FOR FARM INCOME ENHANCEMENT OPPORTUNITIES FOR SMALL, PART-TIME, AND LIMITED-RESOURCE FARMING OPERATIONS IN EAST CENTRAL OKLAHOMA

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TABLE OF CONTENTS

LIST OF TABLES

Table		Page

Table | Page

LIST OF FIGURES

Figure | Page

NOMENCLATURE

OWNAC owned acres, represents the initial acreage owned by the farm operator

OWNMCH owned machinery, a dollar amount representing the value of machinery on the farm

OWNLVK owned livestock, a dollar amount representing the value of livestock on the farm

CASH a dollar amount representing the value of demand deposits and currency on hand held by the operator

PLAND price of land per acre

FWAGE per hour wage rate for farm labor

OFWAGE per hour wage rate for off-farm labor

HRSAC hours of labor required per acre

OPLAB farm labor supplied by the operator annually

LEVHOM years of family labor available

MANRET returns to management from farming in dollars per acre

EQRET returns to equity in farming operation, percent basis

DEPRAT depreciation rate

INTMON interest rate available in money market

INTLND interest rate on land mortgage

INTSTL interest rate on short-term loan

AUTCON autonomous consumption by household

APC marginal consumption of marginal disposable income

LEQRAT required equity for land purchase

MINAC minimum acres per tract

PCTDNL percent down payment required on land

NETWTH net worth

TMTGL total mortgage on land

STLOAN amount of short-term loan

PMINAC price of land per acre times the minimum acres per tract

DPCRIT percent of value of tract(s) purchased that must be paid as a down payment

LVKREQ dollar value of livestock required on a per acre basis

MCHREQ dollar value of machinery required on a per acre basis

FRMINC income from farming

ERROR a standard normal random variable

RFINC randomized farm income

CVFINC coefficient of variation of farm income

T a variable ranging from 1-30 indicating the year of the 30-year growth cycle in which the farm is operating

ASSETS a dollar amount representing the sum of the value of owned land, livestock, machinery, and the value of cash held by the operator

MEQRAT a minimum equity ratio below which the farming operation is deemed bankrupt, percent basis

CHAPTER I

GENERAL PROBLEM

Eastern Oklahoma agriculture is typified by small, low-income farms which are operated as family enterprises (Horne, p. 7). In this respect, the area is representative of the farm sector structure of a larger part of the nation and in particular the South and North Central regions of the U.S., where such farms are concentrated. Orden, Buccola, and Edwards reported that 14 southern states contained 794,148 small farms, or nearly 50 percent of the nation's small farms in 1980 (p. 2).

Despite decreases in numbers of small farms, they continue to represent the majority of all U.S. farms. Small farms decreased by 931,253 or 69 percent between 1959 and 1974 (Tweeten, Cilley, and Popoola, p. 77). Data for the period 1960-1980 show a continuous decline in the numbers of small farms (Table 1). If this trend were to continue, full-time small farms would disappear entirely by the mid-1990s.

In attempting to analyze the small-farms sector, one immediately encounters problems with the definitions. Lewis enumerates no less than 42 different definitions of small farms used in various articles and bulletins (p. 86). Regardless of the definition used, the small farm population is diverse (Carlin and Crecink, p. 933). Small farm families exhibit varying degrees of dependency on farming for income. Small farms may contain either small or large acreages and their

Table 1.[1] Number of Small Farms* in the U.S. by Value of Sales, 1960-1980[1]

Year	Number of Farms (1,000's)	Percent Decline
1960	3623	---
1961	3463	4.4
1962	3303	4.6
1963	3161	4.3
1964	3043	3.7
1965	2915	4.2
1966	2767	5.1
1967	2678	3.2
1968	2571	4.0
1969	2449	4.7
1970	2388	2.5
1971	2330	2.4
1972	2240	3.9
1973	2046	8.7
1974	1986	2.9
1975	1985	.1
1976	1922	3.2
1977	1659	13.7
1978	1578	4.9
1979	1501	5.1
1980	1481	1.3

*Sales of $20,000 or less.

[1] U.S. Department of Agriculture, Economic Research Service. Economic Indicators of the Farm Sector, Income and Balance Sheet Statistics, 1980. Statistical Bulletin No. 674. Washington, D.C.: U.S. Department of Agriculture, September 1981, p. 95.

operators may be either old or young, established or beginning. The enterprise mix is diverse as well.

Larson and Lewis, found few common problems among small farms grouped by alternative definitions (p. 8). The only common characteristic they found was the small dollar amount of farm products sold.

The occurrence of chronic low farm income and the resulting demise of the full-time small-farm sector of U.S. agriculture has no one prevailing cause. Many socio-economic factors which are offered as explanation, among which are:

1. Lack of profitable farm investment opportunities and/or lack of adequate investment capital or equity against which to borrow funds for operating or purchasing modern equipment.

2. Lack of education or experience which would enable one to find off-farm employment, manifesting itself in an excess supply of labor on the farm and thereby reducing the incentive to adapt labor-saving, higher-production technology.

3. Inadequate managerial skill to implement high-technology practices.

4. Small acreages and low-volume production which makes it infeasible to employ equipment that requires high production to keep unit costs low.

5. Low family income and primary dependence on farm income causing reluctance to risk new practices or alternative enterprises and technologies.

6. Inaccessibility or lack of markets for products which could increase income.

7. Lack of information concerning alternative enterprises and production strategies.

While not exhaustive, the above list demonstrates the wide range of factors contributing to low farm income. In addition, public agencies, particularly the Cooperative Extension Service, have been accused of denying the small farmer an appropriate share of public services (Humphries, p. 879). In some cases, the small farmer may have remained in business in spite of and not because of public agencies.

In Oklahoma, while the declining number of small farms in the aggregate has followed national trends, researchers have shown that certain categories of small farms have increased in numbers over this period (1960-1980) (Tweeten, p. 6). Specifically, those small farms operated by aged or part-time operators have become more numerous, while small farms operated by full-time, able-bodied operators have declined sharply (Figure 1).

The demise of the full-time small farm operator has been the subject of much research that has led to differing conclusions as to the future of such operations. Historically, the small full-time operator has been characterized as inefficient and unresponsive to a changing economic environment. Those studies that consider economic efficiency in conventional enterprises and focus on the inability of small farm operators to achieve economies-of-size conclude that these operators must "get big or get out".

Antithetic to the "get big or get out" argument are those who maintain that small farms may be operated as viable economic units providing sufficient income for family support. These researchers

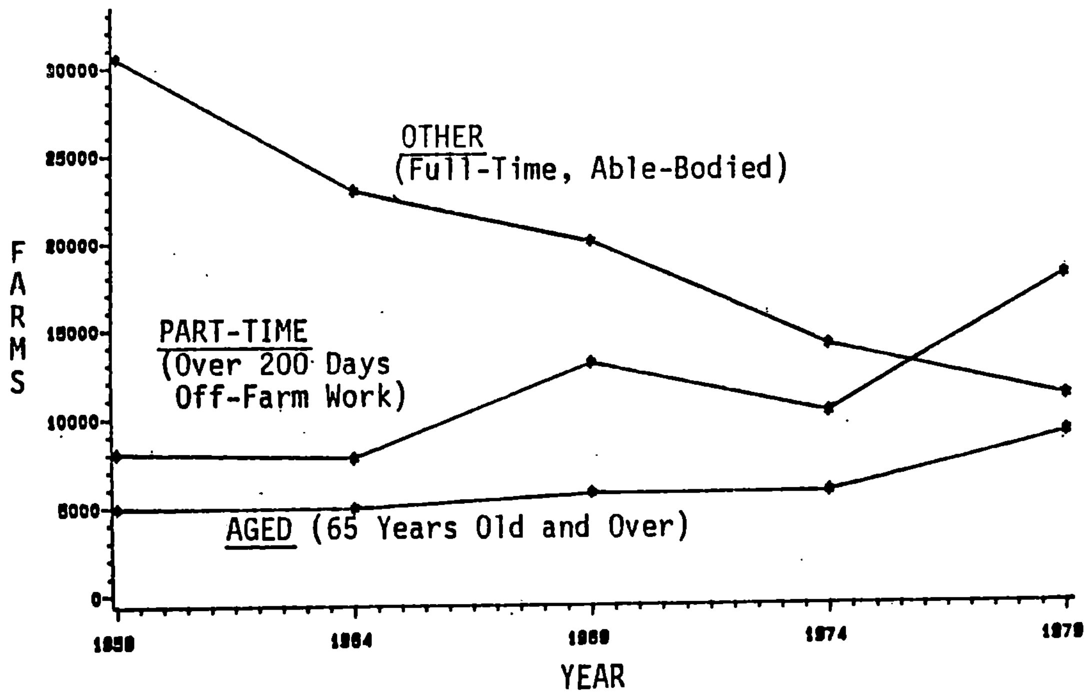

Figure 1. Trends in number of small farms ($2,500 - $20,000 sales) in Oklahoma by status of operator, 1959-1979. Adjusted for inflation and 1974 undercount

direct their attention to the production of specialty crops and hold that traditional enterprises will not be profitable for the small farmer. One researcher concluded that "the small farmer must get out of the large farmer's ballpark" (Whatley, p. 40). One solution could be a reorientation of enterprises on the farm.

Other researchers have looked elsewhere to explain the decline of the small full-time operator. Institutional barriers such as tax laws and government programs alleged to favor large operators have been cited as principal contributors to the decline. For example, one observer concluded that, "Agriculture - as we've known it - has maybe 10 or 15 years left if tax laws remain the same. One by one, family farms will give it up" (Breimyer, p. 17). This school of thought would seem to indicate that the problems of small farmers are not found "within-the-fences" and that appropriate action to sustain the sector must come from reform in the institutional environment.

The low returns experienced by full-time small farmers have caused many to seek off-farm income to supplement farm earnings. The result has been a growing class of part-time farm operators. Part-time farming has been viewed alternatively as "hobby farming," merely another rung on the traditional agricultural ladder approach to full-time farming, or a new life-style whereby operators preferring to live on a farm may do so and yet have off-farm income. For researchers, efforts to develop programs and alternatives to assist these operators in their farming activities have been especially difficult. Not enough is known concerning these operators' attitudes toward farm versus off-farm employment and the comparative returns from such efforts to suggest appropriate farm enterprise organizations. Additionally, not much is known of opportunities to increase farm income on both part-time and full-time small farms by expanding specialty crop production.

The recent "dramatic increases" in involuntary bankruptcies among Oklahoma farms, occurring amidst a period of declining real estate values, pose a particularly unattractive situation for current and future borrowers and lenders (Laval, pp. 1-8). For heavily indebted borrowers who have mortgaged their land as collateral to secure funds, declining land values may leave them with insufficient receipts from foreclosure proceedings to retire their indebtedness. Similarly, lending institutions may find themselves undersecured, or in the extreme -- unsecured.

With foreclosure unattractive for either party under such circumstances, maintaining economic viability of the farming operation assumes increased importance. Alternative enterprise selection and farm organization, with emphasis on specialty crops and/or off-farm income, need to be evaluated for their potential for relief from or avoidance of this outcome.

Research Objectives and Hypotheses

Research Objectives

The central objective of this research is to determine for East Central Oklahoma the current structure and future plans for farm operations and the possible impact on future farm economic viability and structure of alternative enterprise selection, off-farm employment and federal policies. Specific objectives of this study of farms in East Central Oklahoma include:

1. Identification of the distribution of farms according to the commitment to farming of respective operators based upon their allocation to farming of available labor.

2. Determination by budget and linear programming techniques the income optimizing combinations of conventional and/or alternative enterprise organizations.

3. Measurement of the competitiveness of alternative farm enterprise organizations with off-farm job opportunities for available labor as indicated by return-per-unit of labor invested and the potential for expansion of the farm operation.

4. Simulation of opportunities for growth and survivability over time of representative farms in a dynamic, uncertain environment.

5. Analysis of the impact of alternative federal fiscal-monetary policies on growth potential of farming operations in East Central Oklahoma.

Hypotheses

1. The incidence of poverty is higher on small farms than on larger farms.

2. Full-time farmers make more efficient use of their resources than do part-time farmers.

3. Current small farm families, by adopting efficient practices and conventional crops, could earn an income comparable to the county per capita personal income.

4. Part-time farming operations can be transformed into full-time operations while maintaining or increasing total family income.

5. Full-time small farms in poverty producing traditional enterprises can raise income above the poverty level with expansion in acreage by farming more efficiently and by introducing more labor-intensive specialty enterprises.

Methods and Procedures

The research undertaken will require development of a typical farm scenario for part-time and full-time operators, respectively. A survey of East Central Oklahoma farm operators, described in detail in Chapter III, will be used for this objective. The aged and disabled operators, who may be assumed to be retired or at least not actively expanding their operations, are not included because their farm needs and objectives are different than for other farmers.

Since the late twenties and early thirties, the typical-farm concept has been used in applied agricultural research by policymakers and analysts having a particular need for information on policy impacts and indicators of well-being at the farm level (Hatch, Gustafson, Baum, and Harrington, p. 31). Typical farms analyses have provided information for descriptive studies concerning the financial health of farms in the sector (Jensen, Hatch, and Harrington, p. 10) and measurement of the efficiency of resource use in a micro-economic environment (Miller, Rodewald, and McElroy, p. 21).

Hatch, Gustafson, Baum, and Harrington point out that specification of a typical farm is not an easy task and is often associated with the concept of a mean or a mode (p. 31). As they indicate, an average size farm would represent the mean of all farms in the population but would not necessarily be a close approximation of any specific farm. An alternative is to define the typical farms so that they approximate the greatest number of real farms. This alternative can be accomplished by choosing modal intervals from marginal distributions of the decision criteria variables. Having specified their typical farms, Hatch et al. demonstrate the usefulness of the typical farm data for assessing the financial strength of full equity and minimum equity farm situations in a comparative static analysis.

Development of a Part-Time Operator Typical Farm

The 143 operators classified as part-time in the survey were categorized according to farm size in acres and a histogram was constructed. The histogram suggested an exponential distribution to approximate the actual observed distribution.

The maximum likelihood method of estimation was used to determine the average farm size, approximately 202 acres, for the part-time operators. All part-time operators having greater than 202 acres were deleted, leaving 96 operators (or farms) in the sample. The average acreage of the remaining farms was then calculated to be approximately 80 acres, the mode of the sample (Appendix Table 8).

Development of a Full-Time Operator Typical Farm

The remaining 119 operators, denoted as full-time farmers, were similarly categorized. A two parameter gamma function was fitted using numerical methods to estimate the parameters and average for this group. The average calculated was 345 acres and all operators having smaller than average acreage were deleted from the sample. The average of the remaining 67 farms was again calculated yielding an estimate of approximately 1200 acres, a value consistent with FEDS typical size for Oklahoma commercial farms (Appendix Table 9).

Once a typical farm has been identified and the resources catalogued, a wide range of analytic tools are available to the researcher. While the method varies according to the researcher and his needs, abstract modeling is perhaps the most widely utilized. Models are basically a representation of real-world phenomenon and are widely used in situations where time or economic considerations hinder actual observation of these phenomena. Recent development of mathematical techniques utilizing computers have enhanced the attractiveness of mathematical models.

Techniques used for mathematical models include marginal analysis, linear programming and simulation. Prior to the development by George Dantzig of the simplex algorithm for solving linear programming problems in 1947, the neoclassical model of the multi-product, multi-factor firm formulated by J.R. Hicks was probably the most widely accepted mathematical model of the firm among economists (Naylor, p. 263). In order to apply marginal analysis to the economic theory of the firm, it is necessary to reduce the problem of the firm to one of finding the optimal values of some objective function subject to a set of constraints. The objective function and the constraints must both be concave and continuous with non-zero first and second order partial derivatives. Linear programming, on the other hand, searches for an optimal value of a linear objective function subject to a set of linear constraints. Dorfman pointed out the difficulties of marginal analysis in handling the two-stage problem of profit maximization. The stages involved are; first, determining the technology for the firm, for example, deriving a perscription for achieving the physical maximization presupposed in the definition of the production function, and secondly, maximizing the profit subject to the conditions imposed by the production function described in the first stage (Dorfman, p. 210).

The first problem may be solved independently of the second, but the second must be solved simultaneously with the first or after the first is solved. The Hicksian marginal analysis model in concerned only with the second stage, for it assumes the first has already been solved (Naylor, p. 263). The difficulty with marginal analysis arises when solution of the first problem does not yield a production function that is continuous, concave and with non-zero first and second order partial derivatives. Additionally, multicollinearity arising when estimating production functions from time series precludes specification of detailed production functions required in neoclassical marginal analysis.

Linear programming circumvents some of these difficulties. The survey data available are consistent with the requirements for the use of linear programming to accomplish objectives 1-3 of this study. The basic requirements for linear programming are: 1) an objective function to be optimized (maximized or minimized), 2) resource constraints, and 3) alternative means of organizing resources to optimize the objective function. Mathematically, these may be stated (for the case of maximizing profits, Z, given alternative means of production, X, and restricted resources, b):

Maximize: $Z = C_j X_j$

Subject to: $\sum_{j=i}^{n} a_{ij} X_j \leq b_i \quad (i = 1, 2, \ldots, m)$

and: $X_j \geq 0 \quad (j = 1, 2, \ldots, n)$

where:

C_j = an n-element row vector of net returns

X_j = an n-element row vector of activities

b_i = an m-element column vector of resource restrictions

a_{ij} = an m x n matrix of coefficients denoting the amount of the i^{th} resource used in production of the j^{th} activity.

A planning tool developed at Oklahoma State University that utilizes linear programming is OKFARMS (Oklahoma Farm and Ranch Management System). OKFARMS (utilizes enterprise budgets to determine an optimal farm plan for a specific resource situation (Kletke and Moehle, 1985; Kletke, 1985; Moehle and Kletke, 1985).

While the static framework of linear programming is sufficient to accomplish objectives 1-3, a dynamic model is necessary for objectives 4 and 5. A Fortran computer simulation model developed by Eginton and subsequently modified by Tweeten, Barclay, Pyles and Ralstin has been used to analyze the growth and survivability of farm firms in a dynamic, uncertain environment (Eginton, p. 929; Tweeten, Barclay, Pyles, and Ralstin, pp. 1-22). The model, designed to show the impact of a number of economic forces and government policies on the entrance, survivability and growth of family farms, will be used to accomplish objectives 4 and 5.

Organization of the Study

Chapter II presents a series of environmental factors influencing the number, distribution and operation of small farm enterprises. Chapter III provides a description of the area of study, survey procedures and a description analysis of the survey data. Also, the procedure for developing the proxy farm models and the base parameters for these models is given. Chapter IV is devoted to presentation of the linear programming solutions of the proxy farm models and the simulation model input derived from these solutions. Simulation results are presented in Chapter V along with a description of the model and base parameters needed for the simulation model. Chapter VI consists of conclusions, limitations and suggestions for further research.

CHAPTER II

THEORY

The following discussion explores the theoretical underpinnings of the research and the models used herein. Goals by which results may be judged, such as consumption requirements and equity accumulation are developed. Variables influencing decisions such as interest rates, variation in farm income, labor availability, and propensity to consume are identified.

It is shown that while individuals may choose to live on small farms and operate them as part-time or full-time farmers for many "non-economic" reasons, the dominant goal for the farm is characterized by profit maximization. The models developed and used in the remainder of this text are founded on that premise.

The purpose of this research is to investigate small farms within the current structure of agriculture with respect to their future and the role they play as a means of entry into farming. From the foregoing discussion several issues present themselves. First, research is needed to determine if small farms are financially viable when operated as full-time family operations or part-time farms. Secondly, the impact of off-farm income combined with farm income upon the farm family's economic well-being needs further research. Additionally, the role of small farms, operated on a full-time or part-time basis in the traditional agricultural ladder approach to entry into agriculture, needs analysis. Of concern here is whether the small-farm, operated part-time and financed from off-farm income, can be a vehicle leading to full-time large-scale operation.

Level of Consumption -- Single and Multiple Time Periods

The level of consumption that an individual can attain over time is determined largely by his income and the terms under which he can transfer income from one time period to the next, i.e. the interest rate. A simple example illustrates the possibilities confronting a consumer over a single time period. It is assumed that the consumer, C, can borrow and/or lend at the same interest rate, 6 percent, in the capital market and that C's income is known for certain to be $100 now and $100 at the end of one time period, a year. Figure 2 illustrates the consumption possibilities available to C.

In this illustration, if C chose to consume all his income now, period t = 0, the maximum he could consume would be $194.34, or $100 + $100/1.06. The $94.34 being the current value of the $100 C would receive at the end of the period, t = 1. If on the other hand, C chose to forego all consumption until the end of the period, he would have $206, $100 + $100(1.06), to consume at the end of the period. The significant aspect of Figure 2 is that all income streams that lie on $\overline{AB}$ are equivalent because any income stream $\overline{AB}$ can be transformed into any other stream on $\overline{AB}$ by the appropriate level of borrowing or lending. Point A is the present value of income or wealth of the individual and, in this example the present value of income (V_y) can be calculated as

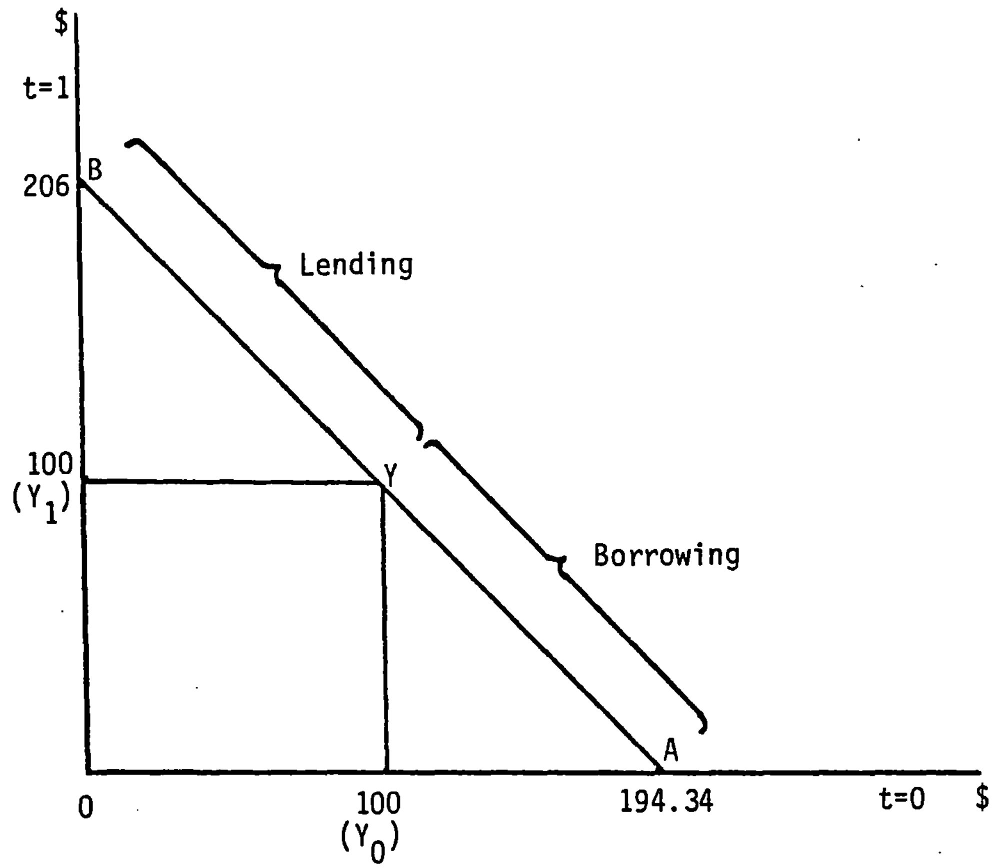

Figure 2. Single time period consumption possibilities available to the individual

$$V_y = Y_0 + \frac{Y_1}{1 + i},$$

where

Y_0 is income at $t = 0$,

Y_1 is income at $t = 1$, and

i is the interest rate for borrowing and lending.

Hence, given the opportunity to borrow or lend at the same interest rate, the consumer is indifferent to the time pattern of his income stream and is concerned only with its present value (Haley and Schall, 1979). Extension to the n-period case is straight-forward. The present value, V_y, of the individual's income stream for n-periods is;

$$V_y = Y_0 + \frac{Y_1}{(1+i_1)} + \frac{Y_2}{(1+i_1)(1+i_2)} + \ldots + \frac{Y_n}{(1+i_1)(1+i_2)\ldots(1+i_n)}$$

or more compactly,

$$V_y = Y_0 + \sum_{t=0}^{n} \frac{Y_t}{\prod_{j=1}^{t}(1+i_j)}.$$

In evaluating alternative decisions, the individual would seek the income stream with the highest present value.

Individuals who, as described in Figure 2, consume in a specific time period at points A or B would very likely be exceptions to general consumption patterns. Many economists have conducted empirical analysis of consumption over the period of the consumer's life in an attempt to support their theories of a long-term consumption function (Ando and Modigliani, 1963; Duesenberry, 1949; and Friedman, 1957). One of the most widely accepted is the "life-cycle" hypothesis postulated by Ando and Modigliani.

Modigliani, who would subsequently receive the 1985 Nobel Prize in Economics for his research on the subject, had observed early in his career as a bank worker in Italy that people tended to save income and forego consumption while their incomes are high so that in the later stages of their lives they can maintain consumption when their incomes are lower. A simple graph, presented in Figure 3, illustrates:

In Figure 3, where T represents the consumer's lifetime, the shaded portion where C lies above y represents the period when income is low and the individual dissaves out of income, y. The portion where y lies above C represents the period when the individual saves out of his income to finance early periods of dissaving and accumulate savings for later periods of dissaving. This theory was shown to be consistent with cross-sectional studies that indicated a falling c/y as income rose. Empirical estimates using annual U.S. data yielded, as a typical result, the following aggregate consumption function (Ando and Modigliani, 1963):

1) $C_t = 0.7{y_t}^L + 0.06a_t$,

where

${y_t}^L$ is the labor share of income, and

a_t is the level of assets.

Dividing 1) by total real income y_t yields 2),

2) $\frac{C_t}{y_t} = 0.7\,\frac{{y_t}^L}{y_t} + 0.06\,\frac{a_t}{y_t}$

which indicates that the c/y ratio is constant if y^L/y (labor share of total income) and a/y (ratio of assets to output) are constant as the economy grows. U.S. data has confirmed that both of these are fairly constant over time with y^L/y about 75 percent and a/y about 3

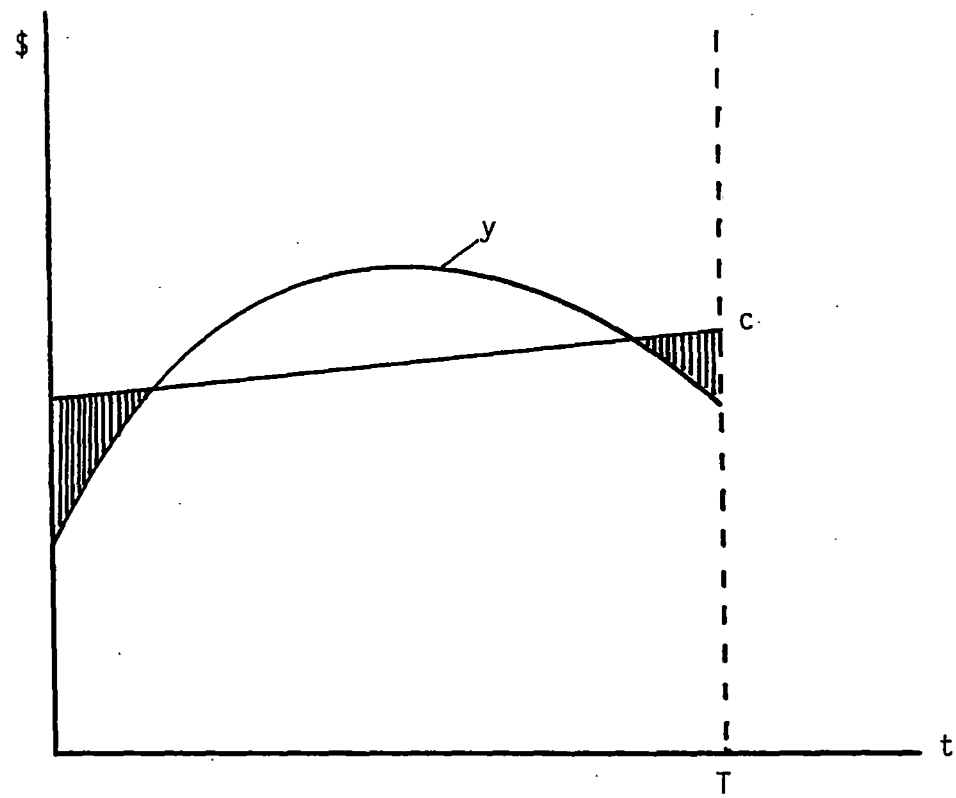

Figure 3. Individual's life-time consumption under "Life-Cycle" hypothesis

(Branson, p. 194). Inserting these values into 2), yields

$$3)\ \frac{c_t}{y_t} = (.7)(.75) + (.06)(3) = .71.$$

The Ando and Modigliani function therefore suggests an average propensity to consume (APC) out of total income of about .7 over time.

