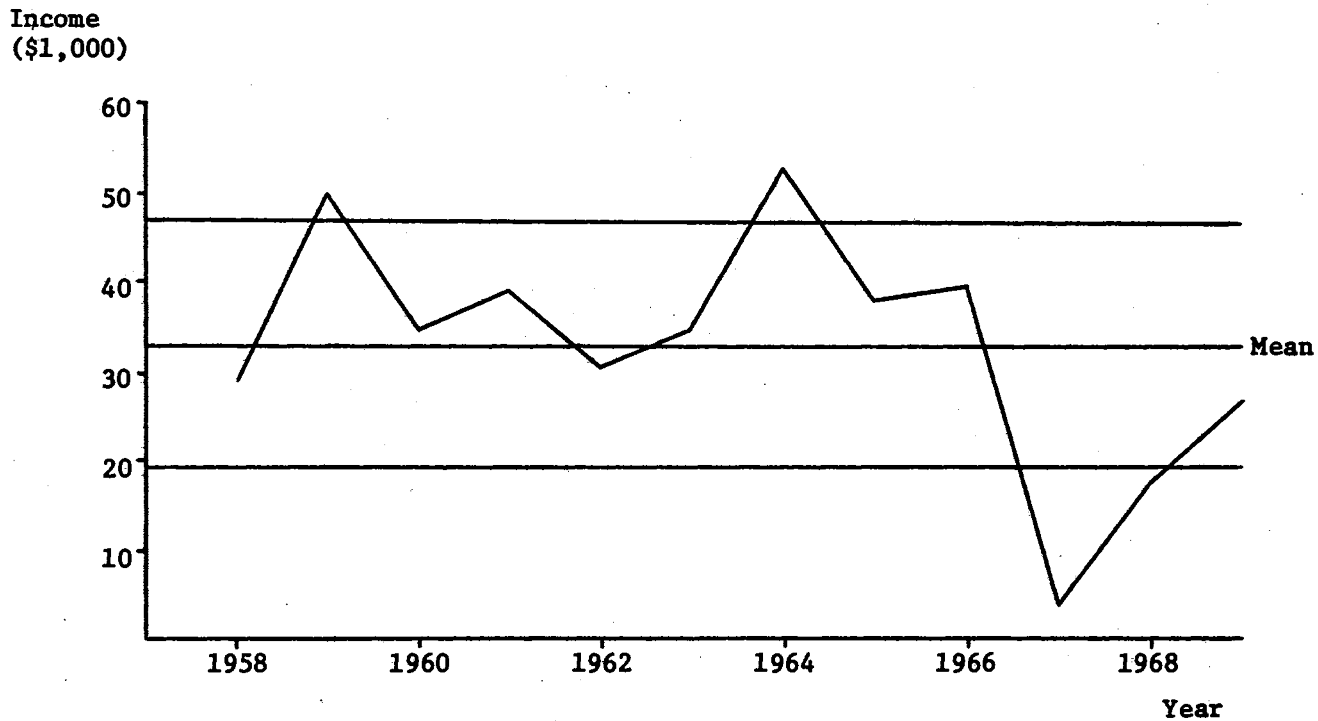

Figure 14. Annual Income and Range of One Standard Deviation From the Mean for 640 Acre Tenant Operated Two Man Farm at Maximum Income, 1958-69

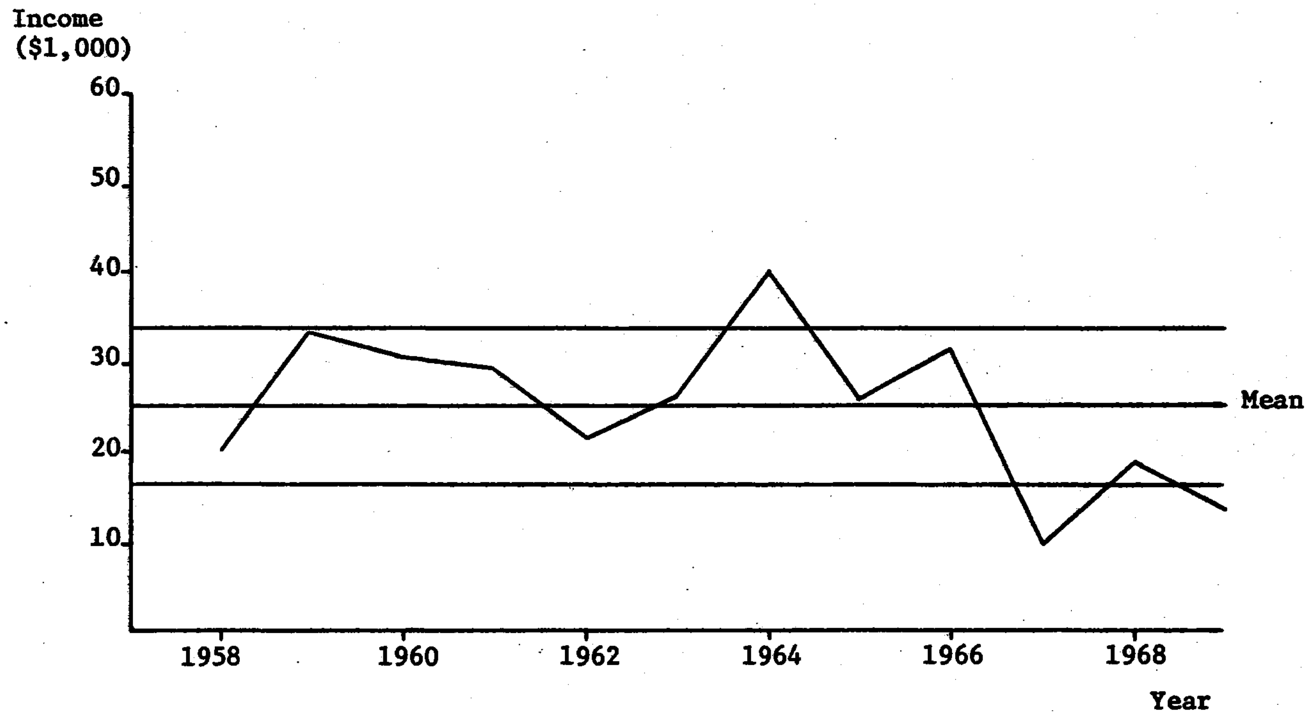

Figure 15. Annual Income and Range of One Standard Deviation From the Mean for 640 Acre Tenant Operated Two Man Farm at $25,000 Income Level, 1958-69

TABLE XXXII

MARGINAL VARIANCE FOR CONSTRAINTS AT SPECIFIED LEVELS OF INCOME FOR THE 640 ACRE TENANT-OPERATED TWO-MAN FARM

Resource Restrictions	Unit	$10,000	$12,500	$15,000	$17,500	$20,000	$22,500	$25,000	$27,500	$30,000	$30,500	$31,000	$32,759
Cropland	Acre	—	—	—	—	—	—	—	—	—	—	—	—
Mixed Cropland	Acre	—	—	—	—	19,949	50,807	98,123	184,992	271,861	289,235	306,608	a
Clay Cropland	Acre	—	—	—	—	—	—	—	—	—	—	—	—
Cotton Allotment	Acre	—	—	—	—	—	—	—	—	—	—	—	—
Labor													
December-April	Hour	—	—	—	—	—	—	—	—	—	—	—	—
May-June	Hour	—	—	—	—	—	—	—	—	—	—	—	—
July-September	Hour	—	—	—	—	—	—	28,140	75,333	122,526	131,964	141,403	a
October-November	Hour	—	—	—	—	—	—	—	—	—	—	—	—
Income	Dol.	2,224	2,780	3,336	3,892	4,851	6,026	8,502	12,288	16,074	16,831	17,588	a

[a]Values not estimated.

Three-Man Farm

Relative income variability for the three-man tenant-operated farm is identical to the two-man farm for efficient plans up through \$22,500 (Table XXIX). Farm organizations are also identical (Tables XXX and XXXIII). As with the two-man situation, mixed cropland also becomes limiting at \$20,000. Labor is never a limiting factor for the three-man farm (Table XXXIV). Crop organizations between the two- and three-man farm do not change until \$25,000 when July-September labor becomes a limiting factor for the two-man farm.

Maximum expected income is \$37,419 with a standard deviation of \$16,034 and a relative variability of 42.87 percent. The farm organization for the plan having maximum expected income includes seven acres of P_3 (allotment cotton on mixed soil), 363 acres of P_{14} (corn-wheat-grain sorghum, doublecrop rotation, on mixed soil) and 187 acres of P_{29} (allotment cotton on clay soil). There is neither unused land nor slack cotton allotment (Tables XXXIII and XXXIV).

The land resource is not completely utilized for income levels below \$32,500; however, at the \$30,000 level only one acre of clay soil is not utilized. There is a slack of 89 acres of cotton allotment at the \$30,000 level, 60 acres at \$32,500 and 31 acres at \$35,000. From a landlord-tenant relationship point of view, anything less than maximum expected income may not be acceptable. However, it may be possible for the tenant to rent cropland without the cotton allotment.

The farm organization for the efficient farm plan at the \$32,500 income level consists of 370 acres of P_{14} (corn-wheat-grain sorghum, doublecrop rotation, on mixed soil) and 134 acres of P_{29} (allotment

TABLE XXXIII

MINIMUM VARIANCE ORGANIZATION FOR SELECTED LEVELS OF INCOME FOR THE TENANT-OPERATED 640 ACRE THREE-MAN FARM

Activity[a]	$10,000 (1)	$12,500 (2)	$15,000 (3)	$17,500 (4)	$20,000 (5)	$22,500 (6)	$25,000 (7)	$27,500 (8)	$30,000 (9)	$32,500 (10)	$35,000 (11)	$37,419 (12)
	acres											
P_3	--	--	--	--	--	1.08	3.24	--	--	--	--	6.80
P_6	2.12	2.65	3.18	3.71	--	--	--	--	--	--	--	--
P_{11}	25.37	31.72	38.06	44.40	40.04	25.91	--	--	--	--	--	--
P_{14}	154.32	192.90	231.48	270.06	307.10	343.01	366.76	370.00	370.00	370.00	370.00	363.20
P_{27}	21.78	27.22	32.67	38.11	22.86	--	--	--	--	--	--	--
P_{29}	14.59	18.24	21.89	25.54	35.63	48.13	64.16	86,83	104.58	133.52	163.12	187.20
P_{36}	--	--	--	--	--	--	--	35.90	82.22	65.78	30.25	--
P_{38}	--	--	--	--	--	--	--	--	16.88	--	--	--
P_{41}	--	--	--	--	--	--	--	4.90	--	--	--	--
P_{42}	--	--	--	--	--	--	5.52	--	--	--	--	--
Set Aside[b]	2.92	3.65	4.38	5.11	7.13	9.84	13.48	17.37	20.92	26.70	32.62	38.80
Total	221.10	276.38	331.66	386.93	412.76	427.97	453.16	515.00	594.60	596.00	595.99	596.00
	dollars											
Standard Deviation	3,335	4,168	5,002	5,836	6,695	7,642	8,680	9,902	11,243	12.720	14,354	16,034
	percent											
Coefficient of Variation	33.4	33.4	33.4	33.4	33.5	34.0	34.7	36.0	37.5	39.1	41.0	42.9

[a]See Table XXI for crop description.

[b]To participate in the Government price support program for cotton, cropland equivalent to 20 percent of the cotton allotment must be taken out of production.

TABLE XXXIV

SLACK (UNUSED) RESOURCES AT SPECIFIED LEVELS OF INCOME FOR THE 640 ACRE TENANT-OPERATED THREE-MAN FARM

Resource Restrictions	Unit	$10,000	$12,500	$15,000	$17,500	$20,000	$22,500	$25,000	$27,500	$30,000	$32,500	$35,000	$37,419
Cropland	Acre	374.90	319.62	264.35	209.07	183.25	168.03	142.84	81.00	1.40	0.00	0.00	0.00
Mixed Cropland	Acre	166.41	115.51	64.62	13.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clay Cropland	Acre	208.49	204.11	199.73	195.35	183.25	168.03	142.84	81.00	1.40	0.00	0.00	0.00
Cotton Allotment	Acre	179.41	175.76	172.11	168.46	158.37	144.79	126.60	107.17	89.42	60.48	30.88	0.00
Labor													
December-April	Hour	1,034.91	973.39	911.87	850.34	812.08	781.77	739.07	697.57	643.31	633.54	616.08	601.38
May-June	Hour	775.27	738.84	702.41	665.98	660.86	666.14	636.76	591.01	522.50	521.10	503.66	483.58
July-September	Hour	917.73	819.41	721.10	622.78	541.93	464.90	399.87	325.63	237.00	217.23	191.73	178.32
October-November	Hour	676.35	639.94	603.53	567.11	557.51	558.41	520.31	450.89	371.13	332.91	296.50	253.48

cotton on clay soil). Income standard deviation is $12,720 with a relative variability of 39.14 percent. This compares with an $11,243 standard deviation and 37.48 percent variability at the $30,000 level.

The slope of the efficiency frontier decreases noticeably at expected income levels above $25,000 (Figure 16). However, this income level utilizes only 453 acres of cropland with a slack of 143 acres. The standard deviation is $8,680 resulting in 34.72 percent relative variability. The efficient organization is three acres of P_3 (allotment cotton on mixed soil), 367 acres of P_{14} (corn-wheat-grain sorghum, doublecrop rotation, on mixed soil), 64 acres of P_{29} (allotment cotton on clay soil), and six acres of P_{42} (soybeans, group VI-wheat-soybeans, group VI, doublecrop rotation, on clay soil). This is the only income level that included activity P_{42} in the efficient organization for both owner and tenant situations.

