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To the Graduate Council:

I am submitting herewith a thesis written by Gene Warren Turner entitled "Individual Farm Adjustments in the Mixed Soil Group, 90-159 Acres Open Land, Henderson County, Tennessee." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

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INDIVIDUAL FARM ADJUSTMENTS IN THE MIXED SOIL GROUP, 90-159 ACRES OPEN LAND, HENDERSON COUNTY, TENNESSEE

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements of the Degree

Master of Science

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by

Gene Warren Turner

June 1962

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CHAPTER I

INTRODUCTION

Adjustments within individual farm operations are a continuous necessity. This adjustment or reallocation of resources is necessary if farmers are to retain their income positions relative to other farmers and other segments of our economy. As a group, farmers tend to adjust reasonably well in the long run; however, farmers in the short run could benefit income-wise by speeding up adjustment.[1]

Many factors continually change which make a reallocation of resources necessary if profits are to be maximized. Variable farm commodity prices, variable labor supply, age, family responsibilities, family goals, changes in demand resulting in changes in income relationships among enterprises, government actions, cultural influences, and alternative employment opportunities are some of the factors which make adjustments necessary. The magnitude and type of adjustment made by an individual farmer is dependent on his managerial ability, capital available, knowledge of opportunities for adjustment, family goals, and his expected returns from the response to a change. The wide variability present in these instances makes it impossible to explain all individual adjustments.

Generally speaking, however, farmers have the following adjustment opportunities. First, they may not adjust and maintain their present

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[1]Norman Efferson, Principles of Farm Management (New York: McGraw-Hill Book Company, Inc., 1953), p. 17.

farm organization. Second, the present farm organization may be retained and part-time or full-time employment may be acquired off the farm. Third, internal adjustments in the farm organization may be made and part-time or full-time employment may be acquired off the farm. Fourth, internal adjustments may be made in the present farm organization involving resource reallocations and resulting changes in output levels. Fifth, the farm may be sold and the farmer move to other employment.

Many farmers are not fully aware of their intra-firm adjustment opportunities. Neither do businessmen and other nonfarmers always fully appreciate the opportunities to increase area income by individual farm adjustment. Many tend to look for opportunities to increase area income solely by bringing in new industry.

This is not to imply that increased industrial activity is not a part of the answer to farm problems. Rather, Schultz maintains that the two conditions necessary for economic progress in agriculture are:

> (1) a rate of expansion in secondary and tertiary industries sufficiently large to absorb the excess labor resources of agriculture, and (2) countercyclical action to maintain agricultural income on a more even level during the course of the business cycle.[2]

Agriculture must be cognisant of its part in our total economic and political economy. Free mobility of resources and people within and between all segments of our economy is necessary for our country's

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[2]Theodore W. Schultz, "Two Conditions Necessary for Economic Progress in Agriculture," Contemporary Readings in Agricultural Economics (New York: Prentice-Hall, Inc., 1955), pp. 202-203.

overall progress. Agriculture must move and share in the mainstream of our country's progress.[3]

Society has accepted the feeling that agriculture should share in and contribute toward the total economic and social progress of the nation. The question then arises as to how it is best to implement such a policy. Several measures have been in use and are currently in use, including public assistance programs, commodity support programs, incentive payments, and research and educational programs. The research and educational programs are the concern of this type of adjustment study. Such studies adopt the proposition that farmers, who so desire, can improve their social and economic position by having access to information which will enable them to make the decisions necessary to adjust their resource uses. Furthermore, it is accepted that adjustment is necessary for continued economic progress.

Agricultural workers and farmers have not always been supplied with specific guides or models to modify general relationships to fit individual farms in specific areas. Many times a gap has existed between general farm management principles and their application to individual farms.[4] Many agricultural workers lack adequate training in farm management and may work many years before developing a thorough understanding of the profit relationships among enterprises in their counties or areas

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[3]Kenneth H. Parsons and Wyn F. Owen, "Implications of Trends in Farm Size and Organization," Contemporary Readings in Agricultural Economics (New York: Prentice-Hall, Inc., 1955), p. 38.

[4]B. B. Williams and H. C. M. Case, "Research Attitudes in Farm Management," Contemporary Readings in Agricultural Economics (New York: Prentice-Hall, Inc., 1955), p. 51.

of responsibility. Adequate adjustment guides could provide new agricultural personnel and others interested in the progress of agriculture with information that would enable them to evaluate the overall adjustment possibilities for an area and to gain an understanding in a short time period that otherwise might take years to develop.

I. OBJECTIVES

The purpose of this thesis was to provide general guidelines that could be used by agricultural workers in working with farmers on adjustment problems and that could be used by the individual farmer in making adjustments. This information was based on conditions peculiar to Henderson County, Tennessee.

Specific objectives were: (1) to estimate an optimum combination of enterprises that would maximize income on a representative farm in the mixed soil group of Henderson County, and (2) to estimate the effect of various levels of investment capital and labor supply on farm income and organization.

II. PROCEDURE TO BE FOLLOWED

The linear programming technique was used to compute the most profitable farm organization. This technique lends itself well to an analysis of this type. It enables the researcher to examine the profitability of more enterprise combinations under various restrictions than would be practical by budgeting or other means of analysis.[5]

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[5] Earl O. Heady and Wilfred Candler, Linear Programming Methods (Ames, Iowa: The Iowa State College Press, 1958), p. 4.

An explanation of the selection of the representative farm resource situation and the necessity of using representative farms will be presented in Chapter II. Restrictions imposed and assumptions of the study will also be presented. The programming matrix will be presented and explained in Chapter III.

Several resource restrictions and enterprise choices were analyzed in this study. The one-man equivalent labor situation assuming unlimited capital will be explored in Chapter IV. The effect of various enterprise choices on net income will be estimated. The effects of restricted capital on net income and farm organization for a one-man labor equivalent situation will be discussed in Chapter V. The two-man equivalent labor situation assuming unlimited capital will be explored in Chapter VI. The effect of various enterprise choices on net income will be estimated.

III. EXPECTED VALUES AND LIMITATIONS OF THE STUDY

This study is only a beginning in aiding in individual farm adjustments. It should provide information that can be used by farmers and those working with farmers in making plans for and working toward farm adjustments. Wheeler states:

> The farm management worker cannot hope to provide ready made solutions for even the most important problems on each individual farm. But extensive analysis in terms of representative operating units will demonstrate appropriate ways of attacking particular problems; moreover, the solutions can be adjusted slightly to fit many situations similar to the ones actually analyzed.[6]

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[6]Richard G. Wheeler, "The Operating Unit Approach to Farm Management Analysis," Contemporary Readings in Agricultural Economics (New York: Prentice-Hall, Inc., 1955), p. 89.

The information developed cannot be applied to any one farm without modifications. Its value lies in its combination with the professional know-how, realistic approach, knowledge of the individual farm situation, and overall understanding of the competent agricultural advisor or individual farmer.

Normative answers, rather than positive answers, are provided by linear programming. Plans presented show what ought to be done in a given situation with given assumptions, rather than what will be done.[7]

The study is directly applicable to the mixed soil group of farms in Henderson County in the years immediately ahead, i.e., 1960-1975. However, it will also be applicable to other areas of the county and to areas outside the county having similar soils, markets, and climatic conditions.

Another possible value of this type of study is in the training of new agricultural personnel. Businessmen have already recognized the value of studies of this type using linear programming as a tool.[8]

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[7] Heady, op. cit., p. 8.

[8] Robert O. Ferguson and Lauren F. Sargent, Linear Programming: Fundamentals and Applications (New York, New York: McGraw-Hill Book Company, Inc., 1958), p. 12.

CHAPTER II

SELECTING THE REPRESENTATIVE RESOURCE AND ACTIVITY SITUATION

Choosing the criteria for selection of a representative farm is a difficult task. However, in attempting an analysis using a linear programming or budgeting techniques, it is necessary to start with discrete sets of resource situations which appear to be, at least, similar to those confronting a large majority of the population. The greater the population variability, with respect to certain sets of variables or characteristics, the more difficult it is to find at least one farm that will typify a substantial part of the observed population. The selection of a representative farm that represents as large a number of observations as possible increases the usefulness of the programming results by the breadth of applicability of the guide line solutions. It must be recognized that the applicability of such guides is a function of the set of conditions surrounding a particular farming situation and as such could be called case studies. The limitations of the case study approach is clearly discussed in numerous pieces of literature and will not be treated here.[9]

The restricting resources were used as the criteria in judging the essential variables constituting the representative farm. The selection of the representative 'land and soil composition' of the farm

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[9] James F. Thompson, "Defining Typical Resource Situations," Farm Size and Output Research, Oklahoma Agricultural Experiment Station, Southern Cooperative Series Bulletin No. 56 (Stillwater, Oklahoma: Oklahoma Agricultural Experiment Station, June 1958), pp. 32-43.

is discussed in the next section. The exogenous factors affecting a selection of alternative activities for the representative situation are discussed under 'markets and prices' in a second section. Finally, other assumptions used in specifying the representative farm resource situations are discussed in the last section.

I. LAND AND SOIL COMPOSITION

The first step in selecting the representative resource situation began with a cross-section farm survey in 1958. The survey was a joint undertaking of the Tennessee Agricultural Experiment Station, the Economics Branch of the Tennessee Valley Authority, and the Economics Research Service of the United States Department of Agriculture. There were several objectives of the survey, but the one of concern for the purpose of this thesis was an inventory of the 1957: (1) land resources with respect to acres and type of soil, (2) capital resources, and (3) labor supply. The census data for the last few years indicated a trend toward larger acreages per farm with a reduction in farm numbers. This trend has continued as the number of farms has declined about 26 per cent from the 1954 to the 1959 census period.[10] A sample of 220 farms was taken in 1958 and constituted approximately 10 per cent of the 1954 farm numbers in Henderson County. The observations for the survey were

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[10] United States Bureau of the Census, Nineteenth Census of the United States, 1960. 1959 Census of Agriculture Preliminary Reports, Henderson County, Tennessee (Washington: Government Printing Office, 1960), p. 1.

selected by interviewing all farmers who met certain criteria within randomly selected interview blocks.[11]

The soils on these 220 farms were classified into six soil groups. This classification was formulated by Gelfond and was based on information contained in the soil survey of Henderson County.[12]

Following are descriptions of the six soil groups.[13]

Group one--Units included were IIe-1, IIe-2, IIIe-1, and IIIe-2. These are well-drained upland or second bottom soils. All of these soils have a fragipan at a depth of 20 to 30 inches except IIe-1. They are nearly level to moderately sloping with slight to moderate erosion and are subject to more severe erosion when found on steeper slopes. Most row crops can be grown on these soils, but should not be grown more than two years in succession. Corn may suffer from drought during a normal growing season. These soils respond well to fertilization.

Group two--Units included were IIw-1 and IIIw-2. These are somewhat poorly to moderately well-drained soils with very little or no erosion. They are subject to overflow. With proper drainage and management, these soils are suited to continuous row cropping. Most crops commonly grown in this area are suited to these soils. Cotton may be late maturing during wet seasons.

Group three--Units included were IIIw-1 and IIIe-3. IIIw-1 soils are nearly level silty soils with fragipans at approximately two feet. They are somewhat poorly drained, low to fair in moisture supplying capacity, and have low natural fertility. The dominant problem is moderately severe water excess, while the secondary problem is the moisture fragipan. IIIe-3 soils are gently sloping

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[11]Farms that did not meet the 1954 Census of Agriculture definition of a farm were not used.

[12]United States Department of Agriculture, "Soil Survey, Henderson County, Tennessee" (United States Government Printing Office, 1960), pp. 1-55.

[13]Harold E. Gelfond, "Expectation of Productivity from the Soils of Henderson County, Tennessee, Under Several Models of Land Use" (unpublished Master's thesis, The University of Tennessee, Knoxville, 1960), p. 26.

and sloping, well-drained, deep, with moderate natural fertility and good moisture supplying capacity. The dominant problem is moderate erosion.

Group four--Units included were IVe-1, IVe-2, IVe-3, and VIe-1. These are moderate to well-drained upland or second bottom soils. They may vary from moderately to severely eroded, and sloping to strongly sloping soils. IVe-2 has a fragipan at a depth of 20 to 30 inches. These soils are best suited for hay and pasture. They can be cultivated once in five or six years under special management practices.

Group five--Units included were IVw-1 and IVw-2. IVw-1 soils are flat or almost level, poorly drained upland or terrace soils with little or no erosion. These soils have silty surfaces and pale yellow, finer textured subsoils over a fragipan or clay layer at 14 to 24 inches deep. Water moves slowly through the pan or clay layer. These soils are very wet in winter and continue so until late spring. In wet seasons, crops tend to drown out in low places; they are also droughty in dry summer months. Natural fertility is low and reaction is acid.

IVw-2 soils are nearly level, somewhat poorly drained soils having little or no erosion. The ground surface is easily worked and is underlain by gray or yellow subsoils. They are subject to overflow and have a high water table. Crops drown out in wet seasons, especially in low-lying areas. These soils are suitable for continuous cropping with proper management and drainage.

Group six--Units included are VIe-2, VIe-3, VIIe-1, and VIIe-2. These are moderately to well-drained upland or second bottom soils. They are sloping to steep, and are severely eroded or subject to severe erosion. These soils are suited only for permanent vegetation, either pasture or trees--better protected if left in trees. VIIe-2 is gravelly with a low water-holding capacity.

Gelfond further classified the 220 farms in the survey into five farm groups. His basis for this classification was the six soil groups defined above.[14] Following are descriptions of the five farm groups:

Farm Group I--50 per cent or more of the open land in soil Group one and/or Group three.

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[14] Ibid., p. 28.

Farm Group II--40 per cent or more of the open land in soil Group two.

Farm Group III--Less than 50 per cent of the open land in soil Group one, Group three, and Group four; or less than 40 per cent of the open land in soil Groups two and five.

