CAPITAL INVESTMENT AND RESOURCE ADJUSTMENTS ON INDIVIDUAL FARMS IN THE OUACHITA HIGHLANDS OF OKLAHOMA

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Submitted to the faculty of the Graduate School of the
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Applied Science in partial fulfillment
of the requirements for the degree of
DOCTOR OF PHILOSOPHY
May, 1961

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HIGHLANDS OF OKLAHOMA

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ACKNOWLEDGEMENTS

I am deeply indebted to Dr. W. B. Back, Graduate Committee Chairman, for encouragement and counsel throughout my graduate program and for supervision and assistance during the preparation of this thesis.

Sincere appreciation is extended Professors Clark Edwards and E. J. R. Booth for their assistance with the mathematics and for many valuable comments and suggestions during this study. I am indebted to the Department of Agricultural Economics for making this study possible.

Appreciation is also extended to the secretarial and statistical staff of the Department of Agricultural Economics, especially to Mrs. Mary Schrick and Mrs. Glenda Pettigrew for typing the earlier drafts, and to Miss Patricia Cundiff for assistance in the data processing.

The writer is indebted to Mrs. Ada Guess for her cooperation in typing the final manuscript.

Finally, special appreciation is due my wife, Norma, and my sons, Gene and John, for their patience and encouragement throughout the graduate program.

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CHAPTER I

INTRODUCTION

The General Problem

The Ouachita Highlands of Oklahoma has been characterized as an area of rural poverty. The counties of Haskell, Latimer, LeFlore, Pittsburg, Pushmataha, and McCurtain were six of the nine Oklahoma counties classified by the United States Department of Agriculture as having "serious" rural low-income levels in 1954.[1] An indication of the "seriousness" of the problem may be gained from an examination of the situation in Latimer county in 1956.

Only about one fourth of the rural residents in the survey of Latimer County were full-time farmers.[2] Less than one fifth of the families were engaged in part-time farming, while the remainder were rural residents not engaged in any farming.[3]

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[1] United States House of Representatives, Congress, 1st Session, Development of Agriculture's Human Resources, United States Government Printing Office, House Document No. 149, Washington, D. C., April, 1955, p. 7.

[2] W. B. Back, Problems of Rural People in Latimer County, (mimeo.), Department of Agricultural Economics, Oklahoma State University, Stillwater, 1957.

[3] Full-time farmers were those with some farming activity, but with less than $800 income from off-farm work. Part-time farmers were those with some farming activity, but with receipt of more than $800 income from off-farm work.

Even though about 45 percent of the families in the survey were engaged in some farming in 1956, only about 18 percent of the total income of all families was from farm sources. The full-time and part-time farmers averaged receiving a net income of only $265 from farms averaging 219 acres in size. Approximately 85 percent of the income from farming was from sales of livestock and livestock products, primarily from cattle. Most of the remainder of the farm income was from field crop sales. Investment in machinery and equipment averaged less than $600 per farm.

Only 17.5 percent of the rural people in the survey were from 16 to 34 years of age in 1956 as compared to 27.2 percent of the rural people in this age interval in the United States in 1950.[4] Of those 21 years of age or older, 33 percent were either partially or totally disabled. Days of employment on own farms averaged 177 days per family during 1956.

That the level of farm sales was more closely related to capital investment than to the amount of land in the farm or the amount of labor available was indicated by the results of a regression analysis of 48 farms in the survey, Appendix Table I. The results also indicate land and labor perhaps were underemployed while insufficient capital was being utilized.[5]

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[4]United States Department of Commerce, Bureau of the Census, "Characteristics of the Population," Census of Population: 1950, Vol. II, Part I, Washington, D. C., 1950, Table 38.

[5]See Appendix A.

Specific Problems

This phenomenon of acute and/or chronic low per capita income in a given rural area can not be attributed to any one particular factor. However, most of the hypotheses advanced as explanations are concerned with the resources (human and/or nonhuman) of the rural residents either directly in terms of amount, quality, and organization, or indirectly in terms of the influence of exogenous factors on the mobility and productivity of these resources.[6] One hypothesis is that values, motives, and knowledge of people in low-income areas differ from those of individuals in other areas.[7] Perhaps such values, motives, and knowledge were not responsible originally for the depressed income.[8] Maybe they came about as an adjustment to the situation.[9] Existence of such values and motives partially reflect the differences between the observed resource use position of low-income farms and resource utilization for maximum economic efficiency. In addition, perhaps these values contribute to perpetuating the low-income situation.

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[6]Cf. W. B. Back, "Economic Disequilibrium and the Low-Income Problem," unpublished paper presented to Southwest Social Science meeting, Dallas, Texas, April, 1957; C. E. Bishop, "Public Policy and the Low-Income Problem," Farm Policy Forum, Vol. 8, No. 4, Iowa State College Press, Ames, 1956, p. 13; J. K. Galbraith, "Inequality in Agriculture Problems and Program," unpublished lecture, Ontario College, Guelph, Canada, November 16, 1956; T. W. Schultz, The Economic Organization of Agriculture, McGraw-Hill Book Company, Inc., New York, 1953, p. 147.

[7]Cf. W. B. Back, "Economic Disequilibrium and the Low-Income Problem," and Bishop, "Public Policy and the Low Income Problem," p. 13.

[8]Ibid.

[9]Ibid.

In general, research conducted in other low-income areas has presupposed individual farmer behavior consistent with profit maximization.[10] Even though the possibility of behavior by the individual farmer consistent with ends other than profit maximization has been recognized, such behavior has not been directly accounted for in the research procedure used.[11]

This study presupposes the possibility of farmer behavior in low-income areas oriented around motives other than profit maximization. That is, the farmers' values and knowledge as well as money income received are considered as factors influencing the utility obtained from a production alternative. Furthermore, the effect of these factors on the farmer's equilibrium position in resource use is believed to be strong enough to warrant their recognition in a model of choice. The results generated by research procedures utilizing models of choice recognizing the farmer's values and knowledge as well as monetary income would be identical to the existing resource use position if all factors and specifications were the same as for the existing situation. However, results identical to the existing resource use position would not necessarily be generated if any of the factors or specifications differed from the existing situation. Hence, such models would permit examination

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[10] Cf. J. Gwyn Sutherland and C. E. Bishop, Possibilities for Increasing Production and Incomes on Small Commercial Farms, Southern Piedmont Area, North Carolina, North Carolina Agricultural Experiment Station, Tech. Bul. 117, December, 1955; and J. Gwyn Sutherland, et. al., An Economic Analysis of Farm and Non-Farm Uses of Resources on Small Farms in the Southern Piedmont, North Carolina, North Carolina Agricultural Experiment Station, Tech. Bul. 138, 1959.

[11] Cf. A. J. Coutu, "Planning of Total Resource Use on Low-Income and Part-Time Farms," Journal of Farm Economics, Vol. XXXIX, No. 5, December, 1957, pp. 1350-1359.

of the effect of variations in the farmer's values and knowledge as well as changes in technology, prices, and costs, or any other variations considered in traditional profit maximization models. In addition, consideration of the farmer's values and knowledge in the model could preclude the possibility of the results indicating a level of resource use differing from maximum utility (as might be the case if only profits were considered). As a consequence of the possibility that farmers' values and knowledge influence choice, the concept of the low-income farmer's problem in this study differs from the usual formulation.

The individual farmer in the Ouachita Highlands area who is interested in increasing farm family income from farm sources is faced with several problems.[12] First of all, the land resource owned by the farmer is probably low in fertility, poorly drained, droughty, erosive, steep, shallow, and/or gravelly.[13] The acid Red-Yellow Podzolic soils of the area were formed from parent materials of shale and sandstone, and, generally, require applications of nitrogen, phosphorus, and potassium for best production.[14] In addition to the generally inferior quality of the land resource, practically no machinery and equipment is owned.

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[12]Interest in increasing farm family incomes and motives other than profit maximization are not inconsistent. For example, the individual may be maximizing utility from the use of his limited resources. However, if with different amounts of resources, higher levels of income and utility could be achieved, the individual would be interested in attaining this higher level of utility.

[13]Fenton Gray and H. M. Galloway, Soils of Oklahoma, Oklahoma State University, Misc. Pub. No. 56, July, 1959, Table 1, p. 54.

[14]Ibid., p. 19.

Given this initial resource situation the three additional problems faced by the farmer seeking higher farm incomes are: (1) to determine possible acceptable alternatives for higher farm incomes and the resource requirements of each alternative; (2) to evaluate these alternatives with respect to the problems associated with (a) acquiring additional resources, if such is necessary, (b) modification in enterprise combinations, where needed, (c) maintaining a sufficient income for farm family living as adjustments proceed; and, (3) to select from among the alternatives considered the one most satisfactory. If there are opportunities for off-farm work, either full time or part time, the farmer is faced with the additional problem of determining the extent to which such opportunity will become a part of his over-all program for providing additional income for the farm family.

Objectives

The first objective of this study was to construct a theoretical model of the utility an individual receives from production alternatives and to account for the behavior indicated by the theoretical model, to the extent possible, in operational models utilizing existing techniques of linear programming.

The second objective was to determine acceptable alternative adjustments in resource use for providing higher farm family incomes on livestock-field crop farms in the Ouachita Highlands area. Within this overall objective, the more specific objectives were: (a) to compare the feasibility of specified opportunities for off-farm income with farm income opportunities with a given labor resource in terms of the effect of such opportunities on resource use and the amounts of each enterprise in the farm operation; (b) to assess the potential of increasing incomes on farms of a given size through increasing yields; (c) to determine the resources required and the enterprise combinations for producing specified higher levels of farm incomes; and, (4) to examine the effect of the equipment situation and variations in the quality of the farm land on the resource requirements and enterprise combinations for specified levels of income.

The third objective was to evaluate the potential for agricultural development from accumulation of assets within agriculture on livestock-field crop farms in the Ouachita Highlands area. Particular attention was to be given to (a) the modifications in enterprise combinations and asset structure as development proceeds over several production periods; and, (b) the potential for accumulating additional capital assets and thereby increasing the income potential while maintaining a sufficient income for farm family subsistence.

The operational models developed and the theory basic to these models will be presented in Chapter II. Chapters III and IV will be concerned with the presentation of results related to the second and third objective, respectively. A summary of the results of the study, accompanied by some general implications, will be presented in Chapter V.

CHAPTER II

THEORY AND MODELS[1]

Much of the literature of economics and other social sciences has been concerned with the motivation of the individual as a social organism. John Stuart Mill stated:

> Political Economy considers mankind as occupied solely in acquiring and consuming wealth; and aims at showing what is the course of action into which mankind, living in a state of society, would be impelled, if that motive, except in the degree in which it is checked by the two perpetual counter-motives... aversion to labor, and desire of the present enjoyment of costly indulgences... were absolute ruler of all their actions.[2]

Wealth was previously defined as all material objects, except those that could be obtained in indefinite quantity without labor.

Marshall assumed that economic activity was motivated by the pursuit of happiness and satisfying human wants but limited by the distaste for labor. Further, the power of goods to satisfy wants might be measured by utility and price would measure the utility to each purchase individually.[3]

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[1]Some of the ideas presented in this chapter were incorporated from W. B. Back and Verner G. Hurt, "Decision Processes for Understanding Capital Use and Investment on Individual Farms," Oklahoma Agricultural Experiment Station, Journal Manuscript No. 557, Stillwater, 1960.

[2]John Stuart Mill, Essays on Some Unsettled Questions of Political Economy, Reprint of Scarce Works in Political Economy, London School of Economics and Political Science, No. 7, Essay V, 1948, p. 138.

[3]Alfred Marshall, Principles of Economics, 8th ed., The Macmillan Company, New York, 1948, Chapter II.

Evolving from the concern with motivations of the individual were attempts to set forth a theory of value and of valuing. Traditionally, most of the attempts to explain and apply the theory of value were generally directed toward the individual as a consumer rather than as a producer of goods. In general, the economic individual was postulated as an organism seeking to maximize satisfaction (utility) by purchasing goods with a given fund available for such purpose.

Traditional theory has recognized that this fund is a product of the individual's resources. Here, the individual is conceived of as an organism seeking to maximize profits from the utilization of the resources which he controls, with profits being measured in terms of monetary units. Hicks states:

> ...the enterprise (the conversion of factors into products) may be regarded as a separate economic unit, detached from the private account of the entrepreneur. It acquires factors, and sells products; its aim is to maximize the difference between their value. In addition to factors acquired on the market, an enterprise may also make use of factors provided by the entrepreneur himself. If these factors are such that they could be sold (if not employed in the business), then their market prices must be debited to the costs of the enterprise. If, however, they cannot be used in any other way than in the business, they do not give rise to costs, and need not (indeed cannot) be reckoned on the debit side of the firms' account.[4]

For many of the factors influencing decisions of management relative to the organization of the production process, monetary costs (market prices) are not established. One such factor, which has long been recognized, is the lack of perfect knowledge.[5]

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[4] J. R. Hicks, Value and Capital, 2nd ed., Oxford University Press, Ames House, London, 1946, p. 79.

[5] Cf. Frank H. Knight, Risk, Uncertainty and Profit, Houghton, Mifflin Company, New York, 1921.

Much of the literature in more recent years has been devoted to attempts to explain the decision processes of the individual in situations where a lack of perfect knowledge exists. Many of these models of choice in economics indicate that ends other than monetary income are related functionally to uncertainty, but become irrelevant in the advent of perfect knowledge.[6] By contrast, the relevance of nonmonetary values independent of uncertainty in explaining the behavior of individuals has received attention in the literature.[7] If these nonmonetary values are relevant in individual business decisions, risk of overemphasis on lack of knowledge is encountered when models of rational choice are used to explain these decisions.

Utility of Production Alternatives

Consideration of a conceptual model developed with the use of the theory of utility may provide some additional insight into some of the problems associated with decision processes and human behavior. Prior to a discussion of some of the specific factors with nonmonetary values which influence the decision of the manager, the model in general form may be specified.

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[6] Cf. Gerhard Tintner, "A Contribution to the Non-Static Theory of Production," in Lange, et. al., Studies in Mathematical Economics and Econometrics, University of Chicago Press, 1941, pp. 92-109; and Albert G. Hart, Anticipations, Uncertainty and Dynamic Planning, Augustus M. Kelley, Inc., New York, 1951.

[7] Cf. John M. Brewster and Howard L. Parsons, "Can Prices Allocate Resources in American Agriculture?" Journal of Farm Economics, Vol. XXVII, No. 4, November, 1956, pp. 938-960; and T. Scitovszky, "A Note on Profit Maximization and Its Implications," Review of Economic Studies, Vol. II, pp. 57-60.

The utility the individual receives from the organization of production may be represented as

$$(2.1) \qquad U = U(V, Y_1, Y_2, \ldots, Y_m, X_1, X_2, \ldots, X_n)$$

where

$$(2.2) \qquad V = \sum_{i=1}^{m} P_{y_i} Y_i - \sum_{j=1}^{n} P_{x_j} X_j$$

and

$$(2.3) \qquad f(Y_1, Y_2, \ldots, Y_m, X_1, X_2, \ldots, X_n) = 0$$

where U is utility, V denotes net monetary income, the Y_i's are physical products, and the X_j's are inputs, both priced and nonpriced.[8] For some X_j such as fertilizer, perhaps the utility associated with all levels of the factor is zero, for $X_j > 0$. For some other $X_j > 0$, for example operator labor, the price of the factor will be zero. Neither of the above conditions would be true for some other factor such as capital, i.e., for such a factor, there may be both price as well as nonprice influences.

If the individual wishes to maximize utility, then a necessary condition is

$$(2.4) \qquad P_{y_i} \cdot \frac{\delta Y_i}{\delta X_j} = P_{x_j} - \frac{\left(\frac{\delta U}{\delta X_j} + \frac{\delta U}{\delta Y_i} \cdot \frac{\delta Y_i}{\delta X_j}\right)}{\frac{\delta U}{\delta V}}$$

for all products Y_i's, and all factors, X_j's. This necessary condition, equation (2.4), is only one of the many conditions which must hold for

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[8]Those factors with an opportunity costs are considered as being priced factors. However, there may also be some non-priced aspects to these factors.

the utility maximizing equilibrium.[9] There may be many levels of output and factor use for which equation (2.4) would be satisfied but where utility would not be the absolute, or over-all maximum, since sufficiency conditions would not be met. However, if utility is an over-all maximum, the necessary condition, equation (2.4), must also obtain. The following discussion is oriented around the effect of variations in the marginal utilities of factors and products on the level of resource use for maximization of utility. Such variations will be examined by use of equation (2.4). Consequently, the discussion presupposes the level of output and resource use when the condition, equation (2.4), obtains will be that for the over-all maximum utility.

The marginal utility of profits, $\frac{\delta U}{\delta V}$, is ordinarily positive. Now consider the case where

$$(2.5) \qquad \frac{\delta U}{\delta X_j} + \frac{\delta U}{\delta Y_i} \cdot \frac{\delta Y_i}{\delta X_j} = 0$$

for all *i* and *j*. Equation (2.4) now becomes

$$(2.6) \qquad P_{y_i} \cdot \frac{\delta Y_i}{\delta X_j} = P_{x_j} \quad .$$

for all *i* and *j*, which is a necessary condition for a profit maximization criterion, i.e., marginal value product equals marginal factor cost.

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[9]For a discussion of necessary and sufficient conditions for equilibrium see R. G. D. Allen, *Mathematical Analysis for Economists*, Macmillan and Company, Ltd., London, 1956, Chapter XIV; J. R. Hicks, pp. 301-303; and Sune Carlson, *A Study on the Pure Theory of Production*, P. S. King and Son, Ltd., London, 1959.

In addition, as the marginal utility of money, $\frac{\delta U}{\delta V}$, equation (2.4) becomes very large relative to the utility of the Y_i's and the X_j's, the term which adjusted for utility approaches zero. Hence, the profit maximization solution as shown in equation (2.6) is approached in the limit.

Suppose that total utility is independent of the level at which the product Y_i is produced, i.e., $\frac{\delta U}{\delta Y_i} = 0$, $Y_i > 0$, and $\frac{\delta U}{\delta X_j} < 0$, $X_j > 0$, while other values of equation (2.4) are the same as for the preceding situation. Such might be the case for operator labor. Now utility is maximized when marginal value product is greater than the price of the factor. Thus, in order to satisfy equation (2.4), an output less than that which maximized profits would be necessary. For those cases where $\frac{\delta U}{\delta X_j} > 0$, for example, pride of workmanship, output which maximized utility would be greater than the profit maximizing level.

To some extent, enterprise preferences may be important in determining the combination of enterprises for the farm organization. For example, an individual might prefer beef cattle to dairy cattle aside from considerations of factor inputs. The necessary condition, equation (2.4) recognizes such enterprise preferences and also reflects the effect on total utility of the complementary or competitive relationships between products, i.e.,

$$(2.7) \qquad \frac{\delta U}{\delta Y_i} = h(Y_1, Y_2, \ldots, Y_m) \qquad (1 \leqslant i \leqslant m)$$

may be the case. If $\frac{\delta U}{\delta Y_i} > 0$, $\frac{\delta Y_i}{\delta X_j} > 0$, in equation (2.4), a larger output would be required for utility maximization than for profit maximization, i.e., utility is maximized when marginal value product is less than the price of the factor. Conversely, for $\frac{\delta U}{\delta Y_i} < 0$, $\frac{\delta Y_i}{\delta X_j} > 0$.

A necessary condition in terms of product substitution may be examined for the products, Y_r and Y_s, $r \neq s$, through transportation of equation (2.4) to

$$(2.8) \qquad P_{y_r} \cdot \frac{\delta Y_r}{\delta X_j} \cdot \frac{\delta U}{\delta V} + \frac{\delta U}{\delta Y_r} \cdot \frac{\delta Y_r}{\delta X_j} = P_{x_j} \cdot \frac{\delta U}{\delta V} - \frac{\delta U}{\delta X_j}$$

and

$$(2.9) \qquad P_{y_s} \cdot \frac{\delta Y_s}{\delta X_j} \cdot \frac{\delta U}{\delta V} + \frac{\delta U}{\delta Y_s} \cdot \frac{\delta Y_s}{\delta X_j} = P_{x_j} \cdot \frac{\delta U}{\delta V} - \frac{\delta U}{\delta X_j}$$

therefore

$$(2.10) \qquad - \frac{\delta Y_r}{\delta Y_s} = \frac{P_{y_s} \cdot \frac{\delta U}{\delta V} + \frac{\delta U}{\delta Y_s}}{P_{y_r} \cdot \frac{\delta U}{\delta V} + \frac{\delta U}{\delta Y_r}} \quad .$$

Now, if $\frac{\delta U}{\delta Y_s} = \frac{\delta U}{\delta Y_r} = 0$, then the necessary condition of equation (2.8) becomes the same as that for a profit maximizing criterion, or

$$(2.11) \qquad - \frac{\delta Y_r}{\delta Y_s} = \frac{P_{y_s}}{P_{y_r}} \quad .$$

If $\frac{\delta U}{\delta Y_s} = \frac{\delta U}{\delta Y_r} \neq 0$, the combination of enterprises for a maximum utility would not necessarily be the same as that for maximum profits. By way of illustration, suppose that $P_{y_s} \cdot \frac{\delta U}{\delta V} = 6$ and $P_{y_r} \cdot \frac{\delta U}{\delta V} = 2$. Now if $\frac{\delta U}{\delta Y_s} = \frac{\delta U}{\delta Y_r} = 2$, the ratio would now equal two rather than three, which results in more Y_s relative to Y_r in the utility maximization than in the profit maximization solution. These results follow from the fact that for $\frac{\delta U}{\delta Y_s} > 0$, $\frac{\delta U}{\delta Y_r} > 0$, as the utility for the products increases relative to the utility of money, the product preference dominates the solution.

One other illustration of the implications of the model may now be given. Suppose that conditions are such that the utility maximizing combination of products coincides with the profit maximizing combination. Now assume that there is an increase in $\frac{\delta U}{\delta Y_s}$ and no change in $\frac{\delta U}{\delta Y_r}$. In order for the utility maximizing equilibrium to be re-established, a greater quantity of Y_s and a smaller quantity of Y_r must be produced provided the products are compliments. For a decline in $\frac{\delta U}{\delta Y_s}$ relative to $\frac{\delta U}{\delta Y_r}$, the converse is true.

Specific Factors Affecting Utility

The above theory indicates that if there are factors other than profits influencing the behavior of farmers, the enterprise combinations and level of resource use for maximum utility differs from that for maximum profits. The remainder of this section will be devoted to a discussion of four factors believed to influence the decisions of farmers in low-income areas. These factors are knowledge, time, effort, and capital requirements. An attempt will be made to defend the proposition that such factors influence the resource use and enterprise combinations on farms in low-income areas and, moreover, as a result of such influence, the level of resource use for maximum utility will be less than that for maximum profits.

The influence of variations in the utility derived from monetary income on the decision processes of the individual is not new in decision models.[10] The degree of knowledge has also received considerable

[10] Cf. Milton Friedman and T. J. Savage, "The Utility Analysis of Choices Involving Risk," AEA Readings in Price Theory, Richard Irwin, Inc., Homewood, Illinois, 1952, pp. 57-96.

attention.[11] Time, effort, and capital, as non-priced factors, have had some attention devoted to them in economics; however, such attention has been small, or nil, in decision models.[12] The major emphasis of this discussion will be on the non-monetary factors. The utility derived from monetary income will be assumed to be independent of the non-monetary factors.