Realized Income

Income for the maximum expected income of $37,419 ranged from $5,561 in 1967 to $61,785 in 1964 for the 12 year period of 1958-69 (Figure 17). This compares with a low and a high of $10,250 in 1967 and $49,107 in 1964, respectively, for a $30,000 expected income (Figure 18). Although the $30,000 efficient organization has a $7,419 lower average return when compared with the maximum income plan, the lowest annual return is $4,689 higher than the lowest annual return of the maximum income plan.

The three-man tenant-operated farm has the same crop organization as the three-man owner-operated farm for the maximum income level. However, the owner-operated farm has a $30,108 higher income with a

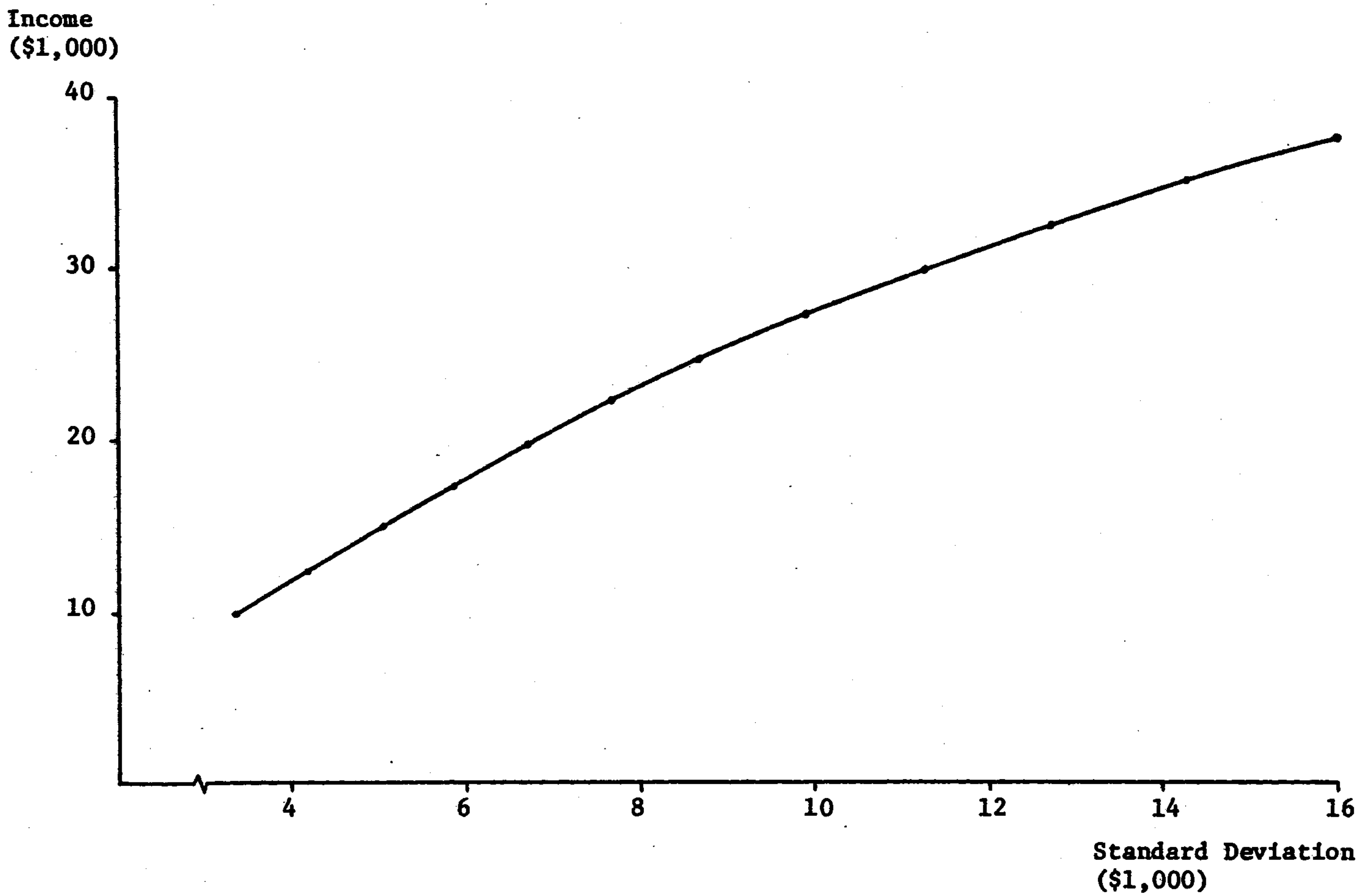

Figure 16. Income-Variance (Standard Deviation) Relationship for 640 Acre Tenant Operated Three Man Farm

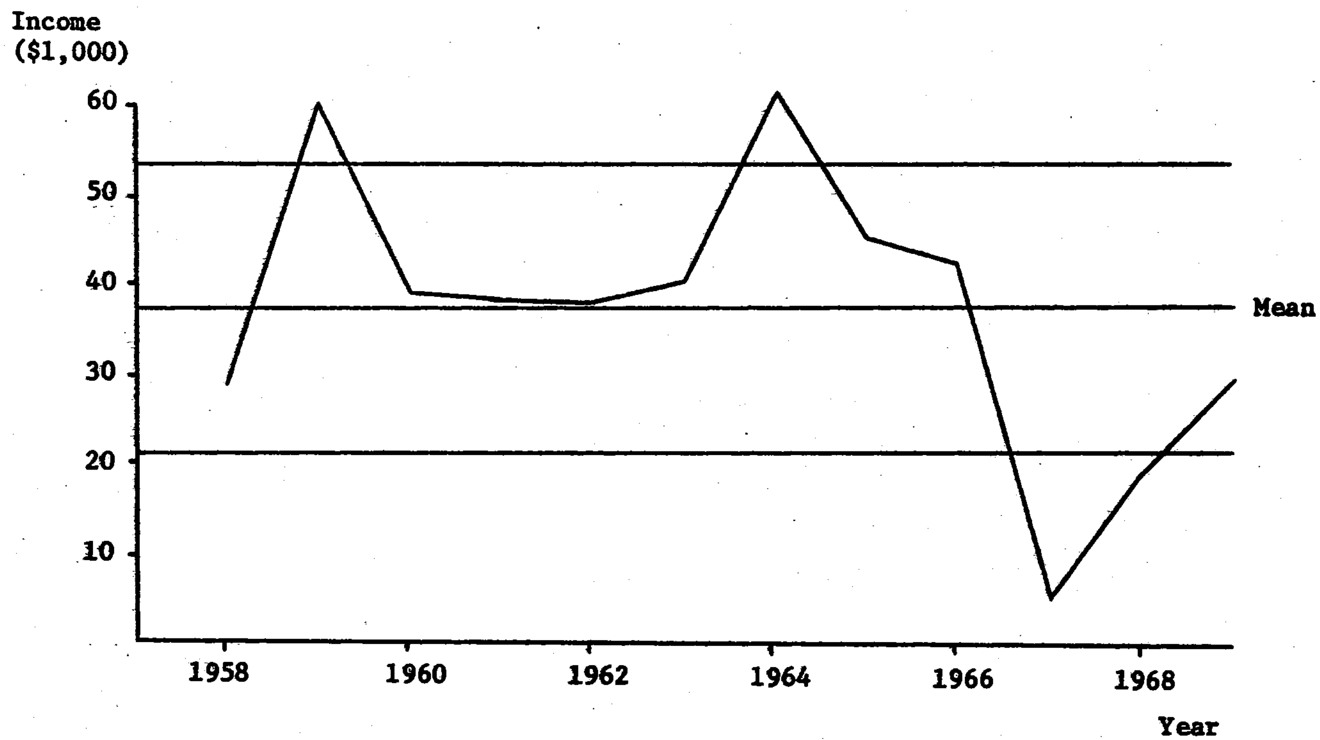

Figure 17. Annual Income and Range of One Standard Deviation From the Mean for 640 Acre Tenant Operated Three Man Farm at Maximum Income, 1958-69

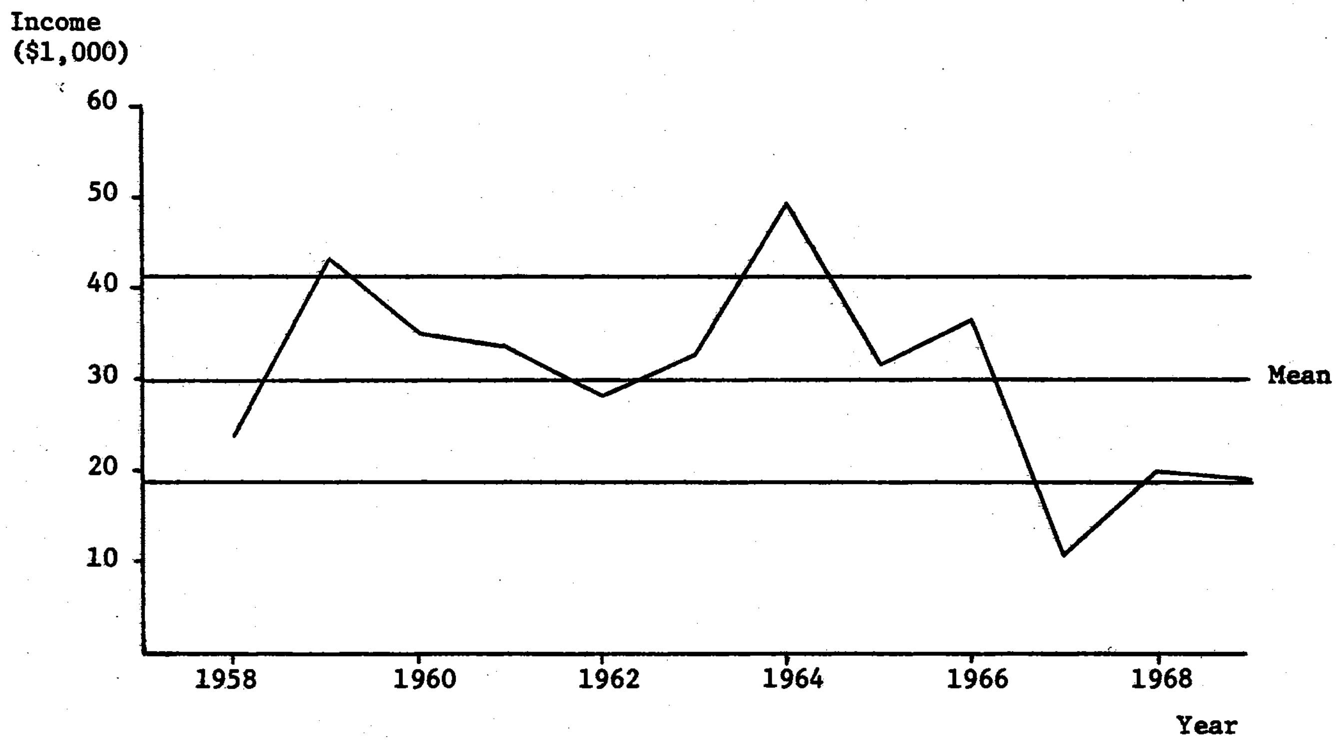

Figure 18. Annual Income and Range of One Standard Deviation From the Mean for 640 Acre Tenant Operated Three Man Farm at $30,000 Income Level, 1958-69

$5,673 higher standard deviation. The coefficient of variation is 32.16 and 42.87 percent for the owner and tenant farms, respectively (Table XXXV). The $30,108 higher income for the owner farm does not have any land cost deducted. If the tenant should become an owner he could expect this amount to cover all land costs and at the same time experience much less relative income variance. This suggests that the tenant not only can reduce risk by diversification but also by becoming an owner. Tenants can also reduce risk by renting only good mixed soil.

TABLE XXXV

COMPARISON OF EXPECTED INCOME AND VARIANCE FOR AN OWNER AND TENANT-OPERATED THREE-MAN FARM AT MAXIMUM EXPECTED INCOME

Tenancy	Expected Income	Standard Deviation	Coefficient of Variation, Percent
Owner	$67,527	$21,707	32.16
Tenant	37,419	16,034	42.87
Difference	$30,108	$ 5,673	10.71

Marginal Variance

Land, and primarily mixed cropland, is the only limiting resource for the restrictions imposed. Mixed cropland is slack for plans with expected income of less than $20,000. Marginal income variance per acre is $19,949 for the $20,000 efficient plan (Tables XXXIV and XXXVI) and increases to $693,715 for the plan having $37,419 expected income. Although clay land is completely utilized around the $30,000 income level it has no influence in reducing income variance by adding additional units. This is because clay land has lower expected returns and higher variance than mixed land. It is the last to be used. Even though its use will increase expected income it also increases variance by a relatively greater amount.