Farm Group IV--50 per cent or more of the open land in soil Group four.

Farm Group V--40 per cent or more of the open land in soil Group five.

Each of these farm groups was further classified into four size groups.[15] This classification was based on acres of open land designated as crop land or pasture land in 1957. Following are descriptions of the four size groups:

Size Group I--Less than thirty acres in crop land or pasture.

Size Group II--From thirty to eighty-nine acres in crop land or pasture.

Size Group III--From ninety to 159 acres in crop land or pasture.

Size Group IV--More than 160 acres in crop land or pasture.

This thesis will be concerned with Farm Group III and Size Group III. Fifteen of the 220 farms surveyed were classified in this group.

Only three farms were classified in Farm Group I, Size Group III. It was felt that they were sufficiently similar to Farm Group III in Size Group III that they could be included in this study. Thus, eighteen farms are classed in Farm Group III in Size Group III. This group will

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[15] This classification was based on modal distribution of the farms involved.

be referred to as the mixed soil group during the remainder of this thesis. The eighteen farms in this group are assumed to be representative of approximately 180 farms in the county.

In selecting the representative farm, one of the eighteen farms was selected as most typical of the mixed soil group. Percentages of the total acreage in each soil group on this actual farm were compared with the average in each soil group on the eighteen farms. After studying this comparison, it was decided that the average acreage in each soil group could be assumed to compose the representative farm. Table I shows the composition of the farm assumed to be representative of the mixed soil group.

Percentage of woodland in Table I is the percentage of woodland on each soil group in Henderson County.[16] The same proportion of woodland was assumed to exist in the representative farm for the mixed soil group as was estimated for the county.

The fifty-nine acres of permanent woodland on the farm were not considered in programming the representative farm. The value of products from the woodland acreage can be added to the income from the various plans.

In developing plans for the farm, it was assumed that soil Group I land could be row cropped one out of three years. Row crops were limited to one-third of the soil Group I acreage or 15.33 acres per year. Alfalfa was also limited to 15.33 acres since about one-third

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[16] Gelfond, op. cit., pp. 150-154. (These percentages were originally from the Soil Conservation Needs Survey.)

TABLE I

REPRESENTATIVE FARM COMPOSITION

Soil Group[a]	Total, acres	Per cent woodland	Woodland acres	Waste and gullied areas, acres	Other land, acres	Open land, acres[b]
I	54.1	.045	2.4	0	5.7	46.0
II	36.6	.005	.2	0	0	36.5
III	6.4	.022	.1	0	.7	5.5
IV	39.4	.082	3.0	5.8	0	30.5
V	12.5	.554	6.9	0	0	5.5
VI	70.5	.663	46.7	11.8	0	12.0
Total	219.5		59.3	17.6	6.4	136.0

[a]Soil Groups one through six, as classified by Gelfond, are referred to as soil Groups I through VI throughout this thesis.

[b]Rounded to nearest .5 acre.

of the soils in this group were suitable for alfalfa production. These were the only restrictions placed on soil Group I land. Other enterprises could be produced as long as they were the most profitable alternatives.

Soil Group II was assumed to be suitable for continuous row cropping. This soil is subject to overflow and its use for alfalfa or small grain production and hog or beef feeding was not considered. The farm was assumed to have a fifteen-acre cotton allotment. Soil Group II land was considered to be the best cotton land on the farm and the possibility of cotton production was restricted to this soil.

Soil Groups III and V lands are poorly drained bottoms or upland subject to moderate erosion. Their use was restricted to either fescue and ladino clover or Bermuda grass pastures.

Soil Group IV land is sloping, to strongly sloping, to moderately steep. Its use was restricted to permanent pasture or temporary pasture. In developing the plan it was found that unless feeding out hogs on pasture was restricted, an unrealistic number would come into the plan. Hogs were, therefore, restricted to the number of sows and market hogs that could be grown and fed on soil Group IV. This restricted the number of sows on the farm to twenty-five sows or less.

Soil Group VI land is moderately steep to steep. Its use was restricted to permanent pastures of fescue and ladino clover or Bermuda grass, or pine trees for pulp wood and timber production.

II. MARKETS AND PRICES

Several exogenous factors were considered in selecting the variables or activities to be used in programming the representative farm situations. Markets and prices were two of the more important factors that were considered. Markets are available for the principal agricultural products currently being produced. Cotton has traditionally been the major cash crop in Henderson County. Hogs, beef cattle, dairy, and forestry products are other major sources of agricultural income.

Numerous cotton gins furnish adequate cotton marketing facilities. A limited market for Grade A milk exists; however, a relatively unlimited market for manufacturing milk is available with milk routes by the producing farms. Weekly auction markets for all classes of livestock are located at Lexington and Scotts Hill. A hog buying station was recently established at Decaturville, which is located twenty-one miles southeast of Lexington. This station buys hogs daily. In addition, the terminal markets at Nashville and Memphis can be reached in two to three hours time. Paved roads lead to Nashville, Memphis, Jackson, and to many points in the county and all weather roads are available in all areas of the county.

Three other markets of interest and recent origin are largely due to the activity of the Henderson County and surrounding county livestock associations. A feeder pig sale is held quarterly at Lexington, a feeder calf sale is held each fall at Huntingdon, and a fat cattle sale is held at Scotts Hill each February.

Wool and lamb pools are available at Jackson. Markets for specialty crops, such as strawberries, tree fruits, and vegetables, are not available, except in amounts that are consumed by the local population.

A pulpwood market for pine is located at Perryville; numerous saw mills operate throughout the county and competitive bidding can be obtained on saw timber.

Markets available, as well as the adaptability of the soil resources, were the principal factors used in determining the enterprises that would be considered on the representative farm. Specialty crops, such as strawberries, vegetables, poultry, and Grade A milk production, were not considered because of limited markets. These special enterprises have their place in the area and in a given situation with adequate managerial ability, they may be the best answer to a farmer's adjustment problem. Enterprises considered in this study are discussed in Chapter III.

Prices used in this study were projected long-range prices for 1975 that were developed for the S-42 project of which this study is a part.[17] The relationships among the prices used is extremely important in a study of this nature. It is the price relationships that determine the organization whereas the absolute prices determine the income levels. An enumeration of the prices used is shown in Table XXII in the Appendix.

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[17] S-42 is a Southern Regional Research Project. Its purpose is to economically appraise farm adjustment opportunities in the Southern region to meet changing conditions.

III. OTHER ASSUMPTIONS FOR REPRESENTATIVE FARM SITUATIONS

Assumptions dealing with labor, management, capital, and machinery are discussed in this section.

Labor

A study of the schedules of the eighteen farms comprising the mixed soil group showed that the average amount of family labor available to the farmers in this group was approximately equal to one-man equivalent of labor. Very little labor was hired, except during the planting and harvesting seasons. For purposes of this study optimum plans were estimated for one- and two-man equivalents of labor. One-man equivalent of labor was computed as 2,844 hours per year. The hours of labor per month were distributed by estimating days in the month and hours per day in which the operator would be available for farm work (Table II).

Labor was further divided into seven time periods. These periods were determined by the ranges in time within which important farm jobs could be performed (Table III). Labor for different purposes was assumed to be substitutable within the ranges of the periods selected. For example, corn could be planted any time in Period III (April 20 to May 31) but not in Period II or Period V. Additional labor could be hired for corn and cotton during Labor Periods III, IV, VI, and VII. The hours hired were limited to one-half the labor requirements for corn during these periods and ten-elevenths the labor requirements for cotton. No labor could be hired other than for corn or cotton. Labor

TABLE II

ONE-MAN EQUIVALENT OF LABOR

Month	Work days	Hours per day	Total hours per month
January	26	8	208
February	24	8	192
March	26	8	208
April	26	9	234
May	26	9	234
June	26	10	260
July	26	10	260
August	26	10	260
September	26	10	260
October	26	10	260
November	26	9	234
December	26	9	234
Total			2,844

TABLE III

LABOR TIME PERIODS

Time period	Dates of period			Hours labor in period
I	December	15-February	28	517
II	March	1-April	20	362
III	April	20-May	31	314
IV	June	1-July	15	390
V	July	15-August	15	260
VI	August	15-September	30	390
VII	October	1-December	15	611
Total				2,844

hired for corn production was assumed to be for planting, land preparation, or harvesting. By allowing only one-half the requirement to be hired it was assumed that one hired man could work along with a family laborer. Labor hired for cotton production was assumed to be for cotton chopping and/or picking. Ten-elevenths of this labor was allowed to be hired, assuming one man would supervise ten hired laborers. Hired labor was priced at seventy-five cents per hour for the type of labor required. Cotton pickers are normally paid by the pound, but seventy-five cents per hour is equivalent to $3.50-$4.00 per hundred pounds of cotton picked if the laborer picks about 170-215 pounds of cotton per day.

Management

Managerial ability was assumed to be at a level to enable the farm operator to achieve the levels of profitability and efficiency implied by the enterprise budgets. The only enterprise directly restricted, other than by land, labor, or capital, was sows producing market hogs. As mentioned previously, sow numbers were restricted to twenty-five. It was assumed that this was a reasonable number that farmers in the area could produce on the representative farm.

Capital

Capital was divided into two categories, investment capital and operating capital. Investment capital was considered to be any capital required for a period longer than one year or that which gave off a flow of services over one production period. Cost of buildings, equipment, machinery, establishing permanent pastures, establishing alfalfa, and

similar items were classed as investment capital. The cost of replacement livestock produced or grown from the farmer's herd was not considered an investment cost. This was assumed to be true because operating capital as feed, etc., is used to produce the replacement animals. The yearly cost charged as investment capital included depreciation, taxes, insurance, and interest on the investment at 6 per cent.

The investment capital figure should not be confused with the new value investment or average investment necessary to produce the enterprise under consideration. Investment capital in this study is the annual long-time investment cost of producing the given enterprise when all costs other than land are considered variable.

The second category of capital was operating capital. Operating capital was considered to be capital spent for services of items used up in one year or less. Feed, fertilizer for crops harvested in one year, hired labor, machinery operating costs, veterinary expenses, and similar items were classed as operating capital. Operating capital was divided into two classes: (1) operating capital committed for one year and (2) operating capital committed six months or less. Operating capital committed for six months included that used for cotton, soybeans, dairy, hogs, and beef steers bought for a six-month or shorter feed period. Cotton and soybeans are sold within a six-month period from the beginning of their production. Thus, operating capital was charged against these enterprises for six months. Dairy, hogs, and steers use operating capital for twelve months, but these enterprises produce income from marketings each six-month period or less.

Consequently, operating capital was charged against these enterprises only for a six-month period. Operating capital used per year was charged interest at a 3 per cent rate on the items listed above which is equivalent to 6 per cent for six months. Other items which required operating capital for a period of one year were charged for capital at a 6 per cent rate and included enterprises which produced feed, sheep, and beef enterprises, other than short-fed steers. For purposes of this study, operating capital was considered to be unlimited. The effects of restricting investment capital are discussed later.

Machinery

Investment costs and operating cost on the tractor were computed assuming the tractor to be used about 600 hours per year. Fixed costs on other machinery were calculated on the basis of normal hourly use for a farm of this size. The operator was assumed to own a corn picker. Preliminary budgeting indicated that with the amount of corn produced on the representative farm it was profitable to own a corn picker. Hay baling and combining were assumed to be custom hired. Cotton in the machine picked activities was custom picked.

CHAPTER III

THE PROGRAMMING MATRIX

A representative farm of 136 acres of open land was programmed for maximum profits.[18] The farm was planned with different labor and capital situations. The first labor and capital situation was a one-man resident labor force (Tables II and III in Chapter II), and unlimited investment and operating capital. The results of these plans are presented in the next chapter. Since capital was considered to be one of the most limiting inputs, the same resource situation was programmed with restricted investment capital as will be discussed in Chapter V. In addition, the same resource situation was planned using two-man equivalents of resident labor and unlimited capital. This situation is discussed in Chapter VI. The matrix used in programming these situations is presented in this chapter.

I. THE MATRIX

The matrix used to estimate the optimum farm organization with one-man labor equivalent and unlimited capital contained twenty-seven resource restrictions and forty-two real activities or variables (Table IV). The restriction or resource column of the matrix indicated the amount of each restricting resource available for use. The variable or activity

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[18] The solutions for all the programs were calculated on the IBM 1620 Electronic Computer at the University of Tennessee Computing Center.