The time dimension used here refers to time preference in production, i.e., in the receipt of income, as compared to time preference in consumption, or in the expenditure of income. An attempt will be made to defend the proposition that an individual's time preference in production can be, and usually is, oriented toward the present regardless of the orientation of time preference in consumption. By way of illustration, suppose that ceteris paribus, the individual has preferences in consumption oriented toward the future, line AB, Figure 1. Now suppose the individual's expected income over time is a constant amount, OC, indicated by line CD.

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[11] Cf. Glenn Johnson, "Learning Processes, The Individual Approach," Proceedings of Research Conference on Risk and Uncertainty in Agriculture, North Dakota Agricultural Experiment Station, Bul. 400, August, 1955.

[12] For example, short-time horizons, moment-in-being, leisure, asset position, desire for less uncertainty, etc., are discussed in the literature as possible explanations of inefficiency in resource use by individuals; however, conceptions of how these values, when considered simultaneously, fit in decision models is not found. Cf. G. L. S. Shackle, Time in Economics, North Holland Publishing Company, Amsterdam, 1958; J. Tinbergen, "The Notion of Horizons and Expectancy in Dynamic Economics," Econometrica, Vol. I, 1933, pp. 247-264; T. Scitovszky, pp. 57-60; Hicks, Part III; Earl O. Heady, Economics of Agricultural Production and Resource Use, Prentice-Hall, Inc., New York, 1952, pp. 540-543.

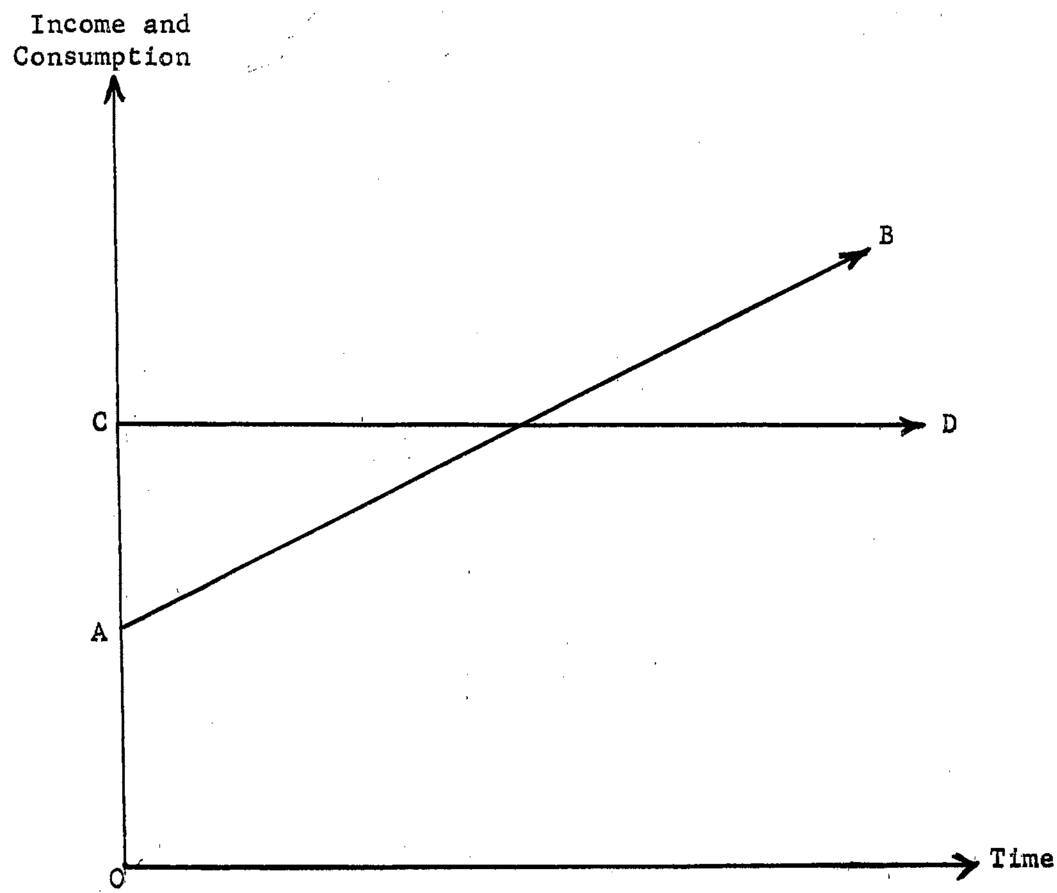

Figure 1. Illustration of Time Preference in Consumption Oriented Toward the Future

Now assume that the individual has an opportunity to modify the time sequence of receipt of income from production. In what direction must it be modified by yield the greatest satisfaction? If such modifications do not result in an increase in the total amount of income over time, then the preferred distribution of income would be less income presently and more in the future. However, opportunities usually exist for investing current income and consequently increasing the total income available for consumption over time, thereby enabling the individual to shift the consumption preference line upward. In such case, it would appear that total satisfaction could be increased by modification of the income stream such that as much as possible would be received presently. If the time preference in consumption is oriented toward the present, as may well be the case for low-income families, time preference in production must also be oriented toward the present. That is, time preference may be more oriented toward the present for production than for consumption, but not less.

Another major reason for the postulated orientation of time preference in production toward the present is that opportunities to decide how to allocate a given income for consumption over time (given uncertainty in future needs in consumption) became more restricted as the receipt of that income is more remote from the present. One would suspect also that there is considerable interdependence between time and the degree of knowledge, i.e., that in most situations the more remote from the present the time considered, the less the degree of knowledge and the greater the uncertainties. Consequently, the greater the likelihood that time preference in consumption, and thus, production, will be oriented toward the present.

Considering the function U = h(T/K), utility will be postulated as decreasing with an increase in time but at an increasing rate, θ_1, Figure 2. This functional relationship will shift with changes in the level of knowledge, (K). As the degree of knowledge decreases, the level of the function will shift as depicted by θ_2.

It is generally agreed that an important element associated with the utility of any object is the physical and mental exertion required to obtain it. Even though these two types of exertion occur differently in various activities, they may be treated as a single variable - effort. Effort, or its opposite, leisure, has received much notice as a contributing factor to the rural low-income problem of the South.[13] The presupposition to such an argument is that southern farmers place higher values upon leisure than their northern counterparts, and this unique value for leisure conflicts with monetary income earning incentives. Regardless of the merit of this hypothesis, effort is a variable in valuing production alternatives for farmers of any income level. If there is increasing disutility associated with additional units of effort required for an alternative in action, unrealistic results may be obtained from our accounting procedures in farm management. When comparing alternatives with unequal requirements in effort, valuing family labor at no cost when underemployed, or at a fixed wage rate, gives greater advantage to the higher labor using alternatives than placed upon such alternatives by farmers. That is, the postulated increasing disutility for

[13]Cf. Bishop, "Public Policy", and Earl O. Heady, Economics of Agricultural Production, pp. 417-422.

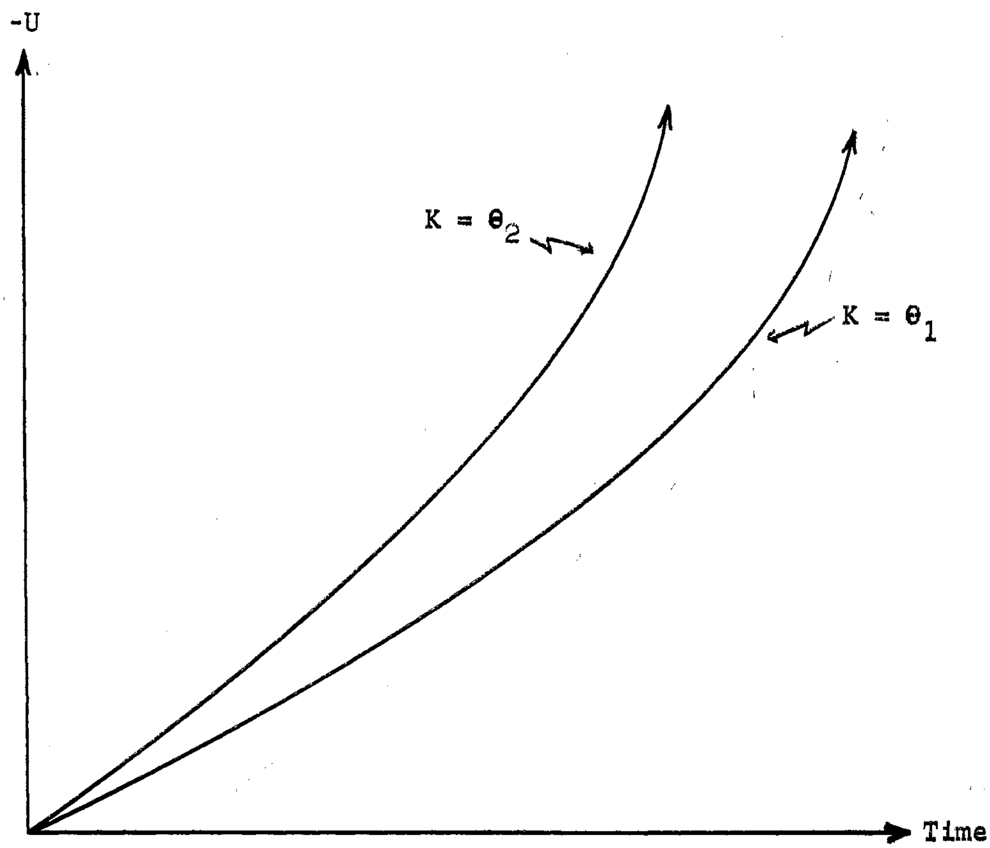

Figure 2. Illustration of Time Preference in Production with with Two Levels of Knowledge

additional effort, implies a supply function for family labor that is upward sloping at an increasing rate. Also, the effort function would be expected to change with change in the level of knowledge. To the extent that the type of work or the degree of exertion (shoveling manure versus plowing) differs between enterprises, there will be some interdependence between the products produced and the disutility of effort. This may be, in part, what is referred to in the literature as enterprise preferences.

The annual monetary costs associated with the stock of capital used are accounted for by equation (2.2). However, there are non-priced aspects of capital considered by individuals in valuation of production alternatives. Reduction in security associated with increased capital use is related to degree of knowledge. There also is discounting for additional capital use in a production alternative for reduction in opportunity to invest in consumption until the capital is replenished by the realization of the consequences of action.[14] This discounting varies with the initial asset position, and it increases as time of realization of the consequences is more remote from the present. Such discounting on the capital dimension may be distinguished from the discounting due to increase in time of receipt of income accounted for on the time dimension. Referred to here, for placement, on the capital dimension, is a discount for worsening of the asset position, as viewed by the

[14] The cost in reference is a non-monetary opportunity cost. Monetary opportunity costs for competing production alternatives are excluded as influential on the parameters of the value-space for particular alternatives in production.

individual, as capital investment increases from a given asset position. The additional discounting with less favorable initial asset position is a premise used in defense of the proposition that low-income farmers with unfavorable asset position must discount the future more than higher income farmers due to the additional pressure of current consumption on resources. This may be true. However, as indicated earlier, such a situation is insufficient for explaining the preference for the present in the receipt of income.

The knowledge dimension, relating to desire for certainty, excludes interdependent effects of knowledge with other sources of utility. However, in conceptualizing the various economic values, the discounting due to lack of knowledge and the discounting due to attitudes independent of uncertainty are distinguished. With knowledge perfect, there would be discounting with increases in time, effort or capital. With imperfect knowledge, any additional discounting on these dimensions as well as on the knowledge dimension, would be attributable to lack of knowledge. If an individual is unaware of an alternative in production, such lack of knowledge accounts for the complete lack of interest in it.

Decision Processes

In the earlier presentation of the utility theory, the necessary conditions derived were for maximization of utility. Serious doubts that the behavior of the individual is maximizing have been raised by several writers. Boulding asserts:

> The reason why the principle of maximization of profits in the firm, and of utility in the household, has produced valuable results is that divergence from the maximand is consciously recognized as a stimulus to action and hence as a force tending to bring the organism back to equilibrium once it has departed from it. In biology, however, and in the equilibrium of many social organisms, the 'maximization of utility' is a purely formal solution, incapable of any interpretive power, because the divergence of the maximand from its maximum value is not an operative force bestirring the organism to change.
>
> It is clear that the concept of an equilibrium position of an organism is a much more general concept than that of a maximum position, particularly if the divergence from equilibrium is related to the dynamic forces which bring about change in the organism. Thus in the case of a labor union it might be quite proper to postulate as an equilibrium not that which maximized a wage bill, or which maximized anything, but that which bore a definite proportion ot some other wage in some other occupation. It might well be that what drives union leaders is the fear of dissatisfaction among their members, and that what creates dissatisfaction is not any absolute level of wages but rather the invidious comparison with the wages of the man next door... It is clear that many such models could be constructed, some of which might prove useful in the interpretation of actual situations, but none of which involved any 'maximizing' except in the most formal and contentless sense... It may well be that the great bulk of human behavior does not follow the patterns of sober, reflective maximization of advantage, but rather follows first the principle of inertia (nobody does anything unless he has to!) and secondly the principle of least resistance (if you have to do anything, you do the thing that is easiest to do!). There is nothing which says that the line of least resistance is the same as the line of greatest advantage except the long, slow retribution of natural selection.[15]

Similar propositions have been advanced by others. For example, Simon had advanced the principle of bounded rationality in an effort to "take account ... of the empirical limits on human rationality, of its finiteness in comparison with the complexities of the world with which

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[15] K. E. Boulding, A Reconstruction of Economics, John Wiley and Sons, Inc., New York, 1950, pp. 36-38.

it must cope.[16] The principle is stated as "the capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problems whose solution is required for objectivly rational behavior in the real world - or even for a reasonable approximation to such objective rationality."[17] In pursuing the idea of bounded rationality and attempting to develop a model incorporating the principle, Simon presents two additional processes of rational decision as follows:[18]

1. (a) "Search for a set of possible outcomes (a subset, S' in S) such that the pay-off is satisfactory (V (s) = 1) for all these possible outcomes (for all s in S').

   (b) "Search for a behavior alternative, (an a in A^o) whose possible outcomes all are in S' (such that a maps upon a set, S_a, that is contained in S')."

2. "Search for a subset S' in S such that V (s) is satisfactory for all s in S' (i.e., $V(s)_{s \in S'} \geqslant k$). Then search for an a in A such that S_a lies in S'."

where A denotes a set of behavior alternatives, A^o ($A^o \subset A$) denotes the considered behavior alternatives; S, the outcomes of choice; V (s) defined for all s in S, the utility of value placed upon each possible outcome; and S_a, the set of outcomes if a is the chosen behavior alternative.

Thus, Simon has postulated the organism as "satisficing" rather than "optimizing". He has applied the principle of bounded rationality in that his procedure does not require the assignment of cardinal utilities to the pay-off functions, V (s), but only that they be satisfactory;

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[16] H. A. Simon, Models of Man, John Wiley and Sons, Inc., New York, 1957, p. 198.

[17] Ibid.

[18] Ibid., pp. 244-252.

i.e., acceptable according to the organism's aspiration level. However, this aspiration level may change over time depending upon the ease or difficulty of discovering satisfactory alternatives and thus tend to bring about a "near uniqueness" of the solution.[19]

The approach taken by Simon suggests that individual farmers are motivated by income goals or targets rather than by optimums, and that these goals or targets fall considerably short of maximum positions of equilibrium. Thus, a target but little above current income levels would not produce the incentive necessary for making major changes in current activities. When motivation by an individual is sufficient to produce activity in search of higher incomes, a search for an appropriate alternative or alternatives for the purpose first gets underway, and the extent of such searching, or learning, depends upon his success in finding acceptable courses of action. If the searching is unsuccessful, the aspiration level, or target, must adjust to the potentialities of the environment to the individual.

Income Targets and Utility

From the preceding, two possible choice criteria are related to two assumptions about motivations: (1) an individual is motivated, continuously, to achieve a maximum utility by his activity, and (2) an individual is motivated toward higher utility positions only in occasional periods when dissatisfaction with current achievement occurs. The first

[19] Ibid., p. 253.

of these two approaches may or may not be consistent with the profit maximization assumption underlying much of economics, and the second approach is inconsistent with that assumption.[20] Either could be consistent with the very wide gap between the resource use position of low-income farmers and the position in resource use consistent with maximum economic efficiency.

The second assumption above is associated with the concepts advanced by both Boulding and Simon. In terms of Boulding's concepts, even though the current position of the individual was different from that position for maximum utility, such difference would not generate an "operative force" sufficient to motivate the individual to change. Such lack of motivation is not necessarily due to lack of knowledge of positions with higher utility as would be the case with Simon's conception.

In terms of the theoretical model presented earlier, equations (2.1)-(2.3), the approach taken by Simon would have the individual farmer motivated by an income goal, say V = V* with V* being some net monetary income less than the maximum possible.[21] Thus, equation (2.2) becomes

$$V^* = \sum_{i=1}^{m} P_{y_i} Y_i - \sum_{j=1}^{n} P_{x_j} X_j \quad . \tag{2.12}$$

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[20]See discussion of utility maximization, p. 11.

[21]This view of behavior is not inconsistent with the propositions that individuals prefer more to less and that they will choose the higher utility-yielding alternative from a mutually exclusive set in perception. The view is that, in an *ex ante* sense, perceptions of "optimum" positions of utility are unknown and unknowable for purposes of action, and the target position is a sort of "subjective optimum".

Now there is an infinite number of enterprise combinations yielding a net monetary income of V* when V* is less than maximum net monetary income. If the same amount of utility is associated with each of these enterprise combinations or if differences are insufficient to motivate the individual to change, than each possible combination is "satisfactory". However, if there are major differences in the associated utilities, then some criterion is required for selecting the organization the individual would consider "most satisfactory". A reasonable criterion would be that the individual would select from those enterprise combinations producing a net monetary income V* the organization yielding the greatest utility.

For such a criterion, the necessary conditions in terms of factor-product and product-product substitution are the same as those of equations (2.4) and (2.10) with the marginal utility of income, $\frac{\delta U}{\delta V}$, replaced by a constant, λ, where $\lambda > 0$. For this case λ denotes the marginal utility of money at the given income level, V*.

The Simon model is a learning model with the knowledge of the individual, i.e., his perception of alternative actions and consequences of actions, being central to the theory. The individual will continue the learning process until sufficient knowledge is gained for achievement of the income goal or until the cost of gaining additional knowledge is greater than the anticipated rewards. If the cost of acquiring additional knowledge is zero, then the individual's ultimate income goal will be the same as that for maximum utility, i.e., the individual will be a "maximizer".[22] For high costs of learning, only one or at most

[22]Cf. Owen H. Sauerlender, "Level of Aspiration and Classical Utility Analysis," unpublished Ph.D. dissertation, University of Minnesota, 1958.

several alternatives would be perceived by the individual as "satisfactory". For other alternatives, the knowledge of the individual would be inadequate and, consequently, their associated utilities would be zero.

Whether or not the conception of behavior advanced by Simon is realistic, the idea of using income targets in farm management analyses of low-income farms may have merit. Such targets chosen for the analysis could provide sets of adjustment alternatives representing ranges in improvements in resource use, although not necessarily the maximum efficiency in resource use.

The utility theory presented earlier also supports the use of income targets. Such support results from the implications of the necessary conditions for utility maximization, equation (2.4). If, as suspected, there are major non-monetary considerations in the valuation of production alternatives by low-income farmers, then the level of income which results in maximum utility would be less than the maximum possible income. Consequently, failure to use capital in amounts sufficient to maximize incomes as well as lags in adopting technical innovations may be related to major non-monetary considerations by the low-income farmers. Even though the targets chosen are below maximum incomes, the approach still has relevance. Few, if any, low-income farmers could be expected to adjust immediately to maximum income positions following publication of research results on how this can be done. Time is required to adjust, and the adjustment process may be in a series of steps.[23] Research

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[23]Cf. Capital accumulation model presented in a later section of this chapter.

results representing less change in present resource use would probably be more acceptable even though in the long run the organization would yield an income considerably higher than the targets used.

The Operational Models

The results of this study were not developed from direct application of the theory of utility presented above. The operational model chosen reflects some of the attributes of utility theory directly and others indirectly.

The major reason for utilizing a model different from that used in presenting the utility theory was the difficulty in obtaining estimates not only of the parameters of the utility function, equation (2.1), but also of the parameters of a non-linear production function, equation (2.3).[24]

The operational model was developed within the general framework of the linear programming technique. The individual was assumed to be seeking to attain some income target, say b_k, from the use of the resources under his control. Let the i^{th} resource controlled by the individual be denoted by b_i, $i \neq k$. Then

(2.13) $$B = (b_1, b_2, \ldots, b_m)$$

is a vector of quantities of the resources and the income target. Now any of the resource utilization and enterprise combinations will be a

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[24]This is not meant to imply that cardinal measurement is required for the utility an individual receives from an alternative in production. It is believed that the individual would only be required to distinguish between the satisfaction received from different alternatives or be indifferent the same as for the traditional utility theory of consumption.

solution of the system

$$(2.14) \qquad AP' \leqslant B' \quad P \geqslant 0$$

where the vector

$$(2.15) \qquad P = (p_1, p_2, \ldots, p_n)$$

denotes the productive processes or enterprises the farmer considers in allocating resources and organizing the farming operation to produce the specified level of income. Here, p_j denotes the level at which the j^{th} productive process is utilized.

Any productive process, p_j, will require some quantity of the i^{th} resource or restraint, b_i, as well as producing net income (positive or negative) in satisfying the income target, b_k. Let this quantity be denoted by a_{ij}. Then

$$(2.16) \qquad A = (a_{ij})$$

is a matrix of size m x n specifying the requirements of each of the resources or restraints by each of the productive processes.

There is an infinite number of combinations of activities, each a solution of the above system, equation (2.13). Consequently, some criterion must be established for selecting a combination. Now there is no reason to suppose that the combination which minimizes the cost of attaining the income target would be the "satisfactory" alternative. However, there is the possibility that the least-cost alternative would be "good enough". The criterion of minimization of the cost of attaining a given income target was selected as an operational procedure for this analysis. Hence, the operational technique will be to minimize the linear cost functional

(2.17) $F = CP'$

subject to the linear restraints, equation (2.16), where vector

(2.18) $C = (c_1, c_2, \ldots, c_n)$

specifies the cost associated with each productive process.[25]

The operational model in the general form specified above does not recognize directly any of the non-priced factors other than the utility of money.[26] However, this model does retain the concept of an

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[25] In terms of continuous functions, with the production function being non-linear, the criterion would be to minimize

$$C = \sum_{j=1}^{n} P_{x_j} X_j$$

where

$$V^* = \sum_{i=1}^{m} P_{y_i} Y_i - \Sigma P_{x_j} X_j$$

and

$$f(Y_1, Y_2, \ldots, Y_m, X_1, X_2, \ldots, X_n) = 0$$

with the necessary conditions being

$$P_{y_i} \frac{\delta Y_i}{\delta X_j} = P_{x_j} (1 + \lambda) \; ; \; \lambda \geqslant 0$$

for all i and j. Hence, the cost-minimization criterion also utilizes the equi-marginal principle; the same principle used in maximization of utility for a given level of income.

[26] If the theoretical model recognized only the utility of money, i.e., the model was

$$U = U(V)$$

$$V = \sum_{i=1}^{m} P_{y_i} Y_i - \sum_{j=1}^{n} P_{x_j} X_j$$

$$f(Y_1, Y_2, \ldots, Y_m, X_1, X_2, \ldots, X_n) = 0$$

then the necessary conditions for maximization of utility would be

$$P_y \frac{\delta Y_i}{\delta X_j} = P_{x_j}$$

for all i and j; the same conditions as for maximum profits.

income target. This use of income targets and other procedures discussed later result in indirect recognition of enterprise preferences and other non-priced factors.