While Ando and Modigliani focused on aggregate U.S. consumption, a more recent study analyzed consumption patterns by farm-families (Richardson and Nixon, p. 23). Richardson and Nixon estimated a Cobb-Douglas functional form,

$$C_t = \beta_0 X_{1t} X_{2t}\, \xi_t.$$

The exact specification used by Richardson and Nixon was, as follows:

$$C_t = \beta_0 X_{1t}^{b1}\, X_{2t}^{b2}\, X_{3t}^{b3}\, X_{4t}^{b4}\, \xi_t,$$

where

C_t is consumption by individual t,

X_{1t} is the number of people in the household,

X_{2t} is the consumer price index,

X_{3t} is after-tax disposable income,

X_{4t} is the age of the head of the household, and

ξ_t is the error term.

Richardson and Nixon's estimate for U.S. farm families was,

$$5)\ C = 23.438\ X_1^{.241} X_2^{.610} X_3^{.390} X_4^{-.229}.$$

They also calculated the average propensity to consume by farm families for 10 geographic areas of the U.S. and produced estimates ranging from .658 for the Mountain States region to .899 for the Northeast region. The Southeast region exhibites an APC of .811, close to the U.S. value of .810.

The Expected Utility Model (EUM) and Investment

Generally, an individual at a specific point in time is recognized to be faced with two decisions: 1) how much to consume in the period and 2) how much to invest in which assets. Introduction of uncertainty into the situation creates additional problems because the individual is then confronted with making consumption decisions based upon an uncertain future income and investment decisions based upon uncertain returns from assets.

The expected utility model is widely regarded as a reasonable guide to individual decisions under these conditions. The model is based upon Bernoulli's principle, or the expected utility theorem. The principle is a logical deduction from a number of postulates (von Neumann and Morgenstern, p. 43). These postulates are:

1) Ordering and transitivity. A person either prefers one of two risky prospects, a_1 and a_2, or is indifferent between them. Among three risky prospects a_1, a_2, and a_3, a person who prefers a_1 to a_2 and a_2 to a_3 will prefer a_1 to a_3.
2) Continuity. If a person prefers a_1 to a_2 to a_3, a subjective probability $p(a_1)$ exists other than zero or one such that he is indifferent between a_2 and a lottery yielding a_1 with probability $p(a_1)$ and a_3 with a probability $(1-P(a_1))$.
3) Independence. If a_1 is preferred to a_2, and a_3 is any other risky prospect, a lottery with a_1 and a_3 as its outcome will be preferred to a lottery with a_2 and a_3 as its outcome when $p(a_1) = p(a_2)$.

Bernoulli's principle states that a utility function exists for a decision maker whose preferences are consistent with the axioms of ordering and transitivity, independence, and continuity, and this utility function, U, associates a single real number with any risky prospect (Bernoulli, 1738).

Expected Monetary Value (EMV) and Certainty Equivalent (CE)

The inclusion of an additional postulate with the preceding three, which lead to Bernoulli's principle, permits the development of the certainty equivalent concept in conjunction with the EMV of a risky prospect. This postulate states:

4) Certainty Equivalent. There exists a certainty equivalent to any risk prospect. If a_1 is preferred to a_2 and a_2 is preferred to a_3, then there exists some probability (p) such that the individual will be completely indifferent to getting a_2 for certain or getting a_1 with probability (p) and a_3 with probability (1-p).

Following Halley and Schall, the (EMV) and (CE) can be used to determine an individual's attitude toward risk. First, fix the scale of the individual's utility index by assuming that its value for a gain of $1,000 is 1.0 and 0.0 for a loss of $1,000, i.e. U($1,000) = 1 and U(-$1,000) = 0.0. The individual is presented a gamble which has as its best possible outcome the gain of $1,000 and as its worst outcome the loss of $1,000 with probabilities p and 1-p, respectively. Axiom (4) associates a certainty equivalent with any such gamble.

If Y represents the certainty equivalent, by the expected utility theorem, the utility U(Y) of Y received for certain must equal the expected utility of the gamble, i.e. $U(Y) = pU(\$1,000) + (1-p)U(-\$1,000)$. Since $U(\$1,000) = 1.0$ and $U(-\$1,000) = 0.0$, $U(Y) = p$.

Setting $p = .5$, the EMV of the gamble is $.5(\$1,000) + .5(-\$1,000) = \$0$. If the individual prefers to lose \$250 for certain rather than risk losing \$1,000 then $U(-\$250) = .5$. Following a similar pattern, other points may be traced out yielding a utility function similar to $U_1(Y)$ in Figure 4, below.

In Figure 4, $U_1(Y)$ represents the utility function of an individual who is willing to accept a certainty equivalent (CE) that is less than the expected monetary value (EMV) of a risky prospect. Individuals exhibiting such behavior are classified as "risk averse." $U_2(Y)$ represents an individual who is indifferent between the CE and the EMV of the risky prospect and is classified as "risk neutral." These individuals would make decisions based only upon the EMV of a risky prospect. Individuals who prefer risk would have a utility function such as that show by $U_3(Y)$. These individuals would prefer to gamble rather than take the same amount for certain, hence their CE > EMV.

From a utility function such as $U_1(Y)$, which is of the form, $U(Y) = a + bY + cY^2$, a utility function in terms of rate-of-return, r, on an investment can be obtained by substituting r for Y yielding,

6) $U(r) = a + br + cr^2$.

The expected value of $U(\tilde{r})$, $E[U(\tilde{r})]$, is then

7) $E[U(\tilde{r})] = a + bE[\tilde{r}] + cE[\tilde{r}^2]$,

where r is a random variable representing the return on a particular investment. Equation 7) may be re-written as,

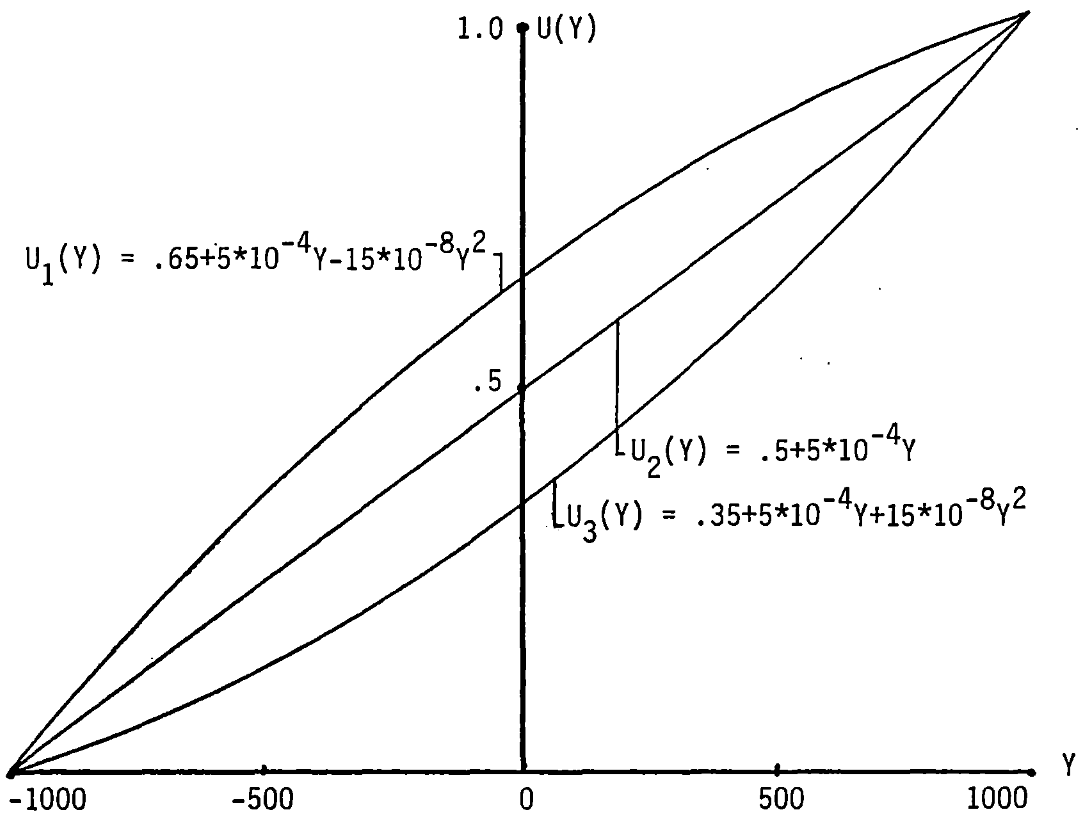

Figure 4. Utility functions exhibiting risk aversion, neutrality, and preference

8) $E[U(\tilde{r})] = a + b\bar{r} + c(\sigma_r^2 + \bar{r}^2)$,

since the expectation of the second moment of a random variable is equal to the variance of the distribution plus the mean, $\bar{r}$, squared.

From Figure 4 and Equation 6) it is obvious that the sign of c reflects, as it is (positive, zero, negative), whether the individual is risk (preferring, neutral, averse). For a particular pair of investments having the same expected return (r), one of which has no variance ($\sigma_r^2 = 0$) while the other does ($\sigma_r^2 > 0$) the certain return investment will be preferred if c is negative while the variable return investment would be preferred if c is positive.

The importance to the research undertaken here of the individual decisionmaker's attitude toward risk can be shown in a hypothetical example, kept simple for convenience. Suppose an individual is confronted with two alternative uses of his labor effort. Alternative A involves working full-time off-farm with an expected income of $23,600 as a result, alternative B involves devoting part of his labor to farming and the remainder to off-farm work with a combined expected income of $23,600. Alternative A is assumed to result in a certain income while alternative B is assumed to result in an income of $19,000 for certain from off-farm work and (.5)($9,200) as the expected farm income. The EMV of each alternative is the same but alternative B involves a variable return and would therefore not be preferred to alternative A by a risk averse decisionmaker. A risk neutral decisionmaker (DM) would look only at the EMV of alternatives A and B and be indifferent among strategies, while a risk preferring individual would prefer alternative B to alternative A.

Therefore, while researchers generally assume that decisionmakers are risk averse (i.e. prefer a greater expected return to a lower expected return and less variance of return to more variance of return), the exact strategy that a particular decisionmaker will follow is unique to the decisionmaker. This result derives from the fact tht decisionmakers have unique utility functions such as given in Equation 6, with unique estimates of the parameters a, b, and c.

Additional Considerations In Utility Function Specification

Lexicographic Utility

An important contribution to utility theory and its use as a tool for decisionmaking is the concept of lexicographic utility. Where the outcomes of alternatives under consideration by the (DM) are multi-dimensional and the (DM) is not prepared to allow tradeoffs between attributes, then the decision upon which strategy to follow must be made according to a prioritized vector of these multi-dimensional attributes. This implies that the DM has rejected the continuity postulate of the expected utility theorem. The continuity postulate implies that a DM will accept an alternative that has as one of its outcomes an unfavorable result if the probability of the unfavorable result is low enough.

The theory underlying this concept may be illustrated by returning to the simple hypothetical situation presented earlier where the DM is considering the strategies for his labor effort, given as alternative A and alternative B. In addition to the attribute of expected return (x_1), it is assumed that the alternatives have some unspecified, additional attributes (x_2, x_3, and x_4) so that the DM faces a multi-attribute outcome.

If the DM has determined that the desired level of attribute x_1 is \$23,000 and that this level of x_1 is hyper-critical to his decision, that is, it may represent a level of income below which some highly undesirable result, such as bankruptcy occurs; then the (DM) may ignore attributes x_2, x_3, and x_4 altogether if each situation does not achieve the minimum level of x_1 desired. In the case of a choice between alternative A and alternative B, the DM would choose alternative A over alternative B because of the variable component, farm income, of alternative B and the possibility, however slight, that total income form alternative B might fall below the safety level.

Lexicographic utility implies then that it may be quite appropriate in explaining the behavior of farm operators to consider the goals that these operators have for their farming operations. It also implies that imposing goal achievement requirements upon alternative farm production organizations may be an appropriate method of identifying preferred combinations.

Considerations on the Origin and Operation of Small and Part-Time Farms

While economists concentrate on behavior prediction through concepts such as cost and returns and utility maximization, other disciplines have alternative theories. Sociologists, examining the same phenomenon, would more likely use a concept such as "quality-of-life." Researchers have noted that the opinions and attitudes expressed by small farmers

> ...indicates that their decisions to live on farms were guided only to a minor extent by economic considerations (Van Es, p. 16).

Quality of life is a term having different meanings according to the background of the researcher employing it. Noting its vagueness in the literature, the U.S. Environmental Protection Agency has stated:

> The concept of Quality-of-Life has emerged in the last few years as an undefinable measure of society's determination and desire to improve or at least not permit a further degradation of its conditions. Despite its current undefinability, it represents a yearning of people for something they feel they have lost or are losing or have been denied, and which to some extent they wish to regain or acquire (p.iii).

"Non-economic" considerations that lead persons to desire a farm style of life may come from positive connotations associated with a rural life-style and/or from negative perceptions of urban life-styles. Few Americans are more than a generation or two removed from an agricultural life-style and a dependence on agriculture for a livelihood. Many are likely to associate with farming and farm -life such positive attributes as: being one's own boss, working in close association with nature, serenity of rural settings and appropriate environment in which to raise a family. These individuals may see farming and rural life as the antithesis of crowded cities and transportation routes, noise, pollution, and crime. For these persons, the desire to live on and operate a farm involves more than profits and rates-of-return on investments.

While sociologic concepts, such as quality-of-life, may contribute significantly to understanding why people choose to live on small farms, economic considerations are not unimportant. Researchers have found that many farmers were not willing to sacrifice economic well-being simply for the sake of an agrarian lifestyle (Molnar, p. 10). Other research has shown that small farm operators generally plan to institute changes to increase farm income (Van Es, Fliegel, Eichson, Backus, and Harper, p. 12; Hastings and Shippy, p. 45). In a survey of South Central Plains farmers, the most highly ranked goal of the farm firm was "making the most annual profit" (Harmon, Hatch, Eidman, and Claypool, p. 3).

Farm Management for Profit Maximization

At any given time a manager has control over a set of resources -- land, labor, capital and management (Osburn and Scheeberger, p. 163). Only through the judicious use of these resources may the operator attain an economically viable farming business.

The basic production principles that the profit maximizing small farm operator employs are not different from those employed by his larger farm counterpart.

These principles are demonstrated in the following cases.

Case I

<u>Profit Maximization with Unlimited Capital and Inputs (One Product/Two Variable Inputs)</u>

Maximize $= Py * Yf(X_1, X_2|X_3,\ldots, X_n) - Px_1X_1 - Px_2X_2 - b$

where

Py = price of output, Y,

Px_i = price of the ith input, X,

X_i = variable inputs for i = 1, 2; fixed inputs for i=3,..., n,

Π = profit,

b = fixed costs.

The first-order conditions, F.O.C.,

$$\text{F.O.C.} \quad \frac{\partial \Pi}{\partial X_1} = Py \frac{\partial Y}{\partial X_1} - Px_1 = 0 \rightarrow Py \frac{\partial Y}{\partial X_1} = Px_1, \text{ and}$$

$$\text{F.O.C.} \quad \frac{\partial \Pi}{\partial X_2} = Py \frac{\partial Y}{\partial X_2} - Px_1 = 0 \rightarrow Py \frac{\partial Y}{\partial X_2} = Px_2,$$

imply that the profit maximizing operator will employ these inputs in the production of the output up to the point at which the marginal value product of the input (MVP) equals its price (Px_i).

Case II

Profit Maximization with Unlimited Capital and Inputs (Two Products/One Input)

$$\begin{aligned} \text{Max.} \quad &= Py_1Y_1 + Py_2Y_2 - Px_1X_1 - b \\ &= Py_1\ f(X_1|X_2,\ldots, X_n) + Py_2\ (X_1|X_2,\ldots, X_n) - PxX - b \end{aligned}$$

where

Py_i = price of output Yi,

X_{1i} = amount of X_1 used to produce output Yi,

Px = price of input X,

Yi = $f_i(X_{1i})$,

X = $X_{11} + X_{12} = f(Y_1, Y_2)$,

b = fixed costs,

Π = profit.

The first-order conditions, F.O.C.,

$$\text{F.O.C.} \quad \frac{\partial \Pi}{\partial Y_1} = Py_1 \frac{\partial X}{\partial Y_1} - Px_1 = 0 \rightarrow Py \frac{\partial Y_1}{\partial X} = Px, \text{ and}$$

$$\text{F.O.C.} \quad \frac{\partial \Pi}{\partial Y_2} = Py_2 \frac{\partial X}{\partial Y_2} - Px_1 = 0 \rightarrow Py \frac{\partial Y_2}{\partial X} = Px,$$

imply that the profit maximizing operator will employ the input in the production of the outputs to the point that the marginal value of the input in each use is equated with the input price.

Land

Land usually represents the single most valuable asset of any farm. Its barrenness or bountifulness greatly influences whether the outcome from farming will be failure or success. The economic value of natural resources, particularly land, has been and is the subject of extensive analysis and debate. Most analyses of trends in land values have focused upon rents as they reflect earnings.

Recent research has shown that farmland returns grew faster than that of other assets and consequently made farmland a good investment to 1980 (Melichar, p. 1087). Subsequent analysis has concluded that the ratio of land earnings to land price is in theory invariant to the rate of inflation and that land earnings kept pace with land price increases substantially in excess of national inflation to 1980. In Oklahoma, the average value per acre of farmland increased 120 percent or 12 percent annually in the decade preceding February 1980 (Tweeten, 1981).

The appreciation of land values is recognized by small farmers. In an Illinois survey, approximately 50 percent of the respondents indicated that the increase in land values was a very significant benefit of living on a farm (Van Es et al., p. 77). While appreciation in land values is not normally realized until the property is sold, it has been pointed out that this increase in equity may provide collateral against which a farm operator may borrow to finance current farm business (Plaxico and Kletke, p. 327).

A popular alternative to ownership of farmland is leasing. Through leasing, the farm operator may acquire control of enough land to more fully utilize labor and machinery available and yet avoid the cash-flow problems often associated with outright purchase.

Capital. Entry into farming through the purchase of land and equipment and/or the acquisition of inputs such as feed, seed and fertilizer to sustain a farm requires a vast amount of capital. Financing of such purchases may be accomplished in a variety of ways, among which are: borrowing, use of retained earnings from the farm itself, production contracts or funds generated from other sources personal to the operator -- such as off-farm employment, royalties, dividends, and transfer payments.

Generally, these methods can be categorized as either internal financing or external financing. While each has advantages and disadvantages that are specific to the operator and his farm, general attributes can be associated with one or the other. External financing often requires some form of collateral (land, equipment or crops) as security for the loan and thus puts the farmer at risk of loss through foreclosure. (In a study of East Central Oklahoma farmers, most indicated sufficient collateral to secure a loan but were unwilling to risk going into debt in order to expand operation (Sanford, Tweeten, Rogers, and Russell, p. 6).) Where capital is not otherwise available, it may present the only opportunity available for financing. Internal financing, on the other hand, may free the operator from risks associated with dependence on financial markets or with loss of collateral through business failure. Its principal disadvantage is that reliance on internal financing may constrain farm size to a unit insufficient to support the farm and family needs.

Irrespective of the method of financing, the operator must determine to which enterprises he will devote his capital resources. Small farm operators have been particularly troubled with capital requirements. Capital embodied in the form of equipment often severely restricts the small farmers. Small farmers cannot afford large capital outlays for task-specific machinery when the operation is only a small part of their production technique. As a result, they must employ versatile equipment that may not be as efficient for the particular operation but allows them greater usage throughout the farm. The high capital cost of harvest equipment and the small acreage of crops found on most small farms has necessitated the use of custom harvesters in many areas. Harvest costs may still be high because custom harvesters must be compensated for the additional expenses involved in traveling and set-up between numerous sites and small acreages.

These capital requirements, combined with labor availability, must be considered by the small farmer when setting up his farm enterprises. Not surprisingly, many small farmers emphasize capital intensive enterprises, such as livestock, when labor is in short supply and emphasize more labor intensive enterprises, such as row crops or vegetables, when it is not.

While small and limited-resource farm operators may be constrained in their borrowing by insufficient prospective returns to compensate for high interest rates, they may also face discrimination from lenders according to their debt/equity ratio. Consequently, net equity is sometimes included in the farm income function and theoretically justified by 1) the existence of credit rationing, implying that production expenditures depend on the availability of owned firm funds; 2) wealth effecting the maximum amount of borrowings, as where, the maximum amount of borrowings is an increasing function of the farm's wealth; and 3) the general dependence of the effective cost of capital on the proportion of funds borrowed relative to owned funds. An example of this last dependence is the existence of percentage add-ons to mortgages and other contracts where the downpayment is less than some pre-specified amount (Steigum, p. 641; Chambers and Lopez, p. 4).

Many small farmers may, as a result of their low equity and discrimination by lenders, find themselves caught in a rather vicious cycle of high interest costs and reduced credit due to low equity, and slow equity growth due to high interest payments and under-investment. Consequently, on low-equity farms such as entry-level operations, there may be increased demands for equity formation in early years at the expense of consumption.

Labor. In addition to land, labor constitutes a major input into farm operations. Small farmers must carefully consider how to allocate this resource among production alternatives if they are to achieve a sufficient family income from farming.

Many farm operators face off-farm job opportunities requiring decisions concerning participation in this off-farm labor market and its impact upon their farming activities. Numerous factors influencing off-farm work effort have been identified. Among these are -- age, education, health, race, marital status, family size, levels of indebtedness and net assets, as well as the prevailing off-farm wage.

A mathematical presentation of the decision criteria upon which an individual would decide to work full-time off-farm work is presented by Chambers and Lopez (1984) using a utility function of the form specified by Stiegum (1983) which includes equity in the farm income component. The utility function used is, as follows:

$$1)\ \max_{c,L_1,L_2} \int_0^\infty U(c(t), H-L_1(t) - L_2(t))e^{-\delta t}\, dt$$

$$\text{s.t. i.}\quad \dot{E} = (E(t), L_1(t), v) + wL_2(t) + y(t) - c(t)$$

$$\text{ii. } E(0) = E;\ c \geq \overline{c};\ H - L_1 - L_2 \geq \overline{T};$$

where

c(t) is consumption at time t,

y(t) is finite non-labor income which includes government transfers, etc.,

E(t) is the total level of net equity owned by the farm-household,

$L_1(t)$ is on-farm work,

$L_2(t)$ is off-farm work,

δ is a time discount rate,

H is total time available to the household,

c and l are minimum consumption and leisure levels required by the farmer,

$\rho(\cdot)$ is a farm income function,

v is a vector of output and input prices, and

w is the off-farm wage rate.

Constraint (i), the dynamic counterpart to the static budget constraint, says that total current income (farm income, off-farm income, and transfers) is allocated between current consumption and equity formation (or savings). Constraints (ii) indicate that equity is initially given and that there are minimum levels for consumption and leisure which the family is willing to accept.

The farm income function is defined as:

$$2)\ \rho(E, L_1, V) \equiv \underset{K}{\text{Max}}\ \{\Pi(v, L_1, K) - r(\frac{K-E}{E})(K-E)\}$$

where

K is productive capital,

r is the interest rate on borrowed capital,

K-E is the total stock of debt, and

$\Pi(\cdot)$ is a conditional profit function defined by;

$$3)\ \Pi(v, L_1, K) \equiv \underset{K}{\text{Max}}\ \{vQ : Q \in \tau(Q, K, L_1)\}$$

τ is a compact and convex production possibilities set and Q is a vector of M outputs and N variable inputs having positive and negative signs, respectively. It is assumed that $\Pi(v, L_1, K)$ is twice continuously differentiable and convex in V, non-decreasing in output prices, non-increasing in input prices, positively linearly homogeneous in V, and non-decreasing in L_1 and K. $\Pi(\cdot)$ is also assumed strictly concave in L_1 and K.

Following Stiegum it is assumed that $r'(\cdot)>0$ and $r''(\cdot)>0$. The cash cost of capital is then $r(\cdot)(K-E)$, and the farmer is assumed to be a net borrower. Essential properties of $\rho(\cdot)$ are: (1) increasing and strictly concave in E, (2) non-decreasing and strictly concave in L_1, (3) convex in V, and (4) the vector of first differentials with respect to V equals the net output vector. It is also assumed that $\lim_{E \to \infty} \rho(V, L_1, E)$ is finite.

The constrained, current value Hamiltonian associated with 1) is

4) $H = U(c, H-L_1-L_2)+q[\rho(E, L_1, v)+wL_2+y-c]+\mu(c-\bar{c})+\lambda(H-L_1-L_2-\bar{T})$,

where q is a co-state variable, μ and λ are Lagrangian multipliers, and U_1 and U_2 are the marginal utility of consumption and leisure, respectively.

Chambers and Lopez present the conditions which must hold for: a) the farmers to devote all his efforts to farming; b) the farmer not to work on the farm at all; and c) the farmer to work both on-farm and off-farm at the same time.

The farmer will not work off-farm if

$q\rho_L(E, L_1, V) = U_2(C, H - L_1) + \lambda$ and

$q_w < U_2(C, H - L_1) + \lambda$,

implying $\rho_L(E, L_1, V) > w$.

Simply put, this says that the marginal on-farm earnings, when all labor is allocated to the farm, are higher than the off-farm wage rate.

The farmer does not work on the farm if

$U_2(C, H - L_2) + \lambda > q\rho_L(E, L_1, V)$, and

$U_2(C, H - L_2) + \lambda = q_w$,

implying that $w > \rho_L(E, L_1, V)$.

This last expression implies that the farmer's marginal on-farm earning potential is so low as to be negligible.

The farmer works both on-farm and off-farm when

$\rho_L(E, L_1, V) = w$.

This implies that the value of on-farm work equals the off-farm wage rate and the amount of time spent on farm is, then, independent of preferences and only depends upon production conditions.

The importance of off-farm income has been noted by numerous researchers. Minnick and Walker in an assessment of alternative credit sources for low resource, beginning farmers requested commercial banks, FLBA's, FmHA, PCA's and private lenders to specify any suggestions they had for a prospective entrant into agriculture. A most often observed suggestion from lenders was that the operator needed to obtain off-farm income and save (Minnick and Walker, p. 13).

Figures 5-7 below shed some insight into the labor decisions these operators face. According to Johnson, these figures exhibit the impact upon labor allocation of different size farms, off-farm wage and opportunity costs (p. 105). In Figure 5, two marginal value product (MVP) curves are shown imposed upon a family labor supply and net off-farm wage curve. The lower MVP curve is that assumed associated with the smaller farm and the higher curve assumed associated with the larger farm. The reservation price is the value of the farm family's leisure or the amount of transfer payments at which the members would just be willing to forego any labor effort. If there were no off-farm wage available, then the reservation price would be the opportunity cost of farm labor. In this Figure, the family operating the smaller farm would be willing to work $\overline{OA}$ days per year on the farm and $\overline{AC}$ days per year off-farm. The family operating the larger farm would just be willing to work $\overline{OB}$ days per year or the farm and $\overline{BC}$ days off-farm. The higher MVP of the larger farm results in a greater allocation of labor to farming than on the smaller farm, *ceteris paribus*.