TABLE XXXVI

MARGINAL VARIANCE FOR CONSTRAINTS AT SPECIFIED LEVELS OF INCOME FOR THE 640 ACRE TENANT-OPERATED THREE-MAN FARM

Resource Restrictions	Unit	$10,000	$12,500	$15,000	$17,500	$20,000	$22,500	$25,000	$27,500	$30,000	$32,500	$35,000	$37,419
Cropland	Acre	--	--	--	--	--	--	--	--	--	38,518	80,444	211,353
Mixed Cropland	Acre	--	--	--	--	19,949	50,807	122,295	229,729	326,306	461,778	598,105	693,715
Clay Cropland	Acre	--	--	--	--	--	--	--	--	--	--	--	--
Cotton Allotment	Acre	--	--	--	--	--	--	--	--	--	--	--	--
Labor													
December-April	Hour	--	--	--	--	--	--	--	--	--	--	--	--
May-June	Hour	--	--	--	--	--	--	--	--	--	--	--	--
July-September	Hour	--	--	--	--	--	--	--	--	--	--	--	--
October-November	Hour	--	--	--	--	--	--	--	--	--	--	--	--
Income	Dol.	2,224	2,780	3,336	3,892	4,851	6,026	7,837	10,221	12,451	15,921	19,467	23,978

CHAPTER VI

SUMMARY AND CONCLUSIONS

Research in farm management and production economics is being directed to aid decision making under uncertainty. The planning tool used in this study, quadratic programming, offers considerable promise for planning commercial farms under conditions of uncertainty. Unlike linear programming which is based on single value expectations, quadratic programming also considers income variance. Quadratic solutions yield an efficiency frontier which is comprised of efficient farm plans having minimum income variance for the level of expected income. A quadratic programming model is used to select efficient plans for cotton-soybean type farms of the norther Mississippi River Delta area of Arkansas in this study.

Estimates of net return variability for selected or typical enterprises are based on estimated net returns per acre for the 20 year period 1950-69. Variety test data for the area provided the historic series on yields. Trend in yields was removed from the test data with the expected yield being set at the midpoint of the last half of the period. Product price data were adjusted to a constant price level with 1969 selected as the base. Trend was also removed from these data. Production costs were estimated for typical practices used in the area and were based on six-row equipment. Costs were based on 1969 prices with adjustments made for individual years. Adjustments were made according to an index of cost of production derived from U.S. Department of Agriculture estimates of cotton production costs for large farms of the area.

Efficient plans are derived for both a tenant operated and owner operated 640 acre farm. Labor restrictions are limited to first a two-man and then a three-man situation for each tenure arrangement. Results for a two-man farm appear unreliable because labor requirements are based on average weather conditions for the 20 year period. If annual weather data are used, labor availability is inadequate to perform some operations in a timely manner -- 13 out of 20 years for the two-man labor supply.

Efficient plans are computed for the owner-operated farms by \$5,000 increments in income from \$10,000 up to the maximum. Maximum expected income for the two-man farm is \$58,574 and for the three-man farm \$67,527. The standard deviation of income for the maximum expected income organization is \$20,109 and \$21,707 for the two labor situations, respectively. At these income levels the coefficient of variation is 34.33 percent for the two-man farm and 32.16 percent for the three-man farm. These expected incomes represent residual returns to land and management. Land costs are not deducted from gross income for the owner-operated farms.

By accepting a lower income, income variance can be reduced considerably in some instances. The efficient organization for the two-man farm having an expected income of \$55,000 has a standard deviation of \$14,235 -- approximately \$6,000 less than for the maximum income plan. Relative variability is also reduced with a coefficient of variation of 25.88 percent. The organization changes also. The \$55,000 efficient plan has 62 acres of allotment cotton on mixed soil, 308 acres of corn-wheat-grain sorghum, doublecrop rotation, on mixed soil, 58 acres of allotment cotton on clay soil, 140 acres group VI soybeans on clay soil and five acres of group V soybeans-wheat-group VI soybeans, double-crop rotation, on clay soil. Of 194 acres of cotton allotment only 120 acres are used. Total cropland of 596 acres is used. Cropland includes 370 acres of mixed soil and 226 acres of clay soil.

The efficient plan for the two-man farm at the maximum expected income of $58,574 is 71 acres of corn on mixed soil, 73 acres of allotment cotton on mixed soil, 226 acres of corn-wheat-grain sorghum, doublecrop rotation, on mixed soil, and 121 acres of allotment cotton on clay soil. Cotton allotment is completely utilized but 66 acres of clay cropland is unused because of insufficient labor.

The three-man owner-operated farm requires a much greater reduction in expected income to achieve a given reduction in variability than the two-man farm. Income variance and relative variability is similar for both labor situations at the $55,000 expected income level. The standard deviation is $13,968 and the coefficient of variation is 25.40 percent for the three-man farm at this income. The operator of the three-man farm has a higher degree of income certainty to begin with and, therefore, must give up more income for a given decrease in variability when expected income is above $55,000.

Both absolute and relative income variability increases as the expected income increases along the efficiency frontier. The range in income also increases to the extent that the plan for the maximum expected income also has the lowest income during the worst years. For example, the two-man owner-operated farm employing the plan having an expected income of $55,000 during the 12 year period, 1958-69, incurs the lowest annual income ($29,633) in 1967. This compares with a low of $17,255 for the maximum expected income plan which averaged $58,574. Thus, the lowest annual income is $12,378 lower for the efficient organization having the higher expected income.

Efficient plans are computed for the tenant-operated farm by $2,500 increments in income from $10,000 up to the maximum. Maximum expected income for the two-man tenant-operated farm is $32,759. The crop organization having maximum expected income is 88 acres of allotment cotton on mixed soil, 282 acres of corn-wheat-grain sorghum, doublecrop rotation, on mixed soil and 92 acres of allotment cotton on clay soil. Because of the limited labor supply only 487 acres of cropland are utilized with 109 acres of clay land unused. Thus, with only two full time men the tenant should rent no more than 487 acres of cropland.

The standard deviation for the $32,759 expected income of the two-man tenant-operated farm is $13,691 with a relative variability of 41.79 percent. Annual income, from following this organization, ranged from a low of $3,547 in 1967 to a high of $52,606 in 1964 for the 12 year period 1958-69. Relative income variability for the three-man tenant-operated farm is identical to the two-man farm for efficient plans with expected income of $22,500 or less. Crop organizations also are identical for plans having less than $25,000 expected income. July-September labor becomes a limiting factor for the two-man farm at this level of expected income.

The three-man tenant-operated farm has a maximum expected income of $37,419 with a standard deviation of $16,034 and relative variability of 42.87 percent. The efficient farm plan is identical to that for the owner-operated three-man farm at maximum income. However, the owner-operated farm has a $30,108 higher income with a $5,673 higher standard deviation and a coefficient of variation of only 32.16 percent. The $30,108 higher income for the owned farm has no land cost deducted. If the tenant should become an owner he could expect this amount of additional income to be available to cover the land costs. He could also expect less relative income variance. This suggests that the tenant not only could reduce risk by diversification but also by becoming an owner. Tenants can also reduce risk by farming only good mixed soil. Even when clay land is limiting or completely utilized income variance is not reduced by adding more clay cropland. This is not true for mixed soil because marginal income variance for mixed cropland becomes quite high when the maximum income level is approached for all farm situations programmed. For example, marginal income variance is $1,359,311 per acre at the maximum expected income for the three-man owner-operated farm. Thus, a one acre change in mixed cropland will change income variance by this amount. The reason income variance is not reduced by adding clay soil is because net returns are lower and variance higher than for mixed soil. Clay soil is the last to be used as expected income is increased along the efficiency frontier. Utilization of the clay soil will increase expected income but will also increase variance by a relatively greater amount.

The quadratic programming model used in this analysis is a more realistic approach to farm planning than linear programming. While it considers variability of net returns within one production period, it does not consider planning over time under uncertainty. It requires data on income variance which is not always available. However, quadratic programming is a definite aid to farm financial management because it supplies estimates of income variance for each plan on the efficiency frontier. A limiting factor to the full use of quadratic programming is the lack of information on the exact shape of an individual's utility function.

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APPENDIX

TABLE XXXVII

ALFALFA: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[a]				
Alfalfa Hay	Ton	5.95	--	--
Expenses				
Establishing				
Seed	Lb.	24.00	.56	13.44
Lime[b]	Ton	3.00	8.00	24.00
Fertilizer[c]	Cwt.	4.63	2.75	12.73
Tractor	Hour	1.68	2.55	4.28
Equipment	Acre	1.00	2.39	2.39
Miscellaneous[d]	Acre	1.00	1.26	1.26
Labor	Hour	2.16	1.50	3.24
Interest on Operating Capital[e]	Acre	1.00	2.45	12.25
Normalized at 5 Years[f]				14.72
Annual				
Fertilizer[g]	Cwt.	3.31	2.65	8.77
Herbicide[h]	Acre	.40	5.25	2.10
Insecticide[i]	Acre	2.00	.57	1.14
Tractor	Hour	7.12	2.55	18.16
Equipment	Acre	1.00	21.73	21.73
Miscellaneous[d]	Acre	1.00	6.76	6.76
Labor	Hour	16.45	1.50	24.68
Interest on Operating Capital[e]	Acre	1.00	1.67	1.67
				85.01
Total				99.73

[a]Expected yield.

[b]Custom operation.

[c]20-80-80 pounds of NPK per acre.

[d]Miscellaneous tools and pickup use.

[e]Eight percent on average cost.

[f]Establishing cost normalized on an annual basis with an average stand of five years.

TABLE XXXVII (CONTINUED)

[g]0-60-120 pounds of NPK per acre.

[h]Balan at the rate of .75 pound active material per acre.

[i]Two applications of Methyl Parathion at the rate of .50 pound active material per acre per application.

TABLE XXXVIII

CORN: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[a]				
Corn	Bu.	82.70	--	--
Expenses				
Seed	Lb.	12.00	.26	3.12
Fertilizer[b]	Cwt.	4.15	2.31	9.59
Pre-emergence Herbicide[c]	Acre	1.00	3.50	3.50
Post-emergence Herbicide[d]	Acre	1.00	.97	.97
Tractor	Hours	2.66	2.55	6.78
Equipment	Acre	1.00	11.92	11.92
Miscellaneous[e]	Acre	1.00	1.78	1.78
Labor	Hour	3.67	1.50	5.50
Interest on Operating Capital[f]	Acre	1.00	.86	.86
Total				44.02

[a]Expected yield.

[b]100-30-30 pounds of NPK per acre.

[c]Atrazine at the rate of 1.00 pound active material per acre.

[d]2, 4-D at the rate of .50 pounds active material per acre.

[e]Miscellaneous tools and pickup use.

[f]Eight percent on average cost.

TABLE XXXIX

COTTON: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[a]				
Cotton Lint	lb.	676.0	--	--
Cottonseed	Ton	.593	--	--
Expenses				
Seed	Lb.	24.00	.13	3.12
Fertilizer[b]	Cwt.	3.90	2.58	10.08
Pre-emergence Herbicide[c]	Acre	1.00	2.00	2.00
Post-emergence Herbicide[d]	Acre	2.00	1.12	2.24
Insecticide[e]	Acre	3.00	.90	2.70
Insecticide Application[f]	Acre	2.00	.75	1.50
Defoliant[g]	Acre	1.00	1.59	1.59
Defoliant Application[f]	Acre	1.00	1.25	1.25
Tractor	Hour	5.35	2.55	13.64
Equipment	Acre	1.00	30.74	30.74
Ginning, Bagging and Ties	Cwt.	20.48[h]	1.25	29.70
Miscellaneous[i]	Acre	1.00	4.73	4.73
Labor	Hour	10.78	1.59	16.17
Interest on Operating Capital[j]	Acre	1.00	2.39	2.39
Total				121.85

[a]Expected yield.

[b]80-30-30 pounds of NPK per acre.

[c]Cotoran at the rate of .40 pounds active material per acre.

[d]One application of Cotoran and MSMA at the rate of .25 and .75 pound active material, respectively, per acre and one application of Karmex and MSMA at the rate of .10 and .75 pound active material, respectively, per acre.

[e]One application of Bidrin at the rate of .20 pound active material per acre and two applications of Methyl Parathion at the rate of 1.00 pound active material per acre.

[f]Custom airplane.

[g]Phosphate at the rate of 1.50 pints per acre.

TABLE XXXIX (CONTINUED)

[h]33.4 percent lint, 57.5 percent seed and 9.1 percent trash.

[i]Miscellaneous tools and pickup use.

[j]Eight percent on average cost.

TABLE XL

GRAIN SORGHUM: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[a]				
Grain Sorghum	Bu.	61.60	--	--
Expenses				
Seed	Lb.	11.00	.19	2.09
Fertilizer[b]	Cwt.	3.22	2.54	8.18
Pre-emergence Herbicide[c]	Acre	1.00	3.13	3.13
Post-emergence Herbicide[d]	Acre	1.00	.97	.97
Tractor	Hour	2.62	2.55	6.68
Equipment	Acre	1.00	10.01	10.01
Drying	Bu.	61.60	.15	9.24
Miscellaneous[e]	Acre	1.00	1.68	1.68
Labor	Hour	3.43	1.50	5.14
Interest on Operating Capital[f]	Acre	1.00	.94	.94
Total				48.06

[a]Expected yield.

[b]80-20-20 pounds of NPK per acre.

[c]Propazine at the rate of 1.00 pound active material per acre.

[d]2, 4-D at the rate of .50 pound of active material per acre.

[e]Miscellaneous tools and pickup use.

[f]Eight percent on average cost.

TABLE XLI

OATS: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[a]				
Oats	Bu.	80.00	--	--
Expenses				
Seed	Bu.	2.00	1.58	3.16
Fertilizer[b]	Cwt.	2.96	2.42	7.16
Tractor	Hour	1.64	2.55	4.18
Equipment	Acre	1.00	8.43	8.43
Miscellaneous[c]	Acre	1.00	1.42	1.42
Labor	Hour	2.66	1.50	3.99
Interest on Operating Capital[d]	Acre	1.00	.57	.57
Total				28.91

[a]Expected yield.