The extent to which the operational model reflects the influence of the priced factors, as well as the utility of money, will be essentially the same for the theoretical model as for the traditional theory of the firm. Comparisons of the concepts of linear programming and the traditional theory of the firm have been presented by others.[27] Consequently, these relationships will not be discussed here. However, one possible application of the linear programming model formulated will be considered. The use of the income target and cost minimization criterion permits the determination of the least-cost combination of resources for a given level of net income. In addition, by choosing successively higher income targets, the expansion path of the firm from some low-income position to the level of resource use for maximum profits can be approximated. For example, consider the firm with <u>OA</u> units of resource b_1 and <u>OB</u> units of resource b_2, Figure 3. Assume that there are three activities, P_1-P_3, with the equal income levels denoted by $I_1 < I_2 < I_3$. The equal cost lines are designated by $C_1 < C_2 < C_3$. For an income target of I_1, the least cost combination of resources would be <u>OG</u> units of b_1 and <u>OH</u> units of b_2. For successively higher incomes, the expansion path would be as indicated by the

[27]Robert Dorfman, <u>Application of Linear Programming to the Theory of the Firm</u>, University of California Press, Berkeley, 1951; Robert Dorfman, Paul A. Samuelson and Robert M. Solow, <u>Linear Programming and Economic Analysis</u>, McGraw-Hill Book Company, Inc., New York, Chaps. 6-7; R. G. D. Allen, <u>Mathematical Economics</u>, Macmilland and Company, Ltd., London, 1957, Chapter 16; and Earl O. Heady and Wilfred Candler, <u>Linear Programming Methods</u>, Iowa State College Press, Ames, 1958, Chapter 2.

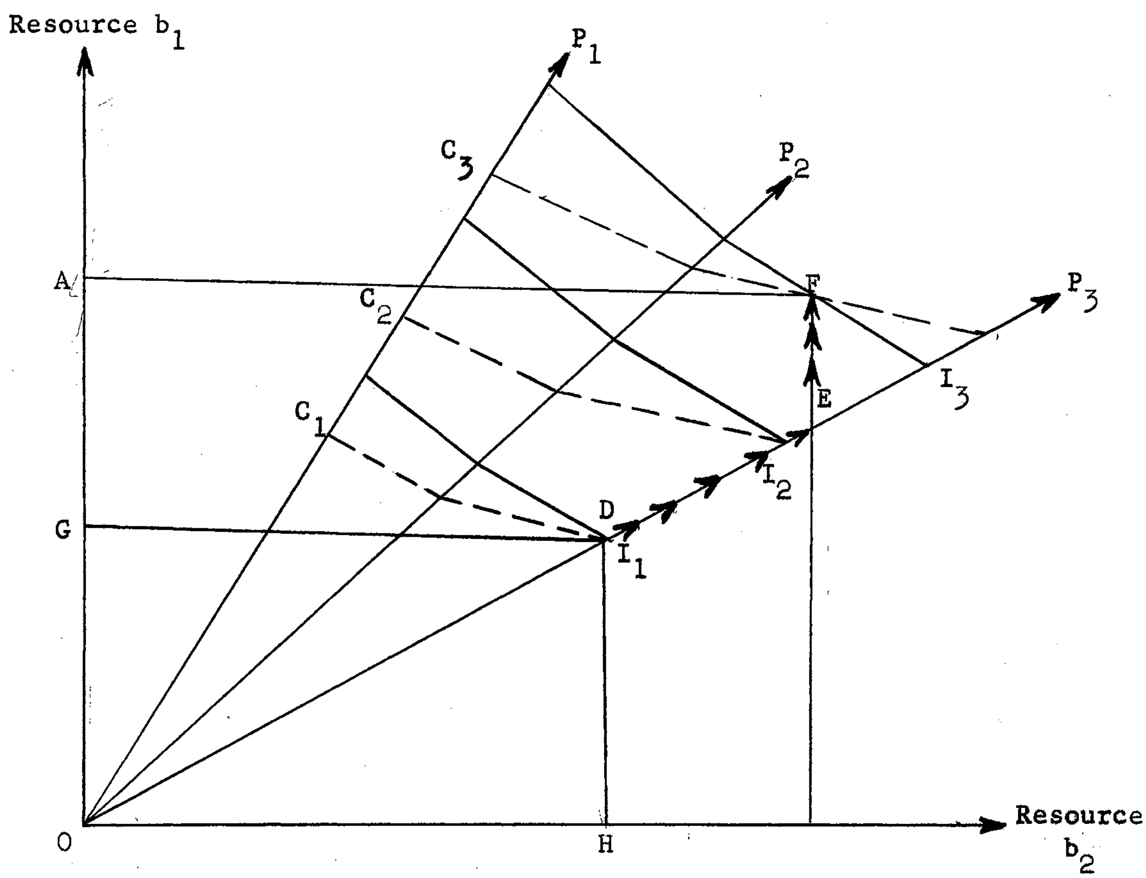

Figure 3. Illustration of Expansion Path with a Linear Model

arrows, line DEF, with point F corresponding to the maximum income from the given quantity of resources.

The extent to which the operational model reflects the influence of the non-priced aspects of factors must now be examined. The input-output coefficients used in the programming problem incorporate, to some extent, consideration of the non-priced aspects of factors by an individual farmer. For example, consider the production function, $Y = F(X_1 \mid X_2)$, Figure 4. The line CAD denotes the ratio between the price of X_1 and the price of Y. Hence, point A represents the level of inputs and resulting output for maximum profits. As was pointed out earlier in this chapter, the level of outputs and of inputs for maximization of utility may be either greater or less than that for maximum profits. It is believed that for farmers in a low-income area the utility maximization output is less than that for maximum profits, say point B. Now both of these combinations of X_1 per unit of X_2 and the resulting level of output may be reflected by the process vectors for the linear programming problem. For example, let V_A, in Figure 5, denote the combination represented by point A and V_B that represented by point B. Hence, choice of V_B as the process vector for the programming problem, to a degree, reflects the influence of the associated disutilities. From an operational viewpoint, choice of input-output coefficients representative of existing conditions in an area, rather than some reflecting experimental results, would be expected to yield more realistic and acceptable results.

Another source of implicit recognition of utility in the operational model is the enterprises or productive processes selected for

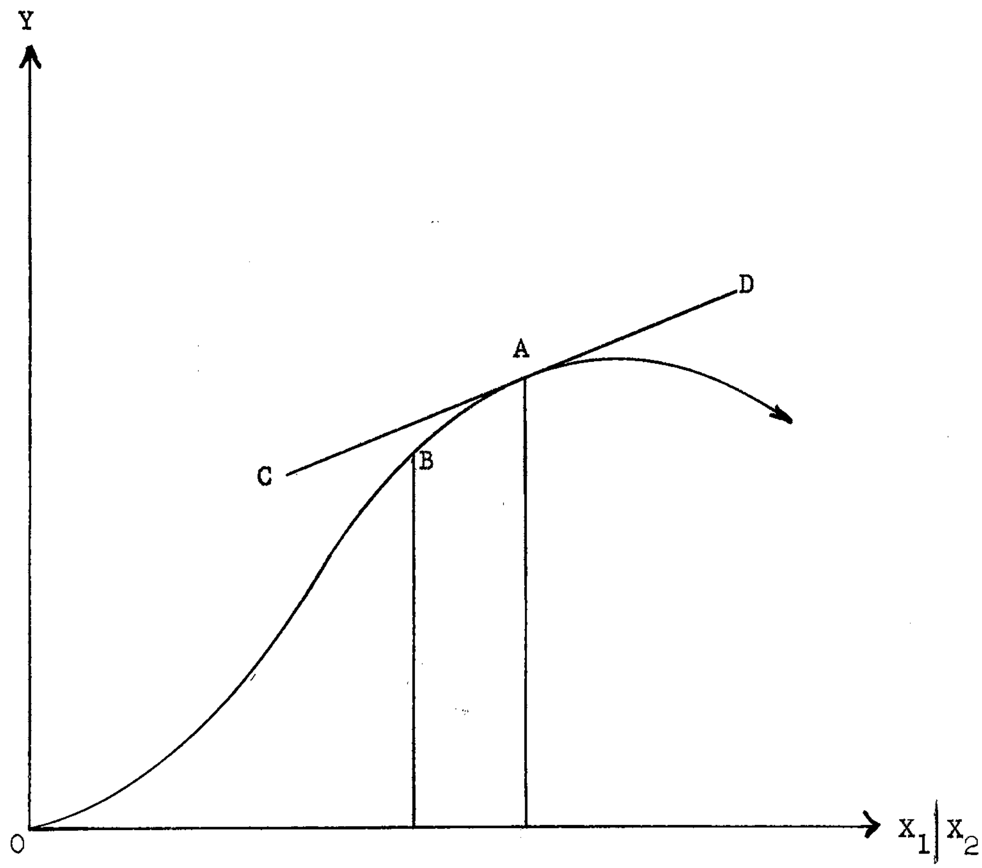

Figure 4. Illustration of Resource Use and Production Below Profit Maximization

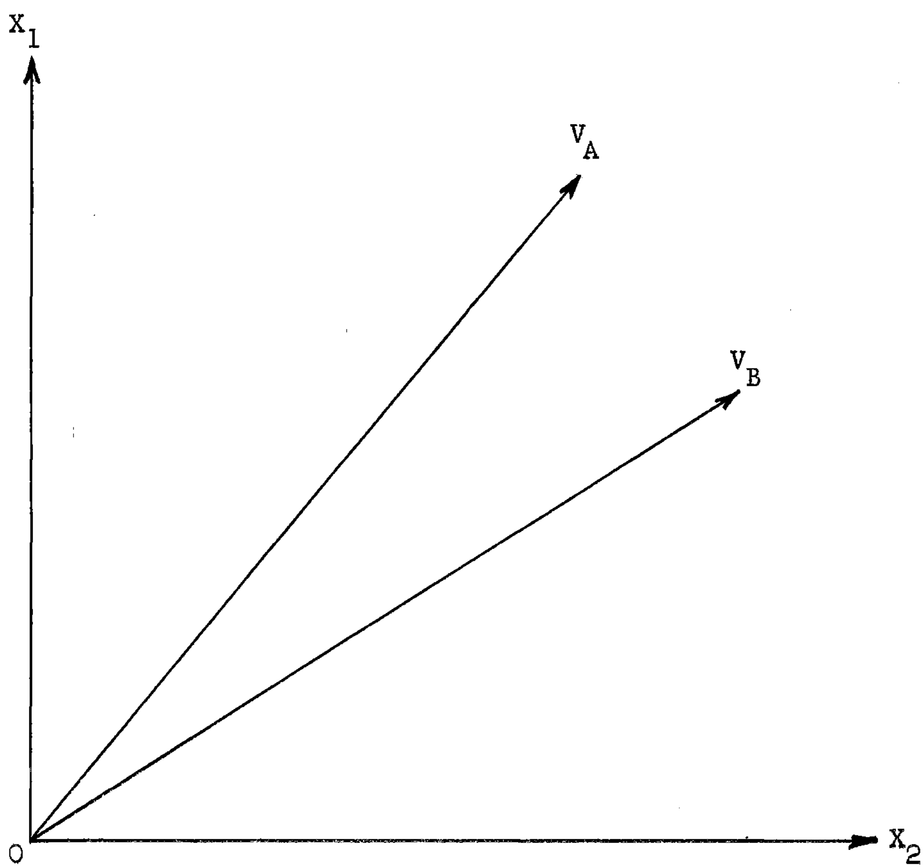

Figure 5. Examples of Process Vectors

consideration. Theoretically, there is an infinite number of productive processes, each different (i.e., that are not linear combinations of the others), from which the farmer must choose a combination to form a farm organization. The application of the linear programming technique requires that some finite number of enterprises be selected for the model. Practical considerations limit this to a relatively small finite number of processes. As a practical matter, many of the infinite number of processes may be excluded on the basis of not being sufficiently different from other activities to warrant consideration. Still other processes may be excluded as being dominated by the remaining activities. However, the activities finally selected for consideration in the model may have been chosen largely on the basis of preferences, implied or otherwise, of the farm operator.[28] Hence, the model contains some implicit consideration of enterprise preferences initially; however, once specified, enterprises are selected for the optimum plan on the basis of costs (returns) only. Empirical results from use of this model are presented in the chapter to follow.

Capital Accumulation

One of the major problems faced by a farm operator in an underdeveloped area is that of accumulating assets sufficient to produce a

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[28]The researcher's perception of alternative activities also limits the range of alternatives considered. Even if profit maximization were the criterion, there is no guarantee that the optimum solution yields the maximum profit possible; only that the optimum combination maximizes profits from the activities considered. There may be some alternative not perceived by the researcher which would increase profits.

higher net income. The problem becomes more difficult with lower initial resources and levels of net farm income. Farmers are also concerned with determining how the farm organization changes from one production period to another as asset accumulation proceeds. Thus more direct consideration of the effects of time as a factor as well as examination of the problems associated with capital accumulation appeared necessary.

Consideration of these factors resulted in the utilization of the general technique in a model similar to that discussed by Loftsgard and Heady.[29] The major difference between their model and the model presented below is the criterion for selecting the optimum combination of resources. The model presented here is based on the cost-minimizing assumption while the Loftsgard-Heady model determines the optimum combination of resources as that which maximizes expected profits.

The Hicksian procedure for dating inputs and outputs was followed for this model. The resource restrictions and restraints for the <u>t</u> different time periods may be denoted by

(2.19) $$B = B^1, B^2, \ldots, B^t)$$

where

(2.20) $$B^k = (B_1^k, b_2^k, \ldots, b_m^k) \qquad (k = 1, 2, \ldots, t)$$

represents the resource restrictions and restraints in the k^{th} time period, with b_1^k denoting the income target.

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[29]Laurel D. Loftsgard and Earl O. Heady, "Application of Dynamic Programming Models for Optimum Farm and Home Plans," <u>Journal of Farm Economics</u>, Vol. XLI, No. 1, February, 1959, pp. 51-62.

Similarly, the available processes may be denoted by

$$(2.21) \qquad P = (P^1, P^2, \ldots, P^t)$$

where

$$(2.22) \qquad P^k = (p_1^k, p_2^k, \ldots, p_n^k)$$

represents the processes considered for the k^{th} time period.

If the level of all processes in the k^{th} time period is independent of the resource restrictions for all other time periods, then the coefficient matrix may be designated by

$$(2.23) \qquad A = \begin{bmatrix} A^1 & 0 & \ldots & 0 \\ 0 & A^2 & \ldots & 0 \\ \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & \ldots & A^k \end{bmatrix}$$

If the process level is not independent, then

$$(2.24) \qquad A = (A^1, A^2, \ldots, A^t)$$

represents the coefficient matrix where A^k will be a sub-matrix of the requirements in all time periods of the processes of P^k.

Hence, the organization of the farm operation during the $\underline{t}$ periods of time will consist of some solution of the system

$$(2.25) \qquad AP' \leqslant B'$$

subject to the restriction that no process will be feasible at a negative level, i.e., that $P_j^k \geqslant 0$.

As indicated previously, the optimum solution will be that which minimizes

$$(2.26) \qquad F = CP'$$

subject to the above restrictions, where

$$(2.27) \qquad C = (C^1, C^2, \ldots, C^t)$$

and

$$(2.28) \qquad C^k = (c_1^k, c_2^k, \ldots, c_n^k)$$

with c_j^k(j=1, 2, ..., n) being the cost associated with the j^{th} productive process in the k^{th} time period.

It is apparent that the model as presented permits consideration of variations in enterprise combinations and the resource situation in different production periods over time. Not so apparent is the recognition of time preference in the receipt of income. Some recognition of such preference was incorporated in the application of the model. Income targets were established at successively higher levels for periods more remote from the initial period, thus implying that an acceptable plan for all periods would have to generate higher net incomes in the future.

The procedure used in specifying the capital borrowing activity for this operational model also recognizes the influence of time preference in the receipt of income. One of the most important factors influencing the feasibility of capital borrowing may well be the time preference orientation of receipt of income toward the present resulting from subsistence requirements of the farm family. If the subsistence requirements for the farm family coincide with the current as well as the future net income, as depicted by line AB, Figure 6; then relatively high net returns are required for capital borrowing to be feasible.[30] For example, consider the capital borrowing activity as specified for the application of the capital accumulation model in

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[30]The concept of lack of investment or actual disinvestment by the individual at sufficiently low levels of income is comparable to formulations of the investment function in the aggregate sense. Cf. Kenneth E. Boulding, Economic Analysis, 3rd. ed., Harper and Brothers, New York, 1955, pp. 294-295.

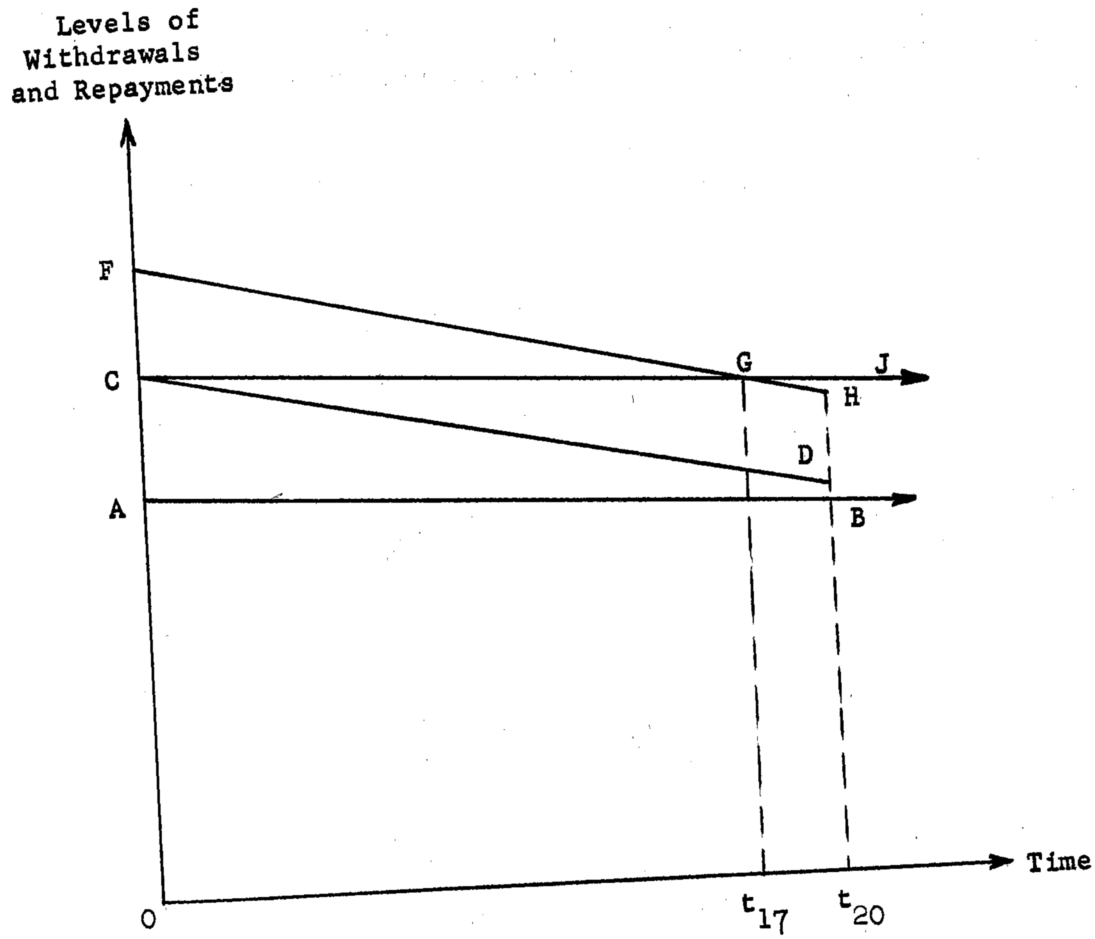

Figure 6. Relation of Schedules of Withdrawals for Consumption and Payments on Loans

this study. The terms of the loan were six percent interest on the unpaid balance with the principal to be repaid in 20 equal annual installments. Now the cost of borrowing (the c_j value) would be only six cents per dollar of unpaid principal in each year. Such implies that in order for capital borrowing to be feasible, additional total income in an amount greater than or equal to the cost must be produced for the entire period of the loan. This additional income is represented by the area ABDC, Figure 6.

Provisions have been made for payment of the annual installments on the principal. Assume the additional income produced by the loan annually is only six percent of the initial principal, as depicted by line CGJ. Further assume that principal repayments amount to CF = DH annually, and the area CDHGF represents total amount borrowed. Since a net income of OA is required for subsistence, and additional income only amounts to AC, total required principal repayment is not provided for until t_{1_j}, after the seventeenth year in this example, when the annual additional income is the same as annual principal repayments plus interest. Thus, for the specified capital borrowing activity to be feasible, additional income produced must at least equal annual principal repayments plus interest charges. Otherwise net income available for family expenditures would be less than that required for subsistence. Under the terms of the loan, additional income would have to be equal to 11 percent of the principal in the first year, 10.7 percent in the second year, 10.1 percent in the third year, etc.

Empirical results from use of this capital accumulation model are presented in Chapter IV. Some operational considerations in use of the model are deferred for discussion in that chapter.

CHAPTER III

RESOURCE ADJUSTMENTS

The trend in the Ouachita Highlands area of Oklahoma has been toward a system of farming organized around an extensive livestock operation, primarily cow-calf enterprises, and related pasture, hay, and feed and cash grain crops.[1] In general, production of cash grain crops has been on a very limited scale.

Farmers in the area who are interested in increasing incomes have four possibilities in adjustment: (1) an increase in the amounts of farm resources, (2) an increase in the productivity of resources used in the same enterprises, (3) an increase in the amount of off-farm work, (4) changes in resource combinations for existing enterprises with present technology, and (5) change to higher income yielding systems of farming, i.e., shift from beef cattle and field crops to enterprises such as dairy, poultry, and/or vegetable or other speciality crops as the main sources of income. Either type of adjustment or some combination of them could result in higher incomes for farm family use.

The fifth alternative, development of new or different enterprises, will not be examined in this study. The question of which of the other four types or combinations of types of adjustment will

[1]Cf. Jimmie J. Gigoux, "Agricultural Development and Production Efficiency in Latimer County, Oklahoma," unpublished Master of Science thesis, Oklahoma Agricultural and Mechanical College, Stillwater, August, 1957, pp. 21-23.

be most acceptable to farmers in the area can not be answered here. However, some indication of the extent to which farm family incomes may be increased by each alternative or combinations of alternatives may be gained from the results presented in this chapter.

The results were obtained from an application of the static linear programming model to different cases selected to reflect the four alternative adjustments. Certain characteristics common to all of the cases examined will be presented next. Following the general specifications of the cases will be a presentation of the results.

General Specifications

The time within a year when receipt and expenditure of income occurred was expected to influence decisions made by the farm operator relative to time of year for working off farm. Generally, income from farming is received from September through November. With sufficient income for subsistence during this period and the months immediately following, off-farm work at this time may be less interesting to the farmer than it would be later, say the following summer. Some recognition of the timeliness of income and expenditures was incorporated in the model used. For all cases with results reported in this chapter, the annual income target was divided into equal quarterly income targets with December-February being the first quarter.[2] In addition,

[2]Operational limitations on the size of the model precluded consideration of more than four income targets.

operating costs had to be financed from receipts or designated income in addition to the income target for the quarter in which the cost occurred. Provisions were made for carryover of income from one quarter to another. Each quarterly income target could be satisfied by either farm or non-farm income or both, depending upon the assumptions for the particular case.