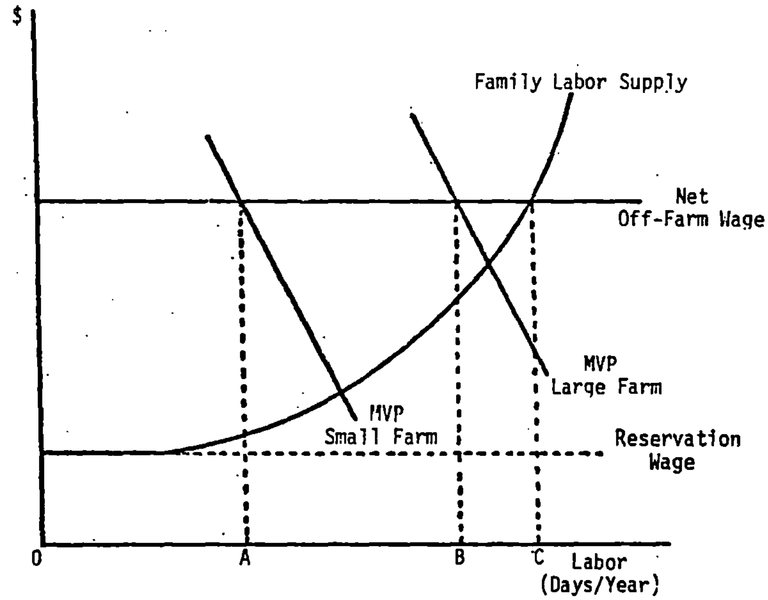

Figure 5. The impact of differing MVP curves upon the allocation of labor between farm and off-farm job opportunities

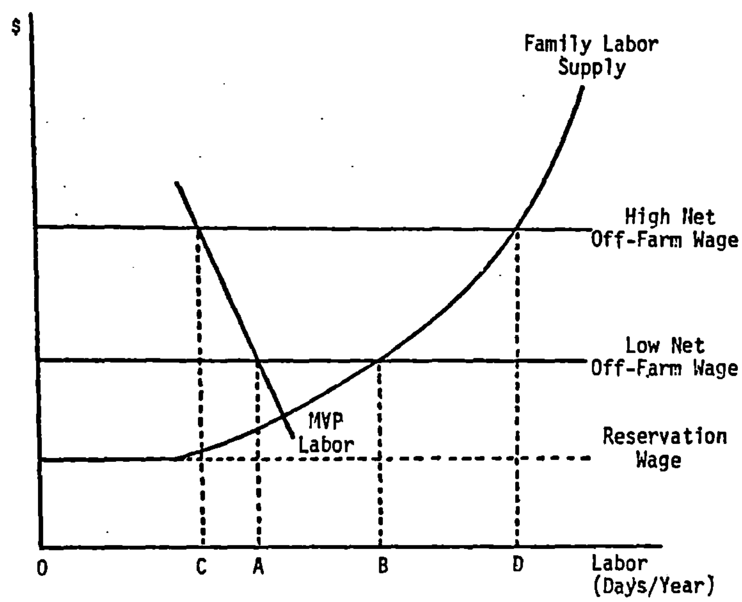

Figure 6. The impact of differing net off-farm wage rates upon the allocation of labor between farm and off-farm jobs

The impact of changes in net off-farm wage is shown in Figure 6. In this graph, a rise in the net off-farm wage results in an increase in the amount of off-farm work done by the family and a decrease in the amount of farm work. At a low net off-farm wage, $\overline{OA}$ days of labor per year are devoted to the farm and $\overline{AB}$ days of labor per year to the off-farm job. At a higher net off-farm wage, $\overline{OC}$ days of labor are used on the farm and $\overline{CD}$ days of labor on the off-farm job.

Figure 7 exhibits changes in input factor ratios when the opportunity cost of one changes. In this graph, it is assumed that the opportunity cost of farm labor increases (i.e. the off-farm wage rate rises). For a given level of output, production practice will be altered so that less of the now more costly factor is used and more of the comparatively less costly factor. This is shown by moving from point C to D and A to B along the respective iso-product curves. Also, a rise in the off-farm wage may cause a shift toward production of a more capital intensive output and away from a more labor intensive output. This is shown by the movement along the budget constraint from point B to point E.

The East Central Oklahoma (ECO) study provides some insight into the situation as perceived by those farm operators. As indicated previously, approximately 40 percent of the operators in the study area were classified as part-time farmers. The average hourly off-farm earnings for the three classifications of operators; aged and disabled, part-time and full-time, were \$8.60, \$10.90 and \$14.00, respectively. Asked to compare the value of their off-farm wage with the returns from a similar work effort on-farm, approximately

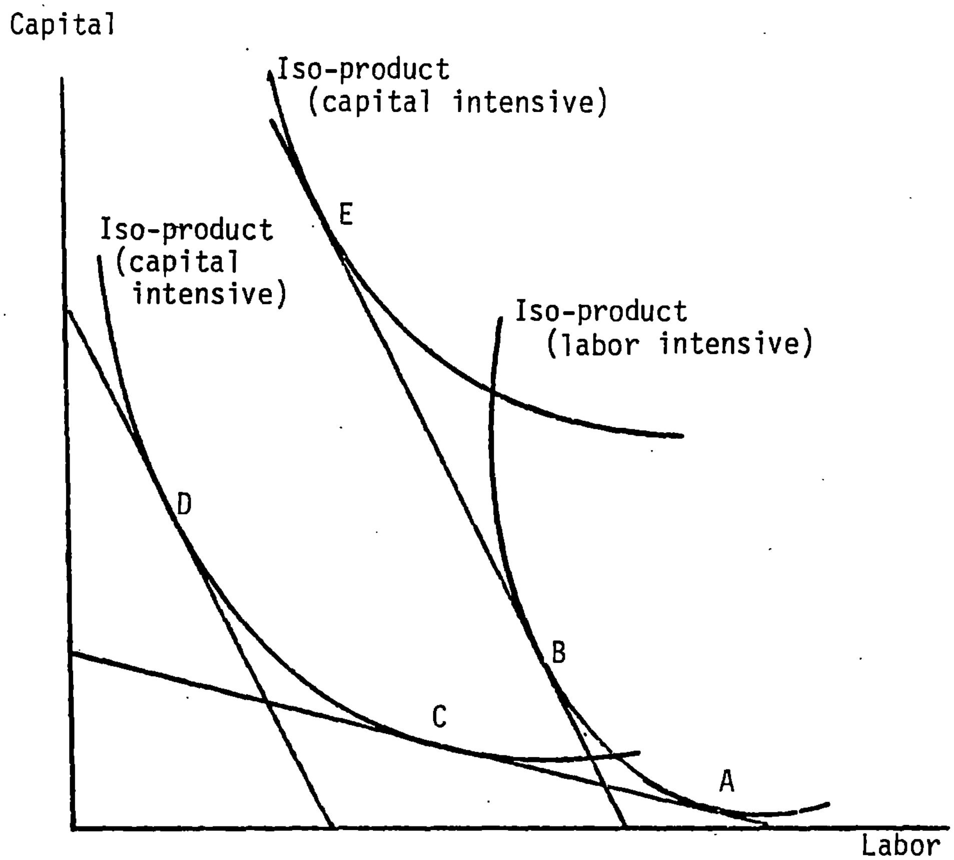

Figure 7. Shifts in production factor ratios and enterprise organization when opportunity cost of labor increases

two-thirds of the respondents considered their off-farm wage to be worth "much more" than they could earn from farming.

Off-farm job opportunities for the operator's spouse can likewise be an important component of total family income. The East Central Oklahoma survey posed similar questions concerning the spouse's off-farm work activity. Off-farm hourly wage rates for the spouses of aged and disabled, part-time and full-time operators were approximately \$4.90, \$6.00 and \$4.90, respectively, values considerably lower than those reported by the operators themselves.

With operators generally facing much greater returns in the off-farm labor market than their spouses and many operators indicating that they value their off-farm work more highly than similar effort on the farm, one could expect the spouse to substitute their labor on-farm for operator labor off-farm. This substitution effect can be demonstrated for an operator and spouse each having 40 hours per week to allocate between farm and off-farm activity. Suppose the operator and spouse have \$10/hour and \$9/hour off-farm wage opportunities, respectively. A total allocation to off-farm work results in a combined income of \$760 per week. If they are determined to farm, with this commitment requiring 10 hours of farm labor per week yielding an average hourly wage of \$8.00, and the operator satisfies the requirement, total earnings would fall to \$740 per week. If the spouse substituted the 10 hours from his \$9/hour off-farm job and the operator allocated all labor to the off-farm job, total income would be \$750, a \$10 per week gain from substitution. At very low off-farm opportunity costs, or conversely, high farm labor returns, a maximization of total income may result from an allocation of labor to farming independently of any substitution effect. Similar circumstances may be held to apply to labor provided by minors on the farm.

Management. Managerial ability is an attribute of farm operators that is particularly difficult to measure but nonetheless is of extreme importance to agriculture professionals assisting operators at the farm level. Management is defined as those activities relating to the organization and operation of the farm for the attainment of specific ends. Organizational decisions include: what to produce, how much to produce, and when to produce it; together with operational responsibilities, such as, determination of methods of production, timing of jobs, selecting equipment or techniques, and choosing personnel.

Managerial ability is fostered principally through experience and education and the ECO farm survey provides some insights concerning those farm operators' education and experience. Survey results indicate that, on-the-average, the farm operators are more highly educated than their non-farm age cohorts. Average number of years of schooling was 11.6 for the survey respondents. Farming experience in the form of growing up on a farm in a farming family prior to entering farming for oneself was indicated by 87 percent of the operators. When querried about their perceptions of their own managerial ability, most were quite confident of the capability. Asked if they would be willing to attend school to improve their farming ability, the response was decidedly negative. However, only about 53 percent were opposed to working with an on-farm agricultural specialist to improve their farming (Sanford, p. 16).

Managerial confidence exhibited in the survey by respondents was with respect to current practices and traditional enterprises. An agricultural specialist working at the farm level would do well to consider the managerial gulf between hay production and some other enterprises such as intensive vegetable production.

CHAPTER III

DESCRIPTIVE ANALYSIS OF THE SURVEY AREA, PROCEDURE, DATA AND PROXY FARM MODEL DEVELOPMENT

Survey Area

The East Central Oklahoma survey was conducted in four counties. The geographic location of the counties is indicated in Figure 8. A brief description of those counties follows:

Wagoner County

Wagoner County has an area of about 380,800 acres or 595 square miles (Polone, p. 2). There are 20,608 acres of water area in the county. Soils on uplands make up 76 percent of the acreage; soils on bottomlands, 19 percent; and water areas, 5 percent. Three physiographic regimes -- the Cherokee Prairie, the Boston Mountains, and the Ozark Highlands are found in the county with the Cherokee Prairie making up 90 percent of the land area.

Principal natural resources of the area include over 65,000 acres of productive flood plains along the Arkansas, Verdigris, and Grand Rivers; an abundance of water, native and tame-pasture plants, gravel, oil, gas, and coal. Average monthly rainfall for Wagoner County is presented in Table 2.

According to the 1982 Census of Agriculture, 96,400 acres of cropland were harvested in that year in Wagoner County on 575 farms. Of these cropland acres, 1,524 were irrigated. Wheat for grain was

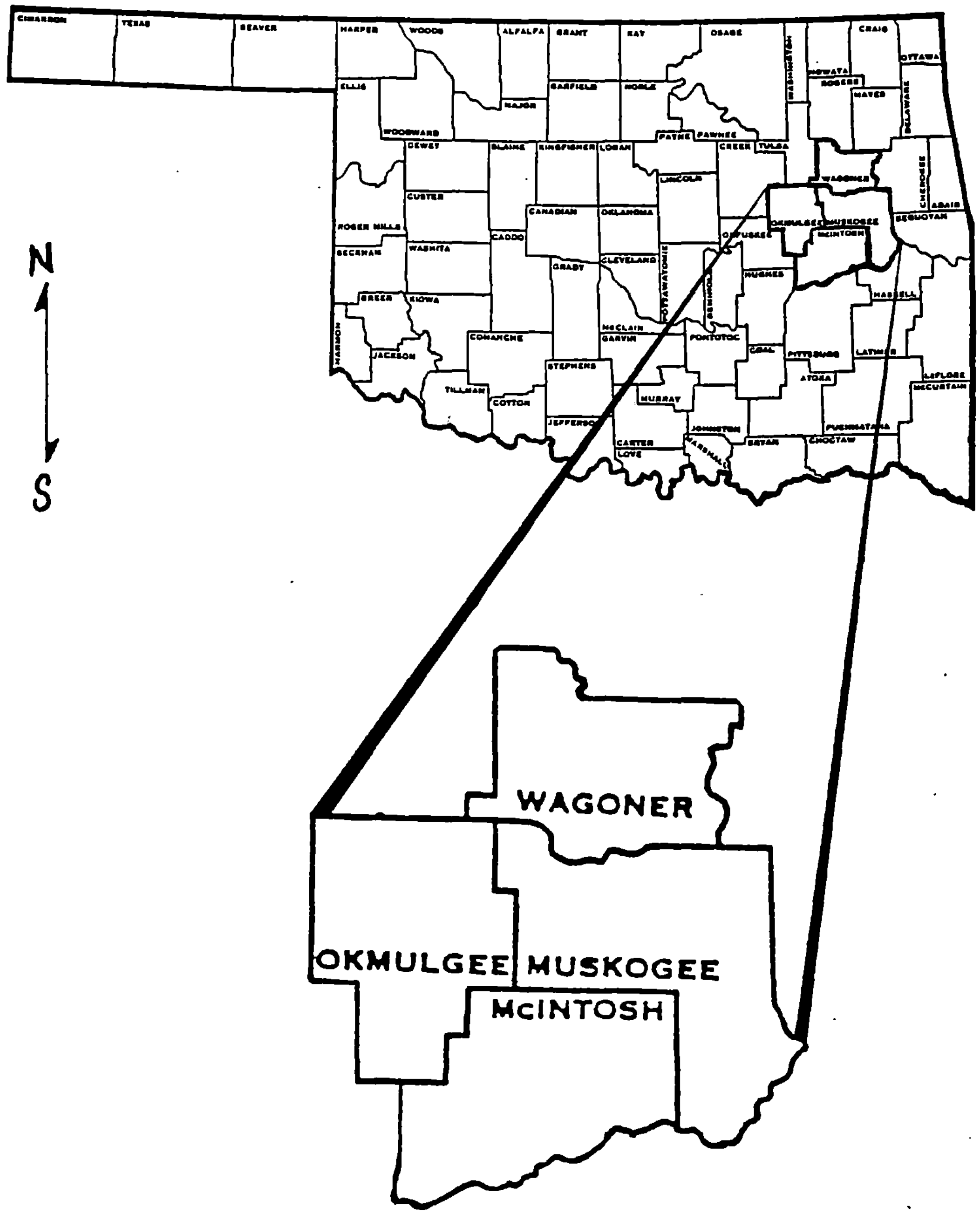

Figure 8. Oklahoma state map and geographic location of survey area

Table 2. Average Monthly Rainfall in East Central Oklahoma Survey Area in Inches by County

	COUNTY			
	WAGONER	MUSKOGEE	OKMULGEE	MCINTOSH
January	2.0	1.68	1.97	1.65
February	2.3	2.21	2.21	2.16
March	3.1	3.19	2.84	3.22
April	5.0	4.75	4.58	4.72
May	5.9	4.86	5.63	4.96
June	5.0	4.44	5.63	4.37
July	3.5	3.32	3.26	3.29
August	3.1	3.01	2.49	3.14
September	3.9	4.40	3.94	4.36
October	3.4	3.56	3.62	3.52
November	2.5	2.90	2.46	2.94
December	2.2	2.28	2.05	2.32
TOTAL	41.9	40.60	40.68	40.65

Source: Soil Surveys, Oklahoma Counties. USDA-SCS.

grown on 40 percent of the cropland, soybeans on 35 percent, and hay on 30 percent of the cropland. Cattle and calves were produced on 740 farms in the county in 1982.

In 1983, there were 47,600 residents in Wagoner County with a per capita personal income of $8,886 (U.S. Department of Commerce, p. 132). Farm earnings for the county were $4,770,000 compared to non-farm industry earnings of $69,278,000.

Okmulgee County

Okmulgee County has a land area of about 700 square miles or 448,000 acres and lies almost entirely within the Cherokee Prairie land resource area (Sparwasser, Bogard, and Henson, p. 6). Nearly half of the county is not suitable for cultivation. Wells are the source of most of the drinking and irrigation water used on farms in this county. Rainfall, impounded by surface structures, is used with increasing frequency on farms. Average monthly rainfall for the county is presented in Table 2.

In 1982, according to the U.S. Census of Agriculture for that year, 879 farms in Okmulgee County produced cattle and calves. In the same year, 532 farms harvested 52,923 acres of cropland, very little of which was irrigated. Wheat for grain was grown on 29 percent of the cropland, soybeans on 8 percent, and hay on 53 percent.

Per capita personal income, averaged $8,784 for the 41,500 residents in this county in 1983. Farm industry earnings were $1,895,000 compared to non-farm industry earnings of $168,760,000.

McIntosh County

McIntosh County has an area of 460,800 acres, or 720 square miles (Swafford and Allgood, p. 21). Areas of water over 40 acres make up 44,960 acres or 9.8 percent of the total acreage. Topographic differences range from the nearly level flood plains of the Canadian Rivers in the western and southwestern part of the county to the moderately steep areas in the northwestern part. In this county, 144,930 acres or 31 percent of the land is classified as prime farmland. Average monthly rainfall is depicted in Table 2.

In 1982, 521 farms in McIntosh County harvested cropland which totalled 41,559 acres. Only 219 acres were irrigated. Wheat was produced on 15 percent of the cropland, soybeans on 13 percent, and hay on 61 percent of the land. Cattle and calves were produced on 732 farms in the county in 1982.

McIntosh County had approximately 16,800 residents in 1983 and a per capita personal income of $7,818. In that county $3,444,000 in earnings were generated by farm industry while non-farm earnings were $42,829,000.

Muskogee County

Muskogee County has an area of about 538,240 acres or 841 square miles (Townsend, Long, Scott, and Gilbertson, p. 32). Areas of water over 40 acres in size make up 18,860 acres, or 3.5 percent of the total acreage. Topographic differences range from the nearly level flood plains of the Arkansas River in the northern and eastern part of the county to the moderately steep areas in the northeastern part.

In 1982, acording to the Census of Agriculture for that year, 817 farms in Muskogee County harvested 104,534 acres of cropland. About 25 percent or 26,128 acres of this was wheat, 25 percent or 26,379 acres was soybeans, and 50 percent or 53,211 acres was hay. Irrigation was practiced on 2,953 acres of this cropland. Cattle and calves were produced on 868 farms in 1982.

Per capita personal income for the 70,400 residents of the county was $9,800 in 1983. In that year, farm earnings in Muskogee County were $3,873,000 and non-farm earnings were $462,420,000.

Survey Procedures

The four East Central Oklahoma counties were chosen as the survey site for the high density of small, part-time, and limited resource operations thought to typify agricultural production in the area. Once the area was selected, the farms in each county were identified and with the aid of topographical maps grouped into clusters of from six to eight farms apiece. The clusters were assigned a number and a table of random units was utilized to identify clusters for survey. Once a cluster was identified, all farms within the cluster were surveyed.

In all, 424 farm operators were surveyed, 372 in a random sampling, and 52 in a minority supplement. Approximately 1 in 10 of the operators in the four-county area were contacted by personal interview in this manner. The respondents were classified as either aged and disabled, part-time, or full-time farm operators. Any respondent who was 65 years old or older in the survey year and/or had 50 percent or greater disability was classified as aged or disabled. Respondents working off-farm 150 or more days annually at least four hours per day were classified as part-time operators. All other respondents were classified as full-time, able-bodied farm operators. The survey was conducted in the summer of 1981 and the information collected corresponds to the 1980 production period.

Survey Data and Proxy Farm Model Development

Part-Time Operator Proxy Farm Model

In the East Central Oklahoma survey, approximately 40 percent of the farms were classified as part-time farming operations. Of the 143 farms so designated, 96 were selected as a data base for development of a part-time proxy farm model. In selecting a subset of the total number of survey respondents that were classified as part-time operators, it was decided to use the lower half of the distribution according to farm size in acres. This was done due to the emphasis intended in the following analysis on small-scale and limited-resource farming operations. It is felt that inclusion of quite large farms (at the extreme of the distribution) in the data base for development of the part-time proxy farm model would significantly distort representation of observed resource levels on this particular farm type. Among those selected, the following characteristics of the farm, operator, and family were observed and utilized to develop the model employed in the subsequent analysis.*

Land Resource. Approximately one-half of the respondents reported cropland as a component of their land resource while pasture

*Numerical values represent averages for selected respondents as reported in 1980.

and range was present on all respondents' farms. Total land resources averaged 80 acres per farm, or 20 acres of cropland and 60 acres of pasture and range. All other land -- timberland, house lots, ponds, and waste -- represented only 6 percent of the total land inventory.

Land Resource Utilization. Wheat, hay, and soybean production comprised over 95 percent of the cropland acreage. Wheat was produced on 44 percent of the cropland for an average of 47 acres per producing farm, soybeans were produced on 23 percent of the cropland for an average of 53 acres per producing farm, and hay was produced on 29 percent of the cropland for an average of 25 acres per producing farm. Grain sorghum and oat production accounted for all but less than 1 percent of the remaining cropland acreage. Production of fruits, nuts, berries, vegetables, sweetcorn, or melons was reported on only five farms for an average of eight acres per producing farm.

Livestock in the form of cattle and calves were present on over 80 percent of the farms. Beef cows represented over one-half of the 29 head average per producing farm. Heifers and steers evenly comprised the remaining inventory. Milk cows represented only 1 percent of the total herd reported. The two farms reporting sales of milk had average sales of $850 in 1980 indicating that these were not commercial milking operations.

Hogs and sheep were produced on only 17 and 6 percent of the farms, respectively. While over one-half of the respondents reported horses or mules on their place in 1980, only one-fifth of those reported any sales, perhaps indicating that most were kept for pleasure or on-farm use and were not regarded as a commercial enterprise. Similarly, poultry were reported on only 17 percent of the farms with less than half of those reporting any sales. The five respondents reporting sales averaged $760 per farm.

Machinery and Equipment. The part-time operators in the sample utilized a wide range of machinery and equipment in their production practices. Overall, they indicated machinery and equipment consistent with the small-scale farming practiced.

Ninety-six percent of the operators reported having at least one motortruck on their farm with the majority having only one truck of one-half ton in size. About a third reported a second truck of three-quarter ton in size.

Seventy-five percent of the respondents reported a tractor on the place in 1980. Again, most owned only one tractor averaging 55 horsepower. About 13 percent reported owning a second tractor.

Self-propelled grain and bean combines were owned by only 7 percent of the part-time operators in the sample. The average head width was 12 feet. No operators owned more than one combine. The relative infrequency of ownership of harvest equipment compared to the incidence of crop production would indicate that many rely upon custom harvesting or sharing of equipment with neighbors.

Labor. The majority of the part-time farming operations utilized only operator and family labor. Only about 1 in 5 operators hired any additional labor and then it was of short duration.

The average hours per week worked off-farm, as reported by the sample respondents, indicates that, for most, their farm efforts are highly limited by labor availability. Respondents reported 44 hours per week of off-farm work. While the survey did not attempt to obtain information about the frequency or duration of work periods, the data suggest at least a standard, 8-5, five-day work week off-farm.

Assuming such a work schedule and also that the operator would (1) do no farm work prior to 8:00 a.m. on a week-day, (2) work on-farm during the week from 5:30 p.m. until dark, and (3) work from daylight to dark on Saturdays when necessary, some measure of the hours of labor available for farm work may be obtained. Utilizing a table of sunrise/sunset times for the same latitude as the survey area, Figure 9 was constructed exhibiting the hours of operator labor available by month under such assumptions. The result was approximately 1,226 hours of labor available concentrated in the summer months and peaking in June.

Part-time operators in the sample reported an average weekly wage of $367 for their off-farm labor. This value represents approximately eight dollars per hour return to such effort. Presumably, operators would be willing to shift labor from off-farm to on-farm employment only when returns from the latter are commensurate with their off-farm opportunity cost.

Another important component of labor availability consists of labor supplied by the operator's family. About 40 percent of operators' spouses indicated some off-farm employment. Average hours per week worked off-farm and weekly wage earnings of 33 and $205, respectively, were reported. For these spouses, this represents a six dollar per hour off-farm opportunity cost. The average time per week worked off-farm by all spouses was approximately 14 hours per farm. This represents an annual off-farm work effort by spouses of 728

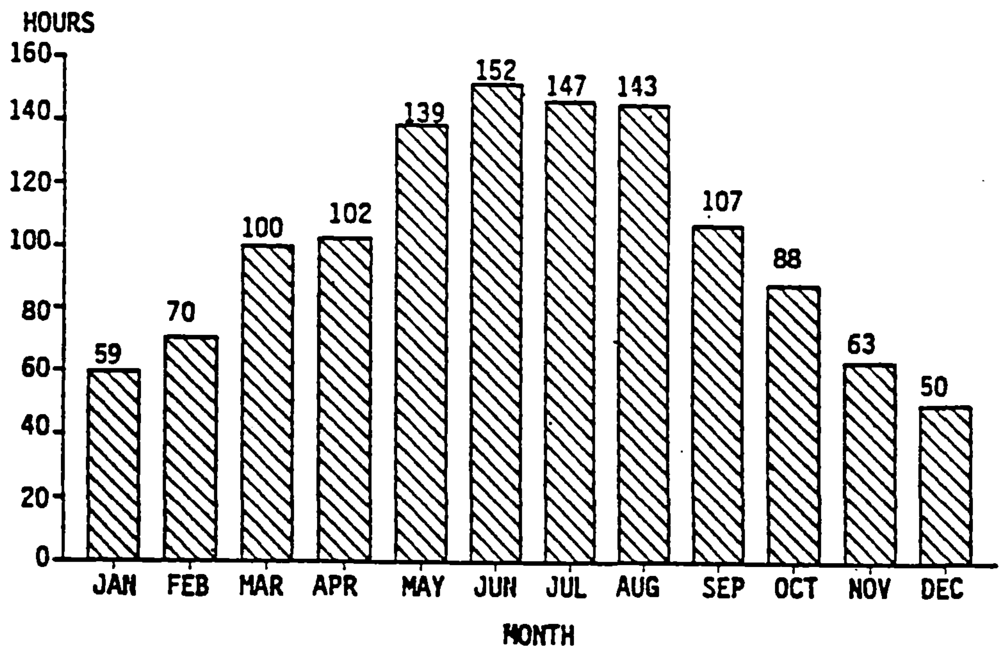

Figure 9. Part-time farm operator annual labor availability

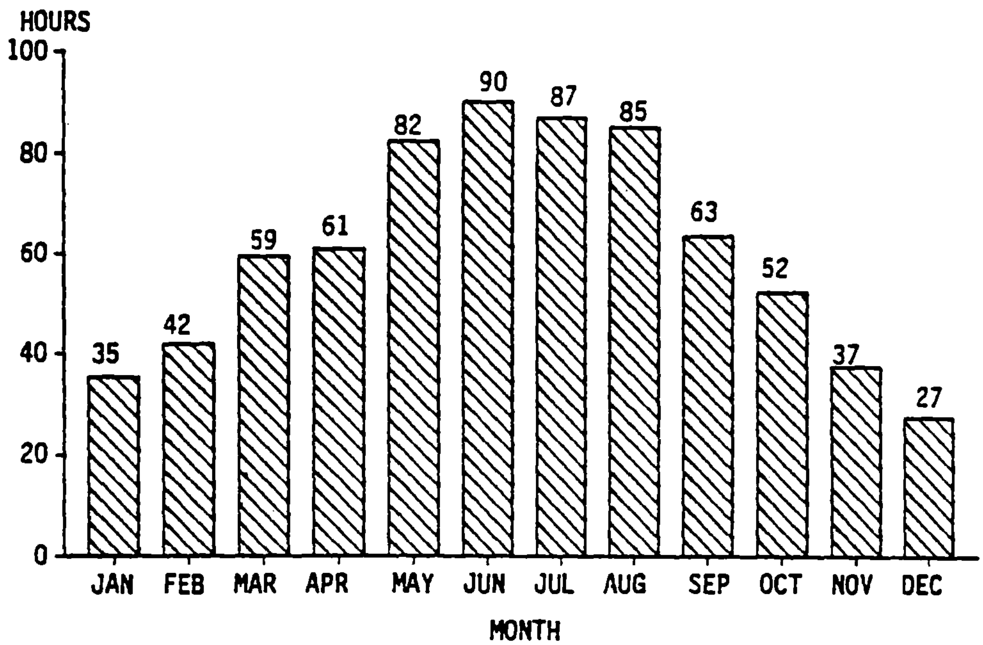

Figure 10. Part-time farm operator spouse annual labor availability

hours per farm. In the absence of more specific information about spouses' allocation of effort to household and family responsibilities, the part-time model assumes that spouses' annual on-farm labor is approximately equal to their off-farm effort of 728 hours. Assuming the monthly distribution of such effort follows that of the operator, Figure 10 was constructed exhibiting the hours of operators spouses' labor availability by month.

The contribution of children to the farm effort is not well known and was not explicitly querried in the East Central Oklahoma survey. Very small children would be expected to have a negative influence upon farm labor availability while older siblings may make a significant positive contribution to the labor requirements of the farm. Part-time operators in the sample had, on the average, one child living at home during the period surveyed. For modelling purposes, it is assumed that the child is a teenager capable of contributing 50 hours of work per month uniformly throughout the year. Figure 11 depicts the total family farm labor available by month under the specified assumptions.