[b]80-0-30 pounds of NPK per acre.

[c]Miscellaneous tools and equipment.

[d]Eight percent on average cost.

TABLE XLII

SOYBEANS, GROUP IV:[a] ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[b]				
Soybeans	Bu.	31.20	--	--
Expenses				
Seed	Bu.	1.20	3.55	4.26
Fertilizer[c]	Cwt.	.50	2.25	1.12
Pre-emergence Herbicide[d]	Acre	1.00	2.88	2.88
Post-emergence Herbicide[e]	Acre	2.00	1.61	3.22
Tractor	Hour	3.38	2.55	8.62
Equipment	Acre	1.00	10.00	10.00
Miscellaneous[f]	Acre	1.00	3.13	3.13
Labor	Hour	6.15	1.50	9.22
Interest on Operating Capital[g]	Acre	1.00	.85	.85
Total				43.30

[a]Very early maturing varieties.

[b]Expected yield.

[c]0-0-30 pounds of NPK per acre.

[d]Lorox at the rate of .50 pound active material per acre.

[e]One application of Dinoseb at the rate of .75 pounds active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

[f]Miscellaneous tools and pickup use.

[g]Eight percent on average cost.

TABLE XLIII

SOYBEANS, GROUP V:[a] ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[b]				
Soybeans	Bu.	31.30	--	--
Expenses				
Seed	Bu.	1.20	3.55	4.26
Fertilizer[c]	Cwt.	.50	2.25	1.12
Pre-emergence Herbicide[d]	Acre	1.00	2.88	2.88
Post-emergence Herbicide[e]	Acre	2.00	1.61	3.22
Tractor	Hour	3.38	2.55	8.62
Equipment	Acre	1.00	10.02	10.02
Miscellaneous[f]	Acre	1.00	3.13	3.13
Labor	Hour	6.15	1.50	9.22
Interest on Operating Capital[g]	Acre	1.00	.85	.85
Total				43.32

[a]Early maturing varieties.

[b]Expected yield.

[c]0-0-30 pounds of NPK per acre.

[d]Lorox at the rate of .50 pound active material per acre.

[e]One application of Dinoseb at the rate of .75 pound of active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

[f]Miscellaneous tools and pickup use.

[g]Eight percent on average cost.

TABLE XLIV

SOYBEANS, GROUP VI:[a] ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[b]				
Soybeans	Bu.	33.10	--	--
Expenses				
Seed	Bu.	1.20	3.55	4.26
Fertilizer[c]	Cwt.	.50	2.25	1.12
Pre-emergence Herbicide[d]	Acre	1.00	2.88	2.88
Post-emergence Herbicide[e]	Acre	2.00	1.61	3.22
Tractor	Hour	3.38	2.55	8.62
Equipment	Acre	1.00	10.02	10.02
Miscellaneous[f]	Acre	1.00	3.13	3.13
Labor	Hour	6.15	1.50	9.22
Interest on Operating Capital[g]	Acre	1.00	.85	.85
Total				43.32

[a]Midseason maturing varieties.

[b]Expected yield.

[c]0-0-30 pounds of NPK per acre.

[d]Lorox at the rate of .50 pound active material per acre.

[e]One application of Dinoseb at the rate of .75 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

[f]Miscellaneous tools and pickup use.

[g]Eight percent on average cost.

TABLE XLV

SOYBEANS, GROUP VII:[a] ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[b]				
Soybeans	Bu.	31.90	--	--
Expenses				
Seed	Bu.	1.20	3.55	4.26
Fertilizer[c]	Cwt.	.50	2.25	1.12
Pre-emergence Herbicide[e]	Acre	1.00	2.88	2.88
Post-emergence Herbicide[f]	Acre	2.00	1.61	3.22
Tractor	Hour	3.72	2.55	9.49
Equipment	Acre	1.00	10.50	10.50
Miscellaneous[g]	Acre	1.00	3.26	3.26
Labor	Hour	6.53	1.50	9.80
Interest on Operating Capital[h]	Acre	1.00	.89	.89
Total				45.42

[a]Late season maturing varieties.

[b]Expected yield.

[c]0-0-30 pounds of NPK per acre.

[d]Lorox at the rate of .50 pounds active material per acre.

[e]One application of Dinoseb at the rate of .75 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

[f]Miscellaneous tools and pickup use.

[g]Eight percent on average cost.

TABLE XLVI

WHEAT: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[a]				
Wheat	Bu.	51.10	--	--
Expenses				
Seed	Bu.	1.25	2.25	2.81
Fertilizer[b]	Cwt.	2.96	2.42	7.16
Tractor	Hour	1.64	2.55	4.18
Equipment	Acre	1.00	7.70	7.70
Miscellaneous[c]	Acre	1.00	1.42	1.42
Labor	Hour	2.66	1.50	3.99
Interest on Operating Capital[d]	Acre	1.00	.55	.55
Total				27.81

[a]Expected yield.

[b]80-0-30 of NPK per acre.

[c]Miscellaneous tools and pickup use.

[d]Eight percent on average cost.

TABLE XLVII

CORN-OATS-GRAIN SORGHUM, DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[ab]				
Corn	Bu.	41.35	--	--
Oats	Bu.	40.00	--	--
Grain Sorghum	Cwt.	25.20	--	--
Expenses[b]				
Corn				
Seed	Lb.	6.00	.26	1.56
Fertilizer[c]	Cwt.	2.08	2.31	4.80
Pre-emergence Herbicide[d]	Acre	.50	3.50	1.75
Post-emergence Herbicide[e]	Acre	.50	.97	.48
Tractor	Hour	1.33	2.55	3.39
Equipment	Acre	.50	11.92	5.96
Miscellaneous[f]	Acre	.50	1.78	.89
Labor	Hour	1.84	1.50	2.75
Interest on Operating Capital[g]	Acre	.50	.86	.43
				22.02
Oats				
Seed	Bu.	1.00	1.58	1.58
Fertilizer[h]	Cwt.	1.48	2.42	3.58
Tractor	Hour	.64	2.55	1.63
Equipment	Acre	.50	7.94	3.97
Miscellaneous[f]	Acre	.50	1.30	.65
Labor	Hour	1.16	1.50	1.73
Interest on Operating Capital[g]	Acre	.50	.52	.26
				13.40
Grain Sorghum				
Seed	Lb.	3.00	.19	.57
Fertilizer[i]	Cwt.	1.61	.254	4.09
Post-emergence Herbicide[e]	Acre	.50	.97	.48
Tractor	Hour	.94	2.55	2.41
Equipment	Acre	.50	8.30	4.15
Drying	Bu.	25.20	.15	3.78
Miscellaneous[f]	Acre	.50	1.42	.71
Labor	Hour	1.32	1.50	1.97
Interest on Operating Capital[g]	Acre	.50	.72	.36
				18.52
Total				53.94

TABLE XLVII (CONTINUED)

[a]Expected yield.

[b]One-half acre each.

[c]100-30-30 pounds of NPK per acre.

[d]Lasso at the rate of .75 pound active material per acre.

[e]2, 4-D at the rate of .50 pound active material per acre.

[f]Miscellaneous tools and pickup use.

[g]Eight percent on average cost.

[h]80-0-30 pounds of NPK per acre.

[i]80-20-20 pounds of NPK per acre.

TABLE XLVIII

CORN-OATS-SOYBEANS, GROUP VI,[a] DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[bc]				
Corn	Bu.	41.35	--	--
Oats	Bu.	40.00	--	--
Soybeans, Group VI	Bu.	12.65	--	--
Expenses[c]				
Corn				
Seed	Lb.	6.00	.26	1.56
Fertilizer[d]	Cwt.	2.08	2.31	4.80
Pre-emergence Herbicide[e]	Acre	.50	3.50	1.75
Post-emergence Herbicide[f]	Acre	.50	.97	.48
Tractor	Hour	1.33	2.55	3.39
Equipment	Acre	.50	11.92	5.96
Miscellaneous[g]	Acre	.50	1.78	.89
Labor	Hour	1.84	1.50	2.76
Interest on Operating Capital[h]	Acre	.50	.86	.43
				22.02
Oats				
Seed	Bu.	1.00	1.58	1.58
Fertilizer[i]	Cwt.	1.48	2.42	3.88
Tractor	Hour	.64	2.55	1.63
Equipment	Acre	.50	7.94	3.97
Miscellaneous[g]	Acre	.50	1.30	.65
Labor	Hour	1.16	1.50	1.73
Interest on Operating Capital[h]	Acre	.50	.52	.26
				13.40
Soybeans, Group VI				
Seed	Bu.	.50	3.55	1.78
Fertilizer[j]	Cwt.	.25	2.25	.56
Post-emergence Herbicide[k]	Acre	1.00	1.61	1.61
Tractor	Hour	1.01	2.55	2.58
Equipment	Acre	.50	7.72	3.86
Miscellaneous[g]	Acre	.50	1.46	.73
Labor	Hour	1.38	1.50	2.07
Interest on Operating Capital[h]	Acre	.50	.52	.26
				13.45
Total				48.87

TABLE XLVIII (CONTINUED)

[a]Midseason maturing varieities.

[b]Expected yield.

[c]One-half acre each.

[d]100-30-30 pounds of NPK per acre.

[e]Lasso at the rate of .75 pound active material per acre.

[f]2, 4-D at the rate of .50 pound active material per acre.

[g]Miscellaneous tools and pickup use.

[h]Eight percent on average cost.

[i]80-0-30 pounds of NPK per acre.

[j]0-0-30 pounds of NPK per acre.

[k]One application of Dinoseb at the rate of .75 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

TABLE XLIX

CORN-WHEAT-GRAIN SORGHUM, DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[ab]				
Corn	Bu.	41.35	--	--
Wheat	Bu.	25.55	--	--
Grain Sorghum	Cwt.	25.20	--	--
Expenses[b]				
Corn				
Seed	Lb.	6.00	.26	1.56
Fertilizer[c]	Cwt.	2.08	2.31	4.80
Pre-emergence Herbicide[d]	Acre	.50	3.50	1.75
Post-emergence Herbicide[e]	Acre	.50	.97	.48
Tractor	Hour	1.33	2.55	3.39
Equipment	Acre	.50	11.92	5.96
Miscellaneous[f]	Acre	.50	1.78	.89
Labor	Hour	1.84	1.50	2.76
Interest on Operating Capital[g]	Acre	.50	.86	.43
				22.02
Wheat				
Seed	Bu.	.62	2.25	1.40
Fertilizer[h]	Cwt.	1.48	2.42	3.58
Tractor	Hour	.64	2.55	1.64
Equipment	Acre	.50	7.28	3.64
Miscellaneous[f]	Acre	.50	1.30	.65
Labor	Hour	1.16	1.50	1.73
Interest on Operating Capital[g]	Acre	.50	.50	.25
				12.89
Grain Sorghum				
Seed	Lb.	3.00	.19	.57
Fertilizer[i]	Cwt.	1.61	2.54	4.09
Post-emergence Herbicide[e]	Acre	.50	.97	.48
Tractor	Hour	.94	2.55	2.41
Equipment	Acre	.50	8.30	4.15
Drying	Bu.	25.20	.15	3.78
Miscellaneous[f]	Acre	.50	1.42	.71
Labor	Hour	1.32	1.50	1.97
Interest on Operating Capital[g]	Acre	.50	.72	.36
				18.52
Total				53.43

TABLE XLIX (CONTINUED)

[a]Expected yield.

[b]One-half acre each.

[c]100-30-30 pounds of NPK per acre.

[d]Lasso at the rate of .75 pound active material per acre.

[e]2, 4-D at the rate of .50 pound active material per acre.

[f]Miscellaneous tools and pickup use.

[g]Eight percent on average cost.

[h]80-0-30 pounds of NPK per acre.

[i]80-20-20 pounds of NPK per acre.

TABLE L

CORN-WHEAT-SOYBEANS, GROUP VI,[a] DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[bc]				
Corn	Bu.	41.35	--	--
Wheat	Bu.	25.55	--	--
Soybeans, Group VI	Bu.	13.60	--	--
Expenses[c]				
Corn				
Seed	Lb.	6.00	.26	1.56
Fertilizer[d]	Cwt.	2.08	2.31	4.80
Pre-emergence Herbicide[e]	Acre	.50	3.50	1.75
Post-emergence Herbicide[f]	Acre	.50	.97	.48
Tractor	Hour	1.33	2.55	3.39
Equipment	Acre	.50	11.92	5.96
Miscellaneous[g]	Acre	.50	1.78	.89
Labor	Hour	1.84	1.50	2.76
Interest on Operating Capital[h]	Acre	.50	.86	.43
				22.02
Wheat				
Seed	Bu.	.62	2.25	1.40
Fertilizer[i]	Cwt.	1.48	2.42	3.88
Tractor	Hour	.64	2.55	1.64
Equipment	Acre	.50	7.94	3.64
Miscellaneous[g]	Acre	.50	1.30	.65
Labor	Hour	1.16	1.50	1.73
Interest on Operating Capital[h]	Acre	.50	.50	.25
				12.89
Soybeans, Group VI				
Seed	Bu.	.50	3.55	1.78
Fertilizer[j]	Cwt.	.25	2.25	.56
Post-emergence Herbicide[k]	Acre	1.00	1.61	1.61
Tractor	Hour	1.01	2.55	2.58
Equipment	Acre	.50	7.72	3.86
Miscellaneous[g]	Acre	.50	1.46	.73
Labor	Hour	1.38	1.50	2.07
Interest on Operating Capital[h]	Acre	.50	.52	.26
				13.45
Total				48.36

TABLE L (CONTINUED)

[a]Midseason maturing varieties.