TABLE IV

THE PROGRAMMING MATRIX

Cost or net revenue			0	-.06	-.03	-1.20
Resource or restriction	Unit	Amount	Name of activity: Investment capital P_1	Operating capital 1-yr. period P_2	Operating capital 6-mo. period P_3	Buy grain P_4
1. Soil Group I	Acre	46.00				
2. Rotation Oat-lespedeza	Acre	30.66				
3. Alfalfa	Acre	15.33				
4. Row crop	Acre	15.33				
5. Soil Group II	Acre	36.50				
6. Cotton	Acre	15.00				
7. Soil Groups III & V	Acre	11.00				
8. Soil Group IV	Acre	30.50				
9. Soil Group VI	Acre	12.00				
10. Investment capital	Dollar	0	-1.			
11. Operating capital 1-year period	Dollar	0		-1.		1.20
12. Operating capital 6-month period	Dollar	0			-1.	
13. Grain	Bushel	0				-1.
14. Labor period I	Hour	517				
15. Labor period II	Hour	362				
16. Labor period III	Hour	314				
17. Labor period IV	Hour	390				
18. Labor period V	Hour	260				
19. Labor period VI	Hour	390				
20. Labor period VII	Hour	611				
21. Spring hired labor	Hour	0				
22. Fall hired labor	Hour	0				
23. Forage period I	Cow day	0				
24. Forage period II	Cow day	0				
25. Forage period III	Cow day	0				
26. Forage period IV	Cow day	0				
27. Hay	Ton	0				

TABLE IV (continued)

THE PROGRAMMING MATRIX

	Cost or net revenue			1.10	-.75	-.75	-.75
	Name of activity			Sell grain	Hired, labor period III	Hired, labor period IV	Hired, labor period VI
Resource or restriction		Unit	Amount	P_5	P_6	P_7	P_8
1.	Soil Group I	Acre	46.00				
2.	Rotation Cat-lespedeza	Acre	30.66				
3.	Alfalfa	Acre	15.33				
4.	Row crop	Acre	15.33				
5.	Soil Group II	Acre	36.50				
6.	Cotton	Acre	15.00				
7.	Soil Groups III & V	Acre	11.00				
8.	Soil Group IV	Acre	30.50				
9.	Soil Group VI	Acre	12.00				
10.	Investment capital	Dollar	0				
11.	Operating capital 1-year period	Dollar	0				
12.	Operating capital 6-month period	Dollar	0		.75	.75	.75
13.	Grain	Bushel	0	1.			
14.	Labor period I	Hour	517				
15.	Labor period II	Hour	362				
16.	Labor period III	Hour	314		-1.		
17.	Labor period IV	Hour	390			-1.	
18.	Labor period V	Hour	260				
19.	Labor period VI	Hour	390				-1.
20.	Labor period VII	Hour	611				
21.	Spring hired labor	Hour	0		1.	1.	
22.	Fall hired labor	Hour	0				1.
23.	Forage period I	Cow day	0				
24.	Forage period II	Cow day	0				
25.	Forage period III	Cow day	0				
26.	Forage period IV	Cow day	0				
27.	Hay	Ton	0				

TABLE IV (continued)

THE PROGRAMMING MATRIX

	Name of activity			Hired, labor period VII	Corn	Alfalfa	Orchard grass ladino pasture
	Cost or net revenue			-.75	-34.34	-47.10	-17.00
	Resource or restriction	Unit	Amount	P_9	P_{10}	P_{11}	P_{12}
1.	Soil Group I	Acre	46.00		1.	1.	1.
2.	Rotation Oat-lespedeza	Acre	30.66			.66	.66
3.	Alfalfa	Acre	15.33			1.	.33
4.	Row crop	Acre	15.33		1.	.33	.33
5.	Soil Group II	Acre	36.50				
6.	Cotton	Acre	15.00				
7.	Soil Groups III & V	Acre	11.00				
8.	Soil Group IV	Acre	30.50				
9.	Soil Group VI	Acre	12.00				
10.	Investment capital	Dollar	0		11.38	17.20	8.60
11.	Operating capital 1-year period	Dollar	0		22.96	29.90	8.40
12.	Operating capital 6-month period	Dollar	0	.75			
13.	Grain	Bushel	0		-60.		
14.	Labor period I	Hour	517				.7
15.	Labor period II	Hour	362		2.1	.9	
16.	Labor period III	Hour	314		1.8	3.2	
17.	Labor period IV	Hour	390		1.5	2.6	4.8
18.	Labor period V	Hour	260			2.6	1.5
19.	Labor period VI	Hour	390			.9	2.6
20.	Labor period VII	Hour	611	-1.	3.8		
21.	Spring hired labor	Hour	0		-1.6		
22.	Fall hired labor	Hour	0	1.	-1.9		
23.	Forage period I	Cow day	0				-11.
24.	Forage period II	Cow day	0				-72.
25.	Forage period III	Cow day	0				-16.
26.	Forage period IV	Cow day	0				-11.
27.	Hay	Ton	0			-3.5	

TABLE IV (continued)

THE PROGRAMMING MATRIX

Cost or net revenue				-67.73	-57.21	-47.30	-57.82
Name of activity				Oats grain, lesp. hay, lesp. hay	Oats grain, lesp. hay, lesp. past.	Oats grain, lesp. past., lesp. past.	Oats grain, lesp. past., lesp. hay
Resource or restriction	Unit	Amount		P_{13}	P_{14}	P_{15}	P_{16}
1. Soil Group I	Acre	46.00		2.	2.	2.	2.
2. Rotation							
Oat-lespedeza	Acre	30.66		2.	2.	2.	2.
3. Alfalfa	Acre	15.33					
4. Row crop	Acre	15.33					
5. Soil Group II	Acre	36.50					
6. Cotton	Acre	15.00					
7. Soil Groups III & V	Acre	11.00					
8. Soil Group IV	Acre	30.50					
9. Soil Group VI	Acre	12.00					
10. Investment capital	Dollar	0		8.77	8.77	7.95	7.95
11. Operating capital							
1-year period	Dollar	0		58.96	48.44	39.35	49.87
12. Operating capital							
6-month period	Dollar	0					
13. Grain	Bushel	0		-28.8	-28.8	-28.8	-28.8
14. Labor period I	Hour	517		.3	.3	.3	.3
15. Labor period II	Hour	362		1.6	1.6	1.6	1.6
16. Labor period III	Hour	314		.8	.8	.8	.8
17. Labor period IV	Hour	390		.53			.53
18. Labor period V	Hour	260		3.9	3.7	5.7	1.1
19. Labor period VI	Hour	390		4.2	3.7	.53	1.1
20. Labor period VII	Hour	611					
21. Spring hired labor	Hour	0					
22. Fall hired labor	Hour	0					
23. Forage period I	Cow day	0					
24. Forage period II	Cow day	0			-18.	-33.	-15.
25. Forage period III	Cow day	0			-72.	-132.	-60.
26. Forage period IV	Cow day	0					
27. Hay	Ton	0		-3.6	-1.6		-2.

TABLE IV (continued)

THE PROGRAMMING MATRIX

Cost or net revenue				-33.50	-44.62	-49.56	89.80
Name of activity				Oats past., lesp. past., lesp. past.	Oats past., lesp. past., lesp. hay	Oats lesp. past., lesp. past. outside rotation	Cotton (machine picked)
Resource or restriction		Unit	Amount	P_{17}	P_{18}	P_{19}	P_{20}
1.	Soil Group I	Acre	46.00	2.	2.	2.	
2.	Rotation Oat-lespedeza	Acre	30.66	2.	2.		
3.	Alfalfa	Acre	15.33			.66	
4.	Row crop	Acre	15.33			.66	
5.	Soil Group II	Acre	36.50				1.
6.	Cotton	Acre	15.00				1.
7.	Soil Groups III & V	Acre	11.00				
8.	Soil Group IV	Acre	30.50				
9.	Soil Group VI	Acre	12.00				
10.	Investment capital	Dollar	0	4.34	4.34	4.60	11.30
11.	Operating capital 1-year period	Dollar	0	29.16	39.68	35.96	
12.	Operating capital 6-month period	Dollar	0				38.14
13.	Grain	Bushel	0				
14.	Labor period I	Hour	517	.6	.6	.6	
15.	Labor period II	Hour	362	1.4	1.4	1.4	
16.	Labor period III	Hour	314				15.9
17.	Labor period IV	Hour	390		.53		12.8
18.	Labor period V	Hour	260	.84	1.1	1.1	.5
19.	Labor period VI	Hour	390	.53	1.1	1.1	.3
20.	Labor period VII	Hour	611				
21.	Spring hired labor	Hour	0				-24.7
22.	Fall hired labor	Hour	0				
23.	Forage period I	Cow day	0	-33.	-33.	-66.	
24.	Forage period II	Cow day	0	-102.	-84.	-168.	
25.	Forage period III	Cow day	0	-144.	-72.	-144.	
26.	Forage period IV	Cow day	0	-11.	-11.	-22.	
27.	Hay	Ton	0		-2.		

TABLE IV (continued)

THE PROGRAMMING MATRIX

	Cost or net revenue			147.20	41.61	-36.30	32.88
	Name of activity			Cotton (hand picked)	Cotton one-fourth share	Corn	Soy-beans
	Measures or restriction	Unit	Amount	P_{21}	P_{22}	P_{23}	P_{24}
1.	Soil Group I	Acre	46.00				
2.	Rotation						
	Oat-lespedeza	Acre	30.66				
3.	Alfalfa	Acre	15.33				
4.	Row crop	Acre	15.33				
5.	Soil Group II	Acre	36.50	1.	1.	1.	1.
6.	Cotton	Acre	15.00	1.	1.		
7.	Soil Groups III & V	Acre	11.00				
8.	Soil Group IV	Acre	30.50				
9.	Soil Group VI	Acre	12.00				
10.	Investment capital	Dollar	0	11.12		12.38	7.36
11.	Operating capital						
	1-year period	Dollar	0			23.92	
12.	Operating capital						
	6-month period	Dollar	0	36.98	12.80		31.76
13.	Grain	Bushel	0			-90.	
14.	Labor period I	Hour	517				
15.	Labor period II	Hour	362			2.1	2.5
16.	Labor period III	Hour	314	15.9		1.8	1.2
17.	Labor period IV	Hour	390	12.8		1.5	2.1
18.	Labor period V	Hour	260	.5			.7
19.	Labor period VI	Hour	390	30.8			2.3
20.	Labor period VII	Hour	611	57.2		4.4	
21.	Spring hired labor	Hour	0	-24.7		-1.6	
22.	Fall hired labor	Hour	0	-80.		-2.2	
23.	Forage period I	Cow day	0				
24.	Forage period II	Cow day	0				
25.	Forage period III	Cow day	0				
26.	Forage period IV	Cow day	0				
27.	Hay	Ton	0				

TABLE IV (continued)

THE PROGRAMMING MATRIX

	Cost or net revenue			-15.01	-14.10	-15.42	-16.04
	Name of activity			Orchard grass and ladino	Fescue and ladino	Bermuda	Fescue and ladino
	Resource or restriction	Unit	Amount	P_{25}	P_{26}	P_{27}	P_{28}
1.	Soil Group I	Acre	46.00				
2.	Rotation Oat-lespedeza	Acre	30.66				
3.	Alfalfa	Acre	15.33				
4.	Row crop	Acre	15.33				
5.	Soil Group II	Acre	36.50	1.			
6.	Cotton	Acre	15.00				
7.	Soil Groups III & V	Acre	11.00		1.	1.	
8.	Soil Group IV	Acre	30.50				1.
9.	Soil Group VI	Acre	12.00				
10.	Investment capital	Dollar	0	6.61	6.75	6.18	8.69
11.	Operating capital 1-year period	Dollar	0	8.40	7.35	9.24	7.35
12.	Operating capital 6-month period	Dollar	0				
13.	Grain	Bushel	0				
14.	Labor period I	Hour	517	.7	.8	.6	.8
15.	Labor period II	Hour	362			6.1	
16.	Labor period III	Hour	314		.9	.7	.9
17.	Labor period IV	Hour	390	4.8	4.3		4.3
18.	Labor period V	Hour	260	1.5	1.3		1.3
19.	Labor period VI	Hour	390	2.6	2.4		2.4
20.	Labor period VII	Hour	611				
21.	Spring hired labor	Hour	0				
22.	Fall hired labor	Hour	0				
23.	Forage period I	Cow day	0	-15.	-24.		-19.
24.	Forage period II	Cow day	0	-97.	-60.	-60.	-45.
25.	Forage period III	Cow day	0	-23.	-24.	-60.	-4.
26.	Forage period IV	Cow day	0	-15.	-12.		-7.
27.	Hay	Ton	0				

TABLE IV (continued)

THE PROGRAMMING MATRIX

	Cost or net revenue			-20.28	-12.93	2.96	-12.93
	Name of activity			Oats past., lesp. past.	Bermuda lesp.	Pine trees	Bermuda lesp.
Resource or restriction		Unit	Amount	P_{29}	P_{30}	P_{31}	P_{32}
1.	Soil Group I	Acre	46.00				
2.	Rotation Oat-lespedeza	Acre	30.66				
3.	Alfalfa	Acre	15.33				
4.	Row crop	Acre	15.33				
5.	Soil Group II	Acre	36.50				
6.	Cotton	Acre	15.00				
7.	Soil Groups III & V	Acre	11.00				
8.	Soil Group IV	Acre	30.50	1.	1.		
9.	Soil Group VI	Acre	12.00			1.	1.
10.	Investment capital	Dollar	0	2.30	7.30	2.95	7.30
11.	Operating capital 1-year period	Dollar	0	17.98	5.63		5.63
12.	Operating capital 6-month period	Dollar	0				
13.	Grain	Bushel	0				
14.	Labor period I	Hour	517	.3			.6
15.	Labor period II	Hour	362	.7			6.1
16.	Labor period III	Hour	314		.7		.7
17.	Labor period IV	Hour	390				
18.	Labor period V	Hour	260	.54			
19.	Labor period VI	Hour	390	.53			
20.	Labor period VII	Hour	611				
21.	Spring hired labor	Hour	0				
22.	Fall hired labor	Hour	0				
23.	Forage period I	Cow day	0	-30.			
24.	Forage period II	Cow day	0	-75.	-37.		-20.
25.	Forage period III	Cow day	0	-60.	-38.		-20.
26.	Forage period IV	Cow day	0	-10.			
27.	Hay	Ton	0				

TABLE IV (continued)

THE PROGRAMMING MATRIX

	Cost or net revenue			41.68	325.20	52.64	187.12
	Name of activity						
				Sheep	Market hogs	Feeder pigs	Dairy
	Resource or restriction	Unit	Amount	P_{33}	P_{34}	P_{35}	P_{36}
1.	Soil Group I	Acre	46.00	.43			
2.	Rotation Oat-lespedeza	Acre	30.66	.43			
3.	Alfalfa	Acre	15.33				
4.	Row crop	Acre	15.33				
5.	Soil Group II	Acre	36.50				
6.	Cotton	Acre	15.00				
7.	Soil Groups III & V	Acre	11.00				
8.	Soil Group IV	Acre	30.50		1.25	.75	
9.	Soil Group VI	Acre	12.00				
10.	Investment capital	Dollar	0	31.00	36.99	28.72	25.63
11.	Operating capital 1-year period	Dollar	0	10.02			
12.	Operating capital 6-month period	Dollar	0		114.20	60.86	74.52
13.	Grain	Bushel	0	4.4	186.20	47.44	26.80
14.	Labor period I	Hour	517	9.44	16.4	15.9	21.4
15.	Labor period II	Hour	362	2.59	9.8	9.8	11.1
16.	Labor period III	Hour	314	2.35	7.4	3.7	8.2
17.	Labor period IV	Hour	390	.9	9.6	4.75	9.1
18.	Labor period V	Hour	260	.6	6.9	3.5	6.2
19.	Labor period VI	Hour	390	.9	10.04	10.0	9.2
20.	Labor period VII	Hour	611	3.66	14.45	12.5	19.9
21.	Spring hired labor	Hour	0				
22.	Fall hired labor	Hour	0				
23.	Forage period I	Cow day	0				40.
24.	Forage period II	Cow day	0	3.96			132.5
25.	Forage period III	Cow day	0	.98			115.
26.	Forage period IV	Cow day	0	.9			20.
27.	Hay	Ton	0	.3			2.81