Capital. The sample respondents reported approximate gross farm sales in 1980 of between $2,500 and $5,000 on average. In that year, net farm income (defined as gross less production costs) was negligible with most operators just breaking even on their farming operations. Total family income, however, portrayed a much brighter picture. This amount, defined as the net of farm and off-farm income, averaged $18,000 per farm. In 1980, farm debt was reported to be about $5,000 per farm. At the end of that year, real estate equity averaged $70,000 per farm. The net farm income and debt values

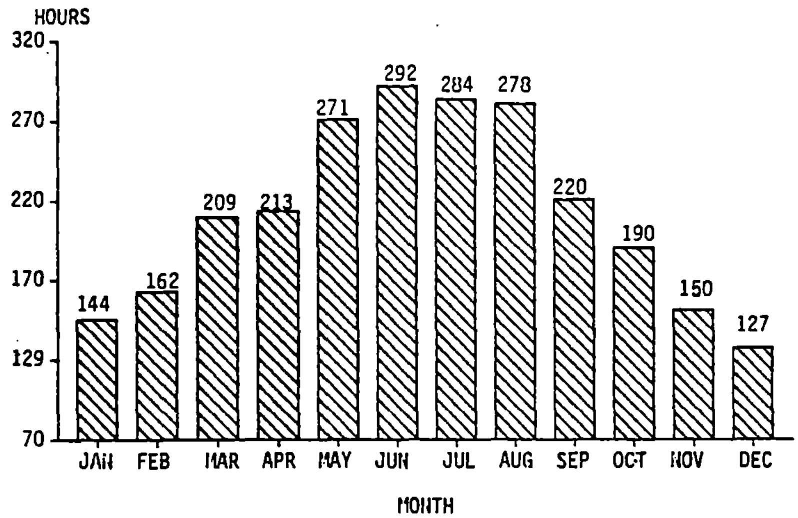

Figure 11. Part-time farm operator family annual labor availability

would indicate that, to the extent 1980 net farm income was typical of historical net income, operators may be relying upon off-farm income for debt servicing and retirement. The high value of net worth indicates substantial equity against which these operators may borrow to finance operation and/or expansion. It is assumed in the part-time proxy farm model that borrowing to finance the farm operation will not exceed 80 percent of the real estate equity that the operator has in his farm. Under this assumption, a $56,000 upper bound is placed upon borrowed capital.

Full-Time Operator Proxy Farm Model

The 130 operators farming on a full-time basis represented about 35 percent of the respondents in the East Central Oklahoma survey. Sixty-seven of these operators were selected as the data base for the full-time farm operator model.

Development of the full-time proxy farm model was accomplished using the upper half of the distribution by acreage of the respondents classified as full-time operators. Since the part-time proxy farm model may be readily evaluated as a full-time operation, the decision to exclude the small full-time operators from the subset of such operators used in the full-time model development is deemed appropriate.

Land Resource. In 1980, farms of the selected respondents averaged about 1,300 acres in size. Eighty-five percent of these operators reported owning cropland for a per farm average of 493 acres. Pasture and range, present on all farms, averaged 663 acres. Other land, timberland, house lots, ponds, and waste represented 147 acres per farm.

Land Resource Utilization. As in the case of the part-time farming operations, wheat, hay, and soybeans were the dominant crops produced on the full-time operated farms. Their combined acreage produced in 1980 was in excess of 100 percent of the cropland available, indicating a sizeable acreage devoted to double-cropping, presumably of wheat followed by soybeans. The combined acreage of all other crops reported; corn, barley, grain sorghum, oats, and peanuts was smaller than the number of acres double-cropped, which was 17 percent of the total crop acreage.

Wheat was produced by 67 percent of all farms for an average per producing farm of 292 acres. Soybeans were produced by 54 percent of the farms with an average of 363 acres per producing farm. Hay was grown on 60 percent of the farms for an average of 175 acres per producing farm.

Cattle and calves were present on 96 percent of all farms in the sample. Number of head averaged 230 per farm. Eighteen percent of farms reported milk cows in 1980. Milk sales for those farms reporting production averaged $73,500 in that year. Beef cows represented half of the total cattle inventory.

Hogs and sheep were produced on only 7 and 4 percent of the farms, respectively. Horses and mules were found on 61 percent of the farms, with only 19 percent of those reporting any sales. Poultry were present on 20 percent of the farms, but no sales were reported.

Machinery and Equipment. The full-time operators had about three motortrucks per farm averaging three-quarter ton or larger in size. These operators also averaged over two tractors per farm of about 100 horse-power. One-half had combines on their place in the survey year. Average head width of 16 feet was reported.

Labor. The operators included in the sample were full-time farmers with no off-farm labor reported. About a third of these operators' spouses reported off-farm work. For those reporting off-farm work, the average hours worked per week and average weekly wage was about 36 and $193, respectively. These values represent an average hourly off-farm wage of $5.36.

Assuming that the full-time operators would work all daylight hours during a five-day work week, Figure 12 was constructed exhibiting the monthly labor availability of such operators. Potential total annual labor provided by the operator under this assumption was estimated to be about 3,466 hours. Spouse's contribution to the full-time operator's farming effort was assumed

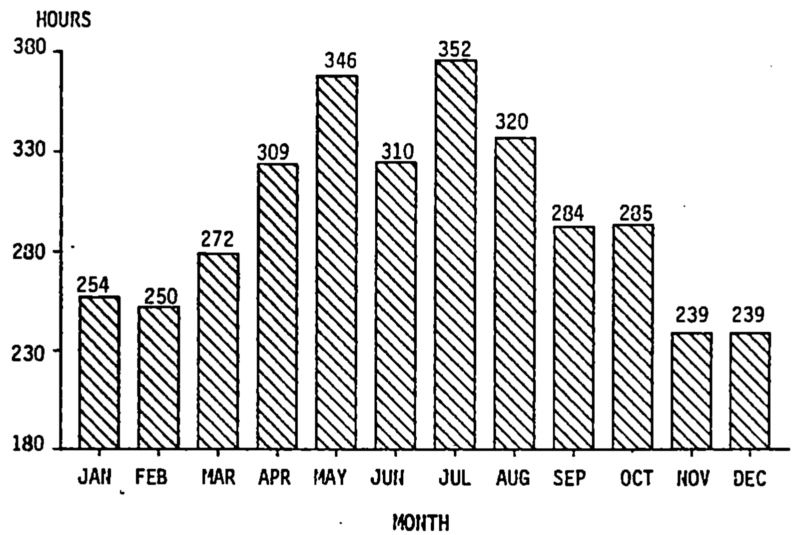

Figure 12. Full-time farm operator annual labor availability

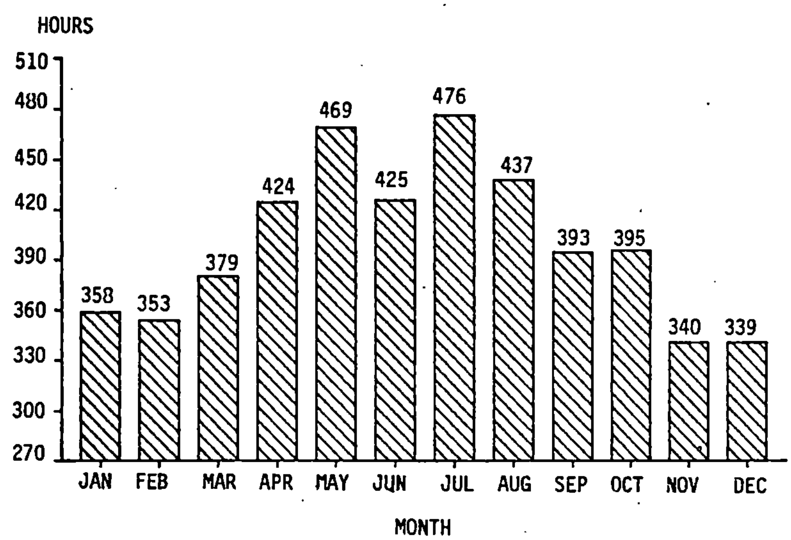

Figure 13. Full-time farm operator family annual labor availability

comparable to that provided by the spouses of part-time operators, i.e. about 728 hours annually. As in the case of part-time operators, full-time operators had, on the average, one child living at home. The child was assumed to contribute 50 hours of labor per month, or 600 hours annually. Figure 13 depicts total family labor available by month under the specified assumptions.

In addition to the family labor, hired labor was frequently employed by the full-time operators in the sample. All operators reported at least some hired farm labor, most of which was seasonal, with only 20 percent reporting full-time hired laborers. The average number of seasonal workers hired was slightly over three persons and the average duration of employment was just over three months per worker. For modelling purposes, it is assumed that this is equal to an additional 600 hours per month of labor during May, June, and July and that the additional labor is distributed over the period similar to that of the operator.

Capital. The full-time farm operators in the sample, operating much larger farms than their part-time counterparts, reported much larger gross farm sales per farm. These sales averaged approximately $60,000 per farm in 1980. Net farm income from these sales averaged only about $5,000 per farm, however. Total family income, defined as the net of farm and off-farm income, averaged $17,500 per farm, less than that of the part-time operators in the sample.

At the end of 1980, the full-time operators reported an average debt of slightly over $30,000 per farm. Net worth of these operators was estimated to be $900,000 per farm in that year. It is assumed that the full-time farmer faces a $120,000 upper bound on borrowed capital in the full-time proxy farm model.

Base Model Parameters

These survey data were utilized to develop a resource base for the initial models used in this study. Appendix Table 10 presents the values for selected resources found on the model farms.

CHAPTER IV

RESULTS OF LINEAR PROGRAMMING SOLUTIONS TO THE PROXY FARM MODELS

In assessing the income potential of the part-time farming operation, three basic groups of enterprises are considered. These are: traditional enterprises, non-traditional enterprises, and specialty enterprises. The traditional enterprises are those which are commonly observed in the East Central Oklahoma production area and related enterprises, while non-traditional enterprises are defined as those which are suited to the area, but not widely observed, such as swine production. Specialty enterprises are those which similarly are suited to the area, but not widely practiced, such as vegetable crops. A complete list of enterprises by group is found in Appendix Table 11, a list of selected outputs and prices in Appendix Tables 12 and 13, and a list of selected inputs, costs, and returns in Appendix Table 14.

Once a particular enterprise is selected for inclusion, machinery and equipment requirements are modified to provide consistency among enterprises, as well as accurately to portray the resource situation found in the part-time proxy farm model as identified through the producer survey. For example, in the case of row crop activities, this involves modification of field activities to reflect 4-row planters and cultivators, and the use of custom harvesting to reflect the widespread absence of harvest equipment on part-time farming operations in the area.

In order to diversify cropping patterns and more accurately depict actual practice, a priori acreage restrictions are placed upon certain enterprises. For instance, hay production on cropland is restricted to not more than one-fourth of the total owned land available on the farm, and specialty crops are restricted to not more than 10 percent of the owned cropland acreage available.

Results are developed first for the part-time model and then for the full-time model. For the part-time model, the base scenario, that described in Appendix Table 10, is analyzed over the following four combinations of enterprises: traditional; traditional and specialty; traditional and non-traditional; and traditional, non-traditional, and specialty. Income and labor values are reported for each combination. Subsequently, land rental is allowed and labor increased under each combination and the values reported again. From the base scenario, farm labor is permitted to increase by halving the off-farm labor of the operator and spouse and directing the freed labor toward the farming activity and then allowed to further increase by removing all off-farm labor.

Three different labor levels are analyzed with additional land rental and without additional land rental, resulting in six analyses for each of the four enterprise combinations. Where permitted, cropland is rented for $35 per acre and pasture for $20 per acre. A 1,000 acre rental limit is placed on each type of land. Capital used in the analysis is borrowed at a 15 percent interest rate.

The part-time model is then analyzed again in the manner described above with a higher level of operating capital, which is increased from $17,000 to $50,000. The initial amount is borrowed at 15 percent interest and the additional $33,000 at 17 percent interest. The impact of the additional capital upon the model solutions is then presented.

An additional solution for an alternative part-time proxy farm model is subsequently presented. The model resource situation is altered to reflect an absence of cropland on the farm and a lower level of pastureland management. Only native grass pasture is allowed on the 80Ä acres of pastureland and only livestock enterprises are evaluated for production. Prices used in this solution are designed to reflect trends prior to 1985. Capital and labor resources are unaltered from the base scenario described in Appendix Table 10.

The primary focus of this study is small and part-time farmers, consequently, less extensive analysis of the full-time farming operation is conducted. The full-time proxy farm model is evaluated with respect to the production of traditional enterprises alone. Values for selected variables in the full-time proxy farm model base scenario are presented in Appendix Table 10.

Part-Time Proxy Farm Model Solution

Production of Traditional Enterprises

Initial linear programming results for part-time operations indicate that family farm labor is not a binding constraint upon net farm income in the proxy farm labor model when only traditional enterprises are considered. Monthly labor requirements, ranging from a low of 2.8 hours in November, December, and January to a high of 67.4 hours in August, could be satisfied by that provided by the operator alone. Total annual labor required is 326.4 hours, or about 13 percent of the labor available. Net farm returns over variable and intermediate fixed costs are approximately $9,850. Combining net farm income (NFI) and off-farm income (OFI) yields a total family income (TFI) of about $33,456 (Table 3, below).

Optimal organization requires that 20 acres of alfalfa be produced on the cropland and the pasture allocated to six stocker steers bought in October and sold in May and 94 summer stocker bought in May and sold in October. All operating capital is used, as well as all available grazing in the month of August.

With additional land rental not allowed and operating capital at the limit, it is apparent that increasing family farm labor would not increase farm income but rather would decrease off-farm family income and thus decrease net family income. If the farm family decreased its off-farm labor by one-half, net family income would fall to $21,653. If the farm family ceased altogether its off-farm work effort and operated the farm as a full-time operation employing traditional enterprises, total family income would equal their net farm income of $9,850. Operated on a full-time basis, the farm would employ only 7 percent of the family labor.

Allowing for rental of additional land for traditional enterprises on the part-time farming operation until labor becomes a limiting factor raises the net farm income by $1,036 and the total family income to $34,492. The 11 percent increase in net farm income is accompanied by a 141 percent increase in labor as annual labor used rises from 326 to 788 hours. The operation would consist of 20 acres of alfalfa, 70 head of summer stockers and ten cows in a cow-calf

Table 3. Solution Values for Selected Variables in the Part-Time Proxy Farm Model by Enterprise Group: Traditional Enterprises; and Traditional and Specialty Enterprises

Level of Off-Farm Work	Land Rental	NFI($)	OFI($)	TFI($)	Labor Used(Hrs.)
Full-time off-farm	No	9850	23606	33456	326.4
	Yes	10886	23606	34492	788.1
Half-time off-farm	No	9850	11803	21653	326.4
	Yes	11417	11803	23220	1136.5
No off-farm work	No	9850	0	9850	326.4
	Yes	11662	0	11662	1320.0

Level of Off-Farm Work	Land Rental	NFI($)	OFI($)	TFI($)	Labor Used(Hrs.)
Full-time off-farm	No	17324	23606	40930	510.0
	Yes	18518	23606	42124	992.0
Half-time off-farm	No	17324	11803	29127	510.0
	Yes	19040	11803	30843	1344.1
No off-farm work	No	17324	0	17324	510.0
	Yes	19120	0	19120	1411.2

enterprise. An additional 229 acres of cropland would be rented at $35 per acre for production of soybeans. Thus, with additional land, resources shift toward the more labor intensive row-crop activity and away from the more capital intensive livestock enterprise. With production so organized, operating capital is at the limit, as well as August grazing and December labor.

When labor is increased and additional land rental allowed, net farm income rises by $531 to $11,417, a modest 5 percent increase over $10,886. This increase in net farm income is offset by an $11,803 decrease in off-farm income so that total family income falls to $23,220. Optimal organization requires production of 20 acres of alfalfa, rental of 447 acres of cropland for soybeans, 43 head of summer stockers and 12 cows in a cow-calf enterprise. Operating capital, August grazing and December labor are at the limit. Total annual labor required is about 1,136 hours.

Finally, decreasing off-farm labor so that the farming operation is a full-time effort and allowing additional land rental, net farm income reaches a maximum of $11,662 with 1,320 hours of annual labor. Soybean production is increased to 549 acres and both livestock enterprises are decreased. All available capital, both operating and intermediate are exhausted.

In summary, with respect to the production of traditional enterprises in the part-time proxy farm model, re-allocation of the family's work effort away from off-farm work to farm work in the manner described above results in each case in a substantial decrease in total family income. For a given level of off-farm work, rental of additional land for the farming operation results in a modest increase in farm and total family income and a substantial increase in the farm labor required.

Production of Traditional and Specialty Enterprises

Optimization of the part-time proxy farm model where traditional and specialty enterprises are allowed indicates that, as in the case of traditional enterprise considered alone, family labor is not a limiting factor to increasing net farm income. The base solution yields a net farm income of $17,324 from 12 acres of alfalfa and two acres each of tomatoes, sweet corn, peas, and okra. Four stockers are held from October to May and 94 summer stockers from May to October. Monthly labor requirements range from 2.2 hours in November, December and January to 98.2 hours in June and total 510 hours annually, or about 20 percent of the available family farm labor. Total family income is $40,930 (see Table 3).

With operating capital at the limit and no additional land rental available, any reallocation of labor toward the farm will result in a decrease in total family income. Reallocation of half of the off-farm labor to the farm results in a total family income of $29,127 and a total cessation of off-farm work results in a total family income of only $17,324.

Allowing land rental in the base scenario results in an increase in production of the traditional enterprises. Alfalfa production increases to 20 acres and soybeans are produced on 232 acres. Sixty-six head of summer stockers are maintained along with 12 cows in a cow-calf operation. Net farm income is increased to $18,516 and labor requirements increase by 95 percent to 992 hours annually.

Increasing farm labor and allowing land rental results in greater soybean production, 446 acres, and a decrease in livestock inventory, with specialty crop production remaining unchanged. All capital, both operating and intermediate, is used, and December labor is exhausted. Net farm income increases to $19,040.

Operated on a full-time basis utilizing traditional and specialty crops and allowing for land rental, the model yields an optimal solution net farm income of $19,120. This $80 increase from $19,040 results from a slight increase in production of soybeans at the expense of a reduced livestock herd. With no off-farm income, total family income is equal to the net farm income of $19,120.

For the part-time operator working full time off-farm, the addition of specialty crops to this enterprise mix results in an increase in net farm income and consequently, in total family income, of $7,474 in the proxy farm model when no additional land is rented. When labor is diverted from off-farm to farm work, a decrease in total family income is experienced. Allowing additional land rental modestly increases net farm income for any given farm labor effort, but is accompanied by substantial increases in annual labor requirements.

Production of Traditional and Non-Traditional Enterprises

Inclusion of non-traditional enterprises among the production alternatives results in an optimum proxy farm organization of 20 acres of alfalfa, 60 acres of fesque and bermuda pasture, 48 feeder pigs and 25 sows in a confinement system. Ninety-four head of summer stockers are maintained on the pasture. All available operating and intermediate capital is used and December labor is exhausted. Total labor required is about 1,841 hours annually, or 72 percent of the labor available. Net farm income over variable and intermediate fixed costs is $29,683. Total family income is $53,289.

Increasing the labor available results in a $5,418 increase in the solution net farm income and a $6,385 decrease in total family income. All capital is used and again December labor is exhausted. Feeder pig production rises to 130 head and the number of sows falls to 11 head. Summer stockers are reduced to 83 head. Annual labor used is increased by about 1,300 hours.

Operated on a full-time basis, the base resource situation could be organized to produce a net farm income of $39,892. Alfalfa and soybeans would be produced on 11 of the cropland acres, with nine acres unused. Feeder pig production would be 203 head and 75 head of summer stockers would be maintained. Annual labor used increases to about 4,303 hours. All November and December labor is exhausted.

Comparison of traditional enterprise organization versus a combination of traditional and non-traditional reveals that the latter yields a higher net farm and total family income than the former in all like resource situations, and that the lowest total family income achieved under any of the six resource situations in the latter exceeds the highest achieved under any of the former. As in the case of previous enterprise organizations, when the traditional and non-traditional organization is considered alone, increases in farm labor and income, at the expense of off-farm labor and income, result in decreases in total family income. Under this enterprise organization, for a given farm labor effort, permitting the rental of

Table 4. Solution Values for Selected Variables in the Part-Time Proxy Farm Model by Enterprise Group: Traditional and Non-Traditional Enterprises; and Traditional, Non-Traditional, and Specialty Enterprises

Level of Off-Farm Work	Land Rental	NFI($)	OFI($)	TFI($)	Labor Used(Hrs.)
Full-time off-farm	No	29683	23606	53289	1840.4
	Yes	29683	23606	53289	1840.4
Half-time off-farm	No	35101	11803	46904	3139.5
	Yes	35101	11803	46904	3139.5
No off-farm work	No	39892	0	39892	4302.6
	Yes	39892	0	39892	4302.6

Level of Off-Farm Work	Land Rental	NFI($)	OFI($)	TFI($)	Labor Used(Hrs.)
Full-time off-farm	No	36332	23606	59938	1977.1
	Yes	36332	23606	59938	1977.1
Half-time off-farm	No	41751	11803	53554	3276.0
	Yes	41751	11803	53554	3276.0
No off-farm work	No	45782	0	45782	4266.0
	Yes	45782	0	45782	4266.0

additional land in the proxy farm model results in no change in the optimal solution from the no land-rental case (Table 4, below).

Production of Traditional, Non-Traditional and Specialty Enterprises

The largest net farm and total family incomes in the part-time proxy farm model are achieved when traditional, non-traditional, and specialty crops are produced. In the base scenario, net farm income is $36,332 and total family income is $57,938. About 1,977 hours of labor, or 77 percent of that available, are used annually. Operating and intermediate capital and December labor is exhausted. Six acres of vegetables and 14 acres of alfalfa are grown on the cropland. Fifty head of feeder pigs, 23 sows, and 93 summer stockers make up the livestock inventory.

Increasing labor raises net farm income to $41,751 but results in a decrease in total family income. Labor used increases to 3,276 hours annually. The largest net farm income obtained in the model is achieved when the farm is operated full-time producing six acres of vegetables, 195 feeder pigs, and 175 summer stockers. About 4,266 hours of labor are required for the $45,782 return over variable and intermediate fixed costs. For any given labor level, additional land rental opportunity did not increase net farm income (see Table 4).

A graphical summary of the total family income achieved in the part-time proxy farm model base scenario by amount of labor available and enterprise combination is presented in Figure 13. From the graph it is apparent that for a given level of farm labor, production of traditional enterprises (T) yields the lowest total family income. Producing specialty crops along with the traditional enterprises (TS)

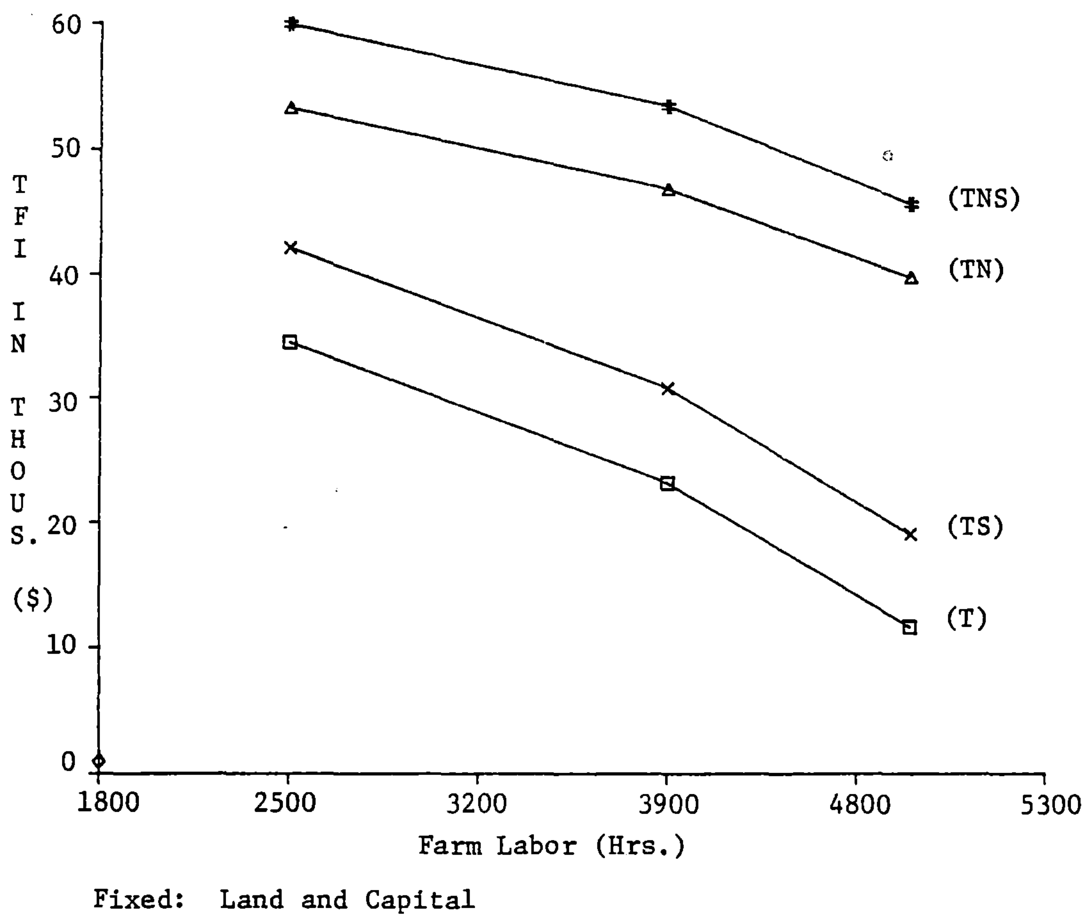

Figure 14. Total family income (TFI) by labor level and enterprise combination

increases total family income at any labor level shown, but not by as much as production of the traditional and non-traditional combination (TN). The greatest total family income is achieved when all three types of enterprises (TNS) are included in the production alternatives.

It is also evident from the graph that the highest total family income for a specific combination of enterprises is achieved when the family maintains its off-farm work effort at its highest level. As labor is diverted from the off-farm work to the farm, the gain in net farm income is not sufficient to offset the loss of off-farm income and total family income falls.

The rental of additional land, as depicted in Tables 3 and 4, results in an increase in total family income via an increase in net farm income for the traditional and traditional and specialty enterprise combinations for any given labor and capital situation. Land rental did not effect the net farm or total family income of the remaining two enterprise organizations since both operating and intermediate capital were at their limits.

Alternative Part-Time Proxy Farm Model Solutions

High Capital Scenario

Analysis of the part-time proxy farm model allowing for increased operating capital reveals that, in the absence of additional land rental, the higher capital level has a small impact upon net farm income. The increase in net farm income averaged 6 percent and ranged from $222 to $1,496.

When land rental is allowed, substantial increases in net farm income are realized. The increases averaged 63 percent, ranging from 20 to 128 percent. The greatest increases were observed in the production of traditional enterprises, where the additional land rental increased the maximum obtainable net farm income from $11,662 to $26,234 (Appendix Table 15).

No Cropland and Reduced Management Level

Solution of the part-time proxy farm model assuming only pastureland producing native grass pasture and traditional livestock enterprises as production alternatives yielded a net farm income of about $3,168. Labor requirements totaled 96.6 hours annually ranging from a monthly low to high of 3.8 and 17.3 hours, respectively. Livestock production consisted of 25 stocker steers and was constrained by a lack of additional grazing from the pastureland in September.

The comparable solution where cropland and intensive pastureland management was permitted yielded a net farm income of about $9,850. Of this amount, only about $2,000 was attributable to the cropland. The intensified pasture management, fesque, and bermuda grass, accounted for the additional $7,850. Thus, a higher level of pasture management, resulting in an increase in grazing availability, would enhance net farm income more than cropland availability, where traditional enterprises alone are considered.

Full-Time Proxy Farm Model Solution

Solution of the full-time proxy farm model yielded a net farm income of $98,978. The 493 acres of cropland were used to produce soybeans, with wheat double-cropped on 215 acres or 44 percent of the cropland. Pastureland was divided between production of native grass pasture (287 acres) and fesque/bermuda pasture (376 acres). Approximately 841 head of stockers were maintained on the pastureland. The optimum organization required an annual labor effort of 3,511 hours and called for the hiring of about 180 hours of labor in excess of that supplied by the farm family in May and June.

The comparatively high net farm income generated under the full-time proxy farm scenario indicates that at least for the larger full-time operators their farming resources and activities are sufficient to support the farm family. For full-time operators facing large land debt retirement requirements or not as well-endowed with initial resources, the situation may be quite different. Optimization of the base resource scenario for part-time operators, when operated on a full-time basis, generated a net farm income of only $9,850 where similar production activities were considered. When pastureland alone was available and a lower level of management assumed, this amount fell to $3,168.

Rates of Return to Equity Capital

Rates of return to equity capital, where equity capital is defined as that part of the farm's assets without debt obligations (Hottel and Reinsel, p. 3), reveal in several cases greater differences in farm organization in the proxy farm models than differences in net farm income or total family income. The rates of return achieved by solution of the part-time proxy farm model and a description of the procedure used to determine these returns along with hypothetical data are presented below in Tables 5 and 6, respectively.