[b]Expected yield.

[c]One-half acre each

[d]100-30-30 pounds of NPK per acre.

[e]Lasso at the rate of .75 pound active material per acre.

[f]2, 4-D at the rate of .50 pound active material per acre.

[g]Miscellaneous tools and pickup use.

[h]Eight percent on average cost.

[i]80-0-30 pounds of NPK per acre.

[j]0-0-30 pounds of NPK per acre.

[k]One application of Dinoseb at the rate of .75 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

TABLE LI

GRAIN SORGHUM-OATS-GRAIN SORGHUM, DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[ab]				
Grain Sorghum	Bu.	30.80	--	--
Oats	Bu.	37.35	--	--
Grain Sorghum	Bu.	25.20	--	--
Expenses[b]				
Grain Sorghum				
Seed	Lb.	5.50	.19	1.04
Fertilizer[c]	Cwt.	1.61	2.54	4.09
Pre-emergence Herbicide[d]	Acre	.50	3.13	1.56
Post-emergence Herbicide[e]	Acre	.50	.97	.48
Tractor	Hour	1.31	2.55	3.34
Equipment	Acre	.50	10.01	5.00
Drying	Bu.	30.80	.15	4.62
Miscellaneous[f]	Acre	.50	1.68	.84
Labor	Hour	1.72	1.50	2.57
Interest on Operating Capital[g]	Acre	.50	.94	.48
				24.49
Oats				
Seed	Bu.	1.00	1.58	1.58
Fertilizer[h]	Cwt.	1.48	2.42	3.88
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	7.72	3.86
Miscellaneous[f]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[g]	Acre	.50	.52	.26
				13.33
Grain Sorghum				
Seed	Lb.	3.00	.19	.57
Fertilizer[c]	Cwt.	1.61	2.54	4.09
Post-emergence Herbicide[e]	Acre	.50	.97	.48
Tractor	Hour	.94	2.55	2.40
Equipment	Acre	.50	8.30	4.15
Drying	Bu.	25.20	.15	3.78
Miscellaneous[f]	Acre	.50	1.42	.71
Labor	Hour	1.31	1.50	1.97
Interest on Operating Capital[g]	Acre	.50	.72	.36
				18.51

TABLE LI (CONTINUED)

Item	Unit	Quantity	Price	Amount
			($)	($)
Total				56.33

[a]Expected yield.

[b]One-half acre each.

[c]80-20-20 pounds of NPK per acre.

[d]Herban at the rate of .50 pound active material per acre.

[e]2, 4-D at the rate of .50 pound active material per acre.

[f]Miscellaneous tools and pickup use.

[g]Eight percent on average cost.

[h]80-0-30 pounds of NPK per acre.

TABLE LII

GRAIN SORGHUM-OATS-SOYBEANS, GROUP VI,[a] DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[bc]				
Grain Sorghum	Bu.	30.80	--	--
Oats	Bu.	37.35	--	--
Soybeans, Group VI[a]	Bu.	12.65	--	--
Expenses[c]				
Grain Sorghum				
Seed	Lb.	5.50	.19	1.04
Fertilizer[d]	Cwt.	1.61	2.54	4.09
Pre-emergence Herbicide[e]	Acre	.50	3.13	1.56
Post-emergence Herbicide[f]	Acre	.50	.97	.48
Tractor	Hour	1.31	2.55	3.34
Equipment	Acre	.50	10.01	5.00
Drying	Bu.	30.80	.15	4.62
Miscellaneous[g]	Acre	1.00	.85	.85
Labor	Hour	1.72	1.50	2.57
Interest on Operating Capital[h]	Acre	.50	.94	.48
				24.49
Oats				
Seed	Bu.	1.00	1.58	1.58
Fertilizer[i]	Cwt.	1.48	2.42	3.88
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	7.72	3.86
Miscellaneous[g]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[h]	Acre	.50	.52	.26
				13.33
Soybeans, Group VI				
Seed	Bu.	.50	3.55	1.78
Fertilizer[j]	Cwt.	.25	2.25	.56
Post-emergence Herbicide[k]	Acre	1.00	1.61	1.61
Tractor	Hour	1.01	2.55	2.58
Equipment	Acre	.50	7.72	3.86
Miscellaneous[g]	Acre	.50	1.46	.73
Labor	Hour	1.38	1.50	2.07
Interest on Operating Capital[h]	Acre	.50	.52	.26
				13.45
Total				51.27

TABLE LII (CONTINUED)

[a]Midseason maturing varieties.

[b]Expected yields.

[c]One-half acre each.

[d]80-20-20 pounds of NPK per acre.

[e]Herban at the rate of .50 pound active material per acre.

[f]2, 4-D at the rate of .50 pound active material per acre.

[g]Miscellaneous tools and pickup use.

[h]Eight percent on average cost.

[i]80-0-30 pounds of NPK per acre.

[j]0-0-30 pounds of NPK per acre.

[k]One application of Dinoseb at the rate of .75 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

TABLE LIII

GRAIN SORGHUM-WHEAT-GRAIN SORGHUM, DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[ab]				
Grain Sorghum	Bu.	30.80	--	--
Wheat	Bu.	25.55	--	--
Grain Sorghum	Bu.	25.20	--	--
Expenses[b]				
Grain Sorghum				
Seed	Lb.	5.50	.19	1.04
Fertilizer[c]	Cwt.	1.61	2.54	4.09
Pre-emergence Herbicide[d]	Acre	.50	3.13	1.56
Post-emergence Herbicide[e]	Acre	.50	.97	.48
Tractor	Hour	1.31	2.55	3.34
Equipment	Acre	.50	10.01	5.00
Drying	Bu.	30.80	.15	4.62
Miscellaneous[f]	Acre	.50	1.68	.84
Labor	Hour	1.72	1.50	2.57
Interest on Operating Capital[g]	Acre	.50	.94	.48
				24.49
Wheat				
Seed	Bu.	.62	2.25	1.40
Fertilizer[h]	Cwt.	1.48	2.42	3.88
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	7.04	3.52
Miscellaneous[f]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[g]	Acre	.50	.50	.25
				12.80
Grain Sorghum				
Seed	Lb.	3.00	.19	.57
Fertilizer[c]	Cwt.	1.61	2.54	4.09
Post-emergence Herbicide[e]	Acre	.50	.97	.48
Tractor	Hour	.94	2.55	2.40
Equipment	Acre	.50	8.30	4.15
Drying	Bu.	25.20	.15	3.78
Miscellaneous[f]	Acre	.50	1.42	.71
Labor	Hour	1.31	1.50	1.97
Interest on Operating Capital[g]	Acre	.50	.72	.36
				18.51

TABLE LIII (CONTINUED)

Item	Unit	Quantity	Price	Amount
			($)	($)
Total				55.80

[a]Expected yield.

[b]One-half acre each.

[c]80-20-20 pounds of NPK per acre.

[d]Herban at the rate of .50 pound active material per acre.

[e]2, 4-D at the rate of .50 pound active material per acre.

[f]Miscellaneous tools and pickup use.

[g]Eight percent on average cost.

[h]80-0-30 pounds of NPK per acre.

TABLE LIV

GRAIN SORGHUM-WHEAT-SOYBEANS, GROUP VI,[a] DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[bc]				
Grain Sorghum	Bu.	30.80	--	--
Wheat	Bu.	25.55	--	--
Soybeans, Group VI	Bu.	13.60	--	--
Expenses[c]				
Grain Sorghum				
Seed	Lb.	5.50	.19	1.04
Fertilizer[d]	Cwt.	1.61	2.54	4.09
Pre-emergence Herbicide[e]	Acre	.50	3.13	1.56
Post-emergence Herbicide[f]	Acre	.50	.97	.48
Tractor	Hour	1.31	2.55	3.34
Equipment	Acre	.50	10.01	5.00
Drying	Bu.	30.80	.15	4.62
Miscellaneous[g]	Acre	.50	1.68	.84
Labor	Hour	1.72	1.50	2.57
Interest on Operating Capital[h]	Acre	.50	.94	.48
				24.49
Wheat				
Seed	Bu.	.62	2.25	1.40
Fertilizer[i]	Cwt.	1.48	2.42	3.88
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	7.04	3.52
Miscellaneous[g]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[h]	Acre	.50	.50	.25
				12.80
Soybeans, Group VI				
Seed	Bu.	.50	3.55	1.78
Fertilizer[j]	Cwt.	.25	2.25	.56
Post-emergence Herbicide[k]	Acre	1.00	1.61	1.61
Tractor	Hour	1.01	2.55	2.58
Equipment	Acre	.50	7.68	3.86
Miscellaneous[g]	Acre	.50	1.46	.73
Labor	Hour	1.38	1.50	2.07
Interest on Operating Capital[h]	Acre	.50	.52	.26
				13.45
Total				50.74

TABLE LIV (CONTINUED)

[a]Midseason maturing varieties.

[b]Expected yield.

[c]One-half acre each.

[d]80-20-20 pounds of NPK per acre.

[e]Herban at the rate of .50 pound active material per acre.

[f]2, 4-D at the rate of .50 pound active material per acre.

[g]Miscellaneous tools and pickup use.

[h]Eight percent on average cost.

[i]80-0-30 pounds of NPK per acre.

[j]0-0-30 pounds of NPK per acre.

[k]One application of Dinoseb at the rate of .75 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

TABLE LV

SOYBEANS, GROUP V[a]-OATS-GRAIN SORGHUM, DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[bc]				
Soybeans	Bu.	15.65	--	--
Oats	Bu.	34.70	--	--
Grain Sorghum	Bu.	25.20	--	--
Expenses[c]				
Soybeans, Group V				
Seed	Bu.	.60	3.55	2.13
Fertilizer[d]	Cwt.	.25	2.25	.56
Pre-emergence Herbicide[e]	Acre	.50	2.88	1.44
Post-emergence Herbicide[f]	Acre	1.00	1.61	1.61
Tractor	Hour	1.69	2.55	4.31
Equipment	Acre	.50	10.02	5.01
Miscellaneous[g]	Acre	.50	3.13	1.56
Labor	Hour	3.08	1.50	4.61
Interest on Operating Capital[h]	Acre	.50	.84	.42
				21.65
Oats				
Seed	Bu.	1.00	1.58	1.58
Fertilizer[i]	Cwt.	1.48	2.42	3.88
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	7.48	3.74
Miscellaneous[g]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[h]	Acre	.50	.52	.26
				13.21
Grain Sorghum				
Seed	Lb.	3.00	.19	.57
Fertilizer[j]	Cwt.	1.61	2.54	4.09
Post-emergence Herbicide[k]	Acre	.50	.97	.48
Tractor	Hour	.94	2.55	2.40
Equipment	Acre	.50	8.30	4.15
Drying	Bu.	25.20	.15	3.78
Miscellaneous[g]	Acre	.50	1.42	.71
Labor	Hour	1.32	1.50	1.98
Interest on Operating Capital[h]	Acre	.50	.72	.36
				18.52
Total				53.37

TABLE LV (CONTINUED)

[a]Early maturing varieties.

[b]Expected yield.

[c]One-half acre each.

[d]0-0-30 pounds of NPK per acre.

[e]Lorox at the rate of .50 pound active material per acre.

[f]One application of Dinoseb at the rate of .76 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

[g]Miscellaneous tools and pickup use.

[h]Eight percent on average cost.

[i]80-0-30 pounds of NPK per acre.

[j]80-20-20 pounds of NPK per acre.

[k]2, 4-D at the rate of .50 pound active material per acre.

TABLE LVI

SOYBEANS, GROUP V[a]-OATS-SOYBEANS, GROUP VI,[b] DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[cd]				
Soybeans, Group V	Bu.	15.65	--	--
Oats	Bu.	34.70	--	--
Soybeans, Group VI	Bu.	13.60	--	--
Expenses[d]				
Soybeans, Group V				
Seed	Bu.	.60	3.55	2.13
Fertilizer[e]	Cwt.	.25	2.25	.56
Pre-emergence Herbicide[f]	Acre	.50	2.88	1.44
Post-emergence Herbicide[g]	Acre	1.50	1.61	1.61
Tractor	Hour	1.69	2.55	4.31
Equipment	Acre	.50	10.00	5.00
Miscellaneous[h]	Acre	.50	3.13	1.56
Labor	Hour	3.08	1.50	4.61
Interest on Operating Capital[i]	Acre	.50	.84	.42
				21.64
Oats				
Seed	Bu.	1.00	1.58	1.58
Fertilizer[j]	Cwt.	1.48	2.42	3.88
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	7.48	3.74
Miscellaneous[h]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital	Acre	.50	.52	.26
				13.21
Soybeans, Group VI				
Seed	Bu.	.50	3.55	1.78
Fertilizer[e]	Cwt.	.25	2.25	.56
Post-emergence Herbicide[g]	Acre	1.00	1.61	1.61
Tractor	Hour	1.01	2.55	2.58
Equipment	Acre	.50	7.72	3.86
Miscellaneous[h]	Acre	.50	1.46	.73
Labor	Hour	1.38	1.50	2.07
Interest on Operating Capital[i]	Acre	.50	.52	.26
				13.43
Total				48.30

TABLE LVI (CONTINUED)

[a]Early maturing varieties.

[b]Midseason maturing varieties.