TABLE IV (continued)

THE PROGRAMMING MATRIX

	Cost or net revenue			45.24	91.69	68.31	99.99
	Name of activity			Beef (1)	Beef (2)	Beef (3)	Beef (4)
	Resource or restriction	Unit	Amount	P_{37}	P_{38}	P_{39}	P_{40}
1.	Soil Group I	Acre	46.00				
2.	Rotation Cat-lespedeza	Acre	30.66				
3.	Alfalfa	Acre	15.33				
4.	Row crop	Acre	15.33				
5.	Soil Group II	Acre	36.50				
6.	Cotton	Acre	15.00				
7.	Soil Groups III & V	Acre	11.00				
8.	Soil Group IV	Acre	30.50				
9.	Soil Group VI	Acre	12.00				
10.	Investment capital	Dollar	0	10.84	10.84	22.89	31.56
11.	Operating capital 1-year period	Dollar	0	103.31	115.71	4.10	11.15
12.	Operating capital 6-month period	Dollar	0				
13.	Grain	Bushel	0		13.89		
14.	Labor period I	Hour	517	1.8	1.8	4.7	6.1
15.	Labor period II	Hour	362	.7	.7	1.6	2.2
16.	Labor period III	Hour	314	.4	.4	.57	.89
17.	Labor period IV	Hour	390	.45	.45	.60	.84
18.	Labor period V	Hour	260	.4	.3	.41	.4
19.	Labor period VI	Hour	390	.15	.9	.70	.7
20.	Labor period VII	Hour	611	1.15	4.0	3.37	4.29
21.	Spring hired labor	Hour	0				
22.	Fall hired labor	Hour	0				
23.	Forage period I	Cow day	0	38.45	38.45	20.	51.
24.	Forage period II	Cow day	0	77.90	77.90	140.	203.
25.	Forage period III	Cow day	0	49.60	49.60	135.	135.
26.	Forage period IV	Cow day	0	18.6	18.60	49.	64.
27.	Hay	Ton	0	.85	1.08	1.8	2.48

TABLE IV (continued)

THE PROGRAMMING MATRIX

	Cost or net revenue			121.95	26.89
	Name of activity			Beef (5)	Beef (6)
Resource or restriction		Unit	Amount	P_{41}	P_{42}
1.	Soil Group I	Acre	56.00		
2.	Rotation Cat-lespedeza	Acre	30.66		
3.	Alfalfa	Acre	15.33		
4.	Row crop	Acre	15.33		
5.	Soil Group II	Acre	36.50		
6.	Cotton	Acre	15.00		
7.	Soil Groups III & V	Acre	11.00		
8.	Soil Group IV	Acre	30.50		
9.	Soil Group VI	Acre	12.00		
10.	Investment capital	Dollar	0	31.56	
11.	Operating capital 1-year period	Dollar	0	18.28	
12.	Operating capital 6-month period	Dollar	0		172.70
13.	Grain	Bushel	0	11.12	13.89
14.	Labor period I	Hour	517	6.1	
15.	Labor period II	Hour	362	2.2	
16.	Labor period III	Hour	314	.89	
17.	Labor period IV	Hour	390	1.74	
18.	Labor period V	Hour	260	1.6	
19.	Labor period VI	Hour	390	2.2	
20.	Labor period VII	Hour	611	4.3	3.5
21.	Spring hired labor	Hour	0		
22.	Fall hired labor	Hour	0		
23.	Forage period I	Cow day	0	51.	
24.	Forage period II	Cow day	0	203.	
25.	Forage period III	Cow day	0	135.	
26.	Forage period IV	Cow day	0	64.	
27.	Hay	Ton	0	2.66	.23

columns indicated the amount of a restricted resource required by one unit of a particular variable or activity under consideration. For example, row 5 in the resource column indicated that 36.5 acres of soil Group II were available for use. One unit of activity number 24 required one acre of this resource and was indicated by the number "one" at the intercept of row 5, column 24. Consequently, the total number of times activity 24 could enter the solution was restricted to 36.5 times. Likewise, any combination of activities entering the solution could use no more than 36.5 acres of soil Group II.

A zero in the resource or restriction column indicated that the resource was, in effect, unlimited. The restriction in row 10, for example, was unlimited as long as conditions imposed by other aspects of the plan were met. For this unlimited condition to exist, however, a negative number usually appears in an activity column in row 10 provided some other activity contained a positive coefficient in this row. In this case a negative one appeared in activity 1. Each time a dollar of investment capital was required by an activity with a positive coefficient, it was necessary that activity 1 enter the solution by the required amount.

Resource or Restriction Column

Rows 1 through 4 in the resource column composed the rotation on soil Group I.[19] Other land restrictions were shown in rows 5 through

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[19]The row crop restrictions in the rotation for soil Group I were discussed in Chapter II. The format allowed the system to choose the most profitable rotation scheme from simple enterprise budgets, and thus reduced the number of combined budgets necessary to accomplish the same purpose.

9 in which simple rotations were assumed, i.e., continuous row crop or forage cover. Capital restrictions were unlimited as shown in rows 10, 11, and 12. Row 13 made it possible to bring grain into the solution as long as it was profitable to produce or purchase grain. Restrictions on hours of labor that could be used in labor periods I through VII are shown in rows 14 through 20. Rows 21 and 22 provide for hiring additional labor in planting and harvesting seasons. A zero appears in the resource column and negative signs appear in the corn and cotton activities in these rows indicating the maximum number of hours of labor that can be hired each time an acre of a cotton- or corn-producing activity comes into the solution. Forage was restricted in rows 23 through 26. Forage could be produced in the corresponding forage period as long as it was profitable and as other restrictions permitted. Hay production was restricted by row 27 and could be produced subject to the same restrictions as forage days.

Cost or Net Revenue Row

The cost or net revenue row in Table IV shows the cost of producing a unit of an activity or the net revenue received from the production of a unit of activity. Minus signs indicated that the activity costs the designated amount. Activities that were used in the production of other activities are sometimes called intermediate activities. Examples of such activities are corn, hay, and pasture. Costs of intermediate activities were entered in the cost row at cost of production. Thus, returns to intermediate activities were reflected in the livestock activities that used them. Positive signs indicated

that a unit of the activity produced a given net revenue in the net revenue or cost row. Net revenue does not always have the same meaning in the net revenue row as it has in conventional budgets. It ordinarily represents estimated returns to labor and management. In this study this was true of cotton, soybeans, and pine trees. In other cases it was not true; for example, the net revenue figure in the beef activities represented returns to land, labor, management, pasture, hay, and grain and the net revenue in the hog activities represented returns to land, labor, management, and grain. Other differing examples were also present in the activities. By handling net revenue in this manner, an activity such as beef was allowed to choose inputs from intermediates that would minimize cost of production, thus maximizing net revenue.

Activities or Matrix Columns

Two types of activities were used in formulating the matrix. Forty-two of these activities were nonbasic or real activities and twenty-seven were the basic or slack activities.[20] There were three categories of nonbasic activities: (1) the purchasing and selling, (2) crop, and (3) livestock activities. These activities are discussed in the subsections that follow.

Purchasing and selling activities. Purchasing and selling activities were used to reduce the size of the matrix and in some

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[20] Slack activities are sometimes called artificial or disposal activities and are necessary to transform the equation into equalities for obtaining a solution.

instances served as transfer activities. The purchasing activities were entered at the cost of acquisition in the net revenue row with a negative coefficient in a particular resource row, thus increasing the quantity of the restricting resource when it was necessary to use this activity in the solution. Conversely, a selling activity contained a positive coefficient in a resource row and decreased the quantity of the restricted resource. The purchasing activities reduced the numbers of other activities required that were connected with a particular restriction. For example, only one activity for feeding hogs with purchased or home produced grain was required when corn was entered as a restriction. Without the corn restriction two hog-producing activities would have been required, i.e., one for home-produced grains and another for purchased grains. An aid in understanding the effect of purchasing and selling activities on the supply of resource is to understand that a negative coefficient in a resource row adds to that particular resource if the activity in question enters the solution and a positive coefficient takes from or uses the resource. The above statement also applies to transfer activities. Transfer activities merely transfer resources from one resource row to another.

Four purchasing and selling activities were used in the matrix. They were capital purchasing, grain purchasing, labor purchasing, and grain selling.

Activities 1, 2, and 3 were capital purchasing activities. Investment capital was purchased by activity 1, operating capital used for the entire year by activity 2, and operating capital used for a six-month

period by activity 3. Activity 4 allowed grain to be purchased and activity 5 allowed grain to be sold. Activities 6, 7, 8, and 9 allowed labor to be hired in periods III, IV, VI, and VII. These labor hiring activities were transfer activities in that they transferred labor permitted to be hired in cotton or corn production to the given resident labor period that was limiting the output.

Crop activities. The crop activities were governed by the soil restrictions outlined in Chapter II. Crop activities, except for cotton and soybeans, were intermediate activities. The only small grain used in the crop activities was oats. It was used because of its flexibility of use for pasture, hay, grain, or combinations of these uses. By the use of appropriate grain conversion factors and by substituting any changed inputs in the budgets, the effect of including other small grains on feed supply and net income can be estimated. Grain produced in the crop activities was converted to bushels of corn equivalent (Table V). Thus, by observing row 13 in the matrix the yields of the various grain activities can be determined. Hay produced was converted to tons of lespedeza hay equivalent. Likewise, row 27 shows the yields of the various hay activities. Pasture produced from various forage was converted to cow acre days of grazing (Table VI). Yearly pasture production was divided into four grazing periods. These grazing periods were considered to be representative of the ranges within which the forage producing activities could be grazed. Forage days of grazing from one pasture were allowed to substitute for another forage

TABLE V

GRAIN AND HAY CONVERSION FACTORS[a]

Crop	Tons to equal one ton lespedeza hay	Bushels to equal one bushel corn
Lespedeza	1.000	
Alfalfa	.909	
Corn		1.000
Oats		1.597

[a]Frank B. Morrison, Feeds and Feeding, (twenty-second edition; Ithaca, New York: The Morrison Publishing Company, 1956), pp. 1,073, 1,078, 1,079.

TABLE VI

COW-ACRE DAYS OF GRAZING FOR SELECTED PASTURE MIXTURES BY SOIL GROUP

Soil Group	Orchard grass and ladino	Fescue and ladino	Bermuda	Oats	Lespedeza
I	110			110	90
II	150				
III		120	120		
IV		75	75	100	75[a]
V		120	120		
VI		30	40		

[a]Also use this figure for lespedeza following oats on Group I soils.

within a period. Dates of the grazing periods and percentage of total pasture production available per pasture period are listed in Table VII.

Activities 10 through 19 utilized soil Group I. Activities 10, 11, and 12 were acre units of corn, alfalfa, and orchard grass-ladino pasture, respectively. Activities 13 through 18 were two-acre units of oats and lespedeza the first year, followed by lespedeza the second year. Actually, they represent one acre of oats and lespedeza and one acre of lespedeza. These activities were combinations of oats for grain or pasture and lespedeza for hay or pasture. They were a part of the three-year soil Group I rotation of one-year row crop, one-year oats followed by lespedeza, and one-year lespedeza. Activity 19 was a two-acre unit of oats and lespedeza for pasture. It could enter the solution outside the three-year rotation.

Activities 20 through 25 were acre units on soil Group II. Activities 20, 21, and 22 were cotton. Activity 20 was custom-machine-picked cotton, activity 21 was hand-picked cotton, and activity 22 allowed cotton to be rented out. Hand-picked and machine-picked cotton were estimated to yield 725 and 690 pounds of lint, respectively. In activity 22 the landlord furnished one-fourth of the seed, fertilizer, pesticide, ginning, and all the land, and received one-fourth the gross revenue. The yield per acre was the same as the hand-picked cotton activity. The tenant furnished three-fourths of the cash expenses, all the labor, and received three-fourths of the gross revenue. Activities 23 through 25 were corn, soybeans, and orchard grass-ladino clover pasture, respectively. Soybeans were assumed to yield thirty-five bushels per acre.

TABLE VII

PERCENTAGE OF GRAZING AVAILABLE BY GRAZING PERIODS FOR PASTURES AND SOIL GROUPS[a]

Soil Group	Dates of grazing periods	Orchard grass-ladino Soils I & II	Fescue-ladino Soils III & V	Fescue-ladino Soils IV & VI	Bermuda all soils	Lespedeza all soils	Oats all soils
I	November 1-March 15	10	20	25	0	0	30
II	March 16-June 30	65	50	60	50	20	60
III	July 1-September 30	15	20	5	50	80	0
IV	October 1-October 31	10	10	10	0	0	10

[a]These forage distributions were obtained from consultation with agronomy personnel.

Activities 26 and 27 were acre units of fescue-ladino clover and Bermuda grass for pasture on soil Groups III and V.

Activities 28, 29, and 30 were acre units of fescue-ladino clover, oats and lespedeza for pasture and Bermuda-lespedeza pastures, respectively, on soil Group IV.