In Table 5 it may be noted that, under selected scenarios of resource availability for a given set of enterprises, net farm incomes (and the corresponding rates of return to equity) are identical in some cases. This results where one of the other factors allowed to vary in the relevant proxy farm model, e.g. labor or land rental, did not alter the optimal net farm income solution. In Table 6, net returns to equity, operator, and family labor and management are determined in the linear programming solutions to the proxy farm models. From these amounts are deducted allowances for labor and management. Total labor used, also available from the model

Table 5. Returns to Equity and Net Farm Income by Enterprise Combination, Level of Off-Farm Work, and Land Rental Opportunity

	Level of Off-Farm Work	Land Rental	NFI($)	Returns to Equity (Pct.)
Traditional Enterprises	Full-time off-farm	No	9850	9.9
		Yes	10886	4.2
	Half-time off-farm	No	9850	9.9
		Yes	11417	-1.1
	No off-farm work	No	9850	9.9
		Yes	11662	-3.6
Traditional and Non-Traditional Enterprises	Full-time off-farm	No	29683	9.5
		Yes	29683	9.5
	Half-time off-farm	No	35101	10.0
		Yes	35101	10.0
	No off-farm work	No	39892	9.4
		Yes	39892	9.4
Traditional, Non-Traditional, and Specialty Enterprises	Full-time off-farm	No	36332	10.8
		Yes	36332	10.8
	Half-time off-farm	No	41751	8.7
		Yes	41751	8.7
	No off-farm work	No	45782	11.7
		Yes	45782	11.7
Traditional and Specialty Enterprises	Full-time off-farm	No	17324	12.9
		Yes	18518	8.3
	Half-time off-farm	No	17324	12.9
		Yes	19040	4.2
	No off-farm work	No	17324	12.9
		Yes	19120	3.6

Table 6. Calculation of Returns to Equity in Farm Production Assets

Production Assets:	(Dollars)
Land and Buildings	80,000.00
Machine and Motor Vehicle	18,000.00
Livestock	17,500.00
Feed Grains and Hay Stored	1,100.00
Other Grains and Fibers Stored	-0-
Demand Deposits and Currency	1,500.00
Total Assets	116,600.00
Production Liabilities:	
Real Estate Secured Debt	30,000.00
Non-Real Estate Secured Debt	16,600.00
Total Liabilities	46,600.00
Equity	70,000.00
Income:	
Cash Receipts	53,350.00
Government Payments	-0-
Other Farm Income	-0-
Total Income	53,350.00
Production Expenses	43,500.00
Net Return to:	
Equity, Opt., Family Labor and Mgt.	9,850.00
Less Opt. and Family Labor Allowance	1,390.00
Less Management Fee Allowance	1,510.00
Net Income to Equity	6,950.00
Ratio (Percent):	
Net Returns to Equity	9.9

solutions, is multiplied by the prevailing farm wage rate of $4.26 per hour and subtracted. Management allowance is calculated as 10 percent of crop sales and 7 percent of adjusted livestock sales and deducted from net returns.

Solutions of the part-time proxy farm model reveal the largest variation in rates of return to equity when traditional (T) and traditional and specialty crop (TS) production are considered. In the case of traditional crops, returns ranged from 9.9 percent to -3.6 percent. The 9.9 percent return was associated with operating the farm with the full-time off-farm job and no additional land rental. The solution to the identical model, but allowing for land rental, resulted in a modest increase in net farm income and a substantial decrease in the rate of return to equity, which fell to 4.2 percent. The fall in the rate of return resulted from the doubling of labor used and the increase in management fees associated with the $20,000 increase in gross farm sales needed to achieve the approximately $1,000 gain in net farm income.

In the remaining solutions with traditional enterprises where land rental was allowed, the rates of return were negative. The -3.6 percent rate of return accrued to the full-time operator of the proxy farm model. In this case, allowances for the 1,320 hours of labor used and management needed to generate $98,393 of gross farm sales exceeded the net farm income by $2,490.

Reporting a decline in returns to equity associated with the rental of additional land that generates a positive return (i.e. an increase in net farm income) is, at first glance, an apparent <u>non sequitur</u>. In evaluating land rental feasibility, the linear programming model utilized weighs returns from renting against costs associated with renting, such as; land rent, additional labor costs, (equipment, seed, feed, fertilizer, and capital) expenses, etc. -- all variable costs -- and permits rental only if returns exceed such costs. In some cases, as where unpaid family labor is available, no charges may be made for the additional labor required.

In determining net returns to equity, allowances for labor and management are subtracted from the net farm income and in some cases may exceed the net farm income, implying negative marginal returns from rental. The inconsistency is largely due to the time frame involved, the net returns to equity reflecting long-run conditions in which labor and management expenses associated with rental must be compensated, and the net farm income value reflecting short-run conditions in which these may not be considered. Long-run adjustment would, at least in theory, require that some expense, probably land rent, fall.

When traditional and specialty crops were allowed in the solution, the rates of return ranged from 12.9 to 3.6 percent. For any given farm labor effort, the additional income generated by land rental was offset by additional labor and management expenses so that net returns to equity declined. The inclusion of non-traditional enterprises in the production alternative resulted in less variation in net returns to equity which averaged about 10 percent for the solutions to proxy farm models employing these enterprises.

Optimization of the full-time proxy farm model with respect to the production of traditional enterprises yielded a net farm income of $98,978. Subtracting labor and management allowances, which totalled about $30,500, resulted in an approximate 7.6 percent return to the operator's $900,000 equity. When full-time operation and traditional enterprises were evaluated in the part-time model, the net return to equity was -3.6 percent. Thus, net returns to equity are sensitive to initial asset endowments and differences in the ratios of labor and management charges to net farm income in these two models.

Exposition and Qualification of Linear Programming Results

Prices

Utilization of linear programming techniques to determine optimum farm organization for profit maximization requires the user to specify input and output prices that, in turn, influence the farm's enterprise organization and net income. Appendix Tables 12 and 13 present selected outputs and prices utilized in the linear programming solutions, as well as, the most recent prices for comparison. The output prices in Appendix Table 12 utilized in the linear programming solutions coincide with the August 1, 1984 - July 31, 1985 period and are relevant to Northeast Oklahoma.

Vegetable prices utilized in the linear programming solutions, presented in Appendix Table 13, conform with those specified by personnel at the Department of Agricultural Economics/Oklahoma State University based upon a 6-year average price for the commodity (Schatzer, Wickwire, and Tilley, pp. 20-53). The prices quoted are those assumed available to the producer F.O.B. Dallas and are adjusted Dallas wholesale prices, the adjustment representing a 15 percent reduction in the wholesale price. Given the already current nature of prices used no more-current (1986) vegetable prices are presented in Appendix Table 13.

Historical trends in prices received by Oklahoma farmers for selected commodity groups are presented in Appendix Table 15. Projected averages for 1985 indicate a decrease from previous years in prices received for most farm products. Other factors held constant, given lower output prices, operators would have to increase farm production to achieve the same level of income obtainable under higher output prices. Comparing prices used in the linear programming proxy farm model with current prices and trends, it is apparent that those prices are more favorable than might be currently available. Consequently, intertemporal pronostications of net farm income based upon the linear programming results could be quite misleading.

Management

The budgets presented in Appendix Table 11, unless a particular budget states otherwise, are prepared according to an assumption of "above average" management ability. In practice, this "above average" management assumption may be roughly translated as a level of management that 60 percent of the operators in the survey area should strive to achieve.

"Management," the expertise of the operator in such areas as the selection and timing of cultural practices associated with enterprises, may come from experience and/or education. Economic theory, verified by real-world observation, suggests that operators who first adopt more efficient practices, improved seed varieties, or genetically superior breeding stock reap the greatest benefit from these technological advances. Those operators who are slow to adopt these advances or that fail to adopt them altogether may find their costs exceeding those of more efficient operators and their operations unprofitable.

Net Farm Income

The net farm income figure resulting from the linear programming solution to a particular proxy farm model is a return to the following: equity, risk, unpaid operator and family labor, and management. OKFARMS, utilized in this research, permits three basic types of solutions to linear programming problems: 1) short-run or operating solution, 2) intermediate-run solution, and 3) long-run solution (Kletke, 1985). Briefly, the short-run or operating solution would be used when only yearly values and costs are considered, intermediate solution when machinery and breeding livestock are considered, and long-run solution when land purchases are considered.

The net farm incomes reported herein result from intermediate solution of the linear programming models. As such, they represent returns above all costs except land purchases, which are not considered in the solutions since all land in the basic resources situation is assumed owned by the operator.

Marketing

An extremely important issue in analyzing results of linear programming solutions to the proxy farm models is the question of market availability for certain enterprises that may appear in the solution. While markets are readily available for long-established (traditional) enterprises, such as, wheat or cattle; market availability for specialty crops, i.e. vegetables, may pose a particularly troublesome problem. In the case of most vegetables, the need for well planned, expedient marketing is heightened by the nature of the product itself. Unlike timber products which, in the absence of a market at maturity, may simply be left standing until more favorable conditions prevail, or harvested crops like wheat or soybeans that may be stored from season to season; matured vegetable crops generally perish rapidly.

Due to the perishability of vegetables, researchers recommend marketing should be planned before commencing production (Tilley and Schatzer, p. 1). A number of potential outlets for fruit and vegetable growers have been identified, among them: pick-your-own operations, roadside markets, farmer's markets, terminal markets, cooperative and private packing facilities, and peddling to restaurants and grocery stores (Tilley, Moesel, and Sleper, pp. 1-3). While a discussion of the advantages and disadvantages of each marketing alternative is beyond the scope of the research undertaken here, a potential producer must identify outlets for his produce to be successful. The interested reader may find more detailed information on marketing alternatives in either of the two publications referenced immediately above.

CHAPTER V

GROWTH SIMULATION MODEL DESCRIPTION, INPUT AND RESULTS

Simulation Model Description And Input Parameters

The simulation model used in this study is an "equilibrium" model utilizing a priori specified real rates of return on resources to estimate income rather than long-term projections of yields, prices, and other variables that usually determine rates of return (Tweeten, Barclay, Pyles, and Ralstin, p. 3). It is assumed that yields, prices, and values for the other variables will, over time, adjust to reflect these specified real rates of return. In this respect, the model is not subject to the error often attending projections of yields, prices, and other variables over extended periods. A simplified flow-chart of the simulation model is presented in Figure 15, below.

The model simulates the growth of a particular farm firm over a 30-year growth horizon. Within this period, the farm firm is allowed to acquire additional land and expand subject to its ability to support a specified family consumption allowance, existing and expected mortgage levels, downpayment criterion, and equity position. The initial land base for the part-time farm is 80 acres. The simulation model provides for acquisition of additional acreage in 40

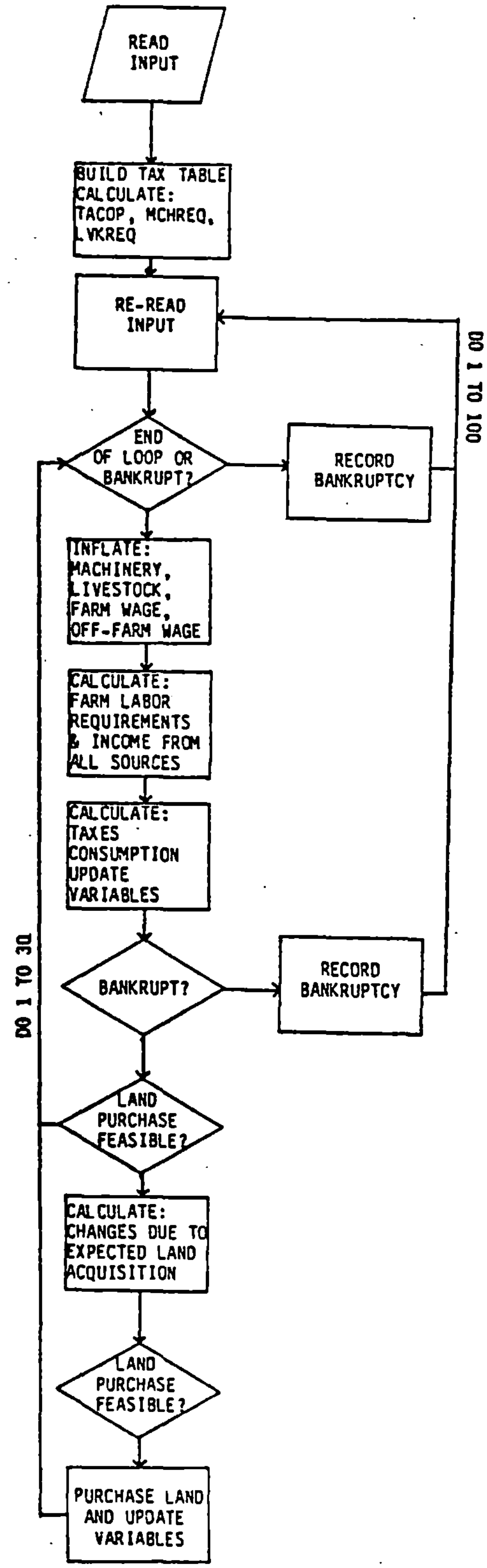

Figure 15. Growth simulation model flow-chart

acre increments. For any individual farm at a specific point in time during the simulation, acreage will be some multiple of 40, i.e. 80, 120, 160, etc., but not less than the initial land base of 80 acres. Of course, averages for a particular group of farms will not exhibit this pattern; however, the average cannot be less than 80 acres.

Once through the 30-year growth cycle for the farm, the model proceeds to simulate another 30-year growth cycle for a farm with similar initial assets. This is done 100 times with ending values for particular variables accumulated and stored for calculating averages. The flexibility of the model permits analysis of a wide range of resource situations and the impact upon expansion of alternative tax schemes, inflation rates, consumption patterns, and off-farm labor activities.

Results of the linear programming (LP) solution to the proxy farm models provide significant input for the growth simulation model. In addition to the net income maximizing enterprise combination, LP output also gives detailed information on labor requirements of the optimal enterprise combination. Dividing the annual total hours of labor required by the number of acres in the farm yields the annual hours of labor per acre (HRSAC)* needed as input for the simulation model. From the optimum enterprise combination, the value of livestock required on a per acre basis (LVKREQ) and machinery required per acre (MCHREQ) is derived.

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*All variable names, assignments, use, and hierarchy of mathematical operators follow general FORTRAN standards. The interested reader may consult Cress, Dirksen, and Graham (1980). Variable names used in the text are defined in the nomenclature section preceding Chapter I.

Other linear programming results that facilitate farm income calculation in the simulation model are gross dollar values of crop and livestock sales. The returns-to-management (MANRET) component of farm income is calculated as a proportion of gross farm sales and expressed on a per acre basis. Operator equity, the excess of the dollar value of the farm's owned assets over debt, obtainable from the LP results, is multiplied by a fixed percent return to calculate the returns-to-equity (EQRET) component of farm income.

The next several pages are devoted to a discussion of assumptions pertaining to, and treatment of, the following components of the simulation model: labor, family allowance and consumption, inflation rates, variation in farm income, taxes and farm growth criteria.

Labor

A particular interest in this study is the impact of off-farm labor and income on the farming operation. In assessing the growth potential of the part-time farming operation, alternative off-farm work scenarios, denoted as A and B for exposition purposes, are evaluated relative to their impact upon off-farm income and expansion of the farm. The growth simulation model is constructed in a manner such that labor must be considered in two separate time periods depending upon whether the model is operating in a year, T, equal to or less than the 20th year in the 30-year farm growth cycle, or beyond the 20th year in the cycle. Beyond year 20 of the growth model, it is assumed that children leave home, or for other reasons the contribution of the operator's family toward farm and off-farm work and income is zero. Consequently, off-farm income and farm labor must be adjusted to reflect this change. The simulation is for an operator beginning at age 35 and retiring at age 65.

In scenario A, the model is run assuming that the operator and spouse's off-farm labor function can be divided at any point between farm an off-farm employment with any labor not used on the farm awarded an off-farm opportunity cost of $8.40 per hour. The total off-farm labor available is 2,808 hours, 2,080 from the operator and 728 from the spouse. If the farming operation is sufficiently large to require 500 hours of the operator's and spouse's off-farm work effort, the 2,308 remaining hours devoted to off-farm work generates an off-farm income of $17,310.

Beyond year 20 of the growth cycle, labor available for farming is restricted to that supplied by the operator to the point that all operator labor (farm plus non-farm) is exhausted. Thereafter, any additional labor needed on the farm is hired. Additionally, off-farm income is limited to that which is earned by the operator. When required farm labor exceeds 1,226 hours, off-farm income is reduced by $8.40 per hour for each hour in excess of the 1,226 that the operator supplies. When the operator labor supplied to the farm exceeds 3,306 hours, off-farm income is zero. Figure 16, below, demonstrates the relationship between required farm labor and off-farm income in the initial 20 years of farm growth ($T \leq 20$) and in the last 10 years ($T > 20$) of the farm growth cycle.

As indicated in Figure 16, for any farm labor effort from 0-2,554 hours, the off-farm income is $23,606. The 2,554 hours represent a contribution to the farm work effort of 600, 1,226, and 728 hours from the child, operator, and spouse, respectively. Within this range (0 -

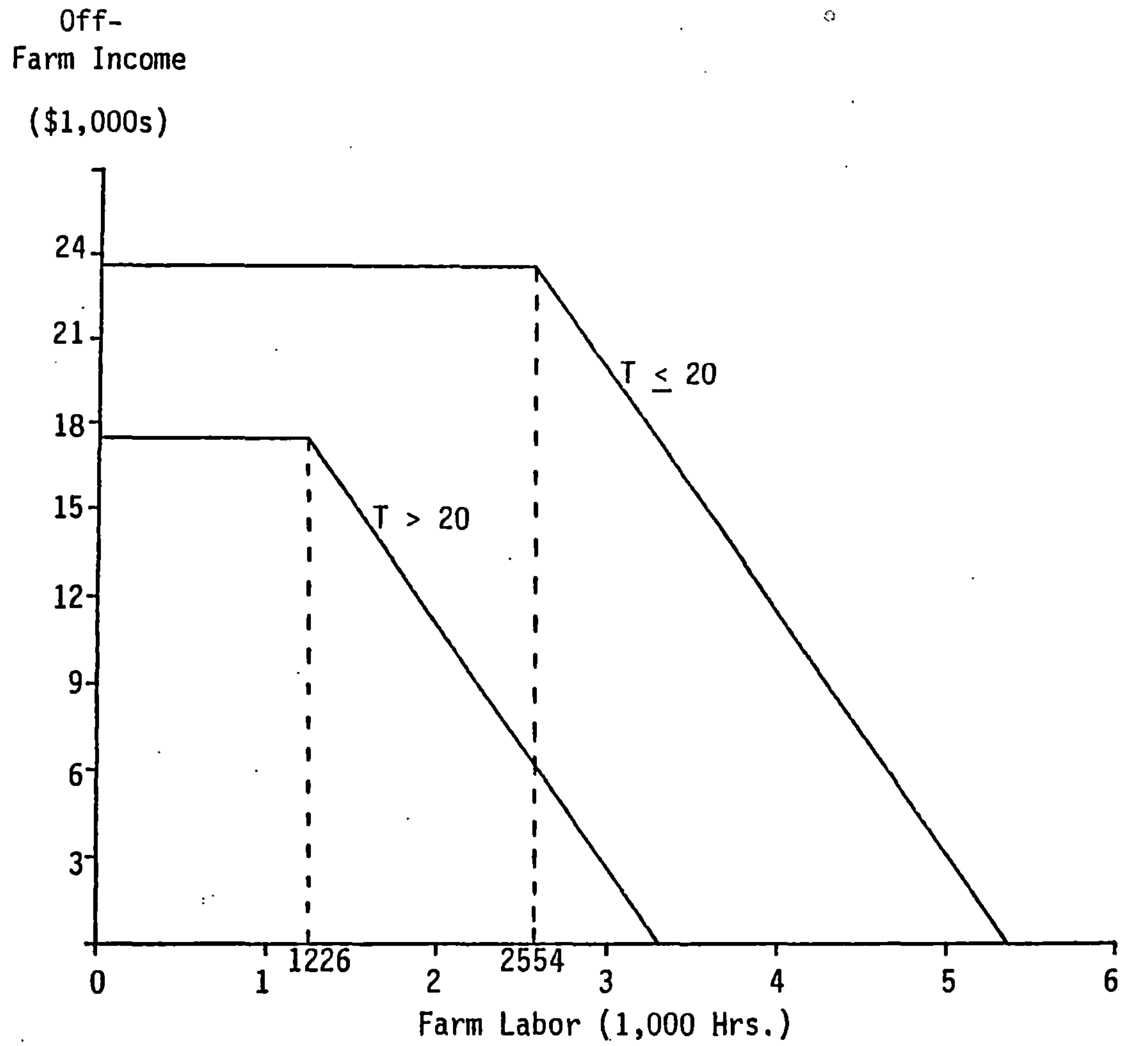

Figure 16. Off-farm labor function "A"

2,554 hours), no labor is diverted from the off-farm jobs toward the farm. For a farming operation requiring 2,554 to 5,362 hours of farm work, $8.40 is deducted from off-farm income for each hour in excess of 2,554. If the farming operation required more than 5,362 hours per year of labor in any year(s) within the initial 20 years of growth, the off-farm income is zero in such year(s).

In scenario B, the off-farm work effort is considered to be restricted to either full-time off-farm work, half-time off-farm, or no off-farm work. Under this assumption, the operator and spouse supply up to 1,954 hours of farm labor without diminishing their off-farm work or income. However, when the farm labor requirement exceeds 2,554 hours (1,954 hours plus 600 hours of labor by the child) but is less than 3,958 hours, the 1,404 hours of off-farm labor freed by the operator and spouse come at the expense of a $11,794 reduction in off-farm income, which falls to $11,812.

Beyond year 20 of the farm growth cycle, only operator labor is used on the farm. If the required farm labor exceeds 1,226 hours but is less than 2,266 hours, off-farm income is $8,736. If the labor requirement exceeds 2,266 hours, off-farm income is zero. Where less than 1,226 hours of labor are needed on the farm, the operator can maintain his full-time off-farm job and off-farm income of $17,472 (see Figure 17).

Family Allowance and Consumption

The investment necessary to expand the farming operation and any decline in off-farm income attending such expansion could easily result in a diminished standard-of-living for the farm family in terms of income available for family consumption. Of concern here is

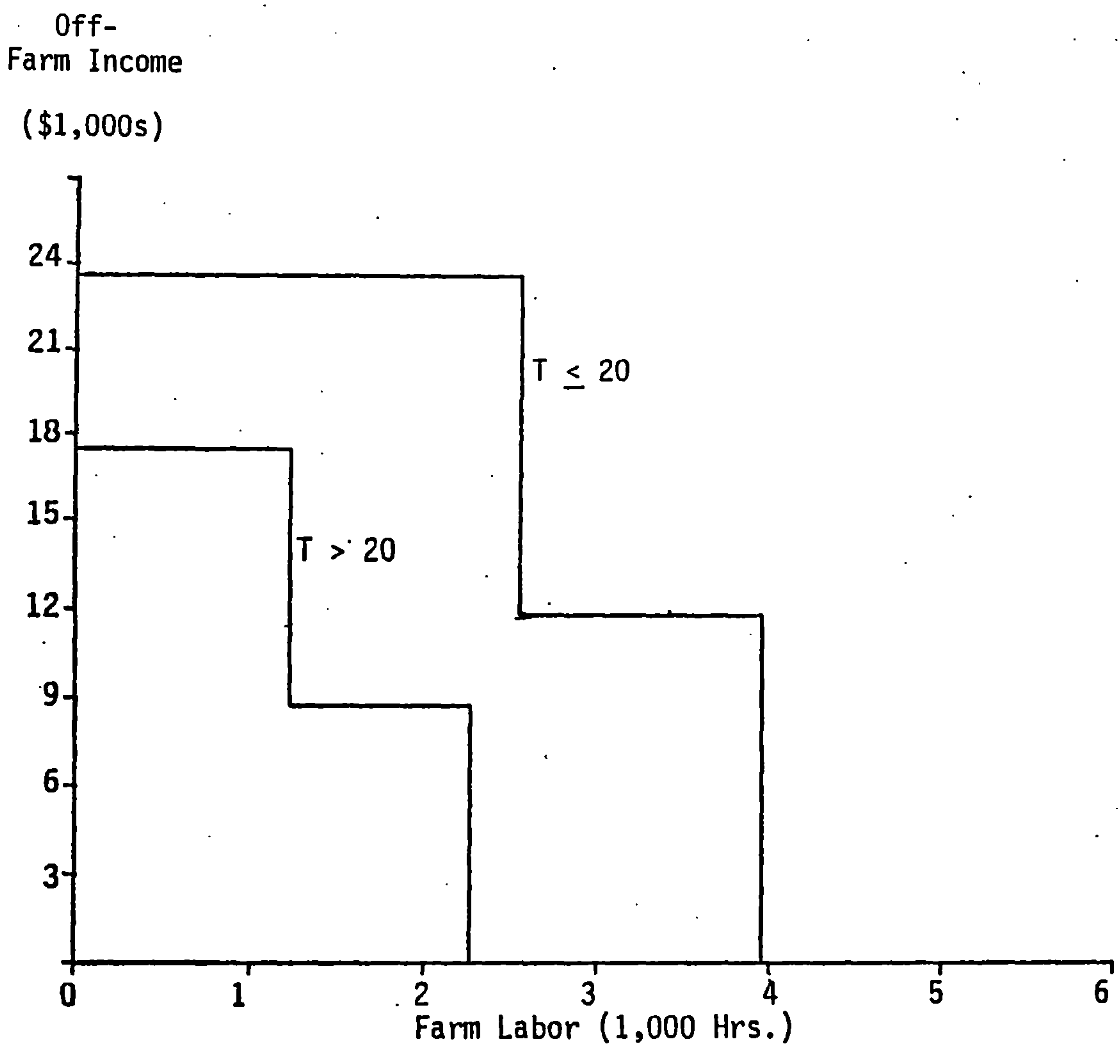

Figure 17. Off-farm labor function "B"

whether the farming operation can be expanded while the farm family increases, or at least maintains, a level of consumption comparable to the median family consumption level for the survey area.

The growth simulation model is designed to allow for alternative levels of family consumption and marginal propensities to consume out of marginal disposable income. In the results presented, two different levels of autonomous consumption are evaluated. From the BEA data discussed earlier, a weighted average family income for the four-county survey area is calculated to be $27,375. If 30 percent of income is saved, the remainder, 70 percent or $19,163, is consumed by the family. Likewise, if 50 percent is saved, $13,688 is consumed by the family. These two values, $19,163 and $13,688, are evaluated as the two levels of autonomous or minimum family consumption in the model. In addition, two levels of marginal consumption are evaluated. Results are obtained for a marginal consumption rate of 70 percent and then for a 90 percent rate of marginal consumption.

The consumption functions used are assumed linear through the origin. In the case where marginal consumption (and average consumption for a linear consumption function) is .7 and minimum allowable consumption is $19,163, a disposable income of say, $26,603, results in a consumption by the family of $19,163 even though $26,603 * .7 = $18,622 because consumption must not be less than $19,163. If a disposable income of $28,603 is obtained, then consumption is $20,022 or $28,603 * .7. The consumption function utilized as a basis for comparison of alternative simulations has an APC = .7, conforming to the empirical research of Richardson and Nixon (1981) discussed in Chapter II. Where an alternative consumption level is used it is explicitly stated in the text.

Inflation Rates

The impact of inflation upon farm growth is evaluated in the model by inclusion of variables reflecting the level of inflation under consideration. In the results following, two levels of inflation are examined -- a "low" rate of inflation, 6 percent, and a "high" rate of 12 percent. Cash-flow problems associated with land purchase in an inflationary economy have been well illustrated. Following Tweeten (1981), if land earnings keep pace with inflation the present value of land is --

$$P_0 = \int_{t=0}^{\infty} \frac{R_0 e^{it}}{e^{rt}} dt = \frac{R_0}{r-i} = \frac{R_0}{(\alpha+i)-i} = \frac{R_0}{\alpha}$$

where,

P_0 = land price,

R_0 = initial rent,

r = discount rate = $\alpha+i$,

i = inflation rate, and

α = real rate of return.

From this equation it can be seen that the current rate of return on farmland is invariant to the expected rate of inflation. Tweeten further illustrates the cash-flow problems in an example where α = 4 percent, inflation = 9 percent, and mortgage rate = 12 percent. Total returns to farmland equal 13 percent, exceeding the 12 percent mortgage rate by 1 percentage point as compensation for risk in farming. However, the 9 percent gain in farmland returns is in the form of capital gains not readily available to service debt, leaving a cash-flow deficit of 12 - 4 = 8 percent.

In the simulation model there is provision for short-term loans, secured by mortgaging the farmer's equity, to cover unexpected cash-flow deficits. In order to obtain the loan, the farmer must meet a minimum equity requirement specified in the model input. If the operator cannot meet this requirement, his operation is declared bankrupt and the growth simulation for that particular farm is terminated.

Variation in Farm Income

Farm income in the model is defined as the sum of management income, equity income, farm labor income, and interest income. In order to randomize farm income, an error term is generated from a standard normal distribution. An upper and lower bound of one standard deviation from the mean is placed upon the range of the error term. The random element of farm income is calculated to be the product of farm income, the coefficient of variation of farm income, and the error term. When the random element is added back to farm income, the value for random farm income is obtained. The following hypothetical case is an example of the farm income randomization procedure.