[c]Expected yield.

[d]One-half acre each.

[e]0-0-30 pounds of NPK per acre.

[f]Lorox at the rate of .50 pound active material per acre.

[g]One application of Dinoseb at the rate of .75 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

[h]Miscellaneous tools and pickup use.

[i]Eight percent on average cost.

[j]80-0-30 pounds of NPK per acre.

TABLE LVII

SOYBEANS, GROUP V[a]-WHEAT-GRAIN SORGHUM, DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[bc]				
Soybeans, Group V	Bu.	15.65	--	--
Wheat	Bu.	23.90	--	--
Grain Sorghum	Bu.	25.20	--	--
Expenses[c]				
Soybeans, Group V				
Seed	Bu.	.60	3.55	2.13
Fertilizer[d]	Cwt.	.25	2.25	.56
Pre-emergence Herbicide[e]	Acre	.50	2.88	1.44
Post-emergence Herbicede[f]	Acre	1.00	1.61	1.61
Tractor	Hour	1.69	2.55	4.31
Equipment	Acre	.50	10.02	5.01
Miscellaneous[g]	Acre	.50	3.13	1.56
Labor	Hour	3.08	1.50	4.62
Interest on Operating Capital[h]	Acre	.50	.84	.42
				21.66
Wheat				
Seed	Bu.	.62	2.25	1.40
Fertilizer[i]	Cwt.	1.48	2.42	3.88
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	6.84	3.42
Miscellaneous[g]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[h]	Acre	.50	.50	.25
				12.70
Grain Sorghum				
Seed	Lb.	3.00	.19	.57
Fertilizer[j]	Cwt.	1.61	2.54	4.09
Post-emergence Herbicide[k]	Acre	.50	.97	.48
Tractor	Hour	.94	2.55	2.40
Equipment	Acre	.50	8.30	4.15
Drying	Bu.	25.20	.15	3.78
Miscellaneous[g]	Acre	.50	1.42	.71
Labor	Hour	1.32	1.50	1.98
Interest on Operating Capital[h]	Acre	.50	.72	.36
				18.52
Total				52.88

TABLE LVII (CONTINUED)

[a]Early maturing varieties.

[b]Expected yield.

[c]One-half acre each.

[d]0-0-30 pounds of NPK per acre.

[e]Lorox at the rate of .50 pound active material per acre.

[f]One application of Dinoseb at the rate of .75 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

[g]Miscellaneous tools and pickup use.

[h]Eight percent on average cost.

[i]80-0-30 pounds of NPK per acre.

[j]80-20-20 pounds of NPK per acre.

[k]2, 4-D at the rate of .50 pound active material per acre.

TABLE LVIII

SOYBEANS, GROUP V[a]-WHEAT-SOYBEANS, GROUP VI,[b] DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOIL

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[cd]				
Soybeans, Group V	Bu.	15.65	--	--
Wheat	Bu.	23.90	--	--
Soybeans, Group VI	Bu.	13.60	--	--
Expenses[d]				
Soybeans, Group V				
Seed	Bu.	.60	3.55	2.13
Fertilizer[e]	Cwt.	.25	2.25	.56
Pre-emergence Herbicide[f]	Acre	.50	2.88	1.44
Post-emergence Herbicide[g]	Acre	1.00	1.61	1.61
Tractor	Hour	1.69	2.55	4.31
Equipment	Acre	.50	10.02	5.01
Miscellaneous[h]	Acre	.50	3.13	1.56
Labor	Hour	3.08	1.50	4.62
Interest on Operating Capital[i]	Acre	.50	.84	.42
				21.66
Wheat				
Seed	Bu.	.62	2.25	1.40
Fertilizer[j]	Cwt.	1.48	2.42	3.88
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	6.84	3.42
Miscellaneous[h]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[i]	Acre	.50	.50	.25
				12.70
Soybeans, Group VI				
Seed	Bu.	.50	3.55	1.78
Fertilizer[e]	Cwt.	.25	2.25	.56
Post-emergence Herbicide[g]	Acre	1.00	1.61	1.61
Tractor	Hour	1.01	2.55	2.58
Equipment	Acre	.50	7.72	3.86
Miscellaneous[h]	Acre	.50	1.46	.73
Labor	Hour	1.38	1.50	2.07
Interest on Operating Capital[i]	Acre	.50	.52	.26
				13.45
Total				47.81

TABLE LVIII (CONTINUED)

[a]Early maturing varieties.

[b]Midseason maturing varieties.

[c]Expected yield.

[d]One-half acre each.

[e]0-0-30 pounds of NPK per acre.

[f]Lorox at the rate of .50 pound active material per acre.

[g]One application of Dinoseb at the rate of .75 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

[h]Miscellaneous tools and pickup use.

[i]Eight percent on average cost.

[j]80-0-30 pounds of NPK per acre.

TABLE LIX

SOYBEANS, GROUP VI[a]-OATS-GRAIN SORGHUM, DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[bc]				
Soybeans, Group VI	Bu.	16.55	--	--
Oats	Bu.	31.95	--	--
Grain Sorghum	Bu.	25.20	--	--
Expenses[c]				
Soybeans, Group VI				
Seed	Bu.	.60	3.55	2.13
Fertilizer[d]	Cwt.	.25	2.25	.56
Pre-emergence Herbicide[e]	Acre	.50	2.88	1.44
Post-emergence Herbicide[f]	Acre	1.00	1.61	1.61
Tractor	Hour	1.69	2.55	4.31
Equipment	Acre	.50	10.62	5.01
Miscellaneous[g]	Acre	.50	3.13	1.56
Labor	Hour	3.08	1.50	4.62
Interest on Operating Capital[h]	Acre	.50	.85	.42
				21.65
Oats				
Seed	Bu.	1.00	1.58	1.58
Fertilizer[i]	Cwt.	1.48	2.42	3.88
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	7.38	3.69
Miscellaneous[g]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[h]	Acre	.50	.52	.26
				13.16
Grain Sorghum				
Seed	Lb.	3.00	.19	.57
Fertilizer[j]	Cwt.	1.61	2.54	4.09
Post-emergence Herbicide[k]	Acre	.50	.97	.48
Tractor	Hour	.94	2.55	2.40
Equipment	Acre	.50	8.30	4.15
Drying	Bu.	25.20	.15	3.78
Miscellaneous[g]	Acre	.50	1.42	.71
Labor	Hour	1.32	1.50	1.98
Interest on Operating Capital[h]	Acre	.50	.72	.36
				18.52
Total				53.33

TABLE LIX (CONTINUED)

[a]Midseason maturing varieties.

[b]Expected yield.

[c]One-half acre each.

[d]0-0-30 pounds of NPK per acre.

[e]Lorox at the rate of .50 pound active material per acre.

[f]One application of Dinoseb at the rate of .75 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

[g]Miscellaneous tools and pickup use.

[h]Eight percent on average cost.

[i]80-0-30 pounds of NPK per acre.

[j]80-20-20 pounds of NPK per acre.

[k]2, 4-D at the rate of .50 pound active material per acre.

TABLE LX

SOYBEANS, GROUP VI[a]-OATS-SOYBEANS, GROUP VI,[a] DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[bc]				
Soybeans, Group VI	Bu.	16.55	--	--
Oats	Bu.	31.95	--	--
Soybeans, Group VI	Bu.	13.60	--	--
Expenses[c]				
Soybeans, Group VI				
Seed	Bu.	.60	3.55	2.13
Fertilizer[d]	Cwt.	.25	2.25	.56
Pre-emergence Herbicide[e]	Acre	.50	2.88	1.44
Post-emergence Herbicide[f]	Acre	1.00	1.61	1.61
Tractor	Hour	1.69	2.55	4.31
Equipment	Acre	.50	10.02	5.01
Miscellaneous[g]	Acre	.50	3.13	1.56
Labor	Hour	3.08	1.50	4.62
Interest on Operating Capital[h]	Acre	.50	.85	.42
				21.66
Oats				
Seed	Bu.	1.00	1.58	1.58
Fertilizer[i]	Cwt.	1.48	2.42	3.88
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	7.38	3.69
Miscellaneous[g]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[h]	Acre	.50	.52	.26
				13.21
Soybeans, Group VI				
Seed	Bu.	.50	3.55	1.78
Fertilizer[d]	Cwt.	.25	2.25	.56
Post-emergence Herbicide[f]	Acre	1.00	1.61	1.61
Tractor	Hour	1.01	2.55	2.58
Equipment	Acre	.50	7.72	3.86
Miscellaneous[g]	Acre	.50	1.46	.73
Labor	Hour	1.38	1.50	2.07
Interest on Operating Capital[h]	Acre	.50	.52	.26
				13.45
Total				48.32

TABLE LX (CONTINUED)

[a]Midseason maturing varieties.

[b]Expected yield.

[c]One-half acre each.

[d]0-0-30 pounds of NPK per acre.

[e]Lorox at the rate of .50 pound active material per acre.

[f]One application of Dinoseb at the rate of .75 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

[g]Miscellaneous tools and pickup use.

[h]Eight percent on average cost.

[i]80-0-30 pounds of NPK per acre.

TABLE LXI

SOYBEANS, GROUP VI[a]-WHEAT-GRAIN SORGHUM, DOUBELCROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[bc]				
Soybeans, Group VI	Bu.	16.55	--	--
Wheat	Bu.	21.90	--	--
Grain Sorghum	Bu.	25.20	--	--
Expenses[c]				
Soybeans, Group VI				
Seed	Bu.	.60	3.55	2.13
Fertilizer[d]	Cwt.	.25	2.25	.56
Pre-emergence Herbicide[e]	Acre	.50	2.88	1.44
Post-emergence Herbicide[f]	Acre	1.00	1.61	1.61
Tractor	Hour	1.69	2.55	4.31
Equipment	Acre	.50	10.02	5.01
Miscellaneous[g]	Acre	.50	3.13	1.56
Labor	Hour	3.08	1.50	4.61
Interest on Operating Capital[h]	Acre	.50	.85	.42
				21.65
Wheat				
Seed	Bu.	.62	2.25	1.40
Fertilizer[i]	Cwt.	1.48	2.42	3.88
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	6.94	3.47
Miscellaneous[g]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[h]	Acre	.50	.50	.25
				12.75
Grain Sorghum				
Seed	Lb.	3.00	.19	.57
Fertilizer[j]	Cwt.	1.61	2.54	4.09
Post-emergence Herbicide[k]	Acre	.50	.97	.48
Tractor	Hour	.94	2.55	2.40
Equipment	Acre	.50	8.30	4.15
Drying	Bu.	25.20	.15	3.78
Miscellaneous[g]	Acre	1.50	1.42	.71
Labor	Hour	1.32	1.50	1.98
Interest on Operating Capital[h]	Acre	.50	.72	.36
				18.52
Total				52.92

TABLE LXI (CONTINUED)

[a]Midseason maturing varieties.

[b]Expected yield.

[c]One-half acre each.

[d]0-0-30 pounds of NPK per acre.

[e]Lorox at the rate of .50 pound active material per acre.

[f]One application of Dinoseb at the rate of .75 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

[g]Miscellaneous tools and pickup use.

[h]Eight percent on average cost.

[i]80-0-30 pounds of NPK per acre.

[j]80-20-20 pounds of NPK per acre.

[k]2, 4-D at the rate of .50 pound active material per acre.

TABLE LXII

SOYBEANS, GROUP VI[a]-WHEAT-SOYBEANS, GROUP VI,[a] DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON MIXED SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[bc]				
Soybeans, Group VI	Bu.	16.55	--	--
Wheat	Bu.	21.90	--	--
Soybeans, Group VI	Bu.	13.60	--	--
Expenses[c]				
Soybeans, Group VI				
Seed	Bu.	.60	3.55	2.13
Fertilizer[d]	Cwt.	.25	2.25	.56
Pre-emergence Herbicide[e]	Acre	.50	2.88	1.44
Post-emergence Herbicide[f]	Acre	1.00	1.61	1.61
Tractor	Hour	1.69	2.55	4.31
Equipment	Acre	.50	10.02	5.01
Miscellaneous[g]	Acre	.50	3.13	1.56
Labor	Hour	3.08	1.50	4.61
Interest on Operating Capital[h]	Acre	.50	.85	.42
				21.65
Wheat				
Seed	Bu.	.62	2.25	1.40
Fertilizer[i]	Cwt.	1.48	2.42	3.88
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	6.84	3.42
Miscellaneous[g]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[h]	Acre	.50	.50	.25
				12.70
Soybeans, Group VI				
Seed	Bu.	.50	3.55	1.78
Fertilizer[d]	Cwt.	.25	2.25	.56
Post-emergence Herbicide[f]	Acre	1.00	1.61	1.61
Tractor	Hour	1.01	2.55	2.58
Equipment	Acre	.50	7.72	3.86
Miscellaneous[g]	Acre	.50	1.46	.73
Labor	Hour	1.38	1.50	2.07
Interest on Operating Capital[h]	Acre	.50	.52	.26
				13.45
Total				47.80

TABLE LXII (CONTINUED)

[a]Midseason maturing varieties.

[b]Expected yield.

[c]One-half acre each.

[d]0-0-30 pounds of NPK per acre.

[e]Lorox at the rate of .50 pound active material per acre.

[f]One application of Dinoseb at the rate of .75 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

[g]Miscellaneous tools and pickup use.

[h]Eight percent on average cost.

[i]80-0-30 pounds of NPK per acre.