Activities 31 and 32 were acre units of pine trees and Bermuda-lespedeza for pasture on soil Group VI. The pines were assumed to be thinned for pulpwood at twenty-year intervals and sold for sawlogs at fifty years of age. All timber sales were stumpage sales. The returns were discounted to the present value of an annuity yielding 6 per cent interest.

Livestock activities. Activities 33 through 42 were livestock activities. None of the livestock activities were credited with manure produced. Activity 33 was a unit of three ewes producing spring lambs, activity 34 was one sow producing two litters of pigs per year. Hogs were produced on pasture with each sow requiring 1.25 acres of pasture which was restricted to soil Group IV. Pasture costs were included in the hog budgets. Hogs were sold as top slaughter hogs with eight pigs per litter weaned. Activity 35 was the same as activity 34, except that the pigs were sold as forty-pound feeders and sows required .75 acre of pasture. Activity 36 was one cow producing 7,500 pounds of manufacturing milk per year. A modern V-type or similar type milking parlor was assumed.

Activities 37 through 42 represented six types of beef cattle systems. Activity 37 was one beef steer bought about October first and sold off pasture the following fall, about September first. The steer

was assumed to grade good to choice when bought and high standard when sold. Buying weight was 450 pounds and selling weight was 820 pounds. Except for cottonseed oil meal and hay fed during the winter months, the only feed was pasture. Activity 38 was one beef steer handled in the same manner as activity 37, except that the steer was put on feed September first and fed a corn-cob and cottonseed meal mixture for about seventy days before selling. Sale date was about November tenth at a weight of 970 pounds, grading good to choice. Activity 39 was one beef cow producing a 90 per cent calf crop. Calves were dropped in February and sold about October first, weighing 490 pounds. Activity 40 was the same as activity 39, except that the calves were kept over the winter and sold the next July weighing 820 pounds and grading high standard. Activity 41 was the same as activity 40, except that the calves were put on a seventy-day feed July first and sold about September tenth. Calves weighed about 970 pounds and graded good to choice when sold. Activity 42 was buying one 780-pound steer grading good to choice. The steer was considered to be on feed from October first to December tenth. Activities 37 through 41 are referred to as Beef (1) through Beef (6) in the matrix.

Slack activities. The twenty-seven slack activities are not shown in the matrix in Table IV, but were automatically introduced by the computer before beginning computation for a solution. The number of slack variables or activities introduced always corresponds to the number of restrictions in the matrix. Thus, twenty-seven restrictions required

twenty-seven slack variables.[21] The slack variables were numbered consecutively beginning with the number following the last real activity or variable. In this matrix, the last real activity was number 42 and the first slack was number 43. The slacks that entered the solution indicated the amount of a resource which was not used by the real or nonbasic activities. For example, slack number 43 represents the amount of the first restriction that was unused and slack number 44 shows the amount of the second restriction that was unused.

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[21] Introduction of a penalty cost on a given slack can be used to force the use of all the corresponding resource, i.e., it will force an equality in the solution.

CHAPTER IV

OPTIMUM INCOME PLANS FOR THE ONE-MAN RESIDENT LABOR AND UNLIMITED CAPITAL SITUATIONS

The amount of resident labor available was equal to about one-man equivalent on the eighteen farms in the mixed soil group. Acreage of open land ranged from 90 to 159 acres. The discussion in this chapter will be devoted to variations of the one-man resident labor situation under the assumptions and restrictions shown in the programming matrix in Chapter III. Four plans were developed using different output-price and enterprise-preference assumptions (Table VIII). Capital was assumed to be unlimited in each plan in order to show the income potential for this group of farms.

Plan I was considered the basic plan for the study because it represented the organization which returned the maximum income for this group of farms with one-man labor equivalent. In the basic plan, the following price and enterprise preferences were assumed: (1) cotton was priced at twenty-six cents per pound, and (2) the purchase of corn and production of hogs were permitted along with all other producer activities included in the program matrix (Table IV). Two modifications in the basic plan were made to show the effects of excluding certain enterprises or activities from the program. First, in Plan II, the purchase of corn was deleted from the programming matrix (Table IV). Second, in Plan III, no corn could be purchased

TABLE VIII

KEY TO PLANS DISCUSSED IN CHAPTER IV[a]

Plan Number	Cotton price per pound		Corn purchasing allowed		Hog activity allowed		Resident labor		Restriction on fixed costs			
	$ .26	$ .30	Yes	No	Yes	No	One-man	Two-man	None	$458	$915	$1,372
I[b]	X		X		X		X		X			
II	X			X	X		X		X			
III		X		X	X		X		X			
IV	X		X			X	X		X			

[a]The variations in assumptions followed in each respective plan are indicated by an X in the appropriate cell.

[b]The basic plan.

but the cotton price was increased to thirty cents per pound. Third, in Plan IV, sows producing market hogs were not considered in obtaining a solution.

The reader should, at this point, pay careful attention to the key showing the variations in the basic plan (Table VIII). The order of discussion in this chapter will be first an explanation of the basic plan, then a discussion on the effects of enterprise preference on income and farm organization, and finally an account of the effect of varying the price of cotton on enterprise combinations and income.

I. THE BASIC PLAN

Three essential elements examined in this farm plan with a given set of resources were the enterprises and estimated net incomes, the estimated input use, and the amount of investment required to initiate the plan.

Enterprise Combinations and Net Income

The crop enterprises included in the basic plan were cash crop enterprises and intermediate crop enterprises (Table IX). The cash crop enterprises were fifteen acres of cotton, the full allotment, and pine trees for pulp and timber production. Cotton production amounted to 10,434 pounds of lint with a gross value of $2,713. The major portion of the cotton acreage was machine-picked. In practice, all the cotton would probably be machine-picked; however, the small acreage of hand-picked cotton was left in the plan for comparative purposes. The output of timber and pulpwood was assumed to occur at discrete points

TABLE IX

ENTERPRISE COMBINATIONS AND NET INCOMES FOR VARIATIONS IN

THE ONE-MAN RESIDENT LABOR SITUATION WITH UNLIMITED CAPITAL

Resource	Enterprise	Unit	Quantity produced			
			Plan I	Plan II	Plan III	Plan IV
Soil I	Corn	Acre	15.33	15.33	15.33	11.83
Soil I	Oats (grain)-lespedeza (hay)	Acre	—	3.36	6.27	2.29
Soil I	Oats (pasture)-lespedeza (pasture)	Acre	8.28	3.23	6.56	9.50
Soil I	Lespedeza hay	Acre	8.28	6.59	12.83	11.79
Soil I	Alfalfa hay	Acre	—	—	—	10.59
Soil II	Corn	Acre	21.50	33.37	21.50	21.50
Soil II	Cotton (hand-picked)	Acre	2.39	3.13	2.49	3.56
Soil II	Cotton (machine-picked)	Acre	12.61	—	12.51	11.44
Soil III-V	Fescue-ladino clover (pasture)	Acre	11.00	11.00	11.00	11.00
Soil IV	Hog-pasture	Acre	30.50	25.35	17.74	—
Soil IV	Oats (pasture)-lespedeza (pasture)	Acre	—	5.15	12.76	30.50
Soil VI	Pulpwood and timber	Acre	12.00	12.00	12.00	12.00
Corn	Grain sold	Bushel	—	—	—	2,042.00
Sows	Market hogs	Sow	25.00	21.00	14.00	—
Dairy cows	Grade C milk	Cow	—[a]	—	10.00	22.00
Deferred-fed steers	Short-fed beef	Steer	10.00	8.00	7.00	6.00
Net returns to land, resident labor, and management		Dollar	5,650	5,308	6,056[b]	4,825

[a]A 2.2 dairy cow unit entered the solution but was not considered practical.

[b]Net income is higher in this plan due to a four-cent per pound advantage in the price of cotton. Net income in Plan I would be $6,067 with a like increase in cotton price.

in time over a fifty-year period; however, in this study, it was presented as dollar earnings per year per acre.

Intermediate products in this plan were corn, pasture, and hay. All of these products were utilized in producing hogs and deferred-fed steers, Beef (2). Total acreage of corn was 36.83, producing 2,845 bushels. Pasture for beef was 19.28 acres which included 8.28 acres of second year lespedeza hay. A total of 16.46 tons of hay was produced. Pasture for hogs amounted to 30.5 acres. It was interesting to note that production of pine trees for pulp and timber products entered the solution when competing with two types of pastures on the rougher land. These pastures could have been used for beef, sheep, or dairy production.

A 2.2 Grade C Dairy Unit entered the plan but was not considered a large enough unit to be practical and, consequently, was not included. Annual fixed costs, operating capital, grain requirements, and net income were adjusted as necessary in rounding beef and hog activities to the nearest whole unit and eliminating the dairy enterprise.[22] Labor, pasture acreage, forage days, and hay were not adjusted. This appeared reasonable since small quantities of forage days or hay were produced in excess of livestock requirements in the original plan. Livestock in the plan included twenty-five sows, on the two-litter system, which produced 397 market hogs per year and ten deferred-fed beef steers, Beef (2).

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[22] All plans were adjusted in this manner. After finding that only 2.2 dairy cows came into the solution, a new solution was obtained by adding a high penalty cost on dairying. However, beef (6) came into the plan in an impractical unit. Thus, reprogramming the plan in this manner was not the answer to the impractical small units of activities.

This enterprise combination resulted in $5,650 net returns to land, resident labor, and management. The price of cotton was twenty-six cents in the basic plan. If the price of cotton were increased to thirty cents, which would be more realistic under present conditions, net income would have been increased to $6,067. Cotton entered into the solution at its full acreage allotment when priced at twenty-six cents per pound and the four-cent increase in the price did not affect the farm organization. The effect on net income of an increase in the selling price of any enterprise can be determined provided the enterprise came into the plan to the full extent allowed at a lower price. To determine the increase in net income in such a case the number of units of the enterprise involved were multiplied by the amount of the increased price and the resulting product added to the original net income produced at the lower price.

Input Use

All of the soil resources were utilized in the basic plan, except 14.11 acres of soil Group I which remained idle (Table X). In addition to the intermediate crops produced which were utilized as inputs by the livestock enterprises, 1,931 bushels of corn were purchased and fed to market hogs and beef steers. Additional labor was hired in periods III, IV, and VII. All the labor was not used in periods I and V, however, the amount unused was relatively small. Total operating capital used during the year was $8,550.

TABLE X

INPUTS OF LAND, LABOR, CAPITAL, AND PURCHASED GRAIN FOR VARIATIONS IN THE ONE-MAN RESIDENT LABOR SITUATION WITH UNLIMITED CAPITAL

Item	Unit	Amount Available	Amount Used			
			Plan I	Plan II	Plan III	Plan IV
Soil I	Acre	46.00	31.89	28.51	40.99	46.00
Soil II	Acre	36.50	36.50	36.50	36.50	36.50
Soil III-V	Acre	11.00	11.00	11.00	11.00	11.00
Soil IV	Acre	30.50	30.50	30.50	30.50	30.50
Soil VI	Acre	12.00	12.00	12.00	12.00	12.00
RESIDENT LABOR -						
Period I	Hour	517	483	441	480	497
Period II	Hour	362	362	362	362	362
Period III	Hour	314	314	314	314	314
Period IV	Hour	390	390	390	390	390
Period V	Hour	260	218	201	223	221
Period VI	Hour	390	390	390	390	390
Period VII	Hour	611	611	611	611	611
HIRED LABOR -[a]						
Period III	Hour	xx	206	21	198	211
Period IV	Hour	xx	171	7	144	134
Period VI	Hour	xx	—	—	—	—
Period VII	Hour	xx	120	175	121	189
Annual Fixed Cost	Dollar	Unlimited	1,789	1,652	1,676	1,624
Operating Capital	Dollar	Unlimited	8,550	5,236	5,881	5,557
Grain Purchased	Bushel	xx	1,931	—	—	—

[a]Amount of hired labor available was determined by the number of acres of corn and cotton that came into the plans as explained in Chapter II.

Investment

The annual fixed capital cost was $1,789 and represented the fixed costs per year or it could be considered as a long-run variable cost. By referring to the budgets this long-run cost was translated into the average value of fixed investment per year or the new value of investment (Table XI). This new figure shows the amount of investment necessary to put the plan into effect at a given point in time. The average value investment is the average value of the fixed inputs over the estimated years of life.

An estimate of investment capital was made by departing from the linearity assumption in the original budgets. Hogs, for example, were originally budgeted in twelve-sow units with one boar per unit. The estimate of investment costs for twenty-five sows in the basic plan would have required two boars. If strict linearity were followed, a fraction of one boar would have been used. Likewise, in the original budgets the cost of a loading chute was included with each twelve-sow unit. In determining investment costs for the twenty-five sows, only one loading chute was used. Other similar examples occur.[23] The applicability of the linearity assumptions in the budgets used is not questioned within the range of activities of this plan.

Shadow Prices

The output from the IBM 1620 listed the activities which did not enter the final solution, and the penalty cost or decrease in net

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[23]This procedure was followed in all plans developed for this study.

TABLE XI

TOTAL INVESTMENT IN MACHINERY, BUILDINGS, EQUIPMENT, AND LIVESTOCK FOR VARIATIONS IN THE ONE-MAN RESIDENT LABOR SITUATION WITH UNLIMITED CAPITAL

Investment Items	Plan I (Dollar)	Plan II (Dollar)	Plan III (Dollar)	Plan IV (Dollar)
Machinery -[a]				
New value	6,880	6,880	6,880	6,880
Average value	3,440	3,440	3,440	3,440
Hog enterprise -				
New value	7,558	6,654	4,364	—
Average value	3,779	3,327	2,182	—
Beef enterprise -				
New value	1,488	1,298	1,204	892
Average value	1,216	1,027	933	730
Dairy enterprise -				
New value	—	—	4,096	8,562
Average value	—	—	2,048	4,281
Pasture and trees -				
New value	422	422	422	834
Average value	211	211	211	417
Total new value	16,348	15,254	16,966	17,168
Total average value	8,646	8,005	8,814	8,868

[a]The complimentary items of investment are shown in Appendix Tables XXIII, XXIV, XXV, and XXVI for machinery, hogs, beef and dairy respectively.

revenue if one unit of the particular activity was forced into the solution. The amount of net income sacrificed or the cost of forcing a unit of an activity into the plan is called the shadow price. Table XII shows each activity, its original cost or net revenue, and its shadow or penalty price. It also shows the activity in the solution that would be forced out if a particular activity was forced in.