A value for farm income (FRMINC) is determined in the model, say $10,000. An error term (ERROR) is generated from a normal distribution with mean equal to zero and a variance of one, i.e., ERROR ~ N(0, 1). The error term may be greater than zero or less than zero, but is restricted to be not less than -1 nor greater than 1. If the error term is -.25 and the coefficient of variation (CVFINC) is 50 percent, then the random element of farm income is calculated as FRMINC * CVFINC * ERROR. In this case the random element = $10,000 * .5 * -.25 = -$1,250. The random farm income

(RFINC) would be equal to FRMINC + RFINC, or \$10,000 - \$1,250 = \$8,750.

The coefficient of variation is defined as the sample standard deviation expressed as a percentage of the sample mean (Steel and Torrie, p. 20). It is a relative measure of variation, in contrast to the standard deviation which is in the same units as the sample. Being the ratio of two averages, it is independent of the units of measurement. Coefficients of variation in farm income of 50 and 75 percent are used in the analysis.

Taxes

The simulation model contains several important tax features. The tax rates used are those specified by the Economic Recovery Tax Act of 1981. The depreciation rate is assumed to be 9 percent which is consistent with replacing machinery about every 12 years. Investment tax credit of 10 percent of the value of new machinery is provided for in the model. Interest expenses are treated as business expenses for tax purposes.

When unexpectedly high income is generated in the model, income averaging is allowed. "Averageable income," the excess of taxable income in the current year over 120 percent of the taxable income of the four preceding years is calculated. The tax liability is then the tax on 120 percent of the average base period income, the taxable income of the four preceding years, plus five times the tax on one-fifth of the averageable income.

Self-employment income tax is determined according to the Social Security Act Amendments of 1983. The largest amount of combined wages and self-employment earnings subject to social security for 1983 was

$35,700. For smaller amounts, the total is multiplied by .0935 and deducted as self-employment tax. The maximum tax is $3,337.95.

Farm Growth Criteria

In order for the farm firm to purchase additional acreage, several conditions must be met. First, the NETWTH/ASSETS ratio, where

NETWTH = ASSETS - TMTGL - STLOAN, and

ASSETS = OWNAC * PLAND + OWNMCH + OWNLVK + CASH,

must exceed the specified ratio required for land purchase, LEQRAT. Second, the number of tracts upon which the firm can meet the downpayment criterion (DPCRIT) where,

DPCRIT = CASH/(PCTDNL * PMINAC),

is determined in the model. When the number of tracts, if any, that can be purchased is calculated, the expectations of changes in affected variables due to the contemplated purchases are derived. In the final stage, the expected cash-flow is evaluated to determine if it is sufficient to cover the present mortgage payment on land plus the increase in mortgage payment due to the contemplated purchase. If any of the criteria are not satisfied, no purchases are made during that particular year of the 30-year growth cycle. In each subsequent year of the cycle, the same procedures are followed to evaluate growth potential.

Simulation Model Output

The simulation model contains subroutines that are used to present the output in a concise and readily available manner. 1) A balance sheet of assets, liabilities, and equity, 2) a summary of sources and uses of personal income, 3) reconciliation of change in equity, 4) operated acreage, and 5) miscellaneous statistics are reported for each of the years in the 30-year growth cycle as averages for the year across the 100 iterations of the 30-year growth cycle. If the user is not interested in every year of the cycle, he may specify in the input those years for which he wishes this output.

In some cases, the farm may go bankrupt within its 30-year growth horizon. When this condition occurs, the growth cycle is truncated and the bankruptcy recorded. At the end of the 100 iterations, the total number of bankruptcies observed is printed. Bankruptcy is deemed to have occurred in the model when the net worth to asset ratio (NETWTH/ASSETS) falls below a previously user-specified minimum equity ratio, MEQRAT. In all simulations reported, this minimum equity ratio is 20 percent.

Growth Simulation Model Results with APC = .7

Initial results from the model were obtained for the simulated growth of the part-time proxy farm producing only traditional enterprises and an APC of .7 from marginal disposable income. Subsequent results were obtained for the same model operated with alternative enterprise combinations. For each enterprise combination, there are four variables evaluated at two different levels each, making for a total of 2^4, or 16 total scenarios evaluated. These 16 scenarios are presented in Appendix Table 17.

Traditional Enterprises

Farm Size and Growth in Acres

The average ending acreage for the 16 runs associated with production of traditional enterprises was 377 acres which, which, when allowance is made for the initial land base of 80 acres, yields an average growth over the 30-year growth horizon of about 300 acres. Average acreage for selected years of the simulated growth period are presented in Appendix Table 18. Average growth in any particular year may be obtained by subtracting the initial land base, 80 acres, from the appropriate table value.

The greatest difference in growth, other factors held constant, were observed between the alternative off-farm work functions. Average acreage by variable level is presented in Appendix Table 19. Average growth over the 30-year growth horizon under the "less restrictive" off-farm labor function, presented previously in Figure 16, was 309 acres compared to 284 acres achieved under the off-farm labor function presented in Figure 17.

The former function, allowing a more gradual decrease in off-farm income as farm labor requirements increased than in later years, provided greater non-farm income to satisfy the family's consumption allowance and mortgage payments and consequently freed larger amounts of capital for continued growth of the farm. Ratios of off-farm income to total family income are presented in Appendix Table 20. From Appendix Table 17, the reader will note that the comparisons of interest in Appendix Table 20 are scenarios 1 vs. 3, 2 vs. 4, 5 vs. 7, etc., in years 25 and 30.

The 25 acre difference in ending growth occurred primarily during years 25-30 of the growth cycle. Farm growth in the initial 20 years required relatively small increases in farm labor, i.e. in year 20 a 315 acre farm required only about 1,087 hours (315 acres * 3.45 hours per acre), so that differences in the structure of the off-farm labor functions did not manifest themselves. Beyond year 20 of the growth horizon, when farm labor is restricted to that provided by the operator alone, the growth rate of the farm is slowed under each off-farm labor function and the differences between off-farm labor functions become apparent. For instance, from the entries in Appendix Table 19 on the last two lines for year 20 it is seen that average acreage for all farms in year 20 is about 316 acres, for a growth of about 236 acres in the initial 20 years. Growth over the remaining 10 years is only about 60 acres. Analyzing by differences in off-farm labor functions, growth in the last 10 years under labor function "A" is about 80 acres, while under labor function "B" it is only about 50 acres. These figures indicate a significant "dampening" effect on growth resulting from reduced off-farm income in a farming operation dominated largely by off-farm work and income, and reflect the importance of the assumptions pertaining to the gradual withdrawal of the part-time operator from the off-farm labor market. However, alternative labor assumptions do not markedly influence ability to form a full-time farming unit within the specified time horizon.

The autonomous consumption minimums of $19,163 and $13,688 influenced farm growth slightly (see Appendix Table 19). Ostensibly, these base requirements should be effective for only the first few years of the farm's growth or until sufficient total income is attained that they no longer represent the minimum required consumption. The $19,163 base resulted in an average ending growth of 294 acres, while the $13,688 base resulted in an ending average growth of 300 acres.

The average ending acreage for years 1, 2, and 3 under the $19,163 and $13,688 bases were 91 and 118 acres, 120 and 120 acres, and 146 and 154 acres, respectively (see Appendix Table 18 where odd-numbered scenarios correspond to the $19,163 minimum limit and even-numbered scenarios correspond to the $13,688 minimum limit on consumption). The difference in consumption bases therefore influenced the rate of growth in the initial years but this difference was largely "washed out" in the remaining years of farm growth.

Differences in average ending farm growth attributable to the alternative inflation rates were likewise negligible. Slightly higher growth, 299 acres, was achieved under the 12 percent inflation scenario than under the 6 percent scenario, 295 acres. Average acreage for years 1, 2, and 3 under the 12 and 6 percent inflation rates were 104 nd 105 acres, 120 and 120 acres, and 144 and 156 acres, respectively. Inflation, resulting in higher principal and interest payments on mortgages, decreases the expansion capability, as the inflation rate increases, of a fixed equity. Thus it might be expected that the lower inflation rate would facilitate early expansion. From Appendix Table 19, it is evident that the lower inflation rate resulted in more rapid expansion through the first 10 years of simulated growth.

Alternative coefficients of variation of farm income exhibited little impact upon farm firm growth over the 30-year growth horizon. The 75 percent coefficient of variation yielded an average growth of 297 acres while the 50 percent coefficient of variation yielded an average growth of 297.5 acres. While greater instability in farm income resulting from higher coefficients of variation could cause cash-flow problems resulting from unexpectedly low farm income, the inclusion of short-term borrowing in the growth simulation model should mitigate the impact of these fluctuations on farm growth. Additionally, as seen in Appendix Table 20, off-farm income dominates total family income through the majority of the 30-year growth horizon when only traditional enterprises are considered. Thus, variation in farm income should not impact growth as much as might be expected in a more farm-income dependent total family income.

Family Income and Consumption

Total family income for the 16 runs associated with the production of traditional enterprises averaged $29,200,* $38,950, $44,900, and $38,930 for years 1, 10, 20, and 30, respectively. As in the case of farm size and growth in acres, patterns of growth in total family income exhibited little responsiveness to alternative levels of inflation, autonomous consumption or coefficients of variation. Significant differences were observed, however, among the total family income values associated with alternative off-farm labor functions. These contrasts can be seen in Appendix Table 21 in comparisons of scenarios 1 and 2 with 3 and 4, 5 and 6 with 7 and 8, etc., in years 25 and 30.

In all cases, irrespective of the off-farm labor function, beyond year 20 of the growth horizon, when farm labor is restricted to that supplied by the operator alone, total family income decreases as a result of falling off-farm income. Only in the scenarios associated with labor function "A" does total family income begin to increase again in the last 10 years of farm growth, usually in about the 24th year. The alternative labor function, "B," results in a steady

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*All dollar values in the text are reported in 1984 dollars.

decrease in total family income throughout the last 10 years of farm growth. By the last year of the growth horizon, the average difference in total family income between alternative off-farm labor functions is about $9,570.

Consumption patterns, as would be expected, followed patterns in total family income. By the end of the 20 year growth horizon, consumption under the less restrictive off-farm labor function was about $5,000 greater than under the alternative function, "B" (see Table 7). Under the latter labor function, annual family consumption peaked at approximately $29,000 in about year 20 and decreased thereafter.

Traditional/Specialty Enterprises

Farm Size and Growth in Acres

Inclusion of specialty enterprises along with the traditional enterprises in the model, with an APC = .7, yielded an average growth for all farms in the simulation of 339 acres. (Average acreage for selected years is presented in Appendix Table 22.) This represents about a 40 acre average increase over acreage when production is confined to traditional crops. While the 40 acre increase exceeds the average acreage attained under the production of traditional enterprises by only about 13 percent, the $517,721 average increase in equity over 30 years represents about a 37 percent improvement over the $378,946 increase resulting from the production of only traditional enterprises (see Appendix Table 23). A large portion of the increase is attributable to the higher value of machinery present on the traditional and specialty enterprise producing farm.

Table 7. Average Annual Family Consumption (in 1984 Dollars) for Years 1, 15, and 30 with APC = .7, by Enterprise Group and Off-Farm Labor Scenario

Enterprise Group	Labor Scenario	Year 1	Year 15	Year 30
Traditional	A	18483	26590	27521
	B	18449	26574	22518
Traditional and Specialty	A	19407	33537	30825
	B	19455	33470	25358
Traditional and Non-Traditional	A	23770	36552	47386
	B	23747	36186	45235
Traditional, Non-Traditional, and Specialty	A	25154	42577	58463
	B	24926	34832	53829

The largest difference in average ending growth size was again observed among the alternative off-farm labor functions. The "less restrictive" labor function resulted in an ending average of 439 acres while the alternative labor function yielded an ending average of 400 acres.

The higher minimum level of autonomous consumption resulted in a lower average acreage for the first year of operation, 109 acres, than the average, 120 acres, achieved under the lower consumption minimum. By years 2 and 3 the difference had been eliminated. Average yearly ending acreage for these two years under the high and low base consumption levels were 125 and 124, and 159 and 160 acres, respectively. These differences are presented in Appendix Table 22 where the relevant comparisons are scenarios 1 vs. 2, 3 vs. 4, 5 vs. 6, etc.

The two levels of inflation yielded slightly different average ending acreages. Ending acreage associated with the 6 percent rate of inflation was 421 acres and under the 12 percent inflation rate was an average of 417 acres.

The alternative coefficients of variation in farm income resulted in a six acre difference in ending average acreage. Under the 75 percent coefficient of variation, a 416 acre average was attained, while the 50 percent coefficient of variation produced a 422 acre average.

Family Income and Consumption

Total family income for the 16 runs associated with the production of traditional/specialty enterprises average $31,110, $46,445, $56,050, and $40,980 for years 1, 10, 20, and 30, respectively. Again, only the off-farm labor functions generated significant differences in average total family income. By year 30, average total family income was $8,980 greater under labor function "A" than under labor function "B." These differences are exhibited in Appendix Table 24.

Under either labor function, average total family income decreased beyond year 20 when farm labor was restricted to that provided by the operator alone. Prior to the completion of the 30 year growth period, average total family income began to increase again under either labor function, unlike the pattern of continued decreases in average total family income in the last 10 years of the simulation exhibited under labor function "B" and the production of only traditional enterprises.

By the end of the 30 year growth horizon, off-farm income was only a small fraction of total family income in these scenarios in which off-farm income was not driven to zero. In the majority of scenarios including the more restrictive off-farm labor function, off-farm income was eliminated prior to completion of the growth cycle (see Appendix Table 25).

Average annual family consumption patterns followed trends in average annual total family income. By year 30, average consumption was about $5,500 greater under labor scenario "A" than was observed under labor scenario "B" (see Table 7). Under both labor functions, consumption was observed to peak in about year 25 of the growth horizon.

Traditional/Non-Traditional Enterprises

Farm Size and Growth in Acres

Simulation of the growth of farms producing a combination of traditional and non-traditional enterprises yielded an average ending acreage of 549 acres for an average growth of 469 acres. Average acreage by scenario is presented in Appendix Table 26. More substantial differences in ending acreage were observed among the alternative off-farm labor functions, coefficients of variation, and inflation rates than were noted in the previous two enterprise combinations.

The alternative labor functions continued to exhibit the same pattern of difference in average ending acreage with the "less restrictive" off-farm labor function yielding an average of 562 acres versus 535 acres for the alternative labor function (see Appendix Table 27). The 75 and 50 percent coefficients of variation resulted in an average ending acreage of 533 and 565 acres, respectively. The increase in difference over the previous enterprise combinations could be attributable to the much larger proportion of farm income to total family income in this enterprise organization, and consequently greater variation in total family income.

The impact of inflation rates was somewhat more pronounced in the present enterprise organization. The higher inflation rate, 12 percent, resulting in higher interest and principal payments on the mortgage, resulted in an ending average of 539 acres compared to 559 associated with the 6 percent inflation rate. The high inflation rate combined with the high coefficient of variation resulted in an average of 521 acres per farm, while the lower, 6 percent, inflation rate combined with the same coefficient of variation yielded a 545 acre average. Similar results were obtained when the two inflation rates were evaluated against the lower coefficient of variation. The results suggest that, for a given level of variation in farm income, a higher inflation rate slows farm growth, particularly where farm income is the much more dominant component of total family income.

Autonomous family consumption base levels did not significantly influence farm growth. Average consumption in the first year for all farms was about $23,970. Consequently, minimum consumption requirements of $19,163 and $13,688 did not come into use in the growth simulation.

Family Income and Consumption

Total family income for the 16 run associated with the production of traditional/non-traditional enterprises averaged $39,900, $50,030, $64,340, and $69,800 for years 1, 10, 20, and 30, respectively. Total family income, as in the case of income under the previous enterprise groups, declined for several years following year 20 of the growth period (see Appendix Table 28).

The decline was not associated, as in the previous cases, with declines in off-farm income since off-farm income was driven out early in the farms' growth. Under each labor function, off-farm income was less than half of the total factor income on the farm by the end of the second year of operation. On the average under the "less restrictive" labor function, off-farm income was zero by the 11th year of operation. Under the alternative function, zero off-farm income occurred on-the-average before the 8th year of operation (see Appendix Table 29). In this case, the decline in total family income results from the loss of family labor on the farm beyond year 20 and the added expense of hiring the family labor replacement at 4.26 per hour. Average annual family consumption for years 1, 15, and 30, presented in Table 7 indicate that the traditional/non-traditional enterprise organization provides much greater family consumption in the later years of growth than does the traditional/specialty enterprise organization.

Traditional/Non-Traditional/ Specialty Enterprises

Farm Size and Growth in Acres

The final combination of enterprises evaluated permitted production of all the enterprises on the farm. The largest average ending farm size, 624 acres, was obtained. The impact upon growth of alternative labor functions, coefficients of variation and inflation rates were very similar to those observed in the enterprise combination considered previously. Average acreages for selected years by scenario are presented in Appendix Table 30.

A 40 acre difference was observed among labor functions, with the "less restrictive" off-farm labor function resulting in an average farm of 644 acres and the alternative function yielding an average farm of 604 acres (see Appendix Table 31).

The higher inflation rate yielded an ending average farm of 599 acres and the lower rate yielded an ending average farm of 649 acres, a 50 acre difference. The higher coefficient of variation on farm income yielded an average farm of 607 acres and the lower rate, an average farm of 641 acres. For a given level of variation of farm income, the higher inflation rate resulted in smaller average ending acreages. For the 75 percent coefficient, the 12 percent inflation rate resulted in an average acreage of 583 acres and the 6 percent inflation rate resulted in an average acreage of 630 acres. Under the 50 percent coefficient of variation and 12 percent inflation rate an average ending acreage of 615 acres resulted. The same coefficient of variation and 6 percent inflation rate resulted in an average ending acreage of 666 acres. This represents a difference of 47 and 51 acres, respectively.

Family Income and Consumption

Average annual simulated total family income, presented in Appendix Table 31, for the 16 runs associated with production of traditional/non-traditional/specialty enterprises was $41,310, $52,890, $71,820, and $82,000 for years 1, 10, 20, and 30, respectively. As in previous enterprise organizations, total family income fell beyond year 20 of the growth period. However, the decline was short-lived and by year 30 total family income exceeded that achieved in year 20.

In this enterprise organization, off-farm income was eliminated early in the 30-year growth horizon. Under labor function "A," some farms earned off-farm income into the 11th year of operation, while for the alternative off-farm labor function off-farm income declined to zero, on-the-average, during the fourth year of operation. In both cases, off-farm income was less than half of total income earned by the end of the second year. Appendix Table 33 presents ratios of off-farm income to total family income for selected years. The highest levels of family consumption achieved under any enterprise group were observed with production of traditional/non-traditional/ specialty enterprises (see Table 7).

Growth Simulation Model Results With APC = .9

In the following analysis, the growth simulation model was run increasing the APC from .7 to .9 to reflect a premium on present consumption by the farm family. The same enterprise combinations and levels of autonomous consumption, inflation, coefficients of variation and off-farm labor functions were evaluated.

Based upon ending average acreage, there was no significant differences between enterprise organizations or among enterprise organizations with respect to off-farm labor functions, inflation, and autonomous consumption levels, or alternative coefficients of variation. Average ending acreage among farms for the four enterprise combinations were 160, 160, 163, and 163 acres, for an average growth of 80, 80, 83, and 83 acres.

Traditional Enterprises

Production of traditional enterprises yielded an ending average of 160 acres per farm, however, the growth rates differed among farms. The 80 acre average growth (160 acre ending average minus the 80 acre initial land base) represents an average of two acquisitions of 40 acres each. Inflation rates influenced the timing of acquisitions. The initial acquisition, i.e. growth from 80 to 120 acres occurred uniformly under each inflation rate at about the fourth year. The 6 percent rate of inflation resulted in the second acquisition, i.e. the increase from 120 to 160 acres, occurring at about year 19 while the

12 percent rate of inflation delayed the same increase until about year 30, the final year, of the growth simulation. Consumption patterns were similar for all runs averaging $22,181, $25,003, and $23,197 for years 1, 15, and 30, respectively.

Traditional/Specialty Enterprises

Inclusion of specialty enterprises yielded results similar to those obtained from analysis of traditional enterprises considered alone. Average ending acreage was 160 acres for an average growth of 80 acres. Expansion from 80 to 120 acres occurred under each inflation rate at about year four and the final acquisition occurred about year 18 of the growth period. Annual consumption was slightly higher when specialty crops were added, averaging $24,676, $28,154, and $26,403 for years 1, 15, and 30, respectively.

Traditional/Non-Traditional Enterprises

Inclusion of non-traditional enterprises with the traditional enterprises resulted in an ending average of 163 acres for an average growth of 80 acres. The rate of growth was influenced significantly by the alternative labor assumptions. For both labor assumptions, initial land acquisition occurred at about year three, however, the "less restrictive" labor assumption resulted in the second acquisition at about year 13 compared to year 24 for the alternative labor assumption. With a greater decline in off-farm income associated with the first purchase under the latter labor assumption, the increased time interval was necessary to build up resources for the second purchase. Average annual consumption for years 1, 15, and 30 years were $30,340, $32,441, and $26,608, respectively.

Traditional/Non-Traditional/ Specialty Enterprises

When all enterprises were considered, the average ending acreage was 163 acres for an average growth of 83 acres. The labor functions resulted in approximately the same growth pattern as in the case of the traditional/non-traditional enterprise combination. Initial acquisition, from 80 to 120 acres, occurred at year three with the second acquisition occurring at year 13 for the "less restrictive" labor function and at year 17 for the alternative labor function. Average annual consumption for years 1, 15, and 30 was $31,247, $34,148, and $27,050, respectively.

Growth Simulation Model Results for Low-Resource, Low-Management Farming Operation

Linear programming results for a low-management, low-resource proxy farm model in Chapter IV provided input into the growth simulation model to evaluate the growth potential of this type of farming operation. The model was run with APC set equal to .7 and analyzed over the same levels of inflation, autonomous consumption, coefficients of variation on farm income, and alternative off-farm labor functions. Only traditional enterprises were evaluated. Results are presented first for the farm operated on a part-time basis with off-farm income presented and subsequently with no off-farm income, i.e. as a full-time farming operation.

Part-Time Operation

The average ending acreage for the part-time operation was 311 acres for an average growth of 231 acres. Average acreage for selected years by scenario is presented in Appendix Table 34. Neither the inflation levels nor the labor functions exhibited much impact upon the farm growth. The growth required so little extra labor that under either off-farm labor function, off-farm income was maintained at a high level. The alternative coefficients of variation also exhibited little impact upon ending farm size due to the low percentage of total income represented by farm earnings.

The largest impact upon ending size occurred under the alternative autonomous consumption levels. The "high" autonomous consumption level resulted in an ending average of 300 acres while the "lower" level resulted in a 323 acre ending average.

Off-farm income remained a large component of total family income, constituting over one-half at the end of the simulation period. In the absence of off-farm income, the farm could not produce enough income even at the end of the growth period to satisfy family consumption requirements.

Full-Time Operation

The low-management, low-resource proxy farm model was evaluated as a full-time farming operation by removing the off-farm labor functions. Minimum autonomous family consumption requirements were maintained. All farms were observed to go bankrupt before year eight of the growth period. The farms operating under the $13,688 minimum consumption requirement went bankrupt on-the-average during the seventh year of the simulation while those operating with the $19,163 consumption requirement incurred bankruptcy on-the-average during the fourth year of operation. No land purchases were observed.

The consumption requirements, exceeding by far the ability of the farm to generate income, drew down the initial 100 percent equity through borrowing until equity was less than 20 percent, the point at which bankruptcy is deemed to occur. These simulations exhibit the classical "poverty trap" facing low resource/low income farming operations that must sacrifice future income and growth in order to meet current consumption needs.

CHAPTER VI

SUMMARY AND IMPLICATIONS, LIMITATIONS, AND SUGGESTIONS FOR FURTHER RESEARCH

Summary and Implications

The general objective of the foregoing research has been to identify the current condition of small and part-time farming operations in East Central Oklahoma and assess their potential for survivability and expansion. Results suggest future changes in the structure of agriculture in that region, and to the extent the area is representative, of the nation. Of concern is whether current small and part-time farms are viable economically. Of concern is whether small and part-time farms are suitable entry-level mechanisms capable of leading to a full-time farming operation; or are they a "missing rung" in the traditional agricultural ladder approach to entry? Of concern is whether small and part-time farms can provide diversity in regional agriculture, which has been characterized by the trend toward monoculture, or at best a small polyculture, and therefore a "viable option"; or are small and part-time farms likely to be operated as simply small versions of their larger counter-parts?

Hypothesis 1

> The incidence of poverty is higher on small farms than on larger farms.

From the East Central Oklahoma (ECO) farm survey, linear programming, and simulation results, the adjective "small" does not carry any inherent implications regarding the financial position of a particular farm. Much more important determinants are factors such as land base and enterprise selection, and the presence or absence of off-farm income supplementing farm earnings.

If one were to choose to define "small" farms in terms of acreage alone, ignoring the other factors, then it is readily observed from the distributions of farms by size in acres (Appendix Tables 8 and 9) that the absolute incidence of poverty might expectedly be higher on such small farms by the sheer preponderance of their numbers. However, it is likewise observed that the vast majority of such "small" farms tend to be part-time operations rather than full-time farming operations. For instance, among farms of 100 or less acres, part-time operations outnumber their full-time counterparts by a ratio of more than seven to one. From the ECO survey data it is known that among these part-time farming operations, the off-farm income component of total family income averaged about $23,606 in 1980. Thus, off-farm income along is sufficient, in most cases, to elevate total family income above poverty levels.

Similar reasoning applies when attempting to define "small" farms based upon some measure of scale of farming operation such as gross farm sales. The majority of farms having low gross farm receipts are part-time operations which, again, have large off-farm earnings. To associate the term "poverty" with this definition of "small," ignores this most important component of total family income and economic well-being.

The evidence suggests that categorical assertions linking poverty with the concept of "small" versus "large" farms are inherently fallacious. Since poverty is a function of total family income, which includes both farm and nonfarm components, a more accurate assessment of economic well-being must consider the degree of dependence upon farm income alone for family support.

In this respect, linear programming results suggest that poverty is much more likely to be observed upon full-time "small" farms than upon part-time "small" farms. LP and simulation results for the low-resource, low-management full-time farming operation presented in Chapters IV and V exhibit the classical "poverty trap" that such operations confront. In that analysis, the farm was incapable of supporting the family's consumption needs without drawing down its stock of equity. Eventually, bankruptcy was observed in all simulations of this particular farm scenario.

<u>Hypothesis 2</u>

> Full-time farmers make more efficient use of their resources than do part-time farmers.

The degree of efficiency with which the farm operator allocates his productive resources is greatly influenced by his farm resource mix and the opportunities, if any, he faces for off-farm resource employment. Comparison of rates of return to farming efforts between a full-time farm operator with no off-farm opportunity cost for say, labor, and rates of return for part-time operator with high off-farm opportunity costs for labor are onerous. For instance, the full-time operator with a fixed land base may apply a variable factor such as labor in his farming until the return to labor is driven very low.

This is not a problem if he has no alternative employment for his labor. The part-time operator may choose to restrict his farm labor, experiencing a much higher productivity of labor and factor return.

Individually, each may be making an efficient use of this resource. However, comparatively it may seem that the full-time operator is much less efficient in his allocation.

Returns to equity, where equity is defined as that portion of the farm's assets without debt obligations, are presented in Table 5 and are generally favorable for the alternative farm scenarios evaluated. For the part-time proxy farm model with the operator working full-time off-farm, these returns ranged from 9.5 to 12.9 percent over the various enterprise scenarios. The full-time proxy farm model producing traditional enterprise exhibited a 7.6 percent rate of return. These results suggest that for their respective levels of investment in farming, the part-time operators may be making a more efficient allocation of their resources.

Returns to equity calculated from the single-period linear programming results were similar for the traditional enterprise part-time farm and farms producing the alternative enterprise combinations when it was operated with only its initial land base. Allowing land rental, which increased net farm income, raised labor requirements to the degree that returns to equity were driven to low, even to negative, levels. These results suggest that, holding other factors fixed, increasing labor and/or land availability in an attempt to become a full-time farmer will not generate a sufficient gain in farm income to offset expenses and maintain or increase returns to equity.

Hypothesis 3

> Current small farm families, by adopting efficient practices and conventional crops, could earn an income comparable to the county per capita personal income.

The ECO survey data, linear programming, and simulation results indicate that adopting efficient practices and conventional crops will not result in the family earning an income comparable to the county per capita personal income from its farming efforts alone. Allowing for increased farm labor and land rental, net farm income for the part-time proxy farm model was only $11,662 when conventional enterprises were produced.

Off-farm income is critical for the small farm family to achieve the median family income in the survey area, $27,375. In both the linear programming and simulation results, the family achieved the $27,375 income "goal," but only when off-farm income was maintained at high levels. Simulation results indicate that the $27,375 "goal" is attainable over the growth period, but in some years by the barest of margins. Off-farm income alone ($23,606) fell short of the standard. Inclusion of farm income permitted achievement of the "goal" -- but only, among the linear programming scenarios analyzed, when off-farm income was maintained at its highest level. In the absence of off-farm income the farm operation could not have satisfied this objective during the early years of growth in the simulation model.