TABLE LXIII

ALFALFA: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON CLAY SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[a]				
Alfalfa Hay	Ton	4.44	--	--
Expenses				
Establishing				
Seed	Lb.	26.00	.56	14.56
Lime[b]	Ton	3.00	8.00	24.00
Fertilizer[c]	Cwt.	4.63	2.75	12.73
Tractor	Hour	1.70	2.55	4.34
Equipment	Acre	1.00	2.45	2.45
Miscellaneous[d]	Acre	1.00	1.27	1.27
Labor	Hour	2.20	1.50	3.30
Interest on Operating Capital[e]	Acre	1.00	12.55	12.55
Normalized at 5 Years[f]				15.04
Annual				
Fertilizer[g]	Cwt.	2.75	2.64	7.26
Herbicide[h]	Acre	.40	7.88	3.15
Insecticide[i]	Acre	2.00	.57	1.14
Tractor	Hour	7.12	2.55	18.16
Equipment	Acre	1.00	18.41	18.41
Miscellaneous[d]	Acre	1.00	5.96	5.96
Labor	Hour	14.17	1.50	21.26
Interest on Operating Capital[e]	Acre	1.00	1.51	1.51
				76.85
Total				91.89

[a]Expected yield.

[b]Custom operation.

[c]20-80-80 pounds of NPK per acre.

[d]Miscellaneous tools and pickup use.

[e]Eight percent on average cost.

[f]Establishing cost normalized on an annual basis with an average stand of five years.

TABLE LXIII (CONTINUED)

[g]0-50-100 pounds of NPK per acre.

[h]Balan at the rate of 1.12 pound active material per acre.

[i]Two applications of Methyl Parathion at the rate of .50 pound active material per acre per application.

TABLE LXIV

COTTON: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON CLAY SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[a]				
Cotton Lint	Lb.	618.2	--	--
Cottonseed	Ton	.526	--	--
Expenses				
Seed	Lb.	26.00	.13	3.38
Fertilizer[b]	Cwt.	3.20	2.75	8.86
Pre-emergence Herbicide[c]	Acre	1.00	2.16	2.16
Post-emergence Herbicide[d]	Acre	2.00	1.12	2.24
Insecticide[e]	Acre	2.00	1.13	2.26
Insecticide Application[f]	Acre	2.00	.75	1.50
Defoliant[g]	Acre	1.00	1.59	1.59
Defoliant Application[f]	Acre	1.00	1.25	1.25
Tractor	Hour	4.93	2.55	12.57
Equipment	Acre	1.00	29.20	29.20
Ginning, Bagging and Ties	Cwt.	18.37[h]	1.25	22.96
Miscellaneous[i]	Acre	1.00	4.62	4.62
Labor	Hour	10.46	1.50	15.69
Interest on Operating Capital[j]	Acre	1.00	2.17	2.17
Total				110.45

[a]Expected yield.

[b]100-0-0 pounds of NPK per acre.

[c]Telvar at the rate of .60 pound active material per acre.

[d]One application of Cotoran and MSMA at the rate of .25 and .75 pound active material, respectively, per acre, and one application of Karmex and MSMA at the rate of .10 and .75 pound active material, respectively, per acre.

[e]Two applications of Methyl Parathion at the rate of 1.00 pound active material per acre per application.

[f]Custom airplane.

[g]Phosphate at the rate of 1.5 pints per acre.

[h]33.4 percent lint, 57.5 percent seed and 9.1 percent trash.

TABLE LXIV (CONTINUED)

[i]Miscellaneous tools and pickup use.

[j]Eight percent on average cost.

TABLE LXV

GRAIN SORGHUM: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON CLAY SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[a]				
Grain Sorghum	Bu.	57.50	--	--
Expenses				
Seed	Lb.	11.00	.19	2.09
Fertilizer[b]	Cwt.	2.50	2.75	6.88
Pre-emergence Herbicide[c]	Acre	1.00	3.91	3.91
Post-emergence Herbicide[d]	Acre	1.00	.97	.97
Tractor	Hour	2.84	2.55	7.24
Equipment	Acre	1.00	10.59	10.59
Drying	Bu.	57.50	.15	8.62
Miscellaneous[e]	Acre	1.00	1.83	1.83
Labor	Hour	3.83	1.50	5.74
Interest on Operating Capital[f]	Acre	1.00	.96	.96
Total				48.83

[a]Expected yield.

[b]80-0-0 pounds of NPK per acre.

[c]Propazine at the rate of 1.25 pound active material per acre.

[d]2, 4-D at the rate of .50 pound active material per acre.

[e]Miscellaneous tools and pickup use.

[f]Eight percent on average cost.

TABLE LXVI

SOYBEANS, GROUP IV:[a] ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON CLAY SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[b]				
Soybeans	Bu.	24.20	--	--
Expenses				
Seed	Bu.	1.30	3.55	4.62
Pre-emergence Herbicide[c]	Acre	1.00	5.76	5.76
Post-emergence Herbicide[d]	Acre	3.00	1.32	3.96
Tractor	Hour	2.86	2.55	7.29
Equipment	Acre	1.00	9.17	9.17
Miscellaneous	Acre	1.00	2.19	2.19
Labor	Hour	3.44	1.50	5.16
Interest on Operating Capital[f]	Acre	1.00	.76	.76
Total				38.91

[a]Very early maturing varieties.

[b]Expected yield.

[c]Lorox at the rate of 1.00 pound active material per acre.

[d]One application of Dinoseb at the rate of .75 pound active material per acre, one application of Tenoran at the rate of .50 pound active material per acre, and one application of 2, 4-DB at the rate of .10 pound active material per acre.

[e]Miscellaneous tools and pickup use.

[f]Eight percent on average cost.

TABLE LXVII

SOYBEANS, GROUP V:[a] ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON CLAY SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[b]				
Soybeans	Bu.	28.40	--	--
Expenses				
Seed	Bu.	1.30	3.55	4.62
Pre-emergence Herbicide[c]	Acre	1.00	5.76	5.76
Post-emergence Herbicide[d]	Acre	3.00	1.32	3.96
Tractor	Hour	3.05	2.55	7.78
Equipment	Acre	1.00	9.57	9.57
Miscellaneous[e]	Acre	1.00	2.26	2.26
Labor	Hour	3.63	1.50	5.44
Interest on Operating Capital[f]	Acre	1.00	.79	.79
Total				40.18

[a]Early maturing varieties.

[b]Expected yield.

[c]Lorox at the rate of 1.00 pound active material per acre.

[d]One application of Dinoseb at the rate of .75 pound active material per acre, one application of Tenoran at the rate of .50 pound active material per acre, and one application of 2, 4-DB at the rate of .10 pound active material per acre.

[e]Miscellaneous tools and pickup use.

[f]Eight percent on average cost.

TABLE LXVIII

SOYBEANS, GROUP VI:[a] ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON CLAY SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[b]				
Soybeans	Bu.	31.50	--	--
Expenses				
Seed	Bu.	1.30	3.55	4.62
Pre-emergence Herbicide[c]	Acre	1.00	5.76	5.76
Post-emergence Herbicide[d]	Acre	3.00	1.32	3.96
Tractor	Hour	3.05	2.55	7.78
Equipment	Acre	1.00	9.64	9.64
Miscellaneous[e]	Acre	1.00	2.26	2.26
Labor	Hour	3.63	1.50	5.44
Interest on Operating Capital[f]	Acre	1.00	.79	.79
Total				40.25

[a]Midseason maturing varieties.

[b]Expected yield.

[c]Lorox at the rate of 1.00 pound active material per acre.

[d]One application of Dinoseb at the rate of .75 pound active material per acre, one application of Tenoran at the rate of .50 pound active material per acre, and one application of 2, 4-DB at the rate of .10 pound active material per acre.

[e]Miscellaneous tools and pickup use.

[f]Eight percent on average cost.

TABLE LXIX

SOYBEANS, GROUP VII:[a] ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON CLAY SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production				
Soybeans[b]	Bu.	28.50	--	--
Expenses				
Seed	Bu.	1.30	3.55	4.62
Pre-emergence Herbicide[c]	Acre	1.00	5.76	5.76
Post-emergence Herbicide[d]	Acre	3.00	1.32	3.96
Tractor	Hour	3.05	2.55	7.78
Equipment	Acre	1.00	9.61	9.61
Miscellaneous[e]	Acre	1.00	2.26	2.26
Labor	Hour	3.63	1.50	5.44
Interest on Operating Capital[f]	Acre	1.00	.79	.79
Total				40.22

[a]Late season maturing varieties.

[b]Expected yield.

[c]Lorox at the rate of 1.00 pound active material per acre.

[d]One application of Dinoseb at the rate of .75 pound active material per acre, one application of Tenoran at the rate of .50 pound active material per acre, and one application of 2, 4-DB at the rate of .10 pound active material per acre.

[e]Miscellaneous tools and pickup use.

[f]Eight percent on average cost.

TABLE LXX

WHEAT: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON CLAY SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[a]				
Wheat	Bu.	42.50	--	--
Expenses				
Seed	Bu.	1.25	2.25	2.81
Fertilizer[b]	Cwt.	2.50	2.75	6.88
Tractor	Hour	1.64	2.55	4.18
Equipment	Acre	1.00	7.48	7.48
Miscellaneous[c]	Acre	1.00	1.42	1.42
Labor	Hour	2.66	1.50	3.99
Interest on Operating Capital[d]	Acre	1.00	.52	.54
Total				27.30

[a]Expected yield.

[b]80-0-0 pounds of NPK per acre.

[c]Miscellaneous tools and pickup use.

[d]Eight percent on average cost.

TABLE LXXI

GRAIN SORGHUM-WHEAT-GRAIN SORGHUM, DOUBLECROP ROTATION:
ESTIMATED PRODUCTION AND SPECIFIED COST
PER ACRE ON CLAY SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[ab]				
Grain Sorghum	Bu.	28.75	--	--
Wheat	Bu.	21.25	--	--
Grain Sorghum	Bu.	23.40	--	--
Expenses[b]				
Grain Sorghum				
Seed	Lb.	5.50	.19	1.04
Fertilizer[c]	Cwt.	1.25	2.75	3.44
Pre-emergence Herbicide[d]	Acre	.50	1.72	.86
Post-emergence Herbicide[e]	Acre	.50	.97	.48
Tractor	Hour	1.42	2.55	3.62
Equipment	Acre	.50	10.59	5.30
Drying	Bu.	28.75	.15	4.31
Miscellaneous[f]	Acre	.50	1.83	.92
Labor	Hour	1.92	1.50	2.87
Interest on Operating Capital[g]	Acre	.50	.92	.46
				22.30
Wheat				
Seed	Bu.	.62	2.25	1.40
Fertilizer[c]	Cwt.	1.25	2.75	3.44
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	6.82	3.41
Miscellaneous[f]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[g]	Acre	.50	.48	.24
				12.24
Grain Sorghum				
Seed	Lb.	3.00	.19	.57
Fertilizer[c]	Cwt.	1.25	2.75	3.44
Post-emergence Herbicide[e]	Acre	.50	.97	.48
Tractor	Hour	.94	2.55	2.40
Equipment	Acre	.50	8.20	4.10
Drying	Bu.	23.40	.15	3.51
Miscellaneous[f]	Acre	.50	1.42	.71
Labor	Hour	1.32	1.50	1.97
Interest on Operating Capital[g]	Acre	.50	.68	.34
				17.53

TABLE LXXI (CONTINUED)

Item	Unit	Quantity	Price	Amount
			($)	($)
Total				53.07

[a]Expected yield.

[b]One-half acre each.

[c]80-0-0 pounds of NPK per acre.

[d]Herban at the rate of .50 pound active material per acre.

[e]2, 4-D at the rate of .50 pound active material per acre.

[f]Miscellaneous tools and pickup use.

[g]Eight percent on average cost.

TABLE LXXII

GRAIN SORGHUM-WHEAT-SOYBEANS, GROUP VI,[a] DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON CLAY SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[bc]				
Grain Sorghum	Bu.	28.75	--	--
Wheat	Bu.	21.25	--	--
Soybeans, Group VI	Bu.	12.65	--	--
Expenses[c]				
Grain Sorghum				
Seed	Lb.	5.50	.19	1.04
Fertilizer[d]	Cwt.	1.25	2.75	3.44
Pre-emergence Herbicide[e]	Acre	.50	1.72	.86
Post-emergence Herbicide[f]	Acre	.50	.97	.48
Tractor	Hour	1.42	2.55	3.62
Equipment	Acre	.50	10.59	5.30
Drying	Bu.	28.75	.15	4.31
Miscellaneous[g]	Acre	.50	1.83	.92
Labor	Hour	1.92	1.50	2.87
Interest on Operating Capital[h]	Acre	.50	.92	.46
				23.30
Wheat				
Seed	Bu.	.62	2.25	1.40
Fertilizer[d]	Cwt.	1.25	2.75	3.44
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	6.82	3.41
Miscellaneous[g]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[h]	Acre	.50	.48	.24
				12.24
Soybeans, Group VI				
Seed	Bu.	.65	3.55	2.31
Post-emergence Herbicide[i]	Acre	1.00	1.61	1.61
Tractor	Hour	1.01	2.55	2.58
Equipment	Acre	.50	7.68	3.84
Miscellaneous[g]	Acre	.50	1.46	.73
Labor	Hour	1.38	1.50	2.07
Interest on Operating Capital[h]	Acre	.50	.52	.26
				13.40
Total				48.94

TABLE LXXII (CONTINUED)

[a]Midseason maturing varieties.

[b]Expected yield.