Some interesting aspects of relative profitability of certain activities can be discovered by studying the shadow prices. For example, the shadow prices show the relative profitability of the six beef enterprises. Activity 38 or Beef (2) was included in the solution. It was obviously the most profitable in the basic plan. The relative profitability of other beef activities numbered 37, 39, 40, 41, and 42 can be seen by comparing their shadow prices. Each unit of these respective activities, if forced into the solution, would reduce net revenue by $22.92, $166.60, $109.04, $105.02, and $1.88. Activities 39, 40, and 41 were cow-calf plans. They were obviously the least profitable of the beef systems. A unit of activity 37 would not have been as costly a sacrifice as the cow-calf activities; nevertheless, it would have reduced income substantially. Activity 42 would have decreased net income only $1.88 per unit and would have been the next most profitable enterprise. The relative profitability of other enterprises that did not enter the most profitable plan can also be determined.

The shadow prices show how limiting or how valuable each resource may be or the marginal value productivity of the resource.[24] For example,

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[24] Heady, op. cit., pp. 85, 91.

TABLE XII

SHADOW PRICES OR MARGINAL VALUE PRODUCTIVITY (MVP) OF RESOURCES

FOR THE BASIC PLAN (PLAN I) AND THE ACTIVITY THAT WOULD BE FORCED INTO THE SOLUTION[a]

Activity or resource outside the solution					Activity forced out of solution		
Name	Activity or resource no.	Unit	Cost or net revenue (dollar)	Shadow price or MVP (dollar)	Name	Activity or resource no.	Unit
Grain selling	5	Bushel	1.10	.17	Hired labor, Period VII	9	Hour
Hired labor, Period VI	8	Hour	- .75	.32	Cotton (machine-picked)	20	Acre
Alfalfa	11	Acre	-47.10	23.18	Forage day, Period I	67	Forage day
Orchard-grass ladino pasture	12	Acre	-17.00	3.16	Soil Group I	43	Acre
Oats (grain) lesp. (hay) lesp. (hay)	13	2 Acres	-67.73	1.33	Forage day, Period I	67	Forage day
Oats (grain) lesp. (hay) lesp. (pasture)	14	2 Acres	-57.21	12.37	Forage day, Period II	65	Forage day
Oats (grain) lesp. pasture lesp. pasture	15	2 Acres	-47.30	18.73	Oat-lesp. rotation, Soil I	44	2 Acres
Oats (grain) lesp. pasture lesp. hay	16	2 Acres	-57.82	7.75	Forage day, Period I	65	Forage day

TABLE XII (continued)

SHADOW PRICES OR MARGINAL VALUE PRODUCTIVITY (MVP) OF RESOURCES

FOR THE BASIC PLAN (PLAN I) AND THE ACTIVITY THAT WOULD BE FORCED INTO THE SOLUTION[a]

Activity or resource outside the solution					Activity forced out of solution		
Name	Activity or resource no.	Unit	Cost or net revenue (dollar)	Shadow price or MVP (dollar)	Name	Activity or resource no.	Unit
Oats (pasture) lesp. pasture lesp. pasture	17	2 Acres	-33.50	10.99	Oat-lesp. rotation, Soil I	44	2 Acres
Oats (pasture) lesp. pasture lesp. pasture	19	2 Acres	-40.56	8.90	Soil Group I	43	Acre
Cotton rented	22	Acre	41.61	25.20	Cotton (machine-picked)	20	Acre
Soybeans	24	Acre	32.88	43.75	Hired labor, Period VII	9	Hour
Orchard-grass ladino clover	25	Acre	-15.01	45.76	Forage day, Period II	65	Forage day
Bermuda	27	Acre	-15.42	46.66	Dairy	36	Cow
Fescue ladino clover	28	Acre	-16.04	24.69	Oat-lesp. rotation, Soil I	44	2 Acres
Oats (pasture) lesp. (pasture)	29	Acre	-20.28	18.99	Oat-lesp. rotation, Soil I	44	2 Acres
Bermuda-lesp.	30	Acre	-12.93	35.19	Oat-lesp. rotation, Soil I	44	2 Acres
Bermuda-lesp.	32	Acre	-12.93	35.23	Dairy	36	Cow
Sheep	33	3 Sheep	41.68	4.98	Labor, Period I	56	Hour
Feeder pigs	35	Sow	52.64	75.93	Dairy	36	Cow
Beef (1)	37	Steer	45.24	22.92	Beef (2)	38	Steer
Beef (3)	39	Cow	68.31	166.60	Beef (2)	38	Steer
Beef (4)	40	Cow	99.99	109.04	Beef (2)	38	Steer
Beef (5)	41	Cow	121.95	105.02	Beef (2)	38	Steer
Beef (6)	42	Steer	26.29	1.88	Fall hired labor	64	Hour

TABLE XII (continued)

SHADOW PRICES OR MARGINAL VALUE PRODUCTIVITY (MVP) OF RESOURCES

FOR THE BASIC PLAN (PLAN I) AND THE ACTIVITY THAT WOULD BE FORCED INTO THE SOLUTION[a]

Activity or resource outside the solution					Activity forced out of solution		
Name	Activity or resource no.	Unit	Cost or net revenue (dollar)	Shadow price or MVP (dollar)	Name	Activity or resource no.	Unit
Soil I row cropland	46	Acre	—	28.78	Labor, Period I	56	Hour
Soil Group II	47	Acre	—	64.55	Labor, Period I	56	Hour
Cotton rented	48	Acre	—	1.97	Cotton (machine-picked)	20	Acre
Soil Group III-V	49	Acre	—	11.69	Forage day, Period III	67	Forage day
Soil Group IV	50	Acre	—	21.39	Oat-lesp. rotation, Soil I	44	Acre
Soil Group VI	51	Acre	—	2.96	Pine trees	31	Acre
Grain (corn)	55	Bushel	—	1.27	Forage day, Period III	67	Forage day
Labor, Period II	57	Hour	—	3.03	Dairy	36	Cow
Labor, Period III	58	Hour	—	.77	Spring hired labor	63	Hour
Labor, Period IV	59	Hour	—	.77	Spring hired labor	63	Hour
Labor, Period VI	61	Hour	—	.45	Hired labor, Period VII	9	Hour
Labor, Period VII	62	Hour	—	.77	Fall hired labor	64	Hour
Grazing days, Period IV	68	Forage day	—	2.61	Beef (2)	38	Steer
Hay	69	Ton	—	11.42	Oat-lesp. rotation, Soil I	44	Acre

[a]Activities one through forty-two inclusive are shadow prices indicating the reduction in net income when a unit of the activity is forced into the solution and refer to real activities. Activities forty-six through sixty-nine are marginal value productivities of the limiting resources and indicate the amount by which net income would be increased if another unit of the resource were available.

slack 57 corresponding to labor Period II indicated that the marginal value productivity of an additional hour of labor in this period was $3.03. Thus, if suitable labor could have been hired in labor Period II for less than $3.03 per hour, it would have been profitable to hire labor. The marginal value product on one acre of cotton allotment was $1.97; of one acre of soil Group II (slack 47) was $64.55; and of one acre of soil Group I row crop land (slack 46) was $28.78. Hence, the net income could have been increased by increasing the amount of restricted resource available while holding the others constant.

In summary, the shadow prices showed that a reduction in row crops would penalize income severely. Any change in the livestock plan would also reduce income. However, under some circumstances the operator could produce short-fed steers, Beef (6), rather than deferred-fed steers, Beef (2), with very little loss of income. Labor could be hired profitably in Period II at the current price. An additional acre of cotton allotment would increase income only $1.97 if all other restrictions remained the same.

II. VARIATIONS ON THE BASIC PLAN

Three variations of the basic plan with unlimited capital and one-man equivalent of labor were programmed. Two of these variations concerned the enterprises allowed to be produced and the third was a change in the price of cotton. Enterprise combinations and net income, inputs used, and investment necessary for these variations are listed in Tables IX, X, and XI and will be discussed in this section.

Enterprise Preference Variation

The first enterprise variation (Plan II) was made by deleting the corn purchasing enterprise or activity (Table IX). Only grain produced on the farm could be used for livestock production. In contrast to the basic plan, a small acreage of oats for grain came into the solution. Corn replaced 11.87 acres of the cotton allotment, which was the major change in organization. About 1,165 more bushels of corn or its equivalent were produced than in the basic plan. Oats and lespedeza for pasture replaced 5.15 acres of hog pasture. Sow numbers were reduced to twenty-one and deferred-fed steers, Beef (2), to eight. Net income produced by this combination of enterprises was $5,308 or a reduction of $342 from the net income produced in the basic plan. A slightly increased acreage of soil Group I remained idle in Plan II (Table X). Total labor required was reduced but labor in period VII was increased. Annual fixed costs were reduced $137 and operating capital was reduced $3,314. The sharp decrease in operating capital required was caused largely by the deletion of the corn purchasing activity. Both new value and average value investment costs were lowered slightly in Plan II (Table XI).

The second enterprise variation (Plan IV) was obtained by deleting the activity representing market-hog production, causing major changes in the basic plan. Alfalfa replaced part of the lespedeza-oat land and also a portion of the corn land. Soil Group IV was utilized for oats and lespedeza for dairy and beef pasture rather than for hog pasture. Approximately 2,040 bushels of corn were sold. Twenty-two dairy cows and six deferred-fed steers utilized the remainder of the grain, pasture,

and hay produced. This combination of enterprises produced $4,825 net income. Thus, the opportunity cost of not producing market hogs was approximately $825. Shadow prices indicated that Beef (6) would reduce income $1.14 per unit and that sheep would reduce income $1.40 per unit if forced into the plan. Other enterprises would reduce income appreciably more. All the cropland was in production in Plan IV. Operating capital for Plan IV was $2,993 less than for Plan I. Both new value and average value investment costs were slightly higher for Plan IV than for Plan I.

Price Variations

As cotton did not enter Plan II to its full acreage allotment, the price of cotton in this situation was increased to thirty cents per pound. The farm was reprogrammed and the results were presented as Plan III in which cotton entered to its full allotment. Fourteen sows, seven deferred-fed steers, Beef (2), and ten dairy cows utilized the grain, forage, and hay produced. Net income in the Plan III situation was $6,056. It was interesting to note that net income for Plan III was only eleven dollars less than income produced for Plan I with cotton priced at thirty cents in both plans (Table IX).

Less idle land remained in Plan III than in Plans I and II. Operating capital required was $2,669 less in Plan III than in Plan I. More resident labor was utilized and more labor was hired in Plan III than in Plan II (Table X).

New value and average value investment costs were greater in Plan III than in Plans I and II. However, the differences were slight (Table XI).

Feeder Pig Variation

With the restricted amount of grain available in Plan III, feeder pig production might become profitable. Plan III was reprogrammed with the price of feeder pigs increased fifty-five cents per head resulting in a price of nine dollars per head. This amount had originally been charged for selling costs. However, feeder pigs did not come into the plan in this situation. The cost of vaccinating and worming feeder pigs amounting to $1.10 per head was included in the budgets as a cost of producing feeder pigs.

III. SUMMARY

Results of the four plans presented in this chapter indicated that the total cotton allotment of fifteen acres should be used in the one-man labor situation on the representative farm when cotton was priced at thirty cents per pound and when corn could be purchased (Plan I). Sows producing market hogs up to the restricted number of twenty-five were the most profitable livestock enterprise. Corn was the most profitable crop produced on suitable land except for the fifteen acres of cotton. Soil Group VI land was most profitable in trees. Soil Groups III and V land were in fescue-ladino clover pasture. Oats and lespedeza for pasture and hay were produced on soil Group I land when not used for corn production. Some soil Group I land remained idle. It was not profitable to produce oats for grain when corn could be purchased. Steers bought in the fall, wintered with a minimum of feed, pastured the following spring and summer, and put on a seventy-day feed the following July first were the most profitable plan for utilising pasture and hay produced.

An alternative plan (Plan III) not allowing corn to be purchased reduced income only eleven dollars. Major changes from Plan I were that there was less idle land in soil Group I, oats for grain were produced, fewer sows producing market-hogs and fewer deferred-fed steers, Beef (2), were produced, and a ten-cow dairy unit was added. New value investment capital was slightly higher for Plan III but operating capital was considerably lower.

Plans I through IV required about 600 tractor hours of use per year. All plans could profitably hire labor in Period II. Shadow prices indicated that the MVP of an hour of labor in Period II was $3.03 in Plan I. Some soil Group I land remained idle in Plans I, II, and III. Realistically, soil Group IV land would probably remain idle, rather than soil Group I. The plans showed some soil Group I land idle for two reasons; first, sows were restricted by soil Group IV land where hogs would likely be pastured, and second, it resulted from the programming format used in setting up the three-year rotation on soil Group I.

CHAPTER V

OPTIMUM INCOME PLANS FOR THE ONE-MAN LABOR AND RESTRICTED CAPITAL SITUATION

Very few farmers have unlimited capital resources such as were assumed in the previous chapter. The discussion in this chapter will be devoted to differences in farm organization and net income required when investment capital is restricted. In view of the increasing capital requirements confronting individual farm operators, restriction of investment capital is an appropriate topic for a study of this nature.