Hypothesis 4

> Part-time farming operations can be transformed into full-time operations while maintaining or increasing total family income.

The part-time proxy farm model was evaluated over a range of enterprise organizations to determine its capacity to be transformed into a full-time farming operation. Autonomous family consumption requirements, functions of the total family income, were imposed. These were a "low" and "high" level of consumption of $13,688 and $19,163, respectively.

Simulation of the farm's growth over a 30-year horizon was performed for each enterprise group. The farm was deemed "transformed" into a full-time operation if off-farm income was eventually eliminated.

Linear programming results indicate that the part-time proxy farm model could not be operated in a manner sufficient to provide a net farm income capable of satisfying either the "high" or "low" level of autonomous family consumption when only traditional enterprises are considered. Permitting the rental of additional land in the linear programming proxy farm model did not increase net farm income enough to satisfy either level of family consumption. From Table 3 it is seen that increasing farm labor for the fixed resource base at the expense of off-farm income resulted in significant decreases in total family income.

Simulated growth of the part-time, traditional enterprise producing farm again indicated the importance of off-farm income. Throughout the 30-year period of simulated growth off-farm income remained a large proportion of total family income. Thus, it appears that production of traditional enterprises alone is not conducive to transforming a part-time farming operation, such as the one analyzed, into a full-time farming operation.

From both the static and dynamic analysis via linear programming and simulation, it appears that part-time farms constrained to traditional enterprises similar to the model farm are near an "equilibrium" state. Their principal income likely will continue to be derived from off-farm work. Farm income will supplement, and the farm will be a residual claimant upon the family labor effort.

Including specialty crop production with the traditional enterprises in the linear programming analysis of the part-time proxy farm raised net farm income for any given off-farm labor effort. Net farm income alone was sufficient in each case to satisfy the low autonomous consumption requirement ($13,688) but in no case was sufficient to satisfy the high autonomous consumption requirement ($19,163). Permitting land rental and diverting additional labor toward the farm did not result in a farm income larger than the $19,163 consumption requirement.

Returns to equity calculated from the linear programming results revealed this enterprise combination yields higher returns than any other. However, when additional land rental was allowed, the small increases in net farm returns did not offset the large increases in labor requirements so that returns to equity were again driven low in some cases.

Results of the growth simulation for the farm producing traditional and specialty enterprises indicate the importance of the off-farm labor opportunities. Operating under somewhat restrictive off-farm labor opportunities, off-farm labor was eventually eliminated and the farm family became full-time farm operators. On the average, this occurred during the 22nd year of growth. The less restricted labor function resulted in off-farm income throughout the 30-year growth period and higher total family income.

Linear programming analysis of the part-time farm model indicates that minimum consumption income can be reached and exceeded by producing a combination of traditional and non-traditional enterprises. Growth simulation model results indicate that in the initial year of operation the high autonomous consumption level and median family income objective may not be attained without off-farm income. In all cases, however, by the end of the third year of growth these objectives could be attained from farm income alone. Simulation results also indicate that this organizational structure can lead to full-time farm operation. In all simulations, off-farm income was eventually eliminated.

The largest net farm income achieved in the linear programming analysis occurred when all these enterprise groups -- traditional, non-traditional, and specialty -- were considered as production alternatives. The net farm income was sufficient to meet either autonomous consumption level and also meet the family income goal.

Simulation results indicated that this farm organization could be operated on a full-time basis early in its growth phase. In all simulations, off-farm income was eliminated by, on the average, the eighth year of operation.

Linear programming and simulation results indicate that most farming operations in the survey area are capable of producing an acceptable level of family income. The larger farm operations are capable of achieving this through production of traditional enterprises alone, while for the smaller part-time farms, production of traditional enterprises alone will not result in a farm income capable of supporting the farm family. For these small farmers, primary dependence upon off-farm income is essential for achievement of an acceptable level of total family income.

Inclusion of specialty enterprises among the small part-time farm's production alternatives increased the farm income to a level capable of supporting the low autonomous consumption by the family in the absence of off-farm income. Simulation of growth opportunities indicated that this group of enterprises could lead to a full-time farming operation, but only after a protracted period during which the family would depend heavily upon off-farm income for consumption and growth requirements.

Additionally, these operators would sacrifice substantial total family income in the process of enlarging the farm, a price that perhaps many are unwilling to pay. Rather they may maintain their part-time small farm status. The high management level that his enterprise group demands would also burden many operators in the transition from small part-time farm to commercial full-time farm status.

Hypothesis 5

> Full-time small farms in poverty producing traditional enterprises can raise income above the poverty level with expansion in acreage by farming more efficiently and by introducing more labor-intensive specialty enterprises.

Two resource bases were evaluated in the analysis of small full-time farming operations. Both resource bases consisted of 80 acres, one unimproved pasture land and the other 60 acres of improved pasture and 20 acres of crop land.

The linear programming results for the model farm consisting of 80 acres of unimproved, or native grass, pasture yielded a net farm income of $3,168 when only traditional enterprises were produced. LP results for the 80 acres consisting of 60 acres of improved pasture and 20 acres of crop land yielded a net farm income of $9,850.

According to the 1980 Census of Population, poverty income for a rural family of four in that year was $7,500 or less (p. 642). The poverty level of income is adjusted annually according to changes in the Consumer Price Index (CPI). In 1984, the same family would have had to earn over approximately $8,500 to rise above poverty level income (Bureau of Labor Statistics, p. 213). Clearly, the farm consisting of unimproved pasture land did not achieve an income in excess of the poverty level in 1984.

Linear programming results and budgeting techniques indicate that with 1984 prices the minimum size farm consisting of owned, unimproved pasture land, and producing traditional enterprises, that would achieve the poverty threshold income was about 215 acres. If owned improved pasture land was available, only about 70 acres would be required. Thus, quantity and quality of land, as well as, management level are significant factors that influence the capacity of the small full-time farm to achieve an income above the poverty level.

In Table 3, it is shown that the 80 acre base farm model, when operated full-time producing both traditional and specialty crops, could produce a net farm income of about $17,324. This is a significant increase over the $9,850 net farm income achieved by producing traditional enterprises alone. Both exceed the $8,500 poverty level. Net farm income figures in Table 3 increased when land rental opportunity was allowed.

Increasing the land base for the small full time farm in poverty is conducive to achieving a higher net farm income. The dilemma is how to obtain more acreage. For the low-income, full-time small farm producing traditional enterprises land purchase in usually not feasible. Simulation in Chapter V for such an operation resulted in bankruptcy in all cases where even a minimum ($13,688) consumption requirement was imposed. When consumption was allowed to be 70 percent of net farm income, irrespective of how low consumption became, the average size farm at the end of the 30-year growth horizon was only 120 acres and at no time produced an income capable of exceeding the poverty level. The highest average annual consumption obtained was only $4,253.

Land rental is a more feasible alternative for expanding the farm since the renter is not burdened with mortgage payments associated with purchase. LP and budgeting techniques indicate that the small full-time operator renting unimproved pasture would have to lease about 275 acres, if rent was $20/acre/year, for total farm acreage of 355 acres to just achieve the poverty level income of $8,500.

Availability on the small full-time farm of land suitable for crops, traditional or specialty, greatly enhances the opportunity for the operator to achieve an acceptable level of net farm income, as indicated in Table 3. Likewise, specialty crop production is more conducive to attaining an acceptable net farm income than are the traditional cropland enterprises.

From Table 3, the most significant data relate to labor usage in the alternative scenarios evaluated. In most cases, the farm family's labor resource is under-utilized and/or not well compensated. The ECO survey data reveal that the small full-time operator's part-time counterpart earns approximately $8.40 per hour for off-farm family work. Clearly, the small full-time operator capable of working off-farm could greatly enhance his total family income by obtaining off-farm employment and income. For most small full-time operations this course represents greater potential for escaping poverty than increasing their level of farming activity or embarking on more labor-intensive and capital-intensive specialty enterprise ventures.

Additional Findings and Implications

Non-traditional enterprises, when included in the production alternatives and analyzed via linear programming and simulation, demonstrated potential for converting small, part-time farming operations into full-time operations producing a sufficient level of farm income for family consumption. Simulated growth of this type of operation lead to complete reliance upon farm income alone early in the farm's growth horizon.

The impact of alternative rates of inflation upon the ending average acreage of the farms producing the four enterprise groups analyzed exhibited the same pattern across all combinations. For each combination, the higher rate of inflation resulted in a smaller average ending acreage than did the lower inflation rate. The smallest difference, 3.5 acres, was observed in the model allowing growth through expansion of traditional enterprises. Differences for the three models allowing for growth via traditional and specialty enterprises, traditional and non-traditional, and a combination of all three enterprise groups were; 4, 20, and 51 acres, respectively. For a given enterprise group, the simulation model revealed earlier land acquisitions for the farm facing a 6 percent inflation rate than for the same farm facing a 12 percent inflation rate.

Differences due to inflation as a percentage of average ending acreage for the four enterprise combinations were less than 1 percent for the traditional and traditional/specialty combinations, 3.6 percent for the traditional and non-traditional group, and 8.1 percent for the combination of all three enterprises. Clearly, for the first two enterprise combinations the inflation rate difference did not greatly influence expansion opportunities.

Differences among coefficients-of-variation (CV) followed patterns similar to the differences among inflation rates. For a given enterprise group, the higher CV resulted in a smaller average ending acreage than did the lower CV. Average ending acreage on the traditional enterprise farm was 6.5 acres less under the 75 percent CV than under the 50 percent CV. A 6 acre difference was observed on the traditional/specialty enterprise farm, a 32 acre difference on the traditional/non-traditional enterprise farm, and a 34 acre difference on the farm producing a combination of all three enterprise groups. These differences, as a percent of average ending acreage, were: 1.7 percent, 1.4 percent, and 5.8 percent, for the respective enterprise groups. Again, the impact of alternative coefficients-of-variation was not very large on the first two types of farming operations. This result could be expected since on both types of farms, farm income is a much smaller proportion of total family income. Unexpected short-falls in farm income for a particular year can easily be compensated for by increasing consumption of off-farm income.

From the foregoing, it may be concluded that government policy objectives of moderating inflation or maintaining low inflation or of stabilizing farm income through commodity programs will not significantly impact the operation or expansion of part-time farming operations similar to those analyzed here. For those farming operations highly dependent upon off-farm income, the greatest opportunity for enhancement of economic well-being lies in improvement of off-farm jobs and wage rates. For full-time, limited resource operators, farming alone is neither likely to provide sufficient income for immediate family support nor surplus capital for investment in hope of increasing income in the future. Off-farm job opportunities are capable of supplying both.

The importance of farm income as a supplement to off-farm income for part-time operators in achievement of family income "goals" is demonstrated. Adoption of alternative enterprises given fixed resource bases has been shown, in some cases, to offer increased farm income opportunities without diminution of off-farm work and income.

Likewise, it is demonstrated that adoption of alternative enterprises on part-time farms can lead to full-time farming operations when the producer is so inclined and where expansion is aided initially through use of off-farm income. In certain instances, this expansion is possible only where the farm family is willing to reduce current consumption and increase investment to accomplish more rapid farm growth.

Most small part-time farms committed to production of traditional enterprises appear unlikely to alter their current allocation of effort between farm and off-farm work. They enjoy a high off-farm income, supplemented by farm income under favorable conditions and capable of absorbing farm losses in adverse conditions. Their small investment in farming and comparatively large off-farm income results in high farm survivability potential.

Limitations of the Study

Throughout the course of this research every effort has been made to inventory and model as accurately as possible the real-world physical characteristics of farms and farm families in the East Central Oklahoma area. By undertaking a broader analysis, through the use of proxy farm models, rather than a case study approach, the research requires the calculation of averages and "typical" values for certain initial parameters. As a consequence, results and implications must be carefully interpreted and not viewed as universally applicable to all individual farming operations in the survey area.

In taking advantage of the whole-farm planning capabilities of linear programming it is necessary to define a specific objective function which, in this research, is profit maximization. While the survey of goals of farm operators presented in an earlier chapter lends support to the profit maximization objective, it must be considered that, particularly in the case of part-time farm operators, farm ownership and operation may entail goals that are neither readily quantified or qualified nor necessarily consistent with the profit maximization assumptions.

Linear programming also requires specific assumptions about technology, prices, and input and output levels at a given point in time. Thus, measures such as returns to equity, which are extremely sensitive to these factors, must be viewed as relative comparisons for a specific situation and not as projections over time upon which comparisons may be made.

Suggestions for Further Research

Growth of part-time farming operation is often dependent upon off-farm income and consequently upon the assumptions made about the off-farm labor function. Additional research into the ease or difficulty with which off-farm labor may be converted toward the farm as its expansion requires more labor would increase the accuracy of the growth path projections and the impacts upon family income and consumption.

Having identified enterprise combinations, specifically, vegetable and swine enterprises, that show growth potential via the simulated growth model, further analysis of specific operations producing these enterprises is warranted. A systems analysis approach would permit the introduction of stochastic price and yield elements through time and give some measure of the sensitivity of these types of farming operations to variations in these factors not detectable in the equilibrium model used here to simulate growth.

A similar approach could be used to evaluate additional alternative enterprise that may enhance farm income in the East Central Oklahoma area. Recent interest in poultry production in the area could thus be evaluated.

Specialty crops and swine production activities showing potential for increasing income on small farms often entail special marketing and management problems. Additional research on production techniques and market availability for specialty crops is warranted.

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APPENDIX

Table 8. Maximum Likelihood Estimation of the Distribution by Size in Acres of Part-Time Farms in the East Central Oklahoma Survey and Chi-Square Goodness of Fit Test

Class	Size (Acres)	Frequency
Class I	1- 100	118
Class II	101- 200	75
Class III	201- 300	37
Class IV	301- 400	41
Class V	401- 500	21
Class VI	501- 600	17
Class VII	601- 700	11
Class VIII	701- 800	7
Class IX	801- 900	9
Class X	901-1000	7
Class XI	1001-1100	7
Class XII	1101-1200	5
Class XIII	1201-1300	2
Class XIV	1301-1400	0
Class XV	1401-1500	0
Class XVI	1501-High	15

Maximum Likelihood Estimate of the Exponential Density Function Parameter, Λ:

$$L = \lambda^n e^{-\Sigma x_i \lambda} \qquad \text{where, } n = 143 \text{ and } \Sigma x_i = 28881 \text{ acres}$$

$$\ell n L = n\, \ell n \lambda - \Sigma x_i \lambda$$

$$\frac{d\, \ell n\, L}{d\lambda} = \frac{n}{\lambda} - \Sigma x_i = 0$$

$$\frac{1}{\lambda} = \frac{\Sigma x_i}{n} = 201.96$$

$$\hat{\lambda} = \frac{1}{201.96} = .00495$$

Chi-Square Goodness of Fit Test:

H_o: the observations come from an exponential distribution with $\Lambda = .005$.

H_a: not the null.

Table 8. Continued

Size of Farm in Acres (X)	Number
$X \leq 26.71$	15
$26.71 < X \leq 57.74$	22
$57.74 < X \leq 94.00$	22
$94.00 < X \leq 138.63$	19
$138.63 < X \leq 196.17$	16
$196.17 < X \leq 277.26$	14
$277.26 < X \leq 415.89$	14
$415.89 < X$	21

The observed value of U is

$$u = \frac{(15 - 17.87)^2}{17.87} + \frac{(22 - 17.87)^2}{17.87} + \ldots + \frac{(21 - 17.87)^2}{17.87} = 4.86$$

The χ^2 distribution should give a good approximation of the distribution of U. Since $\chi^2_{.95}$ with 7 degrees of freedom equals 14.1, we would accept the H_0 with $\alpha = .05$.

Table 9. Method of Moments Estimation of the Distribution by Size in Acres of Full-Time Farms in the East Central Oklahoma Survey and Chi-Square Goodness of Fit Test

Class	Size (Acres)	Frequency
Class I	1- 100	16
Class II	101- 200	19
Class III	201- 300	8
Class IV	301- 400	19
Class V	401- 500	11
Class VI	501- 600	5
Class VII	601- 700	8
Class VIII	701- 800	5
Class IX	801- 900	6
Class X	901-1000	4
Class XI	1001-1100	3
Class XII	1101-1200	2
Class XIII	1201-1300	2
Class XIV	1301-High	11

Method of Moments Estimates of the Gamma Density Function Parameters, and R.

$$f_X(x) = \frac{\lambda^r x^{r-1}}{\Gamma(r)} e^{-\lambda x} \; ; \; r,\ x,\ \lambda > 0.$$

$$E[X] = \frac{r}{\lambda} \text{ and } E[X^2] = \frac{r(1 + r)}{\lambda^2}.$$

The method of moments estimators for the two parameters, given a random sample of n values of X, are specified by

$$M_1 = \overline{X} = \frac{\tilde{R}}{\tilde{\Lambda}} \text{ and } M_2 = \frac{\tilde{R}(1 + \tilde{R})}{\tilde{\Lambda}^2} = \frac{\overline{X}(1 + \tilde{R})}{\tilde{\Lambda}^2} = \frac{\overline{X}}{\tilde{\Lambda}^2} + \overline{X}^2$$

from which we find the estimators to be

$$\Lambda = \frac{\overline{X}}{M_2 - \overline{X}^2} \text{ and } \tilde{R} = \frac{\overline{X}^2}{M_2 - \overline{X}^2}.$$

The parameter estimates for these data then are

$$\tilde{\lambda} = .003996945 \text{ and } \tilde{r} = 1.7.$$

Table 9. Continued

Chi-Square Goodness of Fit Test:

H_o: the observations come from a gamma distribution with parameters, = .003996945 and R = 1.7.

H_a: not the null.

Size of Farm in Acres (X)	Number
$X \leq 95$	16
$95 < X \leq 157$	11
$157 < X \leq 216$	9
$216 < X \leq 277$	4
$277 < X \leq 345$	13
$345 < X \leq 423$	11
$423 < X \leq 519$	10
$519 < X \leq 648$	10
$648 < X \leq 859$	12
$859 < X$	23

The observed value of U is

$$u = \frac{(16 - 11.9)^2}{11.9} + \frac{(11 - 11.9)^2}{11.9} + \ldots + \frac{(23 - 11.9)^2}{11.9} = 20.5$$

The χ^2 distribution should give a good approximation of the distribution of U. Since $\chi^2_{.99}$ with 9 degrees of freedom equals 21.7, we would accept the H_o with $\alpha = .01$.

Table 10. Proxy Farm Model Base Scenario

Resource (Units/Period)	Part-Time Amount Available	Full-Time Amount Available
Land (acres):		
Cropland	20	493
Pasture or range	60	663
Labor (hours/year):		
Operator	1,226	3,466
Spouse	728	728
Child	600	600
Hired	0	1,800
Machinery:		
Motor truck (≥ .5 ton)	1	3
Tractor (55 hp.)	1	0
Tractor (≥ 100 hp.)	0	2
Combine (16' head)	0	1
Capital (dollars):		
Provided by owner	0	0
Borrowed operating	17,000	50,000
Borrowed intermediate	56,000	120,000

Table 11. Enterprises Evaluated in Proxy Farm Models by Group

Traditional Enterprises

Cow-Calf Cost and Returns/Per Cow
100 Cow Unit, Fall Calving
(11350018)*

Cow-Calf Cost and Returns/Per Cow
100 Units, Spring Calving
Carryover Steers Through Winter
and Sell in Spring
(11350418)

Cow-Calf Cost and Returns/Per Cow
100 Cow Unit
Spring Calving/Native Pasture
(11351118)

Cow-Calf Cost and Returns/Per Cow
100 Cow Unit
Spring Calving/Dry Grass
(11351140)

Cow-Calf Cost and Returns/Per Cow
50 Cow Unit
Fall Calving/Cool Season Pasture
(11351418)

Cow-Calf Cost and Returns/Per Cow
100 Cow Unit
Fall Calving/Cool Season Pasture
(11351518)

Cow-Calf Cost and Returns/Per Cow
100 Cow Unit
Fall Calving/Native Grass
(11352118)

Cow-Calf Cost and Returns/Per Cow
100 Cow Unit
Spring Calving/Fesque Pasture
(11352184)

Cow-Calf Cost and Returns/Per Cow
100 Cow Unit
Fall Calving/Bermuda Pasture
(11352218)

Bermuda Pasture - Fall Overseed
Small Grain and Vetch
(83355101)

50 Head Stocker Budget/Per Head
Buy October 15 - Sell July 15:
Steer Calves, 350# In - 715# Out
Dry Grass Winter
Native Pasture Summer
(11350116)

50 Head Stocker Budget/Per Head
Buy October 15 - Sell May 15:
Steers, 400# In - 690# Out
(13350416)

100 Head Stocker Budget/Per Head
Buy November 15 - Sell March 15:
Steers, 400# In - 565# Out
Small Grain Grazing
(13350516)

Summer Stockers
Buy May - Sell October
Starting Weight - 500#
Sell Weight - 690#
(11351116)

Stocker Budget/Per Calf
50 Head Unit
Buy October - Sell July
Fesque or Ryegrass Pasture
Starting Weight 400#
(13351143)

Stocker Budget/Per Calf
50 Head Unit
Buy October - Sell August
Dry Grass Wintering Program
300 Day Ownership
(13351154)

100 Head Stocker Budget/Per Head
Buy November 15 - Sell May 15:
Steers, 275# In - 530# Out
Small Grain Grazeout
(13350513)

Alfalfa Hay and Pasture
Grazed September Through May
Custom Harvest
(81351801)

Table 11. Continued

100 Head Stocker Budget/Per Head
Buy November 15 - Sell May 15:
Steers, 400# In - 683# Out
Small Grain Grazeout
(13351516)

Fesque Hay and Pasture
Grazed September Through May
Custom Harvest
(84351502)

Fesque Pasture-Hay
Custom Harvest
Grazed September Through May
(84352002)

Native Grass Pasture
Year-Round Grazing
Good to Excellent Range
Conditions
(85350101)

Small Grain Grazeout
(89350101)

Fesque and Bermuda
Combination Hay and Pasture
Intensified Management
Custom Harvest
(84351102)

Grain Sorghum
Custom Harvest
(73350004)

Oats Budget
Custom Harvest
(74351704)

Wheat for Small Grain
Custom Harvest
(76350301)

Soybeans/Per Acre
Custom Harvest
(98350504)

Soybeans/Wheat Per Acre
Custom Harvest
(98350555)

Nontraditional Enterprises

Low Investment Farrow to Finish
Complete Feedmill
Per Sow Basis
(40435612)

Low Investment Farrow to Finish
Purchase Complete Ration
Per Sow Basis
(40435611)

90 Sow Confinement System
Farrow to Finish
Purchase Complete Ration
(40435921)

90 Sow Confinement System/Per Sow
Farrow to Finish
Complete Feedmill
(40435922)

Low Investment Feeder Pig
Per Sow Farrowing
Based on 40 Sow Pasture System
All Rations Purchased
(40435713)

90 Sow Confinement System
Feeder Pig Production
Per Sow Basis
Purchase Complete Ration
(40436023)

Swine Feedlot
Fully enclosed, Fully Slated
100 Head Units
600 Head Capacity Lot
Purchase Complete Ration
(40436124)

Table 11. Continued

Swine Feedlot
Low Investment Dirtlot
100 Head Units
300 Head Capacity Lot
All Rations Purchased Mixed
(40435814)

Low Investment Swine Feedlot
Per Annual Pig Capacity
Dirtlot - 300 Head Capacity
3 Groups/Year
Complete Feedmill
(40435815)

Swine Feedlot
Fully enclosed, Fully Slated
500 Head Capacity
3 Groups/Year
Complete Feedmill
(40436125)

Specialty Enterprises

Asparagus, Established Field
No Till Operation
5 Foot Rows, 10 Inches Irrigation
(99072402)

Fresh Summer Tomatoes
Small Farms
(99072802)

Summer Squash
Sandy Loam Soils
Trickle Irrigation
Small Farms/Owned Equipment
(99072915)

Summer Cucumber
Sandy Loam Soils
Trickle Irrigation
Small Farms/Owned Equipment
(99073015)

Summer Muskmelon
Sandy Loam Soils
Trickle Irrigation
Small Farms/Owned Equipment
(99073115)

Summer Sweet Corn
Sandy Loam Soils
Trickle Irrigation
Small Farms/Owned Equipment
(99073214)

Summer Watermelon
Sandy Loam Soils
Trickle Irrigation
Small Farms/Owned Equipment
(99073215)

Spring Spinach
Sandy Loam Soils
Trickle Irrigation
Small Farms/Owned Equipment
(99073315)

Summer Sweet Potatoes
Sandy Loam Soils
Trickle Irrigation
Small Farms/Owned Equipment
(99073415)

Southern Peas
Sandy Loam Soils
Small Farms/Owned Equipment
(99073515)

Green Beans
Sandy Loam Soils
Trickle Irrigation
Small Farms/Owned Equipment
(99075615)

Summer Okra
Sandy Loam Soils
Trickle Irrigation
Small Farms/Owned Equipment
(99073715)

Table 11. Continued

Summer Eggplant Sandy Loam Soils Trickle Irrigation Small Farms/Owned Equipment (99073915)	Summer Bell Pepper Sandy Loam Soils Trickle Irrigation Small Farms/Owned Equipment (99074015)

*Budget record numbers, Oklahoma State University, Department of Agricutural Economics, enterprise budgets, Northeast Oklahoma.

Table 12. Comparison of Selected Outputs and Prices for Base (1984) Linear Programming Solutions with Current (1986) Prices, Northeast Oklahoma Production Region

Item	Units	1984[1] Price ($/Unit)	1986[2] Price ($/Unit)
Steer Calves (4-500#)	cwt.	74.00	70.50
Heifer Calves (4-500#)	cwt.	66.00	60.50
Commercial Cows	cwt.	43.00	35.00
Aged Bulls	cwt.	46.00	45.00
Steers (7-800#)	cwt.	67.00	60.00
Steers (6-700#)	cwt.	69.00	71.50
Steers (5-600#)	cwt.	72.00	65.00
Slaughter Hogs (220-240#)	cwt.	50.00	42.00
FDR Pigs (35-55)	cwt.	60.00	50.00
Nonbreeder Gilts	cwt.	45.00	45.00
Sows	cwt.	42.50	36.00
Boars	cwt.	32.50	34.00
Corn	bu.	2.80	2.70
Grain Sorghum	cwt.	4.20	3.45
Oats	bu.	1.60	1.50
Wheat	bu.	3.10	2.70
Alfalfa Hay	tons	80.00	65.00
Bermuda Hay	tons	55.00	45.00
Fesque Hay	tons	55.00	45.00
Prairie Hay	tons	55.00	45.00
Sudan Hay	tons	52.00	43.00
Peanuts	cwt.	24.00	24.00
Soybeans	bu.	5.50	5.25

[1]Approximately August 1, 1984 - July 31, 1985.

[2]Approximately August 1, 1985 - July 31, 1986.

Table 13. Vegetable Prices Utilized in Linear Programming Proxy Farm Model Solutions

Item	Units	1985 Price[1] ($/Unit)
Tomatoes	30 lb. lug	7.53
Squash	20 lb. carton	4.49
Cucumber	10/9 bu. carton	8.46
Sweet Corn	45 lb. crate	7.17
Watermelon	cwt.	4.43
Spinach	bu. basket	6.90
Eggplant	33 lb. crate	6.82
Okra	18 lb. carton	5.42
Bell Pepper	10/9 bu. carton	9.80
Peas	24 lb. basket	7.97
Sweet Potatoes	bu. basket	7.94
Green Beans	30 lb. basket	10.07
Muskmelon	70 lb. crate	10.00
Asparagus	cwt.	80.00

[1]Prices for the last two items are those reported in Department of Agricultural Economics/Oklahoma State University enterprise budgets. All other prices are those presented in Department of Agricultural Economics/Oklahoma State University publication, AE 85110, by Schatzer, Wickwire, and Tilley.