Results of a rural survey conducted by the Department of Agricultural Economics, Oklahoma State University, were used to develop the initial resources and restraints other than proportions of land of each quality for the basic farm unit of the cases examined.[3] For the initial cases the amount of land in the farm was slightly larger than the average size of farm in the survey. The amount of land in each class was determined from estimates of county agricultural workers in the area. The county agricultural workers distinguished four classes of land: (1) the open bottomland formed by alluvial deposits from the small streams, (2) the deeper, more fertile and less steep open upland was termed "good upland", (3) the shallow, steep, stony, less productive open upland was called "poor upland", and (4) all forested land was denoted as "forested upland".

Provisions were made for hiring additional farm labor as needed at the average rate for the area, as determined by the survey, of 65 cents per hour. Off-farm work by the farm operator up to the maximum amount specified for each particular case would yield a return, net of transportation costs, of one dollar per hour.

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[3]Back, Problems of Rural People in Latimer County.

For the farms in the survey, farm family and operator labor available per farm averaged slightly more than the equivalent of one man working full time for one year. For this analysis the farm family and operator labor available was established as one man-year equivalent and was available where required at zero cost. Hours of labor available were computed on the basis of five days of eight hours each per week.

The specific farm enterprises considered were as follows:

(1) A cow-calf enterprise with calves to be dropped in the Spring and sold the following Fall.

(2) A corn enterprise on bottomland and on good upland with the production to be sold rather than fed.

(3) Grain sorghum on both bottomland, and good upland, as a cash crop.

(4) Bermuda-clover pasture on either of the three classes of land; bottom, good upland, or poor upland.

(5) Native pasture on the same land classes as bermuda-clover pasture as well as forested upland.

(6) Prairie hay for feed grown on either bottomland or good upland.

(7) Lespedeza hay for feed grown on either bottomland or good upland.

Other activities considered which are discussed in detail in other parts of this section were off-farm work by the farm operator, hiring farm labor, and borrowing capital.[4]

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[4]The applicability of the results may not be restricted entirely to these activities. Substitutes may be appropriate when resource requirements, costs, and returns are similar to the enterprises considered.

The inputs and outputs for the bermuda-clover pasture activity were determined as the annual average inputs and outputs for this activity over a 12-year period. That is, such inputs and outputs reflect (1) the resource requirements and costs for initial establishment, (2) costs and resource requirements for maintenance within the 12-year period, and (3) the deferred income from loss of grazing during the year of establishment.

Capital for investment in livestock for the initial cases was assumed to be available in an amount equal to the average investment in livestock on farms in the survey of comparable size, unless otherwise specified for a particular case. Such capital was available at zero cost.

In all of the cases examined, production of beef cattle was the only activity requiring investment capital. Consequently, the specification of the activity for borrowing additional investment capital was designed to reflect the terms of credit institutions in the area for intermediate term credit. The borrowing activity permitted additional investment capital to be borrowed at an interest rate of six percent on the unpaid balance. Repayment of principal was to be made in five equal annual installments. Another restriction was that the amount borrowed could not exceed fifty percent of the value of land and buildings at the average value for the surveyed farms of $25 per acre.

Prices received and paid were based on weekly livestock market reports, a series maintained by the United States Department of Agriculture, and a survey of equipment dealers serving the area. Input-output coefficients were developed from a survey of county agricultural workers in the area and from secondary sources. Two sets of input-output data were obtained from the agricultural workers: "average" and "above average". Since all these data apply for tractor and equipment and many farmers in Latimer County use horses or mules and corresponding equipment, the "average" obtained from the agricultural workers is above average for all farmers in the county. A more detailed discussion of sources of data and enterprises considered is contained in Appendix B. Prices used and enterprise budgets are also reported in Appendix B. Input and output coefficients reflecting average management were used for all of the cases except case 221.

Case Results

A number of different cases were examined by use of the static model. The presentation of the results obtained will be organized according to the specific situation for which a given case or set of cases was developed. The situations examined were (1) the effect of variations in the income target on the organization (i.e., the amounts of each enterprise and the resource use) of a farm of a given size, (2) the effect of an off-farm work opportunity on enterprise combinations and resource use, (3) the differences in enterprise combinations and resource use for ownership versus custom hire of machinery and equipment, (4) the effect of increasing yields on enterprise combinations and resource use as well as the income earning potential of a farm of a given size, (5) the resource requirements for producing farm incomes above the $1,878 average family income of rural residents in the survey, and (6) the effect of variations in the quality of land in the farm on the resource requirements for higher net incomes.

The Income Target and Farm Organization: Four cases (101-104) were used to examine the effect of varying the income target on the optimum combination of farm enterprises (i.e., the combination of enterprises resulting from the solution of the model for a particular case).[5] No off-farm work opportunity was permitted in any of these cases in order to confine the effects of varying the income targets to the farm operation. The annual income targets were varied in $200 increments from $400 for case 201 to $1,000 for case 104 (Table I). Other initial restraints were the same for each case.

The least-cost combinations of resources for the specified income targets for cases 101-103 and case 104, the maximum farm income, are indicated in Table II.[6] The number of animal units of beef cattle ranged from 9.2 for case 101 to 18.6 for case 103. For the higher income targets, most of the grazing requirements were furnished by improved pasture as compared to native pasture at the lower income levels. Corn production was excluded for the lower income levels

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[5]The cases with inputs and outputs based on custom hire of machinery and equipment were designated by the digit one in the hundreds position of the case number. The two lower order positions of the case number were used to distinguish between cases. The digit two in the hundreds position of the case number denotes use of owned rates for machinery and equipment. The initial resources and restraints were the same for both equipment situations when the identical digits appear in the same order in the two lower order positions of the case number.

[6]The results obtained from the use of the linear programming technique have been rounded for the tabular presentation. Consequently, incomes greater than or less than the income target are indicated for some of the cases.

TABLE I

INITIAL RESTRICTIONS FOR CASES 101-104

Item	Unit	Amount
Quarterly income target		
Case 101	Dols.	100
Case 102	Dols.	150
Case 103	Dols.	200
Case 104	Dols.	250
Other restrictions, cases 101-104:		
Labor available, Dec.-Feb.	Hrs.	514
Labor available, Mar.-May	Hrs.	525
Labor available, June-Aug.	Hrs.	525
Labor available, Sept.-Nov.	Hrs.	520
Bottomland	Acres	20
Good upland	Acres	60
Poor upland	Acres	40
Forested upland	Acres	118
Maximum capital borrowing	Dols.	3,000
Investment capital	Dols.	3,250
Off-farm work	Hrs.	0

TABLE II

NET INCOME, COSTS, ACTIVITIES, AND CAPITAL AND FARM LABOR REQUIRED FOR CASES 101-104

Item	Unit	Amounts for Case Number			
		101	102	103	104
Net farm income	Dols.	400	600	808	996
Operating costs	Dols.	387	690	1,168	1,488
Net farm return per dollar of operating cost	Dols.	1.03	.87	.68	.67
Enterprises:					
Beef cattle	A.U.	9.2	15.1	18.6	18.3
Bermuda-clover, bottomland	Acres	0.0	20.0	11.6	0.0
Bermuda-clover, good upland	Acres	0.0	6.4	25.2	25.7
Bermuda-clover, poor upland	Acres	0.0	0.0	28.4	40.0
Corn, bottomland	Acres	0.0	0.0	8.4	20.0
Native pasture, bottomland	Acres	6.2	0.0	0.0	0.0
Native pasture, good upland	Acres	60.0	25.3	0.0	0.0
Native pasture, poor upland	Acres	26.4	40.0	11.6	0.0
Native pasture, forested upland	Acres	118.0	118.0	118.0	118.0
Prairie hay, bottomland	Acres	13.8	0.0	0.0	0.0
Prairie hay, good upland	Acres	0.0	28.3	34.8	34.3
Total investment[a]	Dols.	7,610	8,642	9,255	9,202
Farm labor required	Hrs.	71	117	143	141
Idle land	Acres	13.6	0.0	0.0	0.0

[a]Investment in land and buildings, livestock, and machinery and equipment.

(cases 101 and 102) but it was an enterprise for the higher income levels (cases 103 and 104).

Labor requirements for each case ranged from 71 hours (case 101) to 143 hours (case 103). The highest total investment in land and buildings and livestock of $9,255 was required for case 103.

The case results presented in this section were developed to provide an indication of the effect of varying the income target on the enterprise combinations and resource use. These results indicate that attainment of the higher income targets would require an increase in the improved pasture and corn enterprises relative to beef cattle as well as an increase in the size of the beef enterprise. For income targets nearer the maximum farm income of about $1,000, corn on bottomland would substitute for improved pastures on bottomland. Labor requirements for all cases were low. This was due in part to the equipment being hired at custom rates. With custom hire, labor required for operating the machinery and equipment was also furnished. For cases 101-104, 89 to 97 percent of the labor available was unused in the operation of the farm.

<u>Off-Farm Work and Farm Organization</u>: Five cases (105-109) were used to examine the effect of variations in opportunity for off-farm work on the enterprise combinations and resource use for a farm of a given size. For the cases examined, acres of each type of land, labor, and capital available initially were the same as for cases 101-104.

Income targets were varied in $600 increments from $800 for case 105 to $3,200 for case 109 (Table III). The amount of off-farm work permitted also varied in 400 hour increments from 400 hours for case 105 to 1,600

TABLE III

INITIAL RESTRICTIONS, NET INCOME AND LABOR UTILIZATION FOR CASES 105-109

Item	Unit	Amounts for Case Number				
		105	106	107	108	109
Initial restrictions:						
Annual income target	Dols.	800	1,400	2,000	2,600	3,200
Off-farm work	Hrs.	400	800	1,200	1,600	2,084
Net income:						
Farm	Dols.	400	600	808	996	904
Non-farm	Dols.	400	800	1,200	1,600	2,084
Total	Dols.	800	1,400	2,008	2,596	2,988
Labor utilization:						
Farm labor	Hrs.	71	117	143	141	141
Work off-farm, Dec.-Feb.	Hrs.	0	0	209	462	514
Work off-farm, Mar.-May	Hrs.	0	479	479	479	525
Work off-farm, June-Aug.	Hrs.	400	321	512	512	525
Work off-farm, Sept.-Nov.	Hrs.	0	0	0	147	520
Hire farm labor	Hrs.	0	0	0	0	141
Total operator labor used	Hrs.	471	917	1,343	1,741	2,084

hours for case 108 and then to 2,084 hours, the total amount of labor available, for case 109. These variations in the income targets and off-farm work opportunity were used to examine not only the feasibility of different levels of off-farm work for achieving higher family income, but also the influence of the pressure of higher income targets on the least-cost combination of resource.

Off-farm work by the farm operator up to the maximum allowed was an activity in the optimum plan for each of the cases (Table III). For the lower levels of off-farm work, the work generally occurred in the second and third quarters, while for the higher levels, the work was distributed about equally through all quarters. Since income from the farm operation was received in the fourth quarter, September-November, the lowest incidence of off-farm work was indicated for this quarter. The income target was not attained in case 109, but it was attained in all other cases. The net income of $2,988 for case 109 was the maximum income from a combination of farming and off-farm work. For this case, full-time work off farm by the farm operator was indicated. Hence, all labor required for operation of the farm was hired.

Farm enterprise combinations and resource use for cases 105-108 were the same as for cases 101-104, respectively (Table II). The farm organization for case 109 was also the same as for case 104. The differenc of $92 in net farm income between cases 104 and 109 was due to differences in amount of hired labor between these cases.

The nature of the substitution relation between working off farm and the production of row-crop enterprises can be inferred from the results. For example, for a given income target, an increase in the opportunity for off-farm work would have resulted in a lower requirement for income from farm sources. Hence, as the off-farm work opportunity would increase, the acres of corn in the optimum solution would decline. Further, as successively higher levels of off-farm work occurred, native pasture would substitute for improved pasture, and returns per dollar of operating cost would increase.

The effect of the amount of off-farm work by the farm operator on resource combinations and enterprises has been examined in this section. The case results presented indicate that off-farm work by the farm operator up to the maximum amount permitted would be a feasible alternative when combined with the different farm organizations for producing farm family incomes higher than the average income from all sources per farm family in the survey. In addition, the lower income targets of say, $1,800, could be attained with 1,200 hours of off-farm work and a farm organization consisting of extensive enterprises (Table II).

Owned Versus Custom Hiring of Machinery and Equipment: In general, very little machinery and equipment is utilized or owned by farmers in the Ouachita Highlands area. Some justification for this lack of ownership of machinery and equipment is indicated by the case results presented in this section.

The same initial restrictions as for case 104 were used for the analysis. However, the costs and returns of the activities considered and other input-output coefficients were for ownership of all equipment other than specialized machinery for harvesting and bermuda sprigging. In addition, machinery depreciation charges of $553 were added to the $1,000 annual income target of case 104 (Appendix Table V).

For case 204, the maximum income from the farm operation amounted to $1,432. This income, net of depreciation for machinery and equipment, would be $879. About the same number of animal units of beef were included in the farm organization for case 204 as for case 104 (Table IV). The difference in the two organizations was a shift in part of the acreage in prairie hay to lespedeza hay. Consequently, the hay requirements of the beef enterprise were produced on a slightly smaller acreage for case 204.

With custom hire of machinery and equipment, all labor required for the operation performed is usually hired. The costs of custom hire include the cost of such labor. Consequently, case 204 required 467 hours of farm operator labor, as compared to 141 hours for case 104, or a difference of 326 hours. Hence, to the extent that the disutility of effort influences the acceptability of the results, ownership of machinery and equipment would be even less satisfactory. Such also would be expected for farm organizations yielding incomes of less than the maximum. However, on the basis of the results of cases 101-104, custom hiring of equipment would require less labor per dollar of net income and perhaps, therefore, would be more satisfactory than ownership of equipment.

Results for case 210 were obtained by making one modification in the initial restrictions of case 204 - the capital restriction was changed to permit borrowing for investment in livestock at zero cost (Table IV). This modification resulted in an increase in the size of the beef cattle enterprise by about two animal units. Other resource use changes were an increase in the acreage of improved pasture and a

TABLE IV

NET INCOME, COSTS, ACTIVITIES, AND CAPITAL AND FARM LABOR REQUIRED FOR CASES 204 AND 210

Item	Unit	Amount for Case Number	
		204	210
Net farm income	Dols.	879	884
Operating costs	Dols.	1,075	1,237
Returns per dollar of operating costs	Dols.	.82	.72
Enterprises:			
Beef cattle	A.U.	18.6	20.5
Bermuda-clover, good upland	Acres	26.9	34.3
Bermuda-clover, poor upland	Acres	40.0	40.0
Corn, bottomland	Acres	20.0	20.0
Corn, good upland	Acres	0.0	0.0
Prairie hay, good upland	Acres	29.8	0.0
Lespedeza hay, good upland	Acres	3.3	25.7
Native pature, forested upland	Acres	118.0	118.0
Total investment[a]	Dols.	16,169	16,501
Farm labor required	Hrs.	467	553

[a]Investment in land and buildings, livestock, and machinery and equipment.

reduction in the total acreage used for hay. This reduction in hay acreage was possible because of the higher yields per acre obtained from lespedeza for hay. Even though the size of the livestock enterprise increased, net farm income increased only about six dollars. At the same time, an increase of approximately $332 in investment in livestock and 86 hours in the amount of labor required was necessary. With no cost for additional operator labor, net returns to additional investment were at a rate of 1.5 percent.

In summary, the objective of this section was to examine enterprise combinations and resource use when equipment was owned as compared with custom hire of equipment. The results presented for the two cases indicate lower maximum net returns for owned as compared with hired equipment. Enterprise combinations differed little between equipment situations. The beef cattle enterprise was slightly larger and some lespedeza hay was produced when equipment was owned as compared to no lespedeza hay production with custom hire of equipment. In addition, labor required for operation of the farm was considerably higher with ownership of equipment. The results also indicated that perhaps ownership of equipment would not be preferred to custom hire for the farm situations programmed if there is disutility for operator and family effort or if high net returns per dollar invested are expected.

Net Farm Income and Higher Yields: Case 221 was developed in order to examine the effect of increasing yields on the amount of net farm income. Inputs and outputs for this case were those of above average management as reported by county agricultural workers in the area (Appendix Table XIV). The same initial restrictions and restraints as for case 204 were used for this case except for a higher income target - $1,600 net of depreciation.

A maximum net farm income of $1,374 was obtained for this case (Table V). Thus, the change in yields from average to above average resulted in an increase in net income of $495.

The optimum combination of enterprises for this case, as compared with cases 204 and 210, consisted of a larger corn enterprise and a smaller beef enterprise. Farm labor required increased by 70 hours over case 210 while investment required for livestock declined slightly over $1,000.

The shift of resources from the beef enterprise to corn production with an increase in yields of corn does not imply that the returns per dollar of operating costs were greater for corn than for beef. Some evidence that the converse was true is reflected by lower returns per dollar of operating costs for this case as compared to the other two cases (cases 204 and 210, Table IV). The increase in the size of the corn enterprise at the expense of beef cattle was due to a higher net return for corn per unit of the limiting resources.

The results for case 221 indicate a higher net farm income than that of the previously discussed cases incorporating the assumption of custom hiring of machinery. However, labor requirements were 482 hours greater for this case than for case 104. Due to the higher total investment including machinery and equipment, returns to investment were less for this case than for case 104 (Table II).

Only this one case was used to examine the effect of higher yields on the farm organization. Although the net farm income for this case

TABLE V

NET INCOME, COSTS, ACTIVITIES, AND CAPITAL AND FARM LABOR REQUIRED FOR CASE 221

Item	Unit	Amount
Net farm income	Dols.	1,374
Operating costs	Dols.	2,119
Returns per dollar of operating costs	Dols.	.65
Enterprises:		
Beef cattle	A.U.	14.6
Bermuda-clover, good upland	Acres	0.0
Bermuda-clover, poor upland	Acres	40.0
Corn, bottomland	Acres	20.0
Corn, good upland	Acres	41.8
Prairie hay, good upland	Acres	0.0
Lespedeza hay, good upland	Acres	18.2
Native pasture, forested upland	Acres	118.0
Total investment[a]	Dols.	15,469
Farm labor required	Hrs.	623

[a]Investment in land and buildings, livestock, and machinery and equipment.

was over 50 percent higher than that for case 204, it was still below the average income from all sources of families in the survey.

Resource Requirements for Higher Farm Incomes: The resources available initially for all of the preceding situations were not sufficient for producing incomes above the average income from all sources for families in the survey except in combination with an off-farm work opportunity. The remaining alternative for higher farm incomes with the livestock-field crops system of farming mentioned earlier was increasing the resources controlled by the farmer.

Six different cases, three with owned equipment (cases 211-213) and three with custom hire of equipment (cases 111-113) based on three different farm sizes, were programmed in order to examine the resource requirements for different levels of net farm income. The size of the three farms used were 640, 720, and 860 acres with other limiting resources and restraints except operator labor in the same proportions but at a higher level than for case 104 (Table VI). The amount of labor available was not increased for these cases. Farms of the above sizes were selected for two reasons. First of all, the previous results indicated that farms of these sizes would be required to produce the higher incomes, and second, it was believed that better comparisons between case situations could be made with farms of specific sizes.

The income targets used for these cases and for all of the cases in the following section were higher than the average income of families in the survey. How much higher these targets should be is arbitrary. For cases 111-113, an income target of $3,000 was selected. Income

TABLE VI

INITIAL RESTRICTIONS FOR CASES 111-113

Item	Unit	Amount for Case Number		
		111	112	113
Quarterly income target	Dols.	750	750	750
Labor available, Dec.-Feb.	Hrs.	514	514	514
Labor available, Mar.-May	Hrs.	525	525	525
Labor available, June-Aug.	Hrs.	525	525	525
Labor available, Sept.-Nov.	Hrs.	514	514	514
Bottomland	Acres	53	60	72
Good upland	Acres	160	180	205
Poor upland	Acres	107	120	153
Forested upland	Acres	318	358	428
Maximum capital borrowing	Dols.	8,000	8,000	8,000
Investment capital	Dols.	8,665	9,750	11,650
Off-farm work	Hrs.	0	0	0

targets for the other cases will be presented in conjunction with the discussion of the case results.

The results obtained for cases 111 and 112 are shown in Table VII. The income target was not attained for case 111, but was almost reached for case 112. The results for these two cases consist of enterprises and resource use in the same proportions but at a larger scale than for case 104 discussed in an earlier section. In other words, these two cases are linear expansions of case 104. The results and limiting resources of other cases presented in prior sections could be multiplied by some expansion factor to provide resource requirements for producing a specified level of income. However, such expansion would not permit variations in the amounts of resources used to produce a specified net income. Stated differently, for a given bundle of resources, income targets differing from the maximum income by various amounts would not be reflected by the linear expansion of the results of a particular case. Certainly such linear expansions would be appropriate in some instances. However, in order to make comparisons between equipment situations in this section and between variations in land quality in the next section based on farms of a specific size, none of the results for the following cases were computed as linear expansions.

The results for case 113 indicate that the income target of $3,000 was attainable on an 860-acre unit (Table VII). The enterprise combinations for this case consisted of less corn, more hay, and more native pasture relative to beef cattle and improved pasture than for cases 111 and 112.

TABLE VII

NET INCOME, COSTS, ACTIVITIES, AND CAPITAL AND FARM LABOR REQUIRED FOR CASES 111-113

Item	Unit	Amounts for Case Number		
		111	112	113
Net farm income	Dols.	2,650	2,987	3,006
Operating costs	Dols.	3,967	4,463	3,785
Net farm returns per dollar of operating costs	Dols.	.67	.67	.79
Enterprises:				
Beef cattle	A.U.	48.8	54.9	67.0
Bermuda-clover, bottomland	Acres	0.0	0.0	48.8
Bermuda-clover, good upland	Acres	68.4	77.1	80.2
Bermuda-clover, poor upland	Acres	107.0	120.0	40.9
Corn, bottomland	Acres	53.0	60.0	23.2
Native pasture, poor upland	Acres	0.0	0.0	112.1
Native pasture, forested upland	Acres	318.0	358.0	428.0
Prairie hay, good upland	Acres	91.6	102.9	124.8
Total investment[a]	Dols.	24,540	27,607	33,225
Farm labor required	Hrs.	376	423	513

[a]Investment in land and buildings, livestock, and machinery and equipment.

The extent to which additional land andinvestment in livestock substituted for operating costs is revealed from a comparison of the results of cases 112 and 113. If land were valued at the average value for the surveyed farms of $25 per acre, the value of assets for case 113 was $5,618 greater than for case 112, while operating costs was $678 lower. Hence, for each additional dollar of capital invested, operating costs were reduced by about 12 cents.

The same initial restrictions as for the above three cases were used in the analysis for ownership of machinery and equipment. One difference was that an annual income target of $3,500 was specified for these cases. This specification was made in order to include machinery and equipment depreciation charges as part of the target above the approximately $2,950 net income for farm family expenditures. The $2,950 income target was only slightly lower than the maximum income from the 720-acre farm when equipment was custom hired.