There were several means of restricting investment capital in a linear programming problem. The method that appeared to be the simplest and circumvented certain problems in aggregation was to restrict the total annual fixed costs that could be incurred in a given year. After obtaining the solution, the investment capital requirements for each activity entering the solution were summarized. This summary then became the new value of capital investment, exclusive of land, required to put the plan into effect. Henceforth, restrictions of the total annual fixed costs will be referred to as investment capital situations.

Annual fixed costs for the unlimited capital situation in Plan I were $1,830.[25] Optimum plans were developed for three levels of investment capital through the restricted levels of fixed costs. Levels used were one-fourth the investment capital of the unlimited capital situation,

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[25] The investment capital figure listed for Plan I in Table X is slightly different because of rounding livestock numbers.

which placed the restricted annual fixed costs at $458; one-half the unlimited capital situation, which placed them at $915; and three-fourths the unlimited capital situation, which placed them at $1,372.

The six restricted capital plans developed will be referred to as Plans V through X. Plan V was the one-fourth investment capital situation; Plan VI was the one-half and Plan VII was the three-fourths, with cotton priced at twenty-six cents per pound and the purchase of corn considered as an alternative. Plan VIII was identical to Plan VII, except corn could not be purchased. Plan IX was identical with Plan VII, except that cotton was priced at thirty cents per pound and corn could be purchased. Plan X was identical to Plan IX, except corn could not be purchased (Table XIII).

I. CHANGES RESULTING FROM RESTRICTED INVESTMENT CAPITAL

Pronounced differences in enterprise combinations and net income, estimated input use, and the estimated amount of investment required to initiate the plan occurred in the restricted capital plans when they were compared to the basic plan (Plan I).

Enterprise Combinations and Net Income

Only the full fifteen acres of cotton allotment and the corn were produced on soil Group II in Plan V. All cotton and corn produced were sold, and no livestock were produced. Net income decreased $2,430 as a result of restricting fixed costs to one-fourth that used in the unlimited capital situation (Table XIV).

TABLE XIII

KEY TO PLANS DISCUSSED IN CHAPTER V

Plan Number	Cotton price per pound		Corn purchasing allowed		Hog activity allowed		Resident labor		Restriction on fixed costs			
	$ .26	$ .30	Yes	No	Yes	No	One-man	Two-man	None	$458	$915	$1,372
I[a]	X		X		X		X		X			
V	X		X		X		X			X		
VI	X		X		X		X				X	
VII	X		X		X		X					X
VIII	X			X	X		X					X
IX		X	X		X		X					X
X		X		X	X		X					X

[a]Plan I was the basic plan discussed in the previous chapter.

TABLE XIV

ENTERPRISE COMBINATIONS AND NET INCOME FOR VARIATIONS IN THE ONE-MAN RESIDENT LABOR SITUATION WITH VARIOUS LEVELS OF ANNUAL FIXED COSTS

Resource	Enterprise	Unit	Quantity produced						
			Plan I	Plan V	Plan VI	Plan VII	Plan VIII	Plan IX	Plan X
Soil I	Corn	Acre	15.33	—	4.03	15.33	15.33	15.33	15.33
Soil I	Oats (P)-lespedeza (P)	Acre	8.28	—	—	—	—	—	9.53
Soil I	Lespedeza (hay)	Acre	8.28	—	—	—	—	—	9.53
Soil II	Corn	Acre	21.50	21.50	21.50	26.34	26.95	21.50	21.50
Soil II	Cotton (hand-picked)	Acre	2.39	12.28	8.67	5.89	5.67	5.79	5.30
Soil II	Cotton (machine-picked)	Acre	12.61	2.72	6.33	4.27	3.88	9.21	9.70
Soil III-V	Fescue-ladino clover pasture	Acre	11.00	—	—	—	—	—	1.89
Soil IV	Hog pasture	Acre	30.50	—	14.47	25.29	21.68	25.46	17.77
Soil IV	Oats (P)-lespedeza (P)	Acre	—	—	—	—	—	—	.81
Soil VI	Pulpwood and timber	Acre	12.00	—	—	—	—	—	—
Corn	Grain sold	Bushel	—	1,935.00	—	—	—	—	—
Sows	Market hogs	Sow	25.00	—	12.00	20.00	18.00	21.00	14.00
Dairy cows	Grade C milk	Cow	—	—	—	—	a	—	7.00
Deferred-fed steers	Short-fed beef	Steer	10.00	—	—	—	—	—	—
Net returns to land, resident labor, and management		Dollar	5,650.00	3,220.00	4,506.00	5,379.00	4,958.00	5,883.00	5,771.00

[a]A small unit of dairy cows (3.17) entered the solution but was disregarded after adjusting for resource use.

In Plan VI, where annual fixed costs were restricted to $915, some of the soil Group I corn land was in production and hog pasture was produced for twelve sows in addition to the enterprises produced in Plan V. Net income decreased $1,144 from the basic plan situation, but showed an increase of $1,286 over the Plan V situation.

Plans VII, VIII, IX, and X, in which fixed costs were restricted to $1,372, called for the full utilization of corn land allowed on soil Group I. An oat-lespedeza rotation for pasture and hay was also produced on soil Group I for Plan X. Sows in varied numbers and the pasture to support them were produced in all four plans. In addition, seven dairy cows entered the Plan X solution. Thus, in the three-fourths investment capital situation the most significant changes occurred in enterprise combinations in which corn was not allowed to be purchased and with cotton priced at twenty-six cents per pound. Plan VII is most directly comparable to the basic plan, net income being but $271 less for it than for the basic plan. In comparing net incomes it should be remembered that in Plans IX and X the price of cotton was assumed to be thirty cents per pound.

Input Use

Only soil Group II was utilized in Plan V and the full amount of resident labor was used only in Periods VI and VII, with additional labor hired in Period VII. Annual fixed costs were restricted to $458 and the unlimited operating capital amounted to $1,233 (Table XV).

Some of the soil Group I land was used for corn production in Plan VI; also some of the soil Group IV land was used for hog pasture.

TABLE XV

INPUTS OF LAND, LABOR, CAPITAL, AND PURCHASED GRAIN FOR VARIATIONS

IN THE ONE-MAN RESIDENT LABOR SITUATION WITH VARIOUS LEVELS OF ANNUAL FIXED COSTS

Item	Unit	Amount Available	Amount used						
			Plan I	Plan V	Plan VI	Plan VII	Plan VIII	Plan IX	Plan X
Soil I	Acre	46.00	31.89	0	4.03	15.33	15.33	15.33	34.39
Soil II	Acre	36.50	36.50	36.50	36.50	36.50	36.50	36.50	36.50
Soil III & V	Acre	11.00	11.00	0	0	0	0	0	1.89
Soil IV	Acre	30.50	30.50	0	14.47	30.50	21.68	25.46	18.58
Soil VI	Acre	12.00	12.00	0	0	0	0	0	0
Resident labor									
Period I	Hour	517	483	10	192	335	359	338	388
Period II	Hour	362	362	51	168	288	302	279	307
Period III	Hour	314	314	284	314	314	314	314	314
Period IV	Hour	390	390	232	344	390	390	390	390
Period V	Hour	260	218	11	88	146	152	149	162
Period VI	Hour	390	390	390	390	390	390	390	390
Period VII	Hour	611	611	611	611	611	611	611	611
Hired labor									
Period III	Hour	xx	206	--	59	75	72	145	156
Period IV	Hour	xx	171	--	--	--		56	71
Period VI	Hour	xx	--	--	--	--		--	--
Period VII	Hour	xx	120	204	171	200	211	175	192
Annual fixed costs-Plan I	Dollar	Unlimited	1,789.00	xx	xx	xx	xx	xx	xx
Annual fixed costs-Plan V	Dollar	458	xx	458	xx	xx	xx	xx	xx
Annual fixed costs-Plan VI	Dollar	915	xx	xx	915	xx	xx	xx	xx
Annual fixed costs-Plans VII, VIII, IX, and X	Dollar	1,372	xx	xx	xx	1,372.00	1,372.00	1,372.00	1,372.00
Operating capital	Dollar	Unlimited	8,550.00	1,233.00	2,718.00	4,475.00	3,630.00	5,290.00	4,280.00
Grain purchased	Bushel	xx	1,931	xx	xx	428	xx	1,051	xx

Resident labor was fully utilized in Periods III, VI, and VII, with additional labor hired in Periods III and VII. Annual fixed costs were $915 and operating capital amounted to $2,718.

Optimum solutions for Plans VII through X utilized increased amounts of soil Group I, especially in Plan X in which dairy cows were substituted for hogs when corn could not be purchased. Resident labor was more fully utilized than in Plans V and VI but not as completely as in the basic plan. Additional labor was hired in all four plans. Annual fixed costs were $1,372 in all of them. Operating capital varied as a result of cotton price changes and the choice of purchase or nonpurchase of corn. Additional corn, 1,051 bushels, was purchased in the Plan IX situation which accounted for most of the change in operating capital. This capital was $4,075 greater for the basic plan situation than for the Plan VII situation in which fixed costs were restricted.

Investment

Total new value and average value investment necessary to place the various plans into effect varied with the amount of annual fixed costs that were permitted (Table XVI). As the amount of fixed costs increased, the new and average values of investment required to initiate the plans increased. Plans V, VI and VII were for the same resource and enterprise preference situations and price assumptions as the basic plan (Plan I). The only differences in the four plans were the amounts of annual fixed costs permitted. The new value of investment when annual fixed costs were restricted to $458 was $6,420 as compared to $16,348 when fixed costs were unlimited. The investment increased for

TABLE XVI

TOTAL INVESTMENT IN MACHINERY, BUILDINGS, EQUIPMENT, AND LIVESTOCK

FOR THE ONE-MAN RESIDENT LABOR SITUATION WITH VARIOUS LEVELS OF ANNUAL FIXED COSTS

Investment items[a]	Plan I (dollar)	Plan V (dollar)	Plan VI (dollar)	Plan VII (dollar)	Plan VIII (dollar)	Plan IX (dollar)	Plan X (dollar)
Machinery -							
New value	6,880	6,420	6,420	6,420	6,420	6,420	6,880
Average value	3,440	3,210	3,210	3,210	3,210	3,210	3,440
Hog enterprise -							
New value	7,558	—	3,732	6,278	5,745	6,465	4,364
Average value	3,779	—	1,866	3,139	2,872	3,233	2,182
Beef enterprise -							
New value	1,488	—	—	—	—	—	—
Average value	1,216	—	—	—	—	—	—
Dairy enterprise -							
New value	—	—	—	—	—	—	3,471
Average value	—	—	—	—	—	—	1,736
Pasture and trees -							
New value	422	—	—	—	—	—	66
Average value	211	—	—	—	—	—	33
Total new value	16,348	6,420	10,152	12,698	12,165	12,885	14,781
Total average value	8,646	3,210	5,076	6,349	6,082	6,443	7,391

[a]The complimentary items of investment are shown in Appendix Tables XXIII, XXIV, XXV, and XXVI for machinery, hogs, beef, and dairy respectively.

the other levels of fixed costs but not by the same proportions; this was due primarily to the lumpiness of certain of the fixed inputs, e.g., machinery when a basic set of a tractor and associated implements was assumed (Table XVI).[26] The additional investments required were for the expansion of the hog enterprise, resulting in an increased amount of fixed costs. The rather abrupt increase in investment in Plan X was due to the increased capital required for dairy cattle in Grade C milk production, which was in part off-set by a decrease in capital investment for hogs.

II. SUMMARY

Results from the plans using restricted capital which were developed in this chapter indicated that if an operator had or was willing to invest only one-fourth of the unrestricted operator's annual capital investment, it was most profitable to produce only cotton and corn. Only soil Group II could profitably be used and no livestock should be produced. The fact that a fractional sow came into Plan V indicated that this was about the point where additional investment capital could be used to add sows for producing market hogs. The one-half capital situation in Plan VI further substantiated this indication; the additional investment capital in this plan was used to add twelve sows and the pasture, buildings, and equipment necessary for market hog production. The three-fourths capital used in Plan VII permitted an

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[26] See Appendix Tables XXIII through XXVII for details of machinery compliment and other enterprise investments.

expansion to twenty sows. The remainder of soil Group I land allowed to produce corn also came into the solution.

The one-fourth unit of investment capital represented by restricted levels of fixed costs resulted in a net return to land, resident labor and management of $3,220. The one-half unit resulted in an increase of $1,286, whereas the three-fourths unit showed a further increase of $873. The net returns when fixed costs were unlimited, however, were $271 greater than the highest of the restricted capital situations.

CHAPTER VI

OPTIMUM INCOME PLANS FOR THE TWO-MAN LABOR AND UNLIMITED CAPITAL SITUATION

The purpose of this chapter was to demonstrate the effect of an additional man-labor equivalent on the farm organization and net income of the representative resource situation. The same activities and matrix, except for changes in the labor supply rows, were used as in programming the one-man labor equivalent situation in Chapter III. The labor supply in the labor periods in resource rows fourteen through twenty were doubled, resulting in the following labor supply for those respective labor periods: 1,034, 724, 628, 780, 520, 780, and 1,222 hours.[27]

Three plans were developed for the two-man labor and unlimited capital situation. They were identified as Plans XI through XIII. In Plan XI, cotton was priced at twenty-six cents per pound, the purchase of corn was considered as an alternative. Plan XII differed from XI in that corn could not be purchased. Plan XIII was like XII, except that in it cotton was priced at thirty cents per pound (Table XVII).

I. EFFECTS OF VARIATION IN RESIDENT LABOR

Interesting changes were seen to have occurred in the enterprise combinations, estimated input use, and the quantity of investment capital required to initiate the plan when the two-man-labor-equivalent situations were compared with those in the basic plan (Plan I).

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[27] Table IV, Chapter III.

TABLE XVII

KEY TO PLANS DISCUSSED IN CHAPTER VI

Plan Number	Cotton price		Corn purchase		Hog activity		Resident labor		Restriction on fixed costs[a]			
	$ .25	$ .30	Yes	No	Yes	No	One-man	Two-man	Unlimited	1/4	1/2	3/4
I	X		X		X		X		X			
II	X		X		X			X	X			
III	X			X	X			X	X			
IIII		X		X	X			X	X			

[a]The fixed costs were restricted to one-fourth, one-half, and three-fourths of the fixed costs obtained under the unlimited capital situation.

Enterprise Combinations and Net Income

In Plan XI corn and the oat-lespedeza rotation accounted for all soil Group I, except for a small acreage of alfalfa. Corn lacked about one-third of an acre of utilising all the cornland permitted by the rotation restriction. The fifteen-acre cotton allotment entered into the solution and the remaining 21.5 acres of soil Group II were in corn. Most of the cotton produced was hand-picked. Pastures for hogs, cattle, and sheep and woodland for pulpwood and timber accounted for the remaining acreage. Twenty-five sows producing market hogs, ten cows producing Grade C milk, and twenty-seven ewes made up the livestock organization and utilized all the hay, pasture and grain produced. Net returns to land, labor and management were $7,331 which was an increase of $1,681 over the basic plan situation (Table XVIII).

In Plan XII corn utilized 1.2 acres of the cotton land specified by the allotment. Alfalfa was not produced. Sixteen sows producing market hogs and fourteen cows producing Grade C milk were the livestock in this solution. Net returns to land, labor and management amounted to $6,853, which was a decrease of $478 from the Plan XI situation, but still ahead of the basic plan.

In Plan XIII, with the assumed cotton price of thirty cents per pound, cotton entered into the solution at the full fifteen-acre allotment. Fifteen sows producing market hogs and fourteen dairy cows producing Grade C milk were the only livestock enterprises. Net returns to land, labor and management were $7,211 which were very close to those of Plan XI.

TABLE XVIII

ENTERPRISE COMBINATIONS AND NET INCOME FOR THE ONE-MAN RESIDENT LABOR SITUATION AND VARIATIONS IN THE TWO-MAN RESIDENT LABOR SITUATION, BOTH WITH UNLIMITED CAPITAL

Resource	Enterprise	Unit	Quantity produced			
			Plan I	Plan II	Plan XII	Plan XIII
Soil I	Corn	Acre	15.33	14.99	15.33	15.33
Soil I	Alfalfa	Acre	—	1.02[a]	—	—
Soil I	Oats pasture and lespedeza pasture	Acre	8.28	16.94	3.05	2.73
Soil I	Lespedeza hay	Acre	8.28	13.05	15.33	15.33
Soil I	Oats grain and lespedeza hay	Acre	—	—	4.95	5.25
Soil I	Oats grain and lespedeza pasture	Acre	—	—	7.34	7.36
Soil II	Corn	Acre	21.50	21.50	22.50	21.50
Soil II	Cotton (hand-picked)	Acre	2.39	12.60	13.80	13.88
Soil II	Cotton (machine-picked)	Acre	12.61	2.40	—	1.12
Soil III & V	Fescue-ladino clover pasture	Acre	11.00	11.00	11.00	11.00
Soil IV	Hog pasture	Acre	30.50	30.50	19.60	18.91
Soil IV	Oats pasture and lespedeza pasture	Acre	—	—	10.90	11.59
Soil VI	Pulpwood and timber	Acre	12.00	12.00	12.00	12.00
Corn	Grain sold	Bushel	—	—	—	—
Sows	Market hogs	Sow	25.00	25.00	16.00	15.00
Dairy cows	Grade C milk	Cow	—	10.00	14.00	14.00
Deferred-fed steers	Short-fed beef	Steer	10.00		—	—
Sheep	Lambs and wool	Ewe	—	27.00	—	—
Net returns to land, resident labor and management		Dollar	5,650.00	7,331.00	6,853.00	7,211.00

[a]This acreage of alfalfa may not be a practical amount, but was left in the plan for comparative purposes.

Input Use

All the land was utilized in Plans XI through XIII. However, resident labor was fully utilized only in Periods VI and VII, with additional labor being hired in Period VII. Annual fixed costs in Plan XI were $2,250 or about $460 higher than in the basic plan. Plans XII and XIII had about the same amount of annual fixed costs as did the basic plan. Operating capital was actually lower in each of the two-man labor situations than it was in the basic plan, because fewer hours of seasonal hired labor were required (Table XIX).

Investment Capital

Total new value and average value investment did not vary greatly between the basic plan and the two-man resident labor situations. However, Plan XI did have a higher investment capital requirement than Plans XII and XIII and all three had higher investment capital costs than did the basic plan situation. Most of the differences in investment resulted from differences in levels of the livestock enterprises in the plans and differences in the types of livestock enterprises (Table XI).

II. SUMMARY

Major changes in the farm organization, income and input use were shown by varying the amount of resident labor available. The additional labor used under the assumptions followed in this chapter resulted in the addition of a Grade C Dairy enterprise in each of the three plans discussed and the addition of a twenty-seven ewe unit of sheep in Plan XI. Also, the additional labor resulted in more

TABLE XIX

INPUTS OF LAND, LABOR, CAPITAL, AND PURCHASED GRAIN FOR THE ONE-MAN RESIDENT LABOR SITUATION AND VARIATIONS IN THE TWO-MAN RESIDENT LABOR SITUATION, BOTH WITH UNLIMITED CAPITAL

Item	Unit	Amount Available	Amount used			
			Plan I	Plan II	Plan III	Plan IIII
Soil I	Acre	46.00	31.89	46.00	46.00	46.00
Soil II	Acre	36.50	36.50	36.50	36.50	36.50
Soil III & V	Acre	11.00	11.00	11.00	11.00	11.00
Soil IV	Acre	30.50	30.50	30.50	30.50	30.50
Soil VI	Acre	12.00	12.00	12.00	12.00	12.00
Resident labor[a]						
Period I	Hour	1,034	483	730	588	574
Period II	Hour	724	362	476	426	447
Period III	Hour	628	314	603	540	555
Period IV	Hour	780	390	639	569	578
Period V	Hour	520	218	334	284	299
Period VI	Hour	780	390	780	780	780
Period VII	Hour	1,222	611	1,222	1,222	1,222
Hired labor						
Period III	Hour	xx	206	-	-	-
Period IV	Hour	xx	171	-	-	-
Period VI	Hour	xx	-	-	-	-
Period VII	Hour	xx	120	243	239	234
Annual fixed costs	Dollar	Unlimited	1,789.00	2,250.00	1,811.00	1,776
Operating capital	Dollar	Unlimited	8,550.00	8,393.00	5,520.00	5,437
Grain purchased	Bushel	xx	1,931	2,123	xx	xx

[a]Resident labor in Plan I is one-half the amount shown in column three.

TABLE XX

INVESTMENT IN MACHINERY, BUILDINGS, EQUIPMENT, AND LIVESTOCK FOR THE ONE-MAN RESIDENT LABOR SITUATION AND VARIATIONS IN THE TWO-MAN RESIDENT LABOR SITUATION, BOTH WITH UNLIMITED CAPITAL

Investment items[a]	Plan I (dollar)	Plan XI (dollar)	Plan XII (dollar)	Plan XIII (dollar)
Machinery -				
New value	6,880	6,880	6,880	6,880
Average value	3,440	3,440	3,440	3,440
Hog enterprise -				
New value	7,558	7,558	4,918	4,679
Average value	3,779	3,779	2,459	2,340
Beef enterprise -				
New value	1,488	—	—	—
Average value	1,216	—	—	—
Dairy enterprise -				
New value	—	4,096	5,189	5,189
Average value	—	2,048	2,595	2,595
Sheep enterprise -				
New value	—	1,560	—	—
Average value	—	780	—	—
Pasture and trees -				
New value	422	462	422	422
Average value	211	231	211	211
Total new value	16,348	20,556	17,409	17,170
Total average value	8,646	10,278	8,704	8,585

[a]The complimentary items of investment are shown in Appendix Tables XXIII, XXIV, XXV, XXVI and XXVII for machinery, hogs, beef, dairy and sheep respectively.

utilization of cropland due primarily to the increased production of livestock.

The net returns to land, resident labor and management were increased by the addition of the extra man-equivalent of labor. For example, this income was increased from $5,650 to $7,331 as resident labor was increased, an increase of $1,681.[28] If this additional resident labor had to be hired at a fixed salary of $5.00 per day or $1,550 per year, then the farmer would gain approximately $131 per year from it. If adequate seasonal labor can be hired or if cotton can be custom machine-picked, then it is unlikely that the extra labor could be justified on this size of farm. Most of the cotton produced in the basic plan was to be custom machine-picked but was to be hand-picked in the two-man situation.

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[28] This comparison was between Plan I (basic plan) and Plan XI when the only difference in assumptions was due to the extra resident labor in the latter plan.

CHAPTER VII

SUMMARY AND CONCLUSIONS

The agricultural industry is continuously undergoing changes which make adjustments in resource use necessary if satisfactory income levels in our agricultural sector are to be maintained. This study was initiated to provide information to educational personnel and farmers concerning opportunities in farm organization adjustments that would increase income.

Specific objectives were: (1) to estimate optimum farm plans for a representative farm of 136 acres of open land in the mixed soil group of Henderson County, Tennessee, and (2) to estimate the effect of various levels of investment capital, labor, and changes in prices of selected enterprises on net income and farm organization.

A survey of 220 farms in Henderson County was conducted in 1958. The soil resources and farm sizes were classified into groups from which a representative farm was selected. This study was concerned with size Group III composed of farms having mixed soil resources. Optimum plans representing various resource and activity situations were developed for this representative farm, using the technique of linear programming.

Several variations of resource and activity situations were planned in order to provide information that would be applicable to such existing resource and enterprise preference situations. Thirteen plans were developed for the representative farm. These plans represented modifications in resident labor, investment capital, cotton

prices, feeder pig prices, choice of purchasing or not purchasing corn, and choice of producing or not producing market hogs.

I. SUMMARY

The discussions in the preceding chapters were devoted to detailed explanations of the various plans and should be referred to in answering specific questions concerning farm organization. This summary will deal with general comparisons of (1) net income and investment and (2) variations in farm organization under the selected resource and enterprise situations.

One-man Labor and Unlimited Capital Situations

Plans I through IV were developed for the one-man labor and unlimited capital resource situations. These plans included variations in choice of purchasing or not purchasing corn, producing or not producing market hogs, and using two cotton price levels. In addition, a variation of Plan III tested the effect of increased feeder pig prices.

The highest net incomes for both levels of cotton prices occurred when corn could be purchased. This high income was largely explained by the increased hog numbers fed when corn was purchased. The lowest income occurred when market hogs were not considered as an alternative (Plan IV). When corn could not be purchased and market hogs could be produced, corn production replaced some of the cotton acreage at the twenty-six cent level of cotton prices (Plan II). Cotton entered into the solution to the full amount of the acreage restriction at the thirty cents per pound price level of cotton for all plans. The plans

with cotton priced at thirty cents per pound always yielded more net income than their counterparts at the twenty-six cents level of cotton prices. Machine-picked cotton acreage was always higher than hand-picked cotton acreage. Feeder pigs did not enter the solution when their price was increased to nine dollars per head in Plan III. When the purchase of corn was not allowed, dairy units entered the solutions along with sows producing market hogs and also deferred-fed beef. Sows and deferred-fed beef were the livestock in the plans allowing the purchase of corn.

The new value of the capital investment required to execute the plans was about the same for all plans. Annual operating capital was considerably higher when corn was purchased, as in Plan I. The operating capital was about the same for all the plans in which corn was not purchased.

One-man Labor and Restricted Capital Situations

Graduated degrees of annual investment capital rationing in the plans developed resulted in correspondingly graduated income levels. Investment capital was rationed by restricting annual fixed costs to one-fourth, one-half, and three-fourths of the annual fixed costs obtained when investment capital was considered unlimited. Since the fixed costs served as guides in determining the farm organization under these capital restriction levels, the amounts of new value investment capital at these levels were not necessarily in the same proportion as the annual fixed costs.

Hand-picked cotton acreage was greater than machine-picked cotton acreage in the one-fourth and one-half investment capital situations,

but machine-picked cotton acreage was greater in the three-fourths capital situation. Thus, as investment capital increased, the proportion of cotton acreage that was machine-picked increased. Furthermore, when investment capital was increased, the number and size of enterprises increased. It was not profitable to buy corn until the three-fourths investment capital level. In no case with limited capital was soil Group VI land utilized.

New value investment capital, as would be expected, increased as the investment capital levels increased. Operating capital also increased as the levels of investment capital increased. Net income increased as the amount of investment capital increased. In the three-fourths investment capital situations net income was highest when corn was allowed to be purchased. However, operating capital was also considerably higher.

One-man Labor and Two-man Labor Situations

The amount of labor available made a difference in optimum farm organization and net income. Three optimum plans were developed utilizing two-man equivalents of labor. These plans assumed unlimited capital and were programmed allowing corn to be purchased and also not allowing the purchase of corn with two price levels of cotton, twenty-six and thirty cents per pound. The plans allowing corn to be purchased yielded the highest net income in both labor situations. The plans developed for the thirty-cent per pound cotton price level also yielded higher net incomes than their counterpart plans at the twenty-six cents level. All the land was utilized in the two-man labor situation. Labor Period VII was the only period in which labor was hired. In contrast

with the one-man situation, in the two-man situations hand-picked cotton acreage was greater than machine-picked acreage.

Sows producing market hogs came into the plans utilizing two-man equivalents of labor in about the same number as they did in the one-man labor situation; however, the other livestock enterprises changed. Dairy and sheep replaced deferred-fed steers when corn was allowed to be purchased.

Net returns to land, labor and management increased by $1,681 in the two-man labor situation as compared to the one-man labor situation. However, this income may not necessarily be realized if one-half the resident labor must be hired on an annual basis. Operating capital was lower for the two-man labor situation because less labor was hired in it. The capital investment required to initiate the plans increased a relatively small amount in the two-man labor situation.

II. CONCLUSIONS

These conclusions