[c]One-half acre each.

[d]80-0-0 pounds of NPK per acre.

[e]Herban at the rate of .50 pound active material per acre.

[f]2, 4-D at the rate of .50 pound active material per acre.

[g]Miscellaneous tools and pickup use.

[h]Eight percent on average cost.

[i]One application of Dinoseb at the rate of .75 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

TABLE LXXIII

SOYBEANS, GROUP V[a]-WHEAT-GRAIN SORGHUM, DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON CLAY SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[bc]				
Soybeans, Group V	Bu.	14.20	--	--
Wheat	Bu.	19.85	--	--
Grain Sorghum	Bu.	23.40	--	--
Expenses[c]				
Soybeans, Group V				
Seed	Bu.	.65	3.55	2.31
Pre-emergence Herbicide[d]	Acre	.50	5.76	2.88
Post-emergence Herbicide[e]	Acre	1.50	1.32	1.98
Tractor	Hour	1.52	2.55	3.89
Equipment	Acre	.50	9.57	4.78
Miscellaneous[f]	Acre	.50	2.28	1.14
Labor	Hour	1.82	1.50	2.72
Interest on Operating Capital[g]	Acre	.50	.78	.39
				20.09
Wheat				
Seed	Bu.	.62	2.25	1.40
Fertilizer[h]	Cwt.	1.25	2.75	3.44
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	6.76	3.38
Miscellaneous[f]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[g]	Acre	.50	.48	.24
				12.21
Grain Sorghum				
Seed	Lb.	3.00	.19	.57
Fertilizer[h]	Cwt.	1.25	2.75	3.44
Post-emergence Herbicide[i]	Acre	.50	.97	.48
Tractor	Hour	.94	2.55	2.40
Equipment	Acre	.50	8.20	4.10
Drying	Bu.	23.40	.15	3.51
Miscellaneous[f]	Acre	.50	1.42	.71
Labor	Hour	1.32	1.50	1.98
Interest on Operating Capital[g]	Acre	.50	.68	.34
				17.53
Total				49.83

TABLE LXXIII (CONTINUED)

[a]Early maturing varieties.

[b]Expected yield.

[c]One-half acre each.

[d]Lorox at the rate of 1.00 pound active material per acre.

[e]One application of Dinoseb at the rate of .75 pound active material per acre, one application of Tenoran at the rate of .50 pound active material per acre, and one application of 2, 4-DB at the rate of .10 pound active material per acre.

[f]Miscellaneous tools and pickup use.

[g]Eight percent on average cost.

[h]80-0-0 pounds of NPK per acre.

[i]2, 4-D at the rate of .50 pound active material per acre.

TABLE LXXIV

SOYBEANS, GROUP V[a]-WHEAT-SOYBEANS, GROUP VI,[b] DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON CLAY SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[cd]				
Soybeans, Group V	Bu.	14.20	--	--
Wheat	Bu.	19.85	--	--
Soybeans, Group VI	Bu.	12.65	--	--
Expenses[d]				
Soybeans, Group V				
Seed	Bu.	.65	3.55	2.31
Pre-emergence Herbicide[e]	Acre	.50	5.76	2.88
Post-emergence Herbicide[f]	Acre	1.50	1.32	1.98
Tractor	Hour	1.52	2.55	3.89
Equipment	Acre	.50	9.57	4.78
Miscellaneous[g]	Acre	.50	2.28	1.14
Labor	Hour	1.82	1.50	2.72
Interest on Operating Capital[h]	Acre	.50	.78	.39
				20.09
Wheat				
Seed	Bu.	.62	2.25	1.40
Fertilizer[i]	Cwt.	1.25	2.75	3.44
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	6.76	3.38
Miscellaneous[g]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[h]	Acre	.50	.48	.24
				12.21
Soybeans, Group VI				
Seed	Bu.	.65	3.55	2.31
Post-emergence Herbicide[j]	Acre	1.00	1.61	1.61
Tractor	Hour	1.01	2.55	2.58
Equipment	Acre	.50	7.68	3.84
Miscellaneous[g]	Acre	.50	1.46	.73
Labor	Hour	1.38	1.50	2.07
Interest on Operating Capital[h]	Acre	.50	.52	.26
				13.40
Total				45.70

[a]Early maturing varieties.

TABLE LXXIV (CONTINUED)

[b]Midseason maturing varieties.

[c]Expected yield.

[d]One-half acre each.

[e]Lorox at the rate of 1.00 pound active material per acre.

[f]One application of Dinoseb at the rate of .75 pound ative material per acre, one application of Tenoran at the rate of .50 pound active material per acre, and one application of 2, 4-DB at the rate of .10 pound active material per acre.

[g]Miscellaneous tools and pickup use.

[h]Eight percent on average cost.

[i]80-0-0 pounds of NPK per acre.

[j]One application of Dinoseb at the rate of .75 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

TABLE LXXV

SOYBEANS, GROUP VI[a]-WHEAT-GRAIN SORGHUM, DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON CLAY SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[bc]				
Soybeans, Group VI	Bu.	15.75	--	--
Wheat	Bu.	18.00	--	--
Grain Sorghum	Bu.	23.40	--	--
Expenses[c]				
Soybeans, Group VI				
Seed	Bu.	.65	3.55	2.31
Pre-emergence Herbicide[d]	Acre	.50	5.76	2.88
Post-emergence Herbicide[e]	Acre	1.50	1.32	1.98
Tractor	Hour	1.52	2.55	3.89
Equipment	Acre	.50	9.64	4.82
Miscellaneous[f]	Acre	.50	2.28	1.14
Labor	Hour	1.82	1.50	2.72
Interest on Operating Capital[g]	Acre	.50	.78	.39
				20.13
Wheat				
Seed	Bu.	.62	2.25	1.40
Fertilizer[h]	Cwt.	1.25	2.75	3.44
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	6.64	3.32
Miscellaneous[f]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[g]	Acre	.50	.48	.24
				12.15
Grain Sorghum				
Seed	Lb.	3.00	.19	.57
Fertilizer[h]	Cwt.	1.25	2.75	3.44
Post-emergence Herbicide[i]	Acre	.50	.97	.48
Tractor	Hour	.94	2.55	2.40
Equipment	Acre	.50	8.20	4.10
Drying	Bu.	23.40	.15	3.51
Miscellaneous[f]	Acre	.50	1.42	.71
Labor	Hour	1.32	1.50	1.98
Interest on Operating Capital[g]	Acre	.50	.68	.34
				17.53
Total				49.81

TABLE LXXV (CONTINUED)

[a]Midseason maturing varieties.

[b]Expected yield.

[c]One-half acre each.

[d]Lorox at the rate of 1.00 pound active material per acre.

[e]One application of Dinoseb at the rate of .75 pound active material per acre, one application of Tenoran at the rate of .50 pound active material per acre, and one application of 2, 4-DB at the rate of .10 pound active material per acre.

[f]Miscellaneous tools and pickup use.

[g]Eight percent on average cost.

[h]80-0-0 pounds of NPK per acre.

[i]2, 4-D at the rate of .50 pound active material per acre.

TABLE LXXVI

SOYBEANS, GROUP VI[a]-WHEAT-SOYBEANS, GROUP VI,[a] DOUBLECROP ROTATION: ESTIMATED PRODUCTION AND SPECIFIED COST PER ACRE ON CLAY SOILS

Item	Unit	Quantity	Price	Amount
			($)	($)
Production[bc]				
Soybeans, Group VI	Bu.	15.75	--	--
Wheat	Bu.	18.00	--	--
Soybeans, Group VI	Bu.	12.65	--	--
Expenses[c]				
Soybeans, Group VI				
Seed	Bu.	.65	3.55	2.31
Pre-emergence Herbicide[d]	Acre	.50	5.76	2.88
Post-emergence Herbicide[e]	Acre	1.50	1.32	1.98
Tractor	Hour	1.52	2.55	3.89
Equipment	Acre	.50	9.64	4.82
Miscellaneous[f]	Acre	.50	2.26	1.13
Labor	Hour	1.82	1.50	2.73
Interest on Operating Capital[g]	Acre	.50	.78	.39
				20.13
Wheat				
Seed	Bu.	.62	2.25	1.40
Fertilizer[h]	Cwt.	1.25	2.75	3.44
Tractor	Hour	.58	2.55	1.48
Equipment	Acre	.50	6.64	3.32
Miscellaneous[f]	Acre	.50	1.26	.63
Labor	Hour	1.09	1.50	1.64
Interest on Operating Capital[g]	Acre	.50	.48	.24
				12.15
Soybeans, Group VI				
Seed	Bu.	.65	3.55	2.31
Post-emergence Herbicide[i]	Acre	1.00	1.61	1.61
Tractor	Hour	1.01	2.55	2.58
Equipment	Acre	.50	7.68	3.84
Miscellaneous[f]	Acre	.50	1.46	.73
Labor	Hour	1.38	1.50	2.07
Interest on Operating Capital[g]	Acre	.50	.52	.26
				13.40
Total				45.68

[a]Midseason maturing varieties.

TABLE LXXVI (CONTINUED)

[b]Expected yield.

[c]One-half acre each.

[d]Lorox at the rate of 1.00 pound active material per acre.

[e]One application of Dinoseb at the rate of .75 pound active material per acre, one application of Tenoran at the rate of .50 pound active material per acre, and one application of 2, 4-DB at the rate of .10 pound active material per acre.

[f]Miscellaneous tools and pickup use.

[g]Eight percent on average cost.

[h]80-0-0 pounds of NPK per acre.

[i]One application of Dinoseb at the rate of .75 pound active material per acre and one application of Tenoran at the rate of .50 pound active material per acre.

TABLE LXXVII

NET RETURNS, STANDARD DEVIATION AND COEFFICIENT OF VARIATION PER ACRE OF ACTIVITY FOR OWNER AND TENANT SITUATIONS, 1950-69

Activity[a]	Average Net Returns		Standard Deviation		Coefficient of Variation, Percent	
	Owner	Tenant	Owner	Tenant	Owner	Tenant
	------dollars------					
P_1	39.36	--	60.47	--	153.64	--
P_2[b]	48.63	17.03	34.67	23.90	71.29	140.35
P_3[bc]	180.04	108.91	86.24	66.69	47.90	61.23
P_4	76.32	31.09	88.44	68.32	115.88	219.74
P_5	10.40	--	26.48	--	254.61	--
P_6[bc]	24.14	6.37	14.48	10.15	60.00	159.42
P_7	23.97	.34	18.59	18.12	77.55	5,328.65
P_8	24.47	--	22.51	--	92.01	--
P_9	28.98	--	24.11	--	83.21	--
P_{10}	22.83	--	26.11	--	114.37	--
P_{11}[bc]	46.59	21.83	26.95	18.53	57.84	84.87
P_{12}	45.27	14.50	17.84	11.49	39.41	79.25
P_{13}	53.36	17.85	24.24	17.79	45.43	99.69
P_{14}[bc]	97.63	49.62	28.59	18.63	29.28	37.55
P_{15}[b]	66.20	26.64	30.07	21.60	45.43	81.10
P_{16}	22.98	.39	24.99	17.09	108.74	4,380.86
P_{17}	35.49	7.49	19.65	14.27	55.36	190.13
P_{18}	37.29	10.40	21.33	14.44	57.21	138.80
P_{19}[b]	49.73	17.48	13.54	9.41	27.23	53.85
P_{20}	31.12	3.99	20.19	13.59	64.87	340.49

TABLE LXXVII (CONTINUED)

Activity[a]	Average Net Returns		Standard Deviation		Coefficient of Variation, Percent	
	Owner	Tenant	Owner	Tenant	Owner	Tenant
	----dollars----					
P_{21}	39.15	6.79	21.48	16.59	54.86	244.37
P_{22}	44.44	8.85	14.78	10.10	33.27	114.11
P_{23}	52.09	15.37	21.74	17.12	41.73	111.38
P_{24}	29.96	2.90	19.81	13.98	66.12	482.12
P_{25}	29.64	6.85	25.09	19.10	63.30	278.76
P_{26}[b]	41.74	11.17	12.42	8.73	29.77	78.12
P_{27}[bc]	51.14	14.74	25.25	19.44	49.37	131.86
P_{28}	6.06	--	48.29	--	796.80	--
P_{29}[bc]	164.76	99.66	97.49	73.69	59.17	73.94
P_{30}	69.78	28.41	97.78	73.88	140.13	260.05
P_{31}	5.08	--	22.38	--	440.50	--
P_{32}	11.67	--	18.82	--	161.27	--
P_{33}	20.75	--	16.00	--	77.12	--
P_{34}[b]	29.10	1.40	18.79	13.76	64.56	983.02
P_{35}[b]	20.98	--	18.84	--	89.80	--
P_{36}[c]	32.73	12.68	19.14	13.21	58.46	104.17
P_{37}	27.77	3.98	25.56	17.40	92.03	437.16
P_{38}[c]	39.17	10.40	18.04	12.35	46.07	118.70
P_{39}	32.88	5.50	19.03	13.21	57.89	240.24
P_{40}[b]	41.71	8.91	18.17	13.89	43.55	155.94
P_{41}[bc]	34.34	6.49	16.70	11.48	48.64	176.81
P_{42}[bc]	43.02	9.79	21.25	15.71	59.39	160.47

TABLE LXXVII (CONTINUED)

[a]See Table XV for names of activities.

[b]Activities that came into solutions for owner situations.

[c]Activities that came into solutions for tenant situations.

VITA

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Doctor of Philosophy

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