The income target assumed for these three cases (211-213) was in all instances below the maximum net income that could have been obtained. Expansion of the results for case 204 indicates that net incomes of $3,265, $3,742, and $4,578 could have been obtained from the resources of cases 211-213, respectively. Thus the $3,500 income target, including equipment depreciation, was attainable on each of the three case farms. The optimum farm organizations and the net incomes exclusive of depreciation charges are shown in Table VIII. Some third-quarter labor would have had to be hired for cases 211 and 213. In addition, there was about 51 acres of idle land in the optimum organization of case 213. In all of these cases, capital required was less than that initially available.

TABLE VIII

NET INCOME, COSTS, ACTIVITIES, AND CAPITAL AND FARM LABOR REQUIRED FOR CASES 211-213

Item	Unit	Amount for Case Number		
		211	212	213
Net farm income[a]	Dols.	2,949	2,953	2,961
Operating costs[b]	Dols.	2,464	2,295	2,151
Net farm returns per dollar of operating costs	Dols.	1.20	1.29	1.38
Enterprises:				
Beef cattle	A.U.	41.3	35.6	32.6
Bermuda-clover, good upland	Acres	82.6	44.1	0.0
Bermuda-clover, poor upland	Acres	29.9	0.0	0.0
Corn, bottomland	Acres	53.0	60.0	62.6
Native pasture, good upland	Acres	0.0	69.1	155.6
Native pasture, poor upland	Acres	77.1	120.0	101.7
Native pasture, forested upland	Acres	318.0	358.0	428.0
Prairie hay, bottomland	Acres	0.0	0.0	9.4
Prairie hay, good upland	Acres	77.4	66.8	49.4
Hire third quarter labor	Hrs.	17.8	9.1	0.0
Total investment[c]	Dols.	31,891	31,144	34,119
Farm operator labor required	Hrs.	1,072	1,048	977
Idle land	Acres	0.0	0.0	51.3

[a]Income net of operating costs and depreciation charges.

[b]Does not include depreciation on equipment.

[c]Includes land and buildings, livestock, and machinery and equipment.

Operating costs exclusive of depreciation charges were considerably lower for cases 211-213 than for cases 111-113; consequently, returns per dollar of costs were higher. However, the hours of farm operator labor required in the least-cost combination of enterprises of cases 211-213 was considerably higher than for cases 111-113.

Some important differences in least-cost combinations of enterprises occurred between the two classes of cases for increasing the size of farm. For the cases with owned equipment, the size of the beef cattle enterprise declined as the size of farm increased; the opposite relation existed for the cases with custom hiring of equipment. Further, the size of the corn enterprise increased slightly as size of farm increased for cases 211-213, but declined for cases 112-113. Hence, with owned rates for equipment, corn was in a more favorable position relative to beef cattle than when equipment was hired. One feature of both classes of cases was the same - the proportion of total land in improved pasture declined as the size of the farm increased.

In summary, the results presented in this section indicate that net farm incomes of $2,600 to $4,600 could be attained with resources consistent with the three case farm units of 640, 720, and 860 acres. For a given size of farm, the pressure on resources for attainment of a specified net income was less when equipment was owned than with hired equipment. However, farm operator labor requirements were higher with owned than with hired equipment. Hence, to the extent that disutilities associated with additional effort are important to the farm operator, ownership of equipment would be less desirable than indicated by the comparison of net incomes.

Quality of Land and Net Farm Income: The proportions of land in each of the four classes differs among farms in the Ouachita Highlands. Some indication of the effect of variations in the proportion of land in each class on the least-cost combination of resources is provided by an analysis of three situations for farm sizes of 640 and 720 acres. The initial restrictions for the cases with custom hiring of all machinery and equipment, cases 114-119, are presented in Table IX. These same initial restrictions and owned rates for equipment were used for cases 214-219. For all cases with custom hire of equipment, an annual income target of $2,950 was used. This was slightly less than the maximum attainable. For the cases with ownership of machinery and equipment, the income target, including depreciation charges, was $3,500, or a net income for farm family expenditures of approximately $2,950.

Results for cases 114-119 disclose considerable differences in the least-cost combination of enterprises and net incomes associated with variations in the proportion of land in each class (Table X). For the situations with the absence of good upland or bottomland as an initial assumption, the income target was not reached for either farm size. Apparently an income greater than the income target could have been attained for either size of farm when poor upland was excluded by initial restriction, cases 118-119.

Since the net income for cases 116 and 117 was the maximum attainable, the proportions of each enterprise were the same for both. Such was not true for cases 118 and 119. The enterprises of case 119 were more extensive and yielded a higher return per dollar of operating costs than for case 118.

TABLE IX

INITIAL RESTRICTIONS FOR CASES 114-119

Item	Unit	Amount for Case Number					
		114	115	116	117	118	119
Quarterly income target	Dols.	737.50	737.50	737.50	737.50	737.50	737.50
Labor available, Dec.-Feb.	Hrs.	514	514	514	514	514	514
Labor available, Mar.-May	Hrs.	525	525	525	525	525	525
Labor available, June-Aug.	Hrs.	525	525	525	525	525	525
Labor available, Sept.-Nov.	Hrs.	520	520	520	520	520	520
Bottomland	Acres	107	120	0	0	80	90
Good upland	Acres	0	0	200	225	240	270
Poor upland	Acres	213	240	120	135	0	0
Forested upland	Acres	318	358	318	358	318	358
Maximum capital borrowing	Dols.	8,000	8,000	8,000	8,000	8,000	8,000
Investment capital	Dols.	8,665	9,750	8,665[a]	9,750[a]	8,665[a]	9,750[a]
Off-farm work	Hrs.	0	0	0	0	0	0

[a]Additional capital could be borrowed at zero cost up to the limit specified.

TABLE X

NET INCOME, COSTS, ACTIVITIES, AND CAPITAL AND FARM LABOR REQUIRED FOR CASES 114-119

Item	Unit	Amount for Case Number					
		114	115	116	117	118	119
Net farm income	Dols.	1,821	2,042	2,054	2,311	2,953	2,960
Operating costs	Dols.	3,102	3,479	2,891	3,253	4,229	3,798
Net farm returns per dollar of operating costs	Dols.	.59	.59	.71	.71	.70	.78
Enterprises:							
Beef cattle	A.U.	0.0	0.0	57.9	65.1	51.0	68.6
Bermuda-clover, bottomland	Acres	0.0	0.0	0.0	0.0	18.6	70.5
Bermuda-clover, good upland	Acres	0.0	0.0	91.5	102.9	144.4	132.2
Bermuda-clover, poor upland	Acres	0.0	0.0	120.0	135.0	0.0	0.0
Corn, bottomland	Acres	107.0	120.0	0.0	0.0	61.4	19.5
Native pasture, good upland	Acres	0.0	0.0	0.0	0.0	0.0	9.2
Native pasture, forested upland	Acres	0.0	0.0	318.0	358.0	318.0	358.0
Prairie hay, good upland	Acres	0.0	0.0	108.5	122.1	95.6	128.6
Total investment[a]	Dols.	16,000	18,000	26,132	29,392	24,925	30,005
Farm labor required	Hrs.	0	0	446	502	400	513
Idle land	Acres	531	598	0	0	0	0

[a]Includes land and buildings, livestock, and machinery and equipment.

In all of the above cases, ownership of some, if not all, of the necessary machinery and equipment would be expected to reduce the cost of attaining the income target. Actually, for some of the cases, ownership of equipment could result in attainment of income targets not realized when the machinery and equipment were hired. In addition, inclusion of a hay buying activity would be expected to facilitate the attainment of the income target for the situations without good upland or bottomland.

The results obtained for cases 214-219 indicate ownership of equipment and the ability to purchase hay facilitated the attainment of the income target (Table XI). The income target of $3,500 (including depreciation charges) was attainable in all cases except 216 and 217. Further, the operating costs were considerably lower for all of these cases, except case 217, than for the cases where machinery was hired. Farm operator labor required for each case was much higher when ownership of equipment was assumed.

A beef cattle enterprise was included in the least-cost combination for each of cases 214-219, whereas, the cases without good upland and with custom hiring of machinery and equipment (cases 114 and 115) did not have bee enterprises. This result was partially due to the inclusion of a hay-buying activity and partially to the ease with which the income target was attained in cases with ownership of machinery and equipment. Further, no idle land was in the optimum organization for the group of cases with ownership of equipment. For cases 214, 215, 218 and 219, the corn enterprise increased as the size of farm increased. In addition, the proportion of total pasture unimproved increased as the size of the beef enterprise declined.

TABLE XI

NET INCOME, COSTS, ACTIVITIES, AND CAPITAL AND FARM LABOR REQUIRED FOR CASES 214-219

Item	Unit	Amounts for Case Number					
		214	215	216	217	218	219
Net farm income	Dols.	2,953	2,965	2,268	2,859	2,947	2,958
Operating costs	Dols.	2,664	2,237	2,409	4,877	2,270	2,141
Net farm returns per dollar of operating costs	Dols.	1.11	1.33	.94	.59	1.30	1.38
Enterprises:							
Beef cattle	A.U.	47.1	29.0	61.3	97.1	38.8	35.0
Bermuda-clover, bottomland	Acres	0.0	5.1	0.0	0.0	26.5	13.9
Bermuda-clover, good upland	Acres	0.0	0.0	104.5	225.0	37.0	0.0
Bermuda-clover, poor upland	Acres	157.4	0.0	120.0	135.0	0.0	0.0
Corn, bottomland	Acres	46.8	71.4	0.0	0.0	53.5	58.0
Native pasture, good upland	Acres	0.0	0.0	0.0	0.0	130.3	227.1
Native pasture, poor upland	Acres	55.6	240.0	0.0	0.0	0.0	0.0
Native pasture, forested upland	Acres	318.0	358.0	318.0	358.0	318.0	358.0
Prairie hay, bottomland	Acres	60.2	43.5	0.0	0.0	0.0	18.1
Prairie hay, good upland	Acres	0.0	0.0	95.5	0.0	72.7	42.9
Hire third quarter labor	Hrs.	0.0	0.0	98.6	0.0	0.0	0.0
Buy prairie hay	Tons	10.5	0.0	16.5	145.6	0.0	0.0
Total investment[a]	Dols.	31,156	29,989	33,641	41,906	29,704	31,039
Farm operator labor required	Hrs.	1,095	994	1,206	1,113	1,046	1,028

[a]Includes land and buildings, livestock, and machinery and equipment.

With the assumption of no bottomland on farms, the optimum organization with owned equipment had larger beef enterprises than where custom hiring was assumed. For both equipment situations, the size of the beef enterprise increased as size of farm increased.

With the assumption of no poor upland on farms, smaller beef enterprises were in the final plans with equipment owned than with custom hiring. The size of the corn enterprise was less on the 640-acre farm, and more on the 720 acre farm, when machinery and equipment was owned rather than hired. Thus, corn on the better land was more profitable, or less costly, relative to utilization of this land for beef production with owned rates of equipment.

That variations in the amount of land of each quality in a farm influences the enterprise combinations as well as the ease of attainment of a given income target is indicated by the results presented in this section. Nevertheless, incomes above the average for farm families in the survey were attained for all cases but one, case 114. For some of the other cases, net farm incomes were but little higher than the average for families in the survey, but, for other cases, the possibility of substantially higher incomes were estimated.

Interpretations

An attempt will be made in this section (1) to compare the results obtained to the existing situation as depicted by the Latimer survey, (2) to examine the differences between the results and the observed situation within the conceptual framework presented in Chapter II, and (3) to consider some implications of the results obtained.

Comparisons: Some of the characteristics of farms in the area were presented earlier. For purposes of this exposition, some of these characteristics will be repeated and others appropriate will be listed.

The average size of farm in the Latimer sample was 21 acres less than the initial 240-acre unit used for the cases programmed.[7] The case farm used was constructed so as to be fairly representative of the characteristics of the average of the surveyed farms. Amount of initial investment capital available and value of land and buildings were in the same proportion for the case farm situation as for the average of the surveyed farms.

On the average, sales of livestock and livestock products, primarily cattle, amounted to about 85 percent of gross farm sales on the surveyed farms. Fourteen percent of the gross farm sales was from field crops and one percent from sales of timber.[8] With enterprise combinations and resource use for maximum income of about $1,000, 64 percent of the gross farm sales was from beef cattle and the remaining 36 percent from corn. For an income target of $800, 80 percent of the gross farm sales was from beef cattle, while the remainder was from sales of corn. For lower income targets, all income was from beef cattle. In general, for cases with ownership of machinery assumed lower, income targets were associated with a smaller proportion of gross farm sales from beef cattle.

The proportion of the farm land in field crops averaged almost six percent for the surveyed farms. This compares with 8.3 percent for

[7]Back, Problems of Rural People in Latimer County, pp. 14-15.
[8]Ibid.

cases 104 and 204 and 3.5 percent for case 103. For the county as a whole, corn, grain sorghum, and small grains each accounted for about 30 percent of the field crops.[9] Grain sorghum was considered as a possible enterprise for the case farms. However, it was not an activity in the final plan for any of the cases.

The specific amount of improved pasture on farms in the area is not available. However, impressions of those conducting the survey were that on the average, very little of the pasture on farms in the area was improved pasture. About 27 acres of improved pasture was required for an income of $600. For the maximum income, all open pasture was improved pasture. In general, for the other cases, as income targets were reduced from maximum income, the proportion of land in improved pasture declined.

Off-farm work for the farm families averaged 79 days or, based on eight-hour days, 632 hours for adult males and females in the survey.[10] Work on own farms averaged 177 days or, based on eight-hour days, 1,416 hours for all adult males and females. Hence, total time employed in both types of work would be almost equivalent to one man working full time. However, for those engaged primarily in full-time farming, off-farm work averaged 67 hours while work on own farms averaged 1,592 hours. Thus, approximately 30 percent of the labor available on farms was idle. The results for cases 105 and 109 indicated that off-farm work would be an activity up to the maximum amount

[9] Gigoux, pp. 21.

[10] Adults are those people 21 years old or older.

available for any case. Considering the results for all cases, from 40 to 93 percent of the labor available initially was not required for the operation of the optimum farm organization. The only alternative use for this labor would have been either off-farm work or leisure. Hence, additional incomes from off-farm work would be a feasible alternative even for those cases where $2,950 net incomes were possible from the farm operation.

Certain differences and conformations are indicated by the above comparisons. First, the results obtained when income targets were about 80 percent of maximum income and machinery was hired on a custom basis are fairly comparable to the existing enterprise combinations and resource use. Second, perhaps there was more improved pasture on the case farms than is actually on farms in the area. Third, the high incidence of corn in the optimum plans for the cases producing incomes nearer the maximum with custom hire of equipment and, to a certain extent, in all of the cases with owned equipment is not in conformance with present systems of farming in the area. Fourth, even though the incidence of grain sorghum production was about the same as for corn on area farms, grain sorghum was not an activity in the results for any of the cases. The comparisons also indicate that while the proportion of gross sales from field crops in the existing situation was less than that for case 103, the acreage in all field crops was between that for cases 103 and 104, i.e., a comparison of acreage in field crops indicates an actual system of farming nearer that for maximum income than does a comparison of proportions of gross sales. That off-farm work would have been a feasible alternative for increasing farm-family incomes is also indicated.

Moreover, a combination of 600 hours of off-farm work and a system of farming such as that for case 103 would be generally comparable to observed situations in the area.

Relation to Theory: Any one of several possible reasons may explain why farms in the area appear to be organized to produce about 80 percent of the maximum income as indicated by the results. In the opportunity cost for nonproduction of corn were negligible, then the farmer could be indifferent between a system such as that for case 104 and one composed entirely of beef cattle and the related forage crops. However, the calculated maximum net income for a system composed of beef cattle and no corn would be $759. The opportunity cost for not producing corn in case 104 would be $237, or $11.85 per acre of corn not produced. Hence, failure to produce more corn than is currently grown on farms in the area could very well be due to the influences of certain non-priced factors not considered in the model.

In terms of the utility theory presented, there may be both enterprise preferences for beef relative to corn as well as differences in the disutilities associated with knowledge and effort for the two enterprises. Certainly, there are differences in the capital requirements and the time of receipt of income. For these two factors alone, beef would be expected to be less favorable than corn. Consequently, substantially different utilities are probably associated with either knowledge, effort, or the enterprise (enterprise preference) for corn to be less acceptable than beef to farmers in the area.

Since the labor requirements for corn in the cases utilizing hired equipment were furnished with the equipment, i.e., no farm operator labor was required, disutilities associated with effort would not be an influence. Other sources of disutility influencing farmer behavior possibly were lack of knowledge of prices and yields. Yield and price variability may reduce the attractiveness of the corn enterprise.

Another possibility is that farmers in the area who would have to hire all machinery and equipment in order to produce corn may believe that such a system is not satisfactory. The usual problems of timeliness and dependability associated with custom hire may preclude this alternative. The wide acceptance in the area of custom hire of equipment for improving pastures as opposed to lack of acceptance for corn production is perhaps related to the nature of the two operations. Timeliness is not as important for pasture improvement, and, generally, all operations required are carried out in a short period of time as compared to different operations spread over several months in corn production.

Perhaps corn production with owned equipment would be an acceptable alternative. However, few farmers in the area own the necessary items of equipment and therefore, are not in a position to produce this crop.

The incidence of more improved pasture in the programmed results than was actually on farms in the area may have been due to several factors. Farmers in the area may not be utilizing this intermediate enterprise for lack of knowledge of input-output relationships. Another possibility is that desirable output responses for this activity may be contingent on better management than is currently practiced by area farmers. A third possibility is that some initial investment in establishment is required. Further, additional returns from this enterprise occur in years subsequent to the establishment of the pasture and the initial investment costs. Lastly, this area is open range. Consequently, the grazing requirements for a beef cattle enterprise as large as or larger than 18 animal units may be furnished in part by the owned land and augmented by open range. Such was not recognized as a possibility in the programming model.

Grain sorghum is often used as a forage crop rather than as a cash grain crop in the area. For the programming, sorghum as a forage crop was not considered. Perhaps less grain sorghum in the results for the cases programmed than is actually grown was due to the failure to consider the forage activity. Use of sorghum for forage may also partially explain the small amounts of improved pasture on farms in the area. Perhaps the forage requirements of livestock are being furnished by sorghum rather than improved pastures.

Enterprise preferences could explain why some grain sorghum as a cash grain crop is produced on farms in the area even though corn may be more profitable. However, the net revenue for corn on good upland of $4.29 per acre is only $.85 higher than that for grain sorghum when equipment is owned; consequently, farmers would probably be indifferent as to which would be produced.

A resource use position nearer to that for maximum income indicated by the comparisons of acreages in field crops than was indicated by comparisons of sources of gross sales may be attributable to several factors. First of all, the sales of field crops consisted entirely of corn for the cases examined, while grain sorghum and small grains as corn were sold by farmers in the area. The budgets developed for this study indicate that total revenue per acre from grain sorghum would probably be from about

$4 to $13 less than from corn. Similar or greater differences could be expected for small grains. However, lower costs for these activities (other than corn) may result in net income levels such that the farmer would be indifferent with respect to choosing one of the alternatives. Consequently, the more likely explanation of the differences between comparisons is that of differing total revenues of crops contributing to gross sales.

The model did not directly recognize disutilities associated with effort with respect to off-farm work. To the extent that such disutilities exist, off-farm work will be less desirable than was indicated in the programmed results. However, the existing returns to labor in the area may be sufficient to result in approximately 90 percent employment of the available labor of those engaged in farming. Available labor per farm surveyed averaged 13 man-equivalent months. Total employment in all places of employment for all farm labor was about 12 man-equivalent months, or 90 percent employed. A lower level of employment existed for those primarily engaged in agriculture (i.e., exclusive of part-time farmers). Whether this was due to lack of employment opportunity or to a desire for leisure is not known. In any case, it would appear that some off-farm work would be an acceptable and feasible alternative source of additional farm family income.

The feasibility of off-farm work indicated by the results would not be inconsistent with the existence of a lack of interest in farming in the area. If the farmer is trying to earn some target income, say $2,000 per year, then perhaps a combination of 1,600 hours of work off-farm at the rate of one dollar per hour and a farm operation producing $400 net income would be preferred. Such net farm income would be produced with enterprise combinations and resource use as indicated by the results for case 101, the most extensive system examined.

Other Implications: Only one case was examined where yields were assumed to be above average. Some increase in net income resulted from the increased yields; however, net income for the average farm was still less than $1,400. For the other cases, similar small increases would be expected. Hence, increases in net incomes from farming in the area as a result of improved practices and higher yields could not be expected to alleviate the low-income problem. However, some combination of both increased yields and accumulation of assets may contribute to a reduction in this problem.

The results presented earlier in this chapter indicate that the size of farms and total investment per farm would have to be from two to three times larger if farms in the Ouachita Highlands area are to produce incomes higher than present incomes of farm families from farm and non-farm sources. Such was the case regardless of the proportions of land of the specified types per farm or the equipment situation assumed. However, the size of farm as well as the total investment required to produce a given net income varied depending on the quality of land, the equipment situation, and the farm organization. For example, the higher income targets were associated with higher investment required per dollar of net income; also, as land increased in quality, investment required per dollar of net income decreased. The investment required per dollar of income was higher for custom hire of equipment than for ownership of equipment at the higher income levels. For incomes of about $1,000, the converse was true. Problems associated with the accumulation of these necessary additional assets constitute the subject matter of the following chapter.

CHAPTER IV

CAPITAL INVESTMENT AND FARM GROWTH

The results of the preceding chapter indicate that substantial increases in farm size and total investment per farm are required if farmers in the Ouachita Highlands are to realize incomes of about $3,000 from a livestock-field crop system of farming. Some reduction in the amount of additional capital assets required could result from use of better techniques. However, improved techniques in the absence of additional assets would not produce an income of $3,000.

Sources of Capital

Primarily, there are four alternative sources of capital for the farm firm: (1) savings from current income, (2) borrowing funds from external sources, (3) investment in the farm firm from external sources, e.g., a corporate organization, and (4) work off own farm by the farm operator. Some combination of the above four possibilities could provide additional capital for the farm.

The asset position of the individually owned farm at the end of a production period will be

(1) $A_n = A_o + (P_1 - C_1) + (P_2 - C_2) + \dots + (P_n - C_n)$

where A_o is the initial asset position and P_i is net production and C_i is net consumption or withdrawals in the i^{th} time period, $(i=1, 2, \dots, n)$.[1]

[1]Dorfman, Samuelson, and Solow, Chapter XI.

Thus, the change in assets of the firm in the i^{th} period is

$$(2) \qquad \Delta A_i = (P_i - C_i) \ .$$

Let ΔA_i be defined as representing capital accumulation resulting from either saving or borrowing from external sources. Which type ΔA_i represents may be important to a development program.

The implications of the level of farm family withdrawals for living expenses may be examined within the above framework. The current and expected earnings of farm families in the absence of additional capital investment, particularly on the low-income farms, probably provides only a minimum acceptable level of living. Indeed, these earnings may only be sufficient for bare subsistence. Due to the low level of earnings, the individual is forced to a distribution of consumption over time which coincides with, and in some cases may exceed, the current and expected level of earnings.[2] Thus, no capital accumulation, or at most a negligible amount, is expected as a result of abstinence.

Capital accumulation as a result of borrowing funds from external sources may be feasible provided certain conditions are met.[3] Considered only as a source of capital the third alternative, a corporate form of organization for the farm firm with capital requirements satisfied through the same of stocks or perhaps even bonds, has certain advantages. The most important of these advantages is that the needed capital would be acquired in such a way that abstinence from consumption by the farm family would not be required. In addition, if the

[2]For example, the initial asset position of the individual may actually worsen over time due to failure to provide for the necessary repairs and replacement of fixed assets.

[3]See earlier discussion, p. 40.

marginal value productivity of this capital were sufficiently high to provide a reasonable return on investment plus some surplus, either the stockholders or the farm operator-manager or both would share such surplus. Thus, even though the marginal value productivity of capital investment might be so low as to preclude borrowed funds as a source, increases in income from the farm operation might be expected as a result of capital investment by stockholders.

The last alternative, working off of the farm to obtain funds for investment has certain attributes. The major attribute of this alternative source of funds is that it would relieve the farm firm of some of the pressure of furnishing the income required by the farm family for subsistence. Hence, savings could become a real alternative source of the needed capital.

This chapter will be devoted to a discussion of the problems and possibilities associated with capital accumulation within a livestock-field crop system of farming with borrowing and earnings from farming constituting the major source of additional capital. The results presented in this chapter were obtained from an application of the capital accumulation model discussed in Chapter II. Results were not obtained for all possible applications of the procedure to problems of the Ouachita Highlands area. Instead, selected cases were used to examine the transition process of a farm firm seeking a higher net income.

Case Results

The cases analyzed were classified into three groups according to differences in inputs of variable factors, yields, and the equipment situation for the particular case. Resource inputs and outputs for an average yield with custom hire of machinery and equipment were used for cases 501-505. The input and output coefficients for cases 601-605 were based on above average yields and also custom hire of machinery and equipment. Ownership of machinery and equipment and above average yields were the basis for the input and output coefficients for cases 611-615. The basic restrictions for all cases are indicated in Table XII. The extent to which changes in the assumptions modify the restraints will be indicated in conjunction with the discussion of the case results.

As in the previous models, capital required for operating expenses was available in an unlimited amount. However, the enterprises included in the final plan for any given year had to return a total income sufficient to cover all operating costs within that year with the net difference used to satisfy the income target. Capital for investment purposes, i.e., for land, land improvements, livestock, and in some cases equipment, was to be available initially in an amount equal to $3,250 and at zero cost. Additional investment capital could be borrowed at an interest rate of six percent. This additional capital would have to be repaid in equal annual installments over a 20-year period. The amount of unpaid principal in any given time period could not exceed 50 percent of the total value of land in the farm valued at $25 per acre. Principal repayments, plus interest charges, were to be derived from current receipts in the given time period. Such specifications were used for the capital borrowing activity in an attempt to

TABLE XII

INITIAL RESTRICTIONS FOR CAPITAL ACCUMULATION MODELS

Item	Period	Unit	Amount
Income target	1	Dols.	1,000
Income target	2	Dols.	1,200
Income target	3	Dols.	1,400
Income target	4	Dols.	1,600
Maximum borrowing possible	All	Dols.	3,000
Investment capital available	All	Dols.	3,250
Bottomland	All	Acres	20
Good upland	All	Acres	60
Poor upland	All	Acres	40
Pasture (bermuda-clover equivalent)	All	Acres	0
Hay (lespedeza equivalent)	All	Tons	0

reflect practices and requirements for long-term loans of credit institutions in the area.

The land buying activity reflects the assumption that the individual could purchase land comparable in quality to the land in the farm initially. That is, one twelfth of all land purchased would be bottomland, one fourth good upland, one sixth poor upland, and the remaining one half forested upland. Purchases in a given period would be available for that period and all succeeding periods.

Lespedeza hay, grain sorghum, and hiring farm labor were not considered as possible alternatives in this model. These enterprises did not appear or seldom appeared in the final solutions of the static cases.

The over-all objective of this chapter was to evaluate the potential for increasing incomes and acquiring additional capital from farming. Hence, an off-farm work opportunity was not included. Except for these activities, the enterprises considered in the model were the same as those listed for the static model plus a land buying activity.

Costs for all periods were not converted to a present value, and neither were the net returns. Such conversion did not appear desirable since the problem was to attain a specified net income in each of the periods considered rather than to compare income and expenditure flows over time.

In some of the cases utilizing this model, the cost associated with the disposal activity for the income target of each period was varied between cases. An economic interpretation of this cost of nonsatisfaction of the income target appears to exist. This cost could represent an internal restriction relating to the rate of net returns per dollar of operating costs. For example, a cost of $5.00 per unit for the disposal activity would mean activities other than nonsatisfaction of the income target would be included in the final plan so long as their inclusion would be at a cost of less than $5.00 per dollar of net income. Other rates of internal aversion to expenditure of funds for operating costs may be reflected by a different cost (value) for the disposal activity for the income target.

The resource requirements, costs, and returns, by enterprises for all cases were based on the budgets in Appendix B.

Custom Hire of Equipment and Average Yields: The problems and the possibilities of attaining higher net farm incomes with average yields and custom hire of all machinery and equipment were examined in cases 501-505. Except for costs associated with non-attainment of the income target, the activities of cases 501-505 have the same inputs and outputs.

Five different levels of cost associated with nonsatisfaction of the income target were examined in these cases. Case 501 reflects the assumption that the individual would attempt to attain the specified income target with the least cost combination of enterprises so long as the net return per dollar of operating expense was greater than 20 percent. Under such restrictions, the optimum combination of resources did not result in attainment of the income target in any of the four periods (Table XIII). The highest net income was for the third period.

The organization of the farm in the fourth period was essentially the same as that for the static model, case 104 (Table II). After the second year, all grazing requirements were furnished by bermuda-clover

TABLE XIII

NET FARM INCOME, COSTS, ACTIVITIES, AND CAPITAL AND FARM LABOR REQUIRED, BY YEARS, CASE 501

Item	Unit	Year 1	2	3	4
Net farm income	Dols.	682	813	1,029	973
Operating costs	Dols.	913	919	1,360	1,417
Farm returns per dollar of operating costs	Dols.	.82	.89	.76	.69
Enterprises:					
Beef cattle	A.U.	7.9	9.5	17.2	17.2
Bermuda-clover, good upland	Acres	10.7	27.8	27.8	27.8
Bermuda-clover, poor upland	Acres	0.0	40.0	40.0	40.0
Corn, bottomland	Acres	20.0	20.0	20.0	20.0
Native pasture, good upland	Acres	34.5	14.3	0.0	0.0
Native pasture, poor upland	Acres	40.0	0.0	0.0	0.0
Prairie hay, good upland	Acres	14.7	17.9	32.2	32.2
Land buying	Acres	0.0	0.0	0.0	0.0
Capital borrowing	Dols.	0	0	1,336	0
Farm labor required	Hrs.	60.8	73.2	132.4	132.4
Additional borrowing possible	Dols.	3,000	3,000	1,664	1,731
Total investment	Dols.	7,632	9,243	10,590	10,590

pasture. Perhaps the failure of the optimum organization to include establishment of bermuda-clover pasture on poor upland and only to a limited extent on good upland in the first period was a consequence of the cost of maint nance. The maintenance of bermuda-clover pasture required an expenditure of $5.66 per acre in addition to the cost of mowing in the fourth year following establishment. For bermuda-clover pasture established in the first period, such costs would influence the net returns and costs for the over-all plan. However, these additional maintenance costs were not considered for bermuda-clover pasture established in period two or thereafter since they occurred in a period not covered by the time span of the plan. Apparently, if maintenance costs were considered, bermuda-clover pasture was not favorable relative to native pasture on poor upland, and favorable only to a limited extent on good upland.

The value of the assets controlled by the individual would have been greater at the end of the four-year period than initially by $2,958. At the same time, his unencumbered equity in land would have declined by $1,269.

The trend from the first to the fourth period was toward a higher proportion of the more intensive enterprises, i.e., more improved pasture for livestock and thus more livestock. Consequently, net returns per dollar of operating expense declined from 82 to 69 cents from the first to the fourth period.

For cases 502-504, internal restrictions were such that an enterprise would have to yield more than ten, eight, and six percent net income per dollar of operating expense, respectively, if it were to be acceptable. Results obtained for these three cases were the same as those discussed above for case 501 (Table XIII).

For case 505, an activity was acceptable for satisfaction of the income target provided a net return per dollar of operating costs greater than two tenths of one percent was obtainable. With this restriction, incomes were greater than $1,000 in the third and fourth periods (Table XIV). Even so, the total of the annual net incomes for the four-year period for case 505 was only three dollars greater than that for case 501. Operating costs were $1,680 higher for case 505 than tor case 501.

The enterprise combinations for case 505 were about the same as for the preceding cases. One difference was the establishment of all of the bermuda-clover pasture in the second period for case 505 as compared to establishment of some bermuda-clover pasture in the first period for case 501. That is, grazing requirements for the first period for case 505 were obtained from native pasture. For the third and fourth periods, all grazing was from bermuda-clover pasture for both cases.

Another difference between the two cases was the purchase of 55 acres of land for case 505, as compared to no purchases of land for case 501. As a result of this land purchase in case 505, total value of assets controlled by the farm operator was $3,940 greater at the end of the fourth period than initially. However, the operator's unencumbered equity in land during the same period declined by $2,811.

The relatively insignficant increase in net income for this case as compared to case 501 indicates purchase of land and expansion of

TABLE XIV

NET FARM INCOME, COSTS, ACTIVITIES, AND CAPITAL AND LABOR REQUIRED, BY YEARS, CASE 505

Item	Unit	Year			
		1	2	3	4
Net farm income	Dols.	796	684	1,004	1,016
Operating costs	Dols.	1,164	1,276	1,930	1,919
Farm returns per dollar of operating costs	Dols.	.68	.54	.52	.53
Enterprises:					
Beef cattle	A.U.	9.7	9.7	21.1	21.1
Bermuda-clover, good upland	Acres	0.0	34.2	34.2	34.2
Bermuda-clover, poor upland	Acres	0.0	49.2	49.2	49.2
Corn, bottomland	Acres	24.6	24.6	24.6	24.6
Native pasture, good upland	Acres	55.7	21.5	0.0	0.0
Native pasture, poor upland	Acres	49.2	0.0	0.0	0.0
Prairie hay, good upland	Acres	18.1	18.1	39.6	39.6
Land buying	Acres	55.4	0.0	0.0	0.0
Capital borrowing	Dols.	0	1,776	2,006	0
Farm labor required	Hrs.	74.7	74.7	162.5	162.5
Additional borrowing possible	Dols.	3,693	1,918	0	189
Total investment	Dols.	9,082	11,027	13,022	13,022

the livestock enterprise through the use of borrowed funds was not very profitable. This may have been due, not so much to the cost of land, as to the requirement for repayment of the principal on borrowed funds. Perhaps the returns to borrowed funds were more than sufficient to pay the interest charged, but were insufficient to pay interest and required repayments of principal and still yield more than a small addition to net income.

Another factor limiting the expansion of the assets controlled by the farm operator was the limitation on borrowing. This limitation of the amount outstanding to 50 percent of the total value of land and buildings was very effective in limiting the expansion of the resource base of the individual farm.

In summary, the results for cases 501-505 indicate very little capital accumulation with average yields and custom hire of machinery and equipment. In addition, incomes greater than $1,029 were not attainable in any of the four periods. Such was due in part to the relatively high demands on current income made by the capital borrowing activity and in part to the limitation of the amount of capital which could be borrowed.

<u>Hire Machinery and Equipment and Above Average Yield</u>: Accumulation of capital and increased incomes from farm sources may result if better managerial practices are followed by the farm operator. The county agricultural workers surveyed generally associated higher yields from specified enterprises with increased use of commercial fertilizers and better management practices. The effect of the higher yields with custom hire of machinery and equipment on enterprise combinations and resource

use was examined in cases 601-605. Initial restrictions for this class of cases were the same as for the preceding group. Differences from the preceding cases in costs, requirements and returns for the enterprises were based on Appendix Table XIV.

As for case 501 in the preceding section, enterprises for case 601 would be acceptable for satisfying the income target of any period provided cost of each additional dollar of net income was less than five dollars. An examination of the results for case 601 reveals the income target was met only in the third period (Table XV). Net incomes and the ratio of net income per dollar of operating costs were higher in every period for this case than for case 501 where average yields were assumed (Table XIII).

Enterprise combinations and resource use were very similar for cases 501 and 601, however, there were some differences in investments. As a result of the higher yield per acre from pasture, the beef enterprise was larger for case 601 than for case 501 in all periods except the second period. The same was true for labor requirements of the two cases. Another difference was the absence of the establishment of any bermuda-clover pasture in the first period for this case, whereas slightly over ten acres were established for case 501. A few acres of land were purchased for this case as compared to no land purchases for case 501. Over $1,000 more investment at the end of the fourth period was required for this case than for case 501.

When an enterprise would have to return a net income greater than ten percent of the operating costs to be acceptable, the results for case 602 were obtained (Table XVI). As a result of purchase of about

TABLE XV

NET FARM INCOME, COSTS, ACTIVITIES, AND CAPITAL AND FARM LABOR REQUIRED, BY YEARS, CASE 601

Item	Unit	Year 1	2	3	4
Net farm income	Dols.	934	994	1,405	1,408
Operating costs	Dols.	1,061	1,001	1,743	1,756
Farm returns per dollar of operating costs	Dols.	.88	.99	.80	.81
Enterprises:					
Beef cattle	A.U.	8.1	8.1	21.6	21.9
Bermuda-clover, good upland	Acres	0.0	20.5	20.5	20.5
Bermuda-clover, poor upland	Acres	0.0	39.5	41.2	41.2
Corn, bottomland	Acres	20.6	20.6	20.6	20.6
Native pasture, good upland	Acres	46.7	26.2	.8	0.0
Native pasture, poor upland	Acres	41.2	1.7	0.0	0.0
Prairie hay, good upland	Acres	15.2	15.2	40.5	41.3
Land buying	Acres	7.5	0.0	0.0	0.0
Capital borrowing	Dols.	0	0	2,411	62
Farm labor required	Hrs.	62.4	62.4	166.3	168.6
Additional borrowing possible	Dols.	3,094	3,094	683	742
Total investment	Dols.	7,605	9,247	11,656	11,708

TABLE XVI

NET FARM INCOME, COSTS, ACTIVITIES, AND CAPITAL AND FARM LABOR REQUIRED, BY YEARS, CASE 602

Item	Unit	Year			
		1	2	3	4
Net farm income	Dols.	1,003	989	1,410	1,448
Operating costs	Dols.	1,159	1,173	1,966	1,979
Farm returns per dollar of operating costs	Dols.	.87	.84	.72	.73
Enterprises:					
Beef cattle	A.U.	8.8	8.8	23.0	23.6
Bermuda-clover, good upland	Acres	0.0	22.7	22.7	22.7
Bermuda-clover, poor upland	Acres	0.0	40.2	43.3	43.3
Corn, bottomland	Acres	22.3	22.3	22.3	22.3
Native pasture, good upland	Acres	50.5	27.8	1.2	0.0
Native pasture, poor upland	Acres	44.6	4.5	1.4	1.4
Prairie hay, good upland	Acres	16.5	16.5	43.0	44.3
Land buying	Acres	27.8	0.0	0.0	0.0
Capital borrowing	Dols.	0	701	2,682	0
Farm labor required	Hrs.	67.8	67.8	177.1	181.7
Additional borrowing possible	Dols.	3,348	2,647	0	169
Total investment	Dols.	8,235	9,956	12,526	12,630

28 acres of land in the first period as well as an increase in the amount of capital borrowed during the total four-year period, about $109 more net income was produced by this case than by case 601. However, costs were also higher by $716. Otherwise, the results for this case contained about the same proportions of livestock, improved pastures, and row crops as case 601.

For cases 603-604, internal restrictions were such that an enterprise would have to yield eight and six percent net income per dollar of operating expense, respectively, if it were to be an acceptable enterprise. Results for these two cases were the same as those for case 602 (Table XVI).

When an activity would be acceptable provided net returns per dollar of cost were greater than two tenths of one percent, the results for case 605 were obtained (Table XVII). Income targets were satisfied in each of the first three periods but not in the fourth period. In order to produce a total of the annual net incomes for the four periods $211 greater in case 605 than was produced by case 602, about 266 additional acres of land were purchased. Also, operating costs increased by $14,711 while total investment at the end of the four-year period was $3,838 greater than for case 602.

The animal units of beef in the optimum plan for case 605 were greater in the first period and less in the latter three periods than for the preceding cases. Production of beef cattle was replaced by a large corn enterprise on good upland (97-112 acres per period) during the last three periods for the case as compared to case 602. Another difference between the enterprises of the two cases was the relatively

TABLE XVII

NET FARM INCOME, COSTS, ACTIVITIES, AND CAPITAL AND FARM LABOR REQUIRED, BY YEARS, CASE 605

Item	Unit	Year 1	2	3	4
Net farm income	Dols.	1,006	1,204	1,402	1,449
Operating costs	Dols.	2,630	6,143	6,068	6,147
Farm returns per dollar of operating costs	Dols.	.38	.20	.23	.24
Enterprises:					
Beef cattle	A.U.	14.8	7.0	14.6	16.1
Bermuda-clover, poor upland	Acres	0.0	36.1	36.1	36.1
Corn, bottomland	Acres	37.5	41.6	41.6	42.2
Corn, good upland	Acres	0.0	111.9	97.6	96.5
Native pasture, good upland	Acres	84.9	0.0	0.0	0.0
Native pasture, poor upland	Acres	75.1	47.2	30.7	48.3
Prairie hay, good upland	Acres	27.7	13.0	27.4	30.1
Land buying	Acres	210.4	49.4	0.0	6.7
Capital borrowing	Dols.	5,453	0	1,341	423
Farm labor required	Hrs.	114.0	54.0	112.4	124.0
Additional borrowing possible	Dols.	178	1,069	0	0
Idle poor upland	Acres	0.0	0.0	16.4	0.0
Total investment	Dols.	13,850	14,708	16,038	16,468

few acres of bermuda-clover pasture established on poor upland and none on good upland for this case as compared to almost all available grazing land in bermuda-clover pasture in case 602.

Even though the increased income targets were reached in three of the four periods, it is doubtful that the enterprises and activities for case 605 would be acceptable to the farm operator. The enterprises and activities would not be acceptable if there were substantial aversions to borrowing, strong preferences for beef cattle, and/or a desire to insure against downward variations in corn prices and/or yields.

As in the preceding cases, the cost of borrowing as well as the limitations on the amount which could be borrowed effectively limited asset accumulation in case 605. An indication that capital borrowing was a more attractive activity if yields were above average is evidenced by a comparison of the results of this case with those of case 505 where average yields were assumed (Table XIV). Land purchases for case 605 were 211 acres greater than for case 505. Also, the total investment at the end of the fourth period was $3,446 greater in case 605 than in case 505.

The results for the preceding cases indicate that even though better yields would facilitate capital accumulation, such accumulation would still be hampered by the limitation on the amount that could be borrowed. In addition, the pressure placed on current incomes by the repayment provisions of the loan to some extent precluded the attainment of the income target in certain periods.

Ownership of Machinery and Equipment and Above Average Yields: Ownership of the necessary items of machinery and equipment and above average yields could facilitate capital accumulation and attainment of higher income targets. The increase in farm income could be the result entirely of an increase in the utilization of available operator labor and the higher yields. Even so, there is a possibility that a plan which increased the value of assets owned and net farm income with ownership of equipment may be preferred to one utilizing hired equipment.

Cases 611-615 were based on the assumption that the farm operator would purchase a set of new equipment consisting of the items indicated in Appendix Table V. This set of equipment would be available for all periods considered in the program. The terms of purchase were one third of the initial cost as a down payment with the remainder of the principal to be repaid in three equal annual installments. In addition, interest at the rate of ten percent on the outstanding principal would have to be paid.[4] Funds required for the down payment were to be obtained from borrowing at terms prescribed by the capital borrowing activity. The appropriate amounts after modification of the initial resources and restrictions to reflect the above assumptions are indicated in Table XVIII.

The adjusted income targets do not include any charge for depreciation of the machinery and equipment. Such charges were not included since this analysis pertains to the income available for farm family subsistence in each period during the capital accumulation phase rather than maintenance of investment. In addition, if the payments for the

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[4]These terms reflect the financing practices of dealers in the area.

TABLE XVIII

INITIAL RESTRICTIONS FOR CASES 611-615

Item	Period	Unit	Amount
Income target[a]	1	Dols.	3,246
Income target[a]	2	Dols.	3,286
Income target[a]	3	Dols.	3,326
Income target[a]	4	Dols.	1,832
Maximum borrowing possible	1	Dols.	700
Maximum borrowing possible	2	Dols.	815
Maximum borrowing possible	3	Dols.	930
Maximum borrowing possible	4	Dols.	1,045
Investment capital available	All	Dols.	3,250
Bottomland	All	Acres	20
Good upland	All	Acres	60
Poor upland	All	Acres	40
Pasture (bermuda-clover equivalent)	All	Acres	0
Hay (lespedeza equivalent)	All	Tons	0

[a]Includes same net income target as preceding cases plus payments required for machinery. Does not include depreciation on machinery and equipment.

machinery can be met in the earlier periods, either sufficient income can be produced in the latter periods to cover depreciation or the same procedure can be used for replacing worn out items as was used for the initial purchases, i.e., borrowing funds and dealer financing.

For case 611, an enterprise would be acceptable provided the net income per dollar of operating costs was greater than 20 percent, the same specification as for cases 501 and 601. In addition, inputs and outputs for above average yields were used.

The results of the programming of this case indicate that the income target was not attainable in the first three periods when payment for the machinery and equipment was being made (Table XIX). However, after the equipment was paid for (the fourth period), the income target was attained. A higher income target than $1,600 could have been satisfied in the fourth period with the same proportion of row crops and beef as in the preceding three periods.

The purchase of about 245 acres of land indicates that, with above average yields, purchasing land for expansion of the corn enterprise was more favorable than using the purchased land for beef on improved pastures. This could have been due in part to the high capital requirement for beef and related enterprises as compared to corn, and in part to the small amount of additional capital which could be borrowed when the equipment was purchased.

Results obtained when enterprises would have to yield more than a ten, eight, and six percent net return to operating costs if they were to be acceptable were the same as for case 611 (Table XIX).

TABLE XIX

NET FARM INCOME, COSTS, ACTIVITIES, AND CAPITAL AND FARM LABOR REQUIRED, BY YEARS, CASE 611

Item	Unit	Year			
		1	2	3	4
Net farm income	Dols.	343	571	742	1,605
Operating costs	Dols.	4,254	4,467	4,457	2,581
Net returns per dollar of operating costs	Dols.	.08	.13	.17	.62
Enterprises:					
Beef cattle	A.U.	6.5	6.7	6.7	10.4
Corn, bottomland	Acres	38.8	40.4	40.4	40.4
Corn, good upland	Acres	104.2	108.6	108.6	26.5
Native pasture, good upland	Acres	0.0	0.0	0.0	75.3
Native pasture, poor upland	Acres	77.6	80.8	80.8	34.1
Prairie hay, good upland	Acres	12.1	12.6	12.6	19.4
Land buying	Acres	225.4	19.5	0.0	0.0
Capital borrowing	Dols.	3,517	534	0	635
Farm labor required	Hrs.	892.3	929.1	929.1	590.3
Additional borrowing possible	Dols.	0	0	318	0
Total investment	Dols.	19,686	20,209	20,209	20,856

When an enterprise would be acceptable provided net returns to operating costs were greater than two tenths of one percent, the results for case 615 were obtained (Table XX). The income target was obtained in the fourth period. In addition, net incomes were higher in the first three periods for this case than for case 611. No livestock and the related activities were in the optimum organization prior to the fourth period and then only to a limited extent.

The maximum permissible amount of capital was borrowed in every period. This capital was borrowed to purchase about 375 acres of land during the first three periods and the few animal units of beef cattle in the fourth period.

The results of the cases examined in this section indicate that income targets could not be attained while paying for equipment. After the equipment was paid for, incomes higher than the $1,600 income target in the fourth period could have been produced. Restrictions on the amount of capital borrowing as well as the repayment provisions limited the accumulation of additional assets.

Interpretation of Results

The model used for the cases in this chapter recognizes the priced factors primarily; however, some of the non-priced factors are considered implicitly. These non-priced factors and their influence on the acceptability of the results obtained may now be considered explicitly. Several criteria may be established for determining whether or not the case results specify a "satisfactory" process for increasing farm incomes.

TABLE XX

NET FARM INCOME, COSTS, ACTIVITIES, AND CAPITAL AND FARM LABOR REQUIRED, BY YEARS, CASE 615

Item	Unit	Year			
		1	2	3	4
Net farm returns	Dols.	512	767	1,034	1,602
Operating costs	Dols.	5,285	5,593	5,931	3,486
Net returns per dollar of operating costs	Dols.	.10	.14	.18	.53
Enterprises:					
Beef cattle	A.U.	0.0	0.0	0.0	2.4
Corn, bottomland	Acres	46.3	48.6	51.2	51.2
Corn, good upland	Acres	139.0	146.0	153.6	51.0
Native pasture, good upland	Acres	0.0	0.0	0.0	24.0
Prairie hay, good upland	Acres	0.0	0.0	0.0	4.5
Land buying	Acres	316.0	27.8	30.5	0.0
Capital borrowing	Dols.	4,650	695	765	420
Farm labor required	Hrs.	945.0	992.5	1,044.5	577.8
Additional borrowing possible	Dols.	0	0	0	0
Total investment	Dols.	20,814	21,509	22,272	22,692

Once these criteria have been established, each of the cases can be evaluated in terms of whether or not the criteria are met. In addition, comparison between cases may be made.

The first criterion considered will be attainment of the income target in each of the four periods. By this criterion, none of the cases presented would be "satisfactory".

Another criterion, producing a net farm income of no less than $1,000 in any period while at the same time total investment increased from the first to the last period, was satisfied by the farm organization for only one case. Total investment increased from the first to the last period in all of the cases. However, the net incomes for farm family living in the earlier periods, particularly for the cases with custom hire of machinery and equipment, would probably be insufficient for subsistence. In addition, the net incomes of the latter periods for the cases with average yields were only slightly higher than those of the 240-acre units in the static analysis of the preceding chapter.

One of the more favorable features of the results for the cases with ownership of equipment was the large size of the total investment in terms of the potential for higher incomes in future years. However, to the extent that disutilities associated with more effort, lack of knowledge about yields of the level assumed and their variability, time preferences for income, and equity position influence the acceptability of a farm organization, such an organization as that obtained by both these cases would be less "satisfactory".

Even though the results of case 605 were "satisfactory" in terms of the second criterion, it is questionable whether such an organization would be preferred to that of cases 601 or 602. It is highly doubtful that a farmer in a low-income area, if given a choice, would prefer to spend about $14,700 more in operating costs to increase net returns by slightly more than $200. This is particularly true in view of the large size of the corn enterprise on good upland in case 605. For this enterprise, net returns above cash costs amounted to only $3.42 per acre. Hence, a reduction in yields of three bushels or a decline in price of 11 cents per bushel would result in losses from the corn enterprise. One desirable feature of this organization was the purchase of additional land. Also, there was a trend toward an increase in the livestock activity and a reduction in the corn enterprise in the latter periods.

Although the results for cases 601-602 do not satisfy the second criterion, net incomes did increase during the four-year period. These increases in incomes were largely the result of improving pastures and increasing the size of the livestock enterprise rather than expanding the acreage in the farm. However, the net income for the fifth period would be expected to decline. Such decline would be due to the relatively large expenditures for maintenance of the bermuda-clover pastures during the fifth period.

For those farm operators whose current expectations are in terms of average yields, the results for the cases with yields above average may be less acceptable than when differences in net incomes only are considered. For example, the knowledge and ability of the farm operator may be such that the above average yields and the associated net incomes would not appear to be a likely alternative result. Consequently, a decision to adopt such practices and techniques as required to attain these yields or to acquire additional knowledge may not be forthcoming. However, there was little difference between the enterprise combinations of the cases with above average yields and those of the cases with average yields. The major difference was more animal units of beef in the latter periods as a result of higher yields from the improved pasture. Hence, perhaps very little additional knowledge would be required.

In general, opportunities for accumulation of additional capital and increasing incomes appear to be very limited within the beef cattle-field crop system of farming. Even less opportunities would appear to exist for those farm units smaller in all respects than the 240-acre unit used in this analysis. However, there are two possible alternatives that have not been programmed which may offer some opportunity.

One alternative source of both income for farm family use and additional capital would be working off farm. For all of the results presented, a substantial portion (50 percent or more) of the available labor was not required for operation of the farm. Thus, if acceptable off-farm work opportunities existed, additional income for subsistence purpose could be obtained during the capital accumulation periods.

Another alternative would be the purchase of used items of machinery and equipment rather than the new equipment and machinery as programmed. Such would be expected to require less capital investment initially and, perhaps, operating costs would not be substantially higher. Since less of the limited supply of investment capital would be required for equipment purchases, more land could be purchased and/or improved, and/or more investment in livestock would be possible. These activities were profitable.

The two alternatives presented here as well as possible combinations of them could represent opportunities for more capital accumulation and higher subsequent incomes from farming and for farm family uses than the alternatives programmed. Thus, subsequent investigation of these two alternatives may be desirable.

Another problem not considered in this study is the potential incomes in periods beyond the four-year period. Perhaps the high incidence of pasture improvement activities in some of the results would not have occurred had more time periods been examined. For most of the cases, bermuda-clover establishment was not an activity prior to the second period. It is suspected that this was due to the requirement for maintenance and the associated costs in the fourth period following establishment and every third period thereafter. If such was the case, then more time periods and consequently a more complex program would have to be considered to adequately evaluate the establishment of bermuda-clover pasture as an enterprise. Perhaps future research also should examine the feasibility and productivity of bermuda-clover pasture without the fourth year maintenance. Omission of the maintenance activity could be desirable on farms attempting to attain higher incomes through increase in assets.

The above does not detract from the adequacy of the programs developed for the time periods considered, however. Such incomes as resulted were attained at least costs for the four periods from the enterprises in the final plans.

CHAPTER V

SUMMARY AND CONCLUSIONS

The over-all purpose of this study was to evaluate the potential for increasing incomes of farm families in the Ouachita Highlands through agricultural resource use adjustment and farm development on livestock-field crop farms. Specifically, the first objective was to construct a theoretical model of the utility an individual receives from production alternatives and to account for the behavior indicated by the theoretical model, to the extent possible, in operational models utilizing existing techniques of linear programming. The second objective was to determine acceptable alternative adjustments in resource use for providing higher farm family incomes on livestock-field crop farms in the Ouachita Highlands area. The third objective was to evaluate the potential for agricultural development from accumulation of assets within agriculture on livestock-field crop farms in the area.

The utility theory presented explicitly recognized the influence of the nonpriced aspects of factors and products as well as the priced aspects. The theory indicated the level of resource use for maximum utility would be less than that for maximum profits if there were important negative utilities associated with inputs in production. Operational linear programming models indirectly accounting for some of the nonpriced aspects of factors were used to program specific farm situations. The criterion for selection of the optimum farm plan was the attainment of a specified level of income at the minimum cost. The use of income targets permitted the determination of enterprise combinations and levels of resource use for incomes less than the maximum possible. The model used for the situations related to the second objective did not consider time as a variable. The capital accumulation model did consider time as a variable through use of the Hicksian procedure of dating inputs and outputs.

Results of a survey of rural residents conducted by the Department of Agricultural Economics, Oklahoma State University, were used to develop the initial resources and restraints other than proportions of land of each quality for the basic farm units of the cases programmed. The amount of land of each type per farm was determined from estimates of county agricultural workers in the area. Resource inputs and product outputs for "average" and "above average" management were based largely on estimates of the county agricultural workers. Estimates of prices of products and inputs were obtained from secondary sources.

There was no definite assurance the income target used and the enterprise combinations and level of resource utilization obtained from application of the model would coincide with choices of individual farmers. Neither could the influence of any particular one of the sources of disutility be evaluated from the model used. However, the results obtained for the cases where the income target was less than the maximum income possible fairly well agree with observed enterprise combinations and resource use on farms in the area. For example, when the farm was organized to produce the maximum income under the given restrictions, 36 percent of gross farm sales were from corn as compared to 14 percent of gross farm sales from crops from the farms in the survey. Results for the case with an income target equal to 80 percent of the maximum income were fairly comparable to observed enterprise combinations. Only about 20 percent of the farm sales were from corn for this case. The opportunity cost for not producing corn in the case with the maximum income was calculated as $237 or $11.85 per acre of corn not produced.

Hence, the results obtained not only indicate the operational model to some extent accounted for the influence of the nonpriced aspects of factors, but they also were consistent with the hypothesis that values, motives, and behavior of farmers in the area other than those consistent with profit maximization influence farm production decisions. Whether the behavior of farmers in the area was due to knowledge limitations, or values independent of knowledge, was not ascertained.

Considering the results for all cases, from 40 to 93 percent of the available labor was not required for the operation of the optimum farm organization. The only alternative use for this labor would have been either off-farm work or leisure. Hence, off-farm work would have been a feasible alternative when combined with a farm organization to produce incomes higher than the average income from all sources of $1,878 per farm family in the survey. For example, an income of $2,400 could have been obtained from a combination of 1,600 hours of off-farm work (at $1 per hour) and a farm income of $800, which was $200 less than the maximum farm income for the 240-acre unit programmed.

Maximum net income with custom hire of machinery and equipment was $117 greater than with ownership of machinery and equipment for the same 240-acre farm unit. As a result of labor being furnished with the equipment, operator labor required to produce the maximum farm income with custom hire of machinery and equipment was 226 hours less than that required if machinery was owned. For an 860-acre farm unit, the maximum net income with ownership of machinery and equipment was almost $1,000 greater than with custom hire of equipment. However, operator labor requirements were also higher with owned rather than custom hired equipment. Hence, to the extent that disutilities associated with effort are important to the farm operator, ownership of equipment would be less desirable than indicated by the comparisons of net incomes.

The net farm income from the basic farm unit was $1,374 when yields were those associated with "above average" management by the county agricultural workers. This income was 50 percent above the net income with "average" yields but still about $500 below the average income from all sources for farm families in the survey.

The results also indicate that with average yields, the size of farm and total investment per farm would have to be from two to three times larger than for the basic 240-acre unit if farms in the Ouachita Highlands area are to produce incomes higher than the present incomes of farm families from both farm and non-farm sources. For a farm unit of 860 acres, the pressure on resources for attainment of a given level of income was less when equipment was owned than when hired on a custom basis. With owned equipment, a reduction in the pressure on resources for producing income resulted in larger beef enterprises relative to corn. The converse was true with ownership of equipment.

Variations in the proportions of each type of land in the farm influenced enterprise combinations as well as the ease of attainment of a specified level of income. In general, the cases with the higher proportions of the better land per farm had larger corn enterprises relative to beef cattle than for the average unit. The cases with the higher proportions of poorer land generally had larger beef enterprises relative to corn than the average unit.

For a given farm size, the total investment required varied depending on the quality of land, the equipment situation, and the farm organization. Higher income targets were associated with higher investment requirements per dollar of net income; also, as land increased in quality, investment required per dollar of net income decreased. The investment required per dollar of income was higher for custom hire of equipment than for ownership of equipment at the higher income levels. For incomes of about $1,000, the converse was true.

For the cases examined, the possibility of increasing incomes from farming through expansion of farm assets generated by the farm business, even if income targets coincide with maximum incomes, appears to be very limited. Income targets of $1,600 were attained in the fourth period for the cases with above average yields and ownership of equipment. A higher income target could have been attained in this period. However, the maximum incomes in the first three periods for any one of these cases were $512, $767, and $1,034, respectively. Thus, incomes for the first two periods would probably be less than that required for subsistence.

The maximum income in any period with custom hire of equipment and above average yields was about $1,450. With average yields, the maximum income in any period with custom hire of equipment was about $1,030. Net incomes were less than $1,000 in at least one of the four periods except for one case.

In general, these results indicate that relatively small increases in incomes and some capital accumulated would be possible. However, limitations on the amount of borrowing, as well as the requirements for maintaining an income sufficient for subsistence in each period would appear to preclude the attainment of incomes as high or higher than $1,878 from capital accumulation and farm development within agriculture.

Two types of loans for acquisition of additional assets were considered in this study: (1) an intermediate term loan with an interest rate of six percent on the unpaid balance and principal to be repaid in five equal annual installments, and (2) a long term loan with an interest rate of six percent on the unpaid balance and with principal to be repaid in 20 equal annual installments. For both types of loans, the amount of principal outstanding could not exceed 50 percent of the value of land and buildings of the farm. These provisions were used in an attempt to reflect the practices and requirements of credit institutions in the area.

Use of intermediate term credit only was considered in the borrowing activity for the static cases. No capital borrowing occurred in any of these cases. Returns to capital were not sufficient to repay principal plus interest in each year and at the same time provide additional income for farm family subsistence.

Since intermediate term credit was not borrowed in the static cases, long-term credit was considered as a source of funds for the capital accumulation model. However, the terms specified may have been more liberal than those of credit institutions in the area. Some capital borrowing occurred in each of the cases programmed. The borrowing of long-term credit also would have been a feasible alternative for the static cases.

Both repayment provisions and the limitation on the amount which could be borrowed hampered capital accumulation. In general, the additional returns generated by the borrowing of funds was not sufficient to provide for payments of principal and interest and still produce a large enough income for subsistence in the earlier periods. For some of the cases, the maximum permissible amount of capital was borrowed, but incomes were below specified subsistence requirements in the first two or three periods of the plan. Probably less than the maximum permissible amount of capital borrowing indicated for some of the cases would occur if capital borrowing were a source of disutility to the farm operator.

The lack of use of intermediate term credit, and the low net incomes in the early periods and small potential for increases in incomes in subsequent periods from use of long-term credit would be consistent with the low level of indebtedness of farms in the area. The amount of loans outstanding was equal to about 10 percent of the value of land and buildings for all farms in the survey.

The results for the capital accumulation cases indicate that capital borrowed was yielding a return slightly higher than interest charges plus principal repayments. Therefore, if farmers either have an adequate supply of capital for investment or could arrange for capital investment from other sources not requiring repayment of principal, increased incomes from farming could result. In addition, low equity financing could also facilitate attainment of higher incomes. The potential for increasing incomes through capital accumulation within agriculture appears to be limited for those farmers who presently do not have a supply of capital for investment purposes, unless the practices and requirements of credit institutions with respect to repayment provisions and equity requirements are modified. Expansion of the present activities of the Federal Land Bank in providing loans not requiring repayment of principal could facilitate asset acquisition in this area.

In general, if an expansion in the size of farms occurs, some off-farm work opportunity for the families displaced would have to be provided. Hence, whether the increases in farm family incomes result from increased farm incomes or increased incomes from nonfarm work, more opportunity for off-farm work would be required. An increase in the incidence of part-time farming would appear more likely if employment were available in the immediate area. Such, however, would not necessarily hinder the adjustment in farm sizes required for higher farm incomes. As more off-farm employment becomes available, the transition process from farming to part-time farming to full-time work off farm and no farming could be accelerated. Thus, farm assets might become available for combination into larger farm units and expansion of farm size could be facilitated by provision of additional off-farm work opportunity. However, if the off-farm employment were of a seasonal nature such that some combination of farming and nonfarm employment would be desirable, organization of larger farm units could be impeded. Employment available in other areas sufficiently distant to require relocation of the family could facilitate the movement of surplus labor off the farms and perhaps remove some of the impediments to organization of the larger farm units.

In general, the results of this study imply that agricultural extension and rural development programs emphasizing improving farm technology in low-income counties of Eastern Oklahoma will probably enjoy only limited success with respect to increasing farm family incomes. However, combination of such programs with programs for assisting farms in the acquisition of additional capital assets (land, livestock, and equipment) through modification of institutional provisions of credit agencies as well as encouragement of investment from nonfarm sources may bring forth the desired results. Emphasis on provision of off-farm employment in the area as well as information relative to employment opportunities in other areas would likely result in both immediate and future improvements in the level of living of rural residents in this low-income area.

SELECTED BIBLIOGRAPHY

Allen, R. G. D. Mathematical Analysis for Economists. London: Macmillan and Company, Ltd., 1956.

__________. Mathematical Economics. London: Macmillan and Company, Ltd., 1939.

Back, W. B. "Economic Disequilibrium and the Low-Income Problem." (Unpublished paper presented to Southwest Social Science meeting, Dallas, Texas). April, 1957.

__________, Problems of Rural People in Latimer County. Department of Agricultural Economics, Oklahoma State University, mimeograph, Stillwater, 1957.

__________, and Verner G. Hurt. "Decision Processes for Understanding Capital Use on Individual Farms." Oklahoma Agricultural Experiment Station Journal Manuscript No. 557, Stillwater, 1960.

Bishop, C. E. "Public Policy and the Low-Income Problem." Farm Policy Forum, 8:4. Ames: The Iowa State College Press, 1956.

Boulding, K. E. A Reconstruction of Economics. New York: John Wiley and Sons, Inc., 1950.

__________. Economic Analysis, 3rd Edition. New York: Harper and Brothers, 1955.

Brewster, John M. and Howard L. Parsons. "Can Prices Allocate Resources in American Agriculture?" Journal of Farm Economics, XXVIII, November, 1956.

Carlson, Sune. A Study on the Pure Theory of Production. London: P. S. King and Son, Ltd., 1939.

Coutu, A. J. "Planning of Total Resource Use on Low-Income and Part-Time Farms." Journal of Farm Economics, XXXIX, December, 1957.

Darley, R. D. and R. C. Suter. Machinery Use and Investment on Missouri Farms. Missouri Agricultural Experiment Station Research Bulletin 536, Columbia, October, 1953.

Dorfman, Robert. Application of Linear Programming to the Theory of the Firm. Berkeley: University of California Press, 1951.

__________, P. A. Samuelson, and R. M. Solow. Linear Programming and Economic Analysis. New York: McGraw-Hill Book Company, Inc., 1958.

Fenton, F. C. and G. E. Fairbanks. The Cost of Using Farm Machinery. Kansas State College Bulletin 74, Manhattan, 1954.

Friedman, Milton and T. J. Savage. "The Utility Analysis of Choices Involving Risk." AEA Readings in Price Theory. Homewood: Richard Irwin, Inc., 1952.

Galbraith, J. K. "Inequality in Agriculture - Problem and Program." (Unpublished lecture, Guelph, Canada). Ontario College, November 16, 1956.

Gigoux, J. J. "Agricultural Development and Production Efficiency in Latimer County, Oklahoma." Unpublished Master of Science thesis, Department of Agricultural Economics, Oklahoma Agricultural and Mechanical College, Stillwater, August, 1957.

Gray, Fenton and H. M. Galloway. Soils of Oklahoma. Oklahoma State University Miscellaneous Publication No. 56, July, 1959.

Hart, Albert G. Anticipations, Uncertainty and Dynamic Planning. New York: Augustus M. Kelley, Inc., 1951.

Heady, E. O. Economics of Agricultural Production and Resource Use. New York: Prentice-Hall, Inc., 1952.

__________, and Wilfred Candler. Linear Programming Methods. Ames: The Iowa State College Press, 1958.

Hicks, J. R. Value and Capital, 2nd Edition. London: Oxford University Press, Ames House, 1946.

Johnson, Glenn. "Learning Processes, The Individual Approach." Proceedings of Research Conference on Risk and Uncertainty in Agriculture. North Dakota Agricultural Experiment Station Bulletin 400, Fargo, August, 1955.

Knight, F. H. Risk, Uncertainty and Profit. New York: Houghton, Mifflin Company, 1921.

Lafferty, D. G. Production Items, Costs and Returns for Winter Oats on Livestock Farms in the Arkansas Ozarks Area. Arkansas Agricultural Experiment Station Report Series 66, Fayetteville, May, 1957.

Loftsgard, L. D. and E. O. Heady. "Applications of Dynamic Programming Models for Optimum Farm and Home Plans." Journal of Farm Economics, XLI, February, 1959.

Marshall, Alfred. Principles of Economics, 8th Edition. New York: The Macmillan Company, 1948.

Mill, J. S. Essays on Some Unsettled Questions of Political Economy. Reprint of Scarce Works in Political Economy, London School of Economics and Political Science, No. 7, Essay V, 1948.

Richey, C. B. "Crop Machine Use." Agricultural Engineers Yearbook 5th Edition. American Society of Agricultural Engineers, 1958.

Sauerlender, O. H. "Level of Aspiration and Classical Utility Analysis." Unpublished Ph.D. dissertation, University of Minnesota, St. Paul, 1958.

Schultz, T. W. The Economic Organization of Agriculture. New York: McGraw-Hill Book Company, Inc., 1953.

Scitovsky, T. "A Note on Profit Maximization and Its Implications." Review of Economic Studies, II.

Shackle, G. L. S. Time in Economics. Amsterdam: North Holland Publishing Company, 1953.

Simon, H. A. Models of Man. New York: John Wiley and Sons, Inc., 1957.

Sutherland, J. G., et. al. An Economic Analysis of Farm and Non-Farm Uses of Resources on Small Farms in the Southern Piedmont, North Carolina. North Carolina Agricultural Experiment Station Technical Bulletin No. 138, Raleigh, 1959.

__________, and C. E. Bishop. Possibilities for Increasing Production and Incomes on Small Commercial Farms, Southern Piedmont Area, North Carolina. North Carolina Agricultural Experiment Station Technical Bulletin No. 117, December, 1955.

Tinbergen, J. "The Notion of Horizons and Expectancy in Dynamic Economics." Econometrica, I, 1933.

Tintner, Gerhard. "A Contribution to the Non-Static Theory of Production." In Lange, et. al., Studies in Mathematical Economics and Econometrics. Chicago, University of Chicago Press, 1941.

Tucker, E. A., et. al. Custom Rates for Farm Operations in Oklahoma. Oklahoma Agricultural Experiment Station Bulletin No. B-473, Stillwater, July, 1956.

United States Department of Agriculture, Agricultural Marketing Service. Agricultural Prices. Washington, D. C., 1953-59.

__________. Weekly Livestock Reports. Oklahoma City, 1951-58.

United States Department of Commerce, Bureau of the Census. "Characteristics of the Population." Census of Population: 1950, Vol. II, Part I, Washington, D. C., 1950.

United States House of Representatives, 84th Congress, 1st Session. Development of Agriculture's Human Resources. Washington, D. C.: United States Government Printing Office, House Document No. 149, April, 1955.

APPENDICES

APPENDIX A

STATISTICAL ANALYSIS FOR LATIMER SAMPLE

The decision to emphasize the problems and processes associated with capital accumulation in this study was to some extent based on the relationships between selected characteristics of farms in the Latimer County sample. The characteristics examined and their specification for the linear regression model were

Y = gross farm sales adjusted for variations in the livestock inventory, in dollars;

X_1 = capital investment in the farming operation other than land, adjusted for variations in livestock inventory;

X_2 = months of farm operator and farm family labor available per year; and

X_3 = acres in the farm operation adjusted for variations in the value of land and improvements.

Criteria used in obtaining adjusted values for the variables are presented in the section to follow.

The estimates obtained by use of least squares are indicated in Appendix Table I. The equations used for each classification of farms were[1]

(1) $Y = b_o + b_1X_1$

(2) $Y = b_o + b_1X_1 + b_3X_3$

---

[1]Fitting an equation of the form $Y = aX_1^{b_1} X_2^{b_2} X_3^{b_3}$ did not result in a larger R^2.

(3) $Y = b_o + b_1X_1 + b_2X_2 + b_3X_3$.

For each of the three farm classifications, little additional variation in adjusted gross farm sales was accounted for with equation (3) that was not accounted for by the solution using only capital as the independent variable. In addition, the negative sign associated with the regression coefficient for land for both the full-time and part-time farm groups indicates that perhaps land was underemployed. Similarly for labor for the full-time, but not for the part-time group. The failure of the land and labor variables to account for more additional variation, the size of the regression coefficients for capital, and the negative coefficients for land for both groups and labor for the full-time farm group suggest a limited utilization of capital relative to labor and land on the farms in the survey.

Procedure for Adjusting Variables

The following procedure was used to adjust gross farm sales and capital investment for changes in the livestock inventory. First of all, the ratio between total sales of livestock and the total value of the ending inventory of livestock was calculated as

$$\frac{S}{E}$$

where $S = \sum_{i=1}^{n}$ and $E = \sum_{i=1}^{n} e_i$ with s_i denoting the sales of livestock and e_i the ending livestock inventory for the i^{th} farm in the sample. If

$$\frac{s_i}{e_i} < \frac{S}{E}$$

an increasing inventory was suspected. Conversely, for a decreasing inventory. If this was such that

$$\frac{s_i}{e_i} \pm z = \frac{S}{E}, \quad 0 < z \leqslant .10$$

the gross farm sales were not adjusted. If there was a sufficiently large increase in inventory, then Δe_i was found such that

$$\frac{s_i}{e_i - \Delta e_i} + .10 = \frac{S}{E}$$

then Δe_i was added to the actual gross farm sales and deducted from the ending inventory of livestock. For an indicated decreasing inventory, Δs_i was found such that

$$\frac{s_i - \Delta s_i}{e_i} - .10 = \frac{S}{E} \quad .$$

Then Δs_i was deducted from gross farm sales and added to the ending inventory of livestock.

The acres in each farm were adjusted for differences in the value of land by the formula

$$\left(\frac{V_i}{2\overline{V}} + 1.00\right) \cdot a_i$$

where V_i denotes the value per acre on the i^{th} farm, $\overline{V}$, the mean value per acre for land in all farms in the sample, and a_i, the number of acres in the farm.

The months of labor available per farm for each of the classes of labor was determined as follows:

(1) For the farm operator and other males 21 years of age or older,

$$(12 - M)N$$

(2) For other males 14-21 years of age,

$$\left(\frac{12 - M}{2}\right) N$$

(3) For females 14 years of age or older,

$$\left(\frac{12 - M}{4}\right)N$$

where M denotes the months of work off farm by each individual and N represents the number of such individuals per farm. The sum of the amounts determined for each class plus the months of labor hired was taken as the amount of labor available on the farm.

APPENDIX TABLE I

RESULTS OF REGRESSION ANALYSES OF ADJUSTED GROSS FARM SALES, Y, CAPITAL INVESTMENT, X_1, LABOR AVAILABLE, X_2, AND ADJUSTED FARM SIZE, X_3, 48 FARMS, LATIMER COUNTY, OKLAHOMA, 1956

Classification	Number of Farms	Coefficients of Regression b_0	b_1 (capital) dollars	b_2 (labor) months	b_3 (land) acres	R^2
All farms	48					
Equation (1)	48	83.44	.233*			.735
Equation (2)	48	191.44	.251*		- .778	.751
Equation (3)	48	96.50	.252*	8.474	- .883	.753
Full-time farms	20					
Equation (1)	20	337.51	.236*			.768
Equation (2)	20	684.71	.287*		-2.101 **	.838
Equation (3)	20	872.27	.288*	-14.935	-1.989 **	.842
Part-time farms	28					
Equation (1)	28	264.32	.144*			.669
Equation (2)	28	214.49	.148*		- .298	.683
Equation (3)	28	183.40	.152*	9.085	- .436	.700

*$\alpha \leq .01$.

**$.01 \leq \alpha < .05$.

APPENDIX B

SOURCE OF DATA FOR THE ANALYSIS

Several different sources were used in obtaining the basic price and input-output data used in the models of this analysis. These sources and the selection of the coefficients which were used are discussed in the remainder of this section.

Prices: The prices received for beef cattle of the selected grades as used in this study were developed from the price quotations of the Oklahoma City, Oklahoma livestock market. These prices are the average of the prices for the months of September-October for the period 1951-1958. A price series for a period of this length was not available for either the Tulsa, Oklahoma or Fort Smith, Arkansas markets. However, a comparison of average prices by grades for these markets for a shorter period of time with the prices for the Oklahoma City market for the same period of time did not reveal any major differences, on the average, between markets. Hence, Oklahoma City market prices were used primarily because a series for a longer period of time was available (Appendix Table II).

Prices for feed grains were developed from a price series maintained by the United States Department of Agriculture. For grain sorghum, the expected price was assumed to be the average of the average price received by Oklahoma farmers per hundredweight in each of the crop years, 1953-58. Since the trend in corn prices during the same period was downward, the expected price for corn was assumed to be the lowest of the annual average prices received by Oklahoma farmers per bushel for the same period as above.

Prices paid by farmers for seed, feed and fertilizer were based on the average of current prices paid by all Oklahoma farmers, except as indicated in Appendix Table III.

Machinery and Equipment Costs: The costs of operating selected items of equipment exclusive of depreciation as used for this study were estimates based on studies conducted in other areas, as indicated in Appendix Table IV. Prices for new items of equipment were obtained from a survey of dealers serving the area. Depreciation charges for the selected items calculated by the straight-line method are indicated in Appendix Table V. Expected costs for custom hire of equipment for specified farm operations were developed from other studies (Appendix Table VI).

Enterprise Requirements and Yields: Estimates of resource requirements and yields for selected enterprises in the Ouachita Highlands area of Oklahoma were obtained from a survey of the county agricultural workers conducted by the Department of Agricultural Economics, Oklahoma State University, in 1957-58. These estimates were for farmers using tractor power and related equipment. Results of this survey were used in developing the enterprise budgets that were the basis of the input-output coefficients for the linear programming models of this study. Prior to a discussion of the specific enterprise budgets developed, some consideration of the rationale of this approach appears desirable.

County agricultural workers, in general, classified the land resources in their area as bottomland, good upland, poor upland and forested upland. Associated with each of these land classes were some input requirements and yield responses for all enterprises considered. Variations by enterprises in inputs and outputs for each class of land were distinguished by the agricultural workers when three types of management were considered. For example, these workers generally associated application of greater amounts of fertilizer and adherence to more of the recommended practices and consequently, higher yields with above average management as compared to average management. In general, little if any fertilizer use and following few or none of the recommended practices were considered as reflecting below average management on the part of the farm operator.

From averages of the estimates of the county agricultural workers of practices, labor and equipment requirements, fertilization rates, and yields for average management on the different classes of land, the enterprise budgets of Appendix B were developed. Some of the more important characteristics and assumptions related to the development of these budgets merit additional discussion.

A budget for the beef cattle enterprise, Appendix Table VII, was developed on the basis of a herd consisting of 25 brood cows; 4 heifers, two to three years old; 4 heifers, one to two years old; and one bull. Calves would be dropped in the spring and sold the following September or October. Expected sales were 21 calves at 470 pounds each and four cull cows weighing 900 pounds each. Costs and returns were computed on a per animal unit basis.

All of the hay, pasture and grain crop budgets were developed for ownership of all items of machinery and equipment except specialized harvesting equipment and planting equipment as indicated, Appendix Tables VIII to XII. Reductions in labor requirements and increases in cash costs for custom hire of all machinery and equipment for these enterprises are shown in Appendix Table XIII. Modifications in enterprise budgets to reflect above average yields are shown in Appendix Table XIV.

APPENDIX TABLE II

PRICES FOR PRODUCTS USED FOR FARM PROGRAMMING ANALYSES

Item	Unit	Highest	Average	Lowest
		dollars	dollars	dollars
Beef cattle:[a]				
Slaughter cows				
Commercial	Cwt.	27.06	15.59	11.29
Utility	Cwt.	23.25	13.61	9.51
Canner and cutter	Cwt.	18.24	10.69	6.98
Stocker and feeder steers (500 lbs. and less)				
Good and choice	Cwt.	36.24	23.70	16.76
Medium	Cwt.	29.50	18.94	12.72
Crops:[b]				
Corn	Bu.	1.50	1.35	1.15
Grain Sorghum	Cwt.	2.20	1.90	1.65

[a]United States Department of Agriculture, Agricultural Marketing Service, Livestock Division, Weekly Livestock Reports, Oklahoma City, Oklahoma, prices quoted under highest and lowest are the average of prices for any three-month period, September-October, during 1951-1958. Average prices are the average of prices for the months, September-October, 1951-1958.

[b]Estimated from United States Department of Agriculture, Agricultural Marketing Service, Agricultural Prices, Washington 25, D. C., based on average of weighted average prices for year, 1953-58, and highest (lowest) price during the period.

APPENDIX TABLE III

PRICES FOR INPUTS USED FOR FARM PROGRAMMING ANALYSES[a]

Item	Description	Unit	Price
			dollars
Seed:			
Clover, large hop		Lb.	1.00
Clover, Ladino		Lb.	.82
Corn	Hybrid	Bu.	10.50
Lespedeza, Kobe		Lb.	.11
Grain sorghum	Hybrid	Cwt.	16.50
Fertilizer:			
10-20-10		Ton	81.00
Superphosphate, 20%		Ton	41.50
Ground limestone[b]		Ton	6.20
Ammonium nitrate		Ton	87.00
Feed:			
Cottonseed meal		Ton	80.00
Prairie hay		Ton	15.00

[a]United States Department of Agriculture, Agricultural Marketing Service, Agricultural Prices, Washington, D. C., April, 1959, pp. 43-49; June, 1959, p. 33.

[b]Oklahoma State ASC office, average of prices for ground limestone delivered and spread, A-Area counties.

APPENDIX TABLE IV

ESTIMATED VARIABLE COSTS FOR SELECTED ITEMS OF EQUIPMENT FOR FARM PROGRAMMING ANALYSES

Item	Cost[a]	Repairs per Year		Lubrication per Year[b]		Use[b]	Repairs per Hour	Lubrication per Hour	Total Variable Cost	Total Variable Including Cost of Tractor
	dollars	percent	dollars	percent	dollars	hours	dollars	dollars	dollars	dollars
Tractor	2,300	3.5	80.50	.7	16.10	860	.09	.02	.11	.51
Plow, moldboard	234	7.0	16.38	.3	.70	150	.11	.01	.12	.63
Disc harrow	290	3.0	6.27	.5	1.05	140	.04	.01	.05	.56
Cultivator	270	3.5	9.45	.3	.81	140	.07	.01	.08	.59
Harrow, 3-sec. spiketooth	125	1.0	1.25	.1	.13	110	.01	--	.01	.52
Planter, 2-row w/fert. attach.	300	2.0	6.00	.5	1.50	100	.06	.02	.08	.59
Drill, 13-7' w/fert. attach.	593	1.5	8.90	.7	4.15	100	.09	.04	.13	.64
Mower, 7'	432	3.5	15.12	.7	3.02	100	.15	.03	.18	.69
Rake, s. delivery	532	2.0	10.64	.5	2.66	44[c]	.24	.06	.30	.81
Baler, pto twine	1,855	3.0	55.65	.8	14.84	93[c]	.60	.16	.56	1.07[d]
Rotary clipper	435	3.5	15.22	.7	3.04	100	.15	.03	.18	.69
E-Z-Flow, 12'	300	1.0	3.00	.7	2.10	50	.06	.04	.10	.62
Truck, 1/2 ton										1.00[e]

[a]Average of list prices of dealers serving area.

[b]F. C. Fenton and G. E. Fairbanks, The Cost of Using Farm Machinery, Kansas State College Bulletin 74, Manhattan, 1954.

[c]R. D. Darley and R. C. Suter, Machinery Use and Investment on Missouri Farms, 1951, Missouri Agricultural Experiment Station, Research Bulletin 536, Columbia, October, 1953, pp. 36-37.

[d]Plus twine at $.75 per ton.

[e]D. G. Laferty, Production Items, Costs and Returns for Winter Oats on Livestock Farms in the Arkansas Ozarks Area, Arkansas Agricultural Experiment Station Report Series 66, Fayetteville, May, 1957, p. 5.

APPENDIX TABLE V

CUSTOM RATES FOR SELECTED USES OF FARM MACHINERY FOR FARM PROGRAMMING ANALYSES[a]

Operation	Unit	Cost per Unit, dollars
Plowing	Acre	4.25[b]
Discing	Acre	1.50
Harrowing	Acre	.75
Planting and fertilizing (2-row)	Acre	1.75
Planting and fertilizing (E-Z-Flow)	Acre	1.50
Cultivating	Acre	1.25
Sprigging bermuda, including sprigs	Acre	14.00
Harvesting:		
Grain sorghum	Acre	5.00
Corn	Acre	5.00
Hay: Mowing and raking	Acre	1.85
Baling	Bale	.17
Hauling and storing:		
Grains	Bu.	.05
Hay	Bale	.08

[a]E. A. Tucker, et. al., Custom Rates for Farm Operations in Oklahoma, Oklahoma Agricultural Experiment Station Bulletin No. B-473, Stillwater, July, 1956.

[b]J. J. Gigoux, p. 95.

APPENDIX TABLE VI

ESTIMATED DEPRECIATION CHARGES FOR SELECTED ITEMS OF EQUIPMENT FOR FARM PROGRAMMING ANALYSES

Item	Initial Cost[a] dollars	Estimated Total Life[b] years	Annual Depreciation[d] dollars
Tractor, 2-plow, gasoline	2,300	11	209.09
Plow, moldboard, 2-14"	234	16	14.63
Disc harrow, 7' tandem	290	16	18.13
Cultivator, 2-row	270	12	22.50
Harrow, 3-sec., spiketooth	125	20	6.25
Planter, 2-row, w/fert. attachment	300	20	15.00
Rotary clipper	435	12[c]	36.25
E-Z-Flow, 12'	300	20	15.00
Mower, tractor, 7'	430	16	18.75
Rake, side delivery	530	15[c]	35.33
Baler, pick-up, pto	1,700	12[c]	141.68
Total	6,914		553.44

[a]Average of list prices of dealers serving area.

[b]F. C. Fenton and G. E. Fairbanks, p. 13.

[c]C. B. Richey, "Crop Machine Use," Agricultural Engineers Yearbook, 5th Edition, American Society of Agricultural Engineers, 1958, p. 77.

[d]Straight-line depreciation for total life. May assume that if sold prior to end of total life, trade-in or salvage value equals undepreciated value.

APPENDIX TABLE VII

ESTIMATED ANNUAL INCOME, EXPENSES, AND NET REVENUE PER ANIMAL UNIT OF BEEF CATTLE USED FOR FARM PROGRAMMING ANALYSES

Item		Price, dollars	Unit	Quantity	Amount, dollars
Income:[a]					
Cull cow	Canner & cutter	10.69	Cwt.	1.12	11.97
Stocker and feeder calf	Good & choice	23.70	Cwt.	3.10	73.47
Total income	Average prices				85.44
Expenses:					
Hay	Produced		Ton	1.48	
Veterinary charges					2.00
Salt			Lbs.	25.00	.30
Selling costs					2.00
Cottonseed meal	40% protein	4.00	Cwt.	1.80	7.20
Bull depreciation			A.U.		1.25
Total expense					12.75
Net revenue:					
	Average prices				72.69

Labor:

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1.0	.9	1.5	.3	.7	.3	.2	.2	.2	.7	.7	1.0	7.7

[a]Incomes determined using average prices (Appendix Table II).

APPENDIX TABLE VIII

ESTIMATED EXPENSES AND PRODUCTION PER ACRE OF BERMUDA AND CLOVER USED FOR FARM PROGRAMMING ANALYSES

Item	Description	Price, dollars	Unit	Quantity	Amount, dollars
Expenses:					
Tractor and machinery	Cash outlay	[a]	Hrs.	3.0	1.79
Fertilizer	10-20-10	4.05	Cwt.	2.0	8.10
Ground limestone	Delivered & spread	6.20	Ton	1.5	9.30
Clover, large hop		1.00	Lb.	1.0	1.00
Clover, Ladino		.82	Lb.	1.0	.82
Lespedeza, Kobe		.11	Lb.	10.0	1.10
Sprigging, Midland	Contract (including sprigs)	14.00	Acre	1.0	14.00
Total expense					36.11
Less ACP cost-share					20.65
Net expenses					15.46
Production:				Average	
Bottomland	Acres required per animal unit			2.5	
Good upland	Acres required per animal unit			3.5	
Poor upland	Acres required per animal unit			4.0	

Labor:

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
0.0	1.4	1.2	0.0	.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4

[a]See Appendix Table IV for costs of the various operations.

APPENDIX TABLE IX

ESTIMATED EXPENSES PER ACRE FOR PASTURE MAINTENANCE AS USED FOR FARM PROGRAMMING ANALYSES

Item	Description	Price dollars	Unit	Quantity	Amount, dollars
Expenses:					
Bermuda and clover:					
Fertilizer	0-20-0, every 3rd year	2.08	Cwt.	2.0	4.16
Fertilizer application	Every 3rd year, cash outlay	.62	Hrs.	0.4	.25
Clipping	Annually	.69	Hrs.	0.8	.55
Total	For 3rd year				4.96
Total	Annually				.55
Native pasture:					
Clipping	Annually	.69	Hrs.	0.8	.55
Total					.55

APPENDIX TABLE X

ESTIMATED INCOME, EXPENSES, AND NET RETURNS PER ACRE OF CORN AS USED FOR FARM PROGRAMMING ANALYSES

Item	Description	Price, dollars	Unit	Quantity	Amount, dollars
Income:					
Corn	On bottomland	1.15	Bu.	40	46.00
	On good upland	1.15	Bu.	21	24.15
Expenses:					
Machinery & equipment	Cash outlay	[a]	Hrs.	6.6	3.28
Fertilizer	10-20-10	4.05	Cwt.	2.0	8.10
Seed	Hybrid	.188	Lb.	10.0	1.88
Harvesting, bottomland	Custom				7.00
Harvesting, good upland	Custom				6.00
Total	Bottomland				20.26
	Good upland				19.86
Net Revenue:					
	Bottomland				25.74
	Good upland				4.29

Labor:

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
0.0	1.4	.9	.7	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1

[a]See Appendix Table IV for costs of performing the various operations.

APPENDIX TABLE XI

ESTIMATED INCOME, EXPENSES, AND NET RETURNS PER ACRE OF GRAIN SORGHUM AS USED FOR FARM PROGRAMMING ANALYSES

Item	Description	Price, dollars	Unit	Quantity	Amount, dollars
Income:					
Grain sorghum	On bottomland	1.90	Cwt.	17.5	33.25
	On good upland	1.90	Cwt.	10.5	19.95
Expenses:					
Machinery & equipment	Cash outlay	[a]	Hrs.	5.1	3.03
Fertilizer	10-20-10	4.05	Cwt.	1.5	6.08
Seed		.165	Lb.	10.0	1.65
Custom harvest		5.75	Acre	1	5.75
					16.51
Net revenue:					
	On bottomland				16.74
	On good upland				3.44

Labor:

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
0.0	0.0	1.4	.9	.7	2.1	0.0	0.0	0.0	0.0	0.0	0.0	5.1

[a]See Appendix Table IV for costs of performing the various operations.

APPENDIX TABLE XII

ESTIMATED PRODUCTION, REQUIREMENTS, AND COSTS PER ACRE OF HAY CROPS AS USED FOR FARM PROGRAMMING ANALYSES

Item	Description	Price, dollars	Unit	Quantity	Amount, dollars
Production:					
Lespedeza hay	On bottomland		Tons	1.4	
	On good upland		Tons	1.2	
Prairie hay	On bottomland		Tons	1.0	
	On good upland		Tons	.8	
Establishment cost:	(Lespedeza)				
Machinery & equipment	Cash outlay	[a]	Hrs.	3.1	1.87
Fertilizer	0-20-0	2.08	Cwt.	2.0	4.16
Seed	Kobe	.11	Lb.	25.0	2.75
Total					8.78
Mowing & raking	Cash outlay, all hay	[a]	Acre	1.0	3.71
Baling, hauling, & storing	Cash outlay				
Lespedeza hay	On bottomland	[a]	Acre	1.0	3.71
	On good upland	[a]	Acre	1.0	3.38
Prairie hay	On bottomland	[a]	Acre	1.0	3.05
	On good upland	[a]	Acre	1.0	2.72
Total cost:					
Lespedeza hay	On bottomland				12.49
	On good upland				12.16
Prairie hay	On bottomland				3.81
	On good upland				3.48

Labor requirements:

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Total
Lespedeza, bottomland	0	1.4	.9	.8	0	0	0	6.0	0	0	0	0	9.1
Lespedeza, good upland	0	1.4	.9	.8	0	0	0	5.4	0	0	0	0	8.5
Prairie hay, bottomland	0	0	0	0	0	0	0	4.8	0	0	0	0	4.8
Prairie hay, good upland	0	0	0	0	0	0	0	4.2	0	0	0	0	4.2

[a]See Appendix Table IV for costs of the various operations.

APPENDIX TABLE XIII

ADDITION TO TOTAL COSTS AND REDUCTION IN ANNUAL LABOR REQUIREMENTS FOR CUSTOM OPERATION OF ALL MACHINERY PER ACRE, BY ENTERPRISES, AS USED FOR FARM PROGRAMMING ANALYSES

Enterprise	Additional Cost	Reduction in Labor
	dollars	hours
Corn, bottomland	8.72	5.1
Corn, good upland	8.32	5.1
Bermuda-clover pasture, bottomland	1.21	1.0
Bermuda-clover pasture, good upland	1.21	1.0
Bermuda-clover pasture, poor upland	1.21	1.0
Native pasture, all land types	.45	.8
Lespedeza hay, bottomland	17.19	9.1
Lespedeza hay, good upland	15.96	8.5
Prairie hay, bottomland	6.60	4.8
Prairie hay, good upland	5.37	4.8

APPENDIX TABLE XIV

ADDITIONAL NET REVENUES, COSTS, AND NET RETURNS PER ACRE FOR ABOVE AVERAGE YIELDS AS COMPARED TO AVERAGE YIELDS, CORN AND BERMUDA-CLOVER PASTURE

Item		Unit	Bottom-land	Good Upland	Poor Upland
Bermuda-clover pasture:					
Yield	Requirement per animal unit	Acre	1.5	2.5	3.0
Additional cost:	100 lbs.; 10-20-10 per acre at establishment	Dols.	4.05	4.05	4.05
	100 lbs.; 0-20-0 per acre every third year	Dols.	2.08	2.08	2.08
Total		Dols.	6.13	6.13	6.13
Corn:					
Yield	Per acre	Bu.	55	32	
Additional total revenue	Per acre at $1.15 per acre	Dols.	17.25	13.80	
Additional cost:	100 lbs. amm. nitrate per acre	Dols.	4.35	4.35	
	Haul and store	Dols.	.75	.55	
Total		Dols.	5.10	4.90	
Additional net revenue	Per acre	Dols.	12.15	8.90	

VITA

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