Table 14. Summary of Costs, Returns, and Selected Inputs for Enterprises Evaluated via Linear Programming by Enterprise Budget Number

Enterprise Budget Number	Enterprise Budget Basis	Fertilizer					Total Operating Costs	Total Fixed Costs	Total Receipts	Returns Above all Costs Except Overhead, Risk, and Management
		Feed[1]	N	P	K	Labor				
		(cwt.)	(lb.)	(lb.)	(lb.)	(hr.)	($)	($)	($)	($)
11351518[2]	Head	---	---	---	---	5.43	120.77	168.07	298.85	10.01
11352184	Head	---	---	---	---	8.82	95.65	151.84	269.75	22.26
13350416	Head	1.0	---	---	---	5.19	443.44	44.29	476.10	-11.63
11351116	Head	---	---	---	---	2.44	397.26	4.88	476.10	73.96
81351801	Acre	---	---	---	---	3.02	168.71	41.27	260.00	50.03
85350101	Acre	---	---	---	---	.17	3.20	1.00	---	-4.20
89350101	Acre	---	58	46	---	2.09	61.32	25.00	---	-86.31
84351102	Acre	---	100	40	40	.14	103.51	1.62	82.50	-22.63
98350504	Acre	---	15	30	15	2.03	92.35	24.27	137.50	20.88
40435922	Head	10.33	---	---	---	23.62	1302.57	425.21	1988.30	260.52
40435713	Head	10.08	---	---	---	20.01	731.84	73.00	866.14	61.30
99072802	Acre	---	40	100	100	20.28	2450.00	98.10	5271.00	2722.89
99073214	Acre	---	60	20	10	27.87	732.96	563.66	1290.60	6.02
99073515	Acre	---	20	40	20	22.48	683.31	119.50	956.40	153.59
99073715	Acre	---	55	60	30	36.34	2055.42	438.42	3613.00	1119.16
99073415	Acre	---	30	60	30	23.52	1549.66	494.54	2382.00	337.79
99075615	Acre	---	98	60	30	20.23	951.49	490.80	1208.40	-233.89
99073915	Acre	---	100	100	50	70.99	2915.71	564.62	3460.00	-20.33
99074015	Acre	---	100	100	50	85.71	3289.73	801.40	3266.00	-824.47
74351704	Acre	---	50	40	20	1.78	71.93	46.62	112.00	-6.55

Table 14. Continued

Enterprise Budget Number	Enterprise Budget Basis	Feed	Fertilizer N	Fertilizer P	Fertilizer K	Labor	Total Operating Costs	Total Fixed Costs	Total Receipts	Returns Above all Costs Except Overhead, Risk, and Management
		(cwt.)	(lb.)	(lb.)	(lb.)	(hr.)	($)	($)	($)	($)
83355101	Acre	---	70	40	20	.75	79.17	7.47	---	-86.64
73350004	Acre	---	40	20	10	2.27	68.37	50.49	151.20	32.34
98350555	Acre	---	50	30	15	2.58	97.34	86.52	200.90	17.04
11350018	Head	6.72	---	---	---	5.30	236.66	189.96	298.85	-127.77
11350418	Head	5.21	---	---	---	5.50	235.62	172.73	369.12	-39.23
11351118	Head	5.22	---	---	---	10.64	223.52	195.01	306.32	-112.22
11351140	Head	4.18	---	---	---	8.82	202.10	151.84	269.75	-84.19
11351418	Head	---	---	---	---	8.49	157.16	158.48	298.85	-16.78
11352118	Head	7.56	---	---	---	9.12	258.19	106.71	298.85	-66.05
11352218	Head	5.77	---	---	---	10.89	291.19	168.37	298.85	-160.71
11350116	Head	6.50	---	---	---	4.92	437.97	45.26	479.05	-4.18
11350516	Head	---	---	---	---	2.76	378.49	7.60	406.80	20.71
11351143	Head	3.00	---	---	---	5.17	458.61	47.75	448.50	-52.86
11351154	Head	5.75	---	---	---	5.17	477.43	42.75	469.00	-51.18
76350301	Acre	---	93	18	0	3.40	92.29	58.56	93.00	-57.85
40435612	Head	129.22	---	---	---	38.06	1549.96	229.24	1735.24	-43.96
40435611	Head	140.42	---	---	---	35.05	1510.64	133.57	1735.24	91.03
40435921	Head	152.58	---	---	---	20.00	1555.19	346.26	1988.30	86.86
40436023	Head	28.97	---	---	---	11.00	697.62	247.34	957.05	12.09
40436124	100 Head	658.00	---	---	---	72.96	11287.61	605.87	11270.00	-623.48

Table 14. Continued

Enterprise Budget Number	Enterprise Budget Basis	Feed	Fertilizer N	Fertilizer P	Fertilizer K	Labor	Total Operating Costs	Total Fixed Costs	Total Receipts	Returns Above all Costs Except Overhead, Risk, and Management
		(cwt.)	(lb.)	(lb.)	(lb.)	(hr.)	($)	($)	($)	($)
40435814	100 Head	687.00	---	---	---	97.78	11798.98	279.48	11270.00	-808.45
40436125	3 Head	19.07	---	---	---	2.31	312.99	30.47	338.10	-5.36
40435815	Head	20.04	---	---	---	3.33	343.65	19.23	338.10	-24.78
99072402	Acre	---	75	---	---	10.33	690.94	7.42	2400.00	1701.64
99072915	Acre	---	65	80	40	57.89	1856.46	571.80	2245.00	-183.26
99073015	Acre	---	100	100	50	53.51	1355.09	489.14	2538.00	693.77
99073115	Acre	---	90	100	50	37.64	997.65	403.95	2100.00	698.40
99073215	Acre	---	64	60	30	40.36	731.15	484.61	886.00	-314.00
99073315	Acre	---	100	100	50	25.60	1071.60	524.20	1932.00	336.19
13350513	Head	1.1	---	---	---	3.72	311.71	9.21	381.60	60.68
13351516	Head	1.1	---	---	---	3.72	397.38	9.21	471.27	64.68
84351502	Acre	---	100	40	40	.10	94.90	1.46	52.00	-44.36
84352002	Acre	---	100	40	40	.15	84.00	.76	41.25	-42.00
13350516	Head	1.05	---	---	---	2.76	378.49	7.60	406.80	20.71

[1]Does not include salt and minerals.

[2]See Appendix Table 11 for enterprise names.

Table 15. Solution Values for Selected Variables in the Part-Time Proxy Farm Model Under High-Capital Scenario by Enterprise Combination, Labor Used, and Land Rental Opportunity

	Level of Off-Farm Work	Land Rental	NFI($)	OFI($)	TFI($)	Labor Used(Hrs.)
Traditional Enterprises	Full-time off-farm	No	10987	23606	34593	410.3
		Yes	24821	23606	48427	1461.2
	Half-time off-farm	No	10987	11803	22790	410.3
		Yes	25661	11803	37464	1694.9
	No off-farm work	No	10987	0	10987	410.3
		Yes	26234	0	26234	1843.6
Traditional and Non-Traditional Enterprises	Full-time off-farm	No	29905	23606	53511	1823.3
		Yes	39825	23606	63431	1594.6
	Half-time off-farm	No	36193	11803	47996	3148.2
		Yes	45655	11803	57458	2956.0
	No off-farm work	No	41388	0	41388	4345.4
		Yes	48948	0	48948	3725.3
Traditional and Non-Traditional Enterprises	Full-time off-farm	No	36674	23606	60280	1963.0
		Yes	45861	23606	69467	1669.9
	Half-time off-farm	No	42963	11803	54766	3288.0
		Yes	51720	11803	63523	2952.9
	No off-farm work	No	47198	0	47198	4298.2
		Yes	55014	0	55014	3722.4
Traditional and Specialty	Full-time off-farm	No	18543	23606	42149	599.9
		Yes	32480	23606	56086	1641.0
	Half-time off-farm	No	18543	11803	30346	599.9
		Yes	33318	11803	45121	1857.6
	No off-farm work	No	18543	0	18543	599.9
		Yes	33613	0	33613	1938.7

Table 16. Index Numbers of Prices Received by Farmers,[1] Oklahoma, 1980-1985 (1910-1914 = 100)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
All feed grains and hay:													
1980	492	488	497	478	467	462	519	560	614	658	683	697	551
1981	684	680	662	639	647	612	572	538	500	522	518	491	589
1982	514	491	497	485	498	492	504	491	519	490	516	518	501
1983	535	5335	563	524	545	543	543	545	545	588	619	622	559
1984	624	613	603	615	537	585	587	578	595	610	572	640	597
1985	651	672	600	611	483	486	518	464	422	NA	NA	NA	545[2]
All crops:													
1980	492	482	462	440	457	451	476	489	528	558	586	580	500
1981	514	476	551	551	540	526	515	518	493	483	493	474	511
1982	477	466	459	462	459	436	432	429	435	440	445	448	449
1983	454	454	472	460	453	442	441	454	475	478	483	490	463
1984	491	481	487	501	487	477	474	480	490	481	470	473	483
1985	475	471	457	454	414	407	406	391	398	NA	NA	NA	430
All livestock and livestock products:													
1980	996	1038	989	914	922	935	906	975	977	892	930	934	951
1981	642	605	614	623	890	901	887	905	884	845	839	813	887
1982	834	881	864	890	917	871	868	841	808	773	782	793	844
1983	763	874	879	907	869	867	811	793	759	759	759	809	818
1984	857	889	898	824	847	743	748	779	778	754	789	900	817
1985	875	881	849	837	849	804	760	760	735	NA	NA	NA	816
All farm products:													
1980	743	760	726	677	688	693	689	730	750	719	751	751	723
1981	725	698	727	732	710	718	699	706	685	659	662	639	697
1982	652	671	659	674	687	653	649	634	619	603	610	617	644
1983	604	663	673	682	659	638	624	620	612	610	613	645	637
1984	670	682	689	657	663	604	605	624	629	612	625	684	645
1985	673	673	651	643	651	608	581	574	564	NA	NA	NA	624

NA - not available.

[1]The interested reader may find the procedures for calculating index numbers in "Prices Received by Oklahoma Farmers 1952-1963," by Blakley, Collins, and Price. Oklahoma State University Experiment Station Publication, P-484, August 1964.

[2]Average based upon months data available.

Table 17. Combinations of Variables (Coefficients of Variation (CV) for Net Farm Income of 50 and 75 Percent, Inflation Rates (INF) of 6 and 12 Percent, Labor Functions (LABFN) "A" and "B," and Autonomous Family Consumption Levels (AUTCON) of $19,163 and $13,688 Evaluated for Each Enterprise Group

	Variable			
Scenario	CV	INF	LABFN	AUTCON
1	50	6	A	19163
2	50	6	A	13688
3	50	6	B	19163
4	50	6	B	13688
5	50	12	A	19163
6	50	12	A	13688
7	50	12	B	19163
8	50	12	B	13688
9	75	6	A	19163
10	75	6	A	13688
11	75	6	B	19163
12	75	6	B	13688
13	75	12	A	19163
14	75	12	A	13688
15	75	12	B	19163
16	75	12	B	13688

Table 18. Average Ending Simulated Farm Acreage for Selected Years by Variable Scenario for Part-Time Operator, Traditional Enterprise Producing, Proxy Farm Model with APC = .7

	Year								
Scenario[1]	1	2	3	5	10	15	20	25	30
1	93	120	152	187	240	280	322	355	389
2	120	120	160	198	240	280	324	359	395
3	89	120	156	188	240	280	323	354	360
4	120	120	160	196	240	281	324	359	360
5	88	120	146	160	200	245	307	337	390
6	120	120	150	160	201	252	314	346	396
7	90	120	142	160	200	246	305	337	364
8	120	120	147	160	202	250	313	347	366
9	92	120	150	182	240	280	322	346	383
10	116	120	160	196	241	282	325	354	391
11	92	120	148	178	238	279	320	348	361
12	116	120	160	194	240	282	326	352	363
13	95	120	139	160	202	250	304	335	384
14	114	120	148	160	205	253	309	344	393
15	91	120	140	160	202	252	305	338	365
16	118	120	154	161	217	271	326	358	377

[1]See Appendix Table 17.

Table 19. Average Simulated Farm Acreage by Year and Variable Level for Part-Time Operator, Traditional Enterprise Producing, Proxy Farm Model with APC = .7

	Year				
Variable	1	5	10	20	30
CV (50%)	105.00	176.13	220.38	316.50	377.50
CV (75%)	104.25	173.86	223.13	317.13	377.13
INF (6%)	104.75	189.88	239.88	323.25	375.25
INF (12%)	164.50	160.13	203.63	310.38	379.37
AUTCON ($19,163)	91.25	171.88	220.25	313.50	374.50
AUTCON ($13,688)	118.00	178.13	223.25	320.13	380.13
LABFN ("A")	104.75	175.38	221.13	315.86	388.85
LABFN ("B")	104.50	174.63	222.38	317.75	364.50

Table 20. Ratio of Simulated Off-Farm Income to Total Family Income by Year and Variable Scenario for Traditional Enterprise Producing, Part-Time Proxy Farm Model with APC = .7

	Year						
Scenario[1]	1	5	10	15	20	25	30
1	.80	.68	.59	.55	.52	.42	.39
2	.81	.68	.59	.55	.52	.42	.38
3	.81	.67	.59	.54	.52	.32	.26
4	.81	.68	.60	.55	.51	.28	.26
5	.81	.67	.62	.59	.54	.43	.38
6	.80	.69	.62	.57	.53	.43	.38
7	.81	.67	.62	.60	.54	.41	.26
8	.82	.67	.63	.58	.54	.40	.25
9	.81	.67	.59	.56	.51	.44	.38
10	.80	.66	.59	.54	.53	.43	.39
11	.82	.67	.59	.56	.51	.33	.27
12	.81	.67	.58	.55	.53	.30	.26
13	.80	.68	.63	.57	.52	.45	.39
14	.81	.67	.62	.56	.53	.43	.36
15	.80	.68	.62	.56	.54	.40	.25
16	.80	.68	.63	.57	.53	.39	.25

[1]See Appendix Table 17.

Table 21. Average Simulated Total Family Income (in $1,000s) by Year and Variable Scenario for Traditional Enterprise Producing, Part-Time Proxy Farm Model with APC = .7

	Year						
Scenario[1]	1	5	10	15	20	25	30
1	29.37	34.99	40.27	42.90	45.65	41.73	42.87
2	29.18	34.47	40.29	42.77	45.71	41.38	43.72
3	29.05	35.46	39.76	43.58	45.34	36.20	32.97
4	29.15	35.02	39.61	43.17	46.29	34.95	33.90
5	29.12	35.19	38.07	40.23	43.82	40.91	43.98
6	29.40	34.19	38.20	41.18	44.38	40.45	44.29
7	29.17	35.16	37.93	40.02	43.78	39.14	33.28
8	28.59	35.29	37.33	40.73	43.38	39.02	34.87
9	29.28	34.98	39.99	42.44	46.15	39.65	44.01
10	29.36	35.58	39.73	43.97	44.43	40.25	42.32
11	28.87	35.21	39.86	41.91	46.15	36.13	33.84
12	29.15	35.19	40.97	42.87	44.78	37.78	34.19
13	29.48	34.83	37.30	41.34	45.82	39.15	42.57
14	29.24	35.20	38.20	41.79	44.13	40.23	45.97
15	29.38	34.56	38.06	42.44	44.06	38.00	35.78
16	29.41	34.67	37.60	41.34	44.66	37.89	34.39

[1]See Appendix Table 17.

Table 22. Average Ending Simulated Farm Acreage for Selected Years by Year and Variable Scenario for Traditional Enterprise Producing, Part-Time Proxy Farm Model with APC = .7

	Year								
Scenario[1]	1	2	3	5	10	15	20	25	30
1	111	129	160	200	276	335	398	410	441
2	120	126	160	200	276	333	400	415	446
3	112	127	160	200	274	336	396	398	403
4	120	127	160	200	276	335	398	400	408
5	108	120	160	176	239	292	363	394	441
6	120	120	160	178	240	294	364	393	443
7	110	120	160	177	239	292	362	368	390
8	120	120	160	180	240	294	366	373	407
9	110	129	160	201	268	330	398	412	430
10	120	130	160	201	271	330	395	411	435
11	110	130	159	203	273	335	392	396	400
12	120	129	160	202	276	332	391	397	404
13	108	120	158	178	237	292	358	384	424
14	120	120	160	178	238	298	367	395	449
15	106	121	155	177	236	293	362	370	381
16	120	121	159	175	236	295	362	375	404

[1]See Appendix Table 17.

Table 22. Average Ending Simulated Farm Acreage for Selected Years by Year and Variable Scenario for Traditional Enterprise Producing, Part-Time Proxy Farm Model with APC = .7

Scenario[1]	Year 1	2	3	5	10	15	20	25	30
1	111	129	160	200	276	335	398	410	441
2	120	126	160	200	276	333	400	415	446
3	112	127	160	200	274	336	396	398	403
4	120	127	160	200	276	335	398	400	408
5	108	120	160	176	239	292	363	394	441
6	120	120	160	178	240	294	364	393	443
7	110	120	160	177	239	292	362	368	390
8	120	120	160	180	240	294	366	373	407
9	110	129	160	201	268	330	398	412	430
10	120	130	160	201	271	330	395	411	435
11	110	130	159	203	273	335	392	396	400
12	120	129	160	202	276	332	391	397	404
13	108	120	158	178	237	292	358	384	424
14	120	120	160	178	238	298	367	395	449
15	106	121	155	177	236	293	362	370	381
16	120	121	159	175	236	295	362	375	404

[1]See Appendix Table 17.

Table 24. Average Simulated Total Family Income ($1,000s) by Year and Variable Scenario for Traditional/Specialty Enterprise Producing, Part-Time Proxy Farm Model with APC = .7

	Year						
Scenario[1]	1	5	10	15	20	25	30
1	31.32	42.21	47.66	51.76	59.44	44.27	46.10
2	31.24	42.16	47.77	53.48	60.57	45.32	46.37
3	31.28	41.15	47.14	53.66	52.44	34.06	37.61
4	31.05	41.85	49.04	53.45	50.03	36.15	38.43
5	30.92	39.23	43.96	50.18	57.54	41.93	44.15
6	30.81	39.10	46.25	48.62	56.92	42.47	44.86
7	31.46	38.79	44.04	49.98	56.21	32.45	35.57
8	31.37	38.81	44.51	50.16	56.95	34.52	34.99
9	31.30	42.23	46.50	52.67	60.29	41.85	44.09
10	31.01	41.63	47.78	52.45	56.27	43.68	45.56
11	31.41	41.71	49.73	52.30	53.75	36.51	35.94
12	30.34	41.77	48.55	51.88	51.80	38.30	36.56
13	31.14	39.05	44.77	51.00	58.19	40.11	44.46
14	30.96	38.57	45.87	50.20	56.35	43.25	48.17
15	31.01	38.97	44.85	49.30	55.94	33.07	35.77
16	31.19	38.88	44.70	48.62	54.07	35.16	37.05

[1]See Appendix Table 17.

Table 25. Ratio of Simulated Off-Farm Income to Total Family Income by Year and Variable Scenario for Traditional/Specialty Enterprise Producing, Part-Time Proxy Farm Model with APC = .7

	Year						
Scenario[1]	1	5	10	15	20	25	30
1	.75	.56	.50	.46	.40	.13	.10
2	.76	.56	.49	.44	.39	.12	.09
3	.75	.57	.50	.44	.30	---	---
4	.75	.56	.48	.44	.29	---	---
5	.76	.60	.54	.47	.41	.17	.10
6	.77	.60	.51	.49	.42	.16	.10
7	.75	.61	.54	.47	.42	---	---
8	.75	.61	.53	.47	.41	---	---
9	.75	.56	.51	.45	.39	.14	.11
10	.76	.57	.49	.45	.42	.13	.11
11	.75	.57	.47	.45	.32	---	---
12	.77	.57	.49	.45	.32	---	---
13	.76	.60	.53	.46	.41	.18	.13
14	.76	.61	.51	.47	.42	.16	.09
15	.76	.61	.53	.48	.42	.01	.01
16	.76	.61	.53	.49	.43	.01	---

[1]See Appendix Table 17.

Table 26. Average Ending Simulated Farm Acreage for Selected Years by Variable Scenario for Part-Time Operator,Traditional/Non-Traditional Enterprise Producing, Proxy Farm Model with APC = .7

	Year								
Scenario[1]	1	2	3	5	10	15	20	25	30
1	120	160	188	231	295	362	446	498	584
2	120	160	187	231	293	364	441	496	581
3	120	150	170	211	274	348	431	484	557
4	120	151	172	209	288	358	436	492	567
5	120	157	166	202	259	325	412	472	568
6	120	155	164	200	258	324	406	474	569
7	120	137	158	194	235	308	389	450	540
8	120	142	160	196	239	319	396	462	550
9	120	158	187	227	281	343	419	474	542
10	120	158	188	233	299	360	436	498	569
11	119	150	174	210	267	322	392	446	514
12	120	147	174	217	292	363	430	478	557
13	120	152	171	202	253	308	380	442	532
14	120	151	172	204	262	316	402	462	551
15	119	139	157	189	233	288	260	412	483
16	120	137	158	191	239	302	382	442	515

[1]See Appendix Table 17.

Table 27. Average Simulated Farm Acreage by Year and Variable Level for Part-Time Operator, Traditional/Non-Traditional Enterprise Producing, Proxy Farm Model with APC = .7

	Year				
Variable	1	5	10	20	30
CV (50%)	120.00	209.25	267.63	419.60	564.50
CV (75%)	119.75	209.13	265.75	400.12	532.88
INF (6%)	119.86	221.13	286.13	428.88	558.87
INF (12%)	119.86	197.25	247.25	390.88	538.50
AUTCON ($19,163)	119.75	208.25	262.12	403.63	540.00
AUTCON ($13,688)	120.00	210.13	271.25	416.13	557.38
LABFN ("A")	120.00	216.25	275.00	417.75	562.00
LABFN ("B")	119.75	202.13	258.38	402.00	535.38

Table 28. Average Simulated Total Family Income ($1,000s) by Year and Variable Scenario for Traditional/Non-Traditional Enterprise Producing, Part-Time Proxy Farm Model with APC = .7

	Year						
Scenario[1]	1	5	10	15	20	25	30
1	39.50	48.84	51.34	58.94	67.98	64.32	73.93
2	40.29	49.04	52.13	60.59	67.86	64.06	71.91
3	39.85	40.06	50.31	57.49	65.54	61.72	68.78
4	39.47	40.31	54.39	60.94	65.51	65.52	73.98
5	39.94	47.07	48.96	54.20	64.48	63.38	73.04
6	39.63	46.57	49.99	54.31	65.17	61.03	71.00
7	39.08	41.93	46.35	52.84	64.26	60.68	69.50
8	40.53	42.59	44.06	55.47	63.35	62.75	69.55
9	40.97	46.49	50.94	60.46	66.52	61.98	69.84
10	38.87	48.20	50.15	56.36	67.34	66.27	72.00
11	39.85	41.18	50.73	53.90	64.67	59.52	61.67
12	39.54	44.27	54.51	59.86	65.64	63.12	77.13
13	39.86	46.18	53.68	51.82	57.00	61.54	67.57
14	40.36	49.60	49.57	50.95	62.77	61.99	73.09
15	40.28	45.50	45.05	51.73	57.71	56.15	60.34
16	40.45	45.18	48.36	50.53	62.71	61.85	62.50

[1]See Appendix Table 17.

Table 29. Ratio of Simulated Off-Farm Income to Total Family Income by Year and Variable Scenario for Traditional/Non-Traditional Enterprise Producing, Part-Time Proxy Farm Model with APC = .7

Scenario[1]	Year 1	5	10	15	20	25	30
1	.60	.11	---	---	---	---	---
2	.58	.11	---	---	---	---	---
3	.59	.02	---	---	---	---	---
4	.60	.01	---	---	---	---	---
5	.59	.17	.01	---	---	---	---
6	.60	.17	.01	---	---	---	---
7	.60	.16	---	---	---	---	---
8	.58	.17	---	---	---	---	---
9	.58	.11	.01	---	---	---	---
10	.61	.10	---	---	---	---	---
11	.59	.06	---	---	---	---	---
12	.60	.03	---	---	---	---	---
13	.59	.17	.03	---	---	---	---
14	.58	.17	.02	---	---	---	---
15	.59	.15	---	---	---	---	---
16	.58	.17	---	---	---	---	---

[1]See Appendix Table 17.

Table 30. Average Ending Simulated Farm Acreage for Selected Years by Variable Scenario for Part-Time Operator, Traditional/Non-Traditional/ Specialty Enterprise Producing, Proxy Farm Model with APC = .7

	Year								
Scenario[1]	1	2	3	5	10	15	20	25	30
1	120	160	191	236	318	403	495	575	684
2	120	160	194	237	320	411	506	574	683
3	120	157	173	203	294	385	480	551	653
4	120	158	170	208	298	386	479	540	646
5	120	159	175	207	273	350	445	522	634
6	120	158	172	208	269	350	442	526	636
7	120	149	160	177	240	318	414	490	591
8	120	148	160	182	252	322	425	496	600
9	120	161	191	238	308	381	471	540	631
10	120	160	193	234	316	395	497	570	667
11	120	150	170	203	269	346	435	498	580
12	120	155	175	212	298	380	478	542	644
13	120	155	175	209	266	331	412	486	587
14	120	156	178	210	274	358	444	528	626
15	120	143	159	184	224	294	375	441	531
16	120	144	162	185	247	322	408	492	588

[1]See Appendix Table 17.

Table 31. Average Simulated Farm Acreage by Year and Variable Level for Part-Time Operator, Traditional/Non-Traditional/Specialty Enterprise Producing, Proxy Farm Model with APC = .7

	Year				
Variable	1	5	10	20	30
CV (50%)	120.00	207.25	283.00	460.75	640.87
CV (75%)	120.00	209.38	275.25	440.00	606.75
INF (6%)	120.00	221.37	302.63	480.13	648.50
INF (12%)	120.00	195.25	255.62	420.63	599.13
AUTCON ($19,163)	120.00	207.13	274.00	440.88	611.38
AUTCON ($13,688)	120.00	209.50	284.25	459.88	636.25
LABFN ("A")	120.00	222.37	293.00	464.00	643.50
LABFN ("B")	120.00	194.25	265.25	436.75	604.12

Table 32. Average Simulated Total Family Income ($1,000s) by Year and Variable Scenario for Traditional/Non-Traditional/Specialty Enterprise Producing, Part-Time Proxy Farm Model with APC = .7

	Year						
Scenario[1]	1	5	10	15	20	25	30
1	41.07	48.77	56.04	66.69	77.56	76.85	95.48
2	41.86	49.20	57.58	69.12	80.31	78.72	88.39
3	40.98	40.43	54.54	66.30	73.92	72.21	83.65
4	39.84	41.97	52.25	65.81	73.57	70.92	84.65
5	42.05	45.78	53.30	59.14	71.77	72.11	81.25
6	41.64	44.13	54.90	59.39	71.00	74.99	85.43
7	41.00	34.54	48.87	56.59	70.23	67.25	80.09
8	40.89	38.21	49.72	55.48	71.59	68.55	76.78
9	41.48	50.68	54.42	61.82	71.49	75.88	85.34
10	41.46	46.91	58.15	66.06	79.35	79.85	87.67
11	41.39	41.34	49.63	60.08	65.67	63.06	77.40
12	41.82	42.77	54.60	64.13	76.29	72.27	82.69
13	42.15	47.97	50.17	55.00	68.00	66.40	78.77
14	40.76	46.76	52.80	66.68	68.59	69.26	81.39
15	41.51	40.10	49.07	54.51	60.98	61.69	65.81
16	41.14	38.54	50.35	55.85	68.83	73.06	77.25

[1]See Appendix Table 17.

Table 33. Ratio of Simulated Off-Farm Income to Total Family Income by Year and Variable Scenario for Traditional/Non-Traditional/Specialty Enterprise Producing, Part-Time Proxy Farm Model with APC = .7

	Year						
Scenario[1]	1	5	10	15	20	25	30
1	.57	.04	---	---	---	---	---
2	.56	.04	---	---	---	---	---
3	.58	---	---	---	---	---	---
4	.59	---	---	---	---	---	---
5	.56	.09	.01	---	---	---	---
6	.57	.09	.01	---	---	---	---
7	.58	---	---	---	---	---	---
8	.57	---	---	---	---	---	---
9	.57	.04	---	---	---	---	---
10	.57	.04	---	---	---	---	---
11	.57	---	---	---	---	---	---
12	.56	---	---	---	---	---	---
13	.56	.10	.02	---	---	---	---
14	.58	.10	.01	---	---	---	---
15	.57	.01	---	---	---	---	---
16	.57	---	---	---	---	---	---

[1]See Appendix Table 17.

Table 34. Average Ending Simulated Farm Acreage for Selected Years by Variable Scenario for Low-Management, Low-Resource, Traditional Enterprise Producing, Part-Time Proxy Farm Model with APC = .7

	Year								
Scenario[1]	1	2	3	5	10	15	20	25	30
1	80	119	121	160	200	240	280	282	304
2	104	120	160	161	210	240	280	301	320
3	80	119	122	159	200	240	280	282	301
4	108	120	160	162	212	241	280	305	320
5	80	118	120	156	197	230	266	279	309
6	106	120	132	160	200	240	280	288	323
7	80	117	120	155	194	229	264	279	310
8	108	120	131	160	200	240	280	286	323
9	80	114	123	156	202	238	274	280	289
10	106	120	159	166	215	243	281	300	323
11	80	114	124	156	201	240	276	281	293
12	106	120	157	164	211	242	280	300	321
13	80	115	120	148	185	221	254	272	296
14	102	120	137	160	200	238	278	293	327
15	80	113	120	149	184	214	251	272	296
16	104	120	133	160	200	238	276	288	323

[1]See Appendix Table 17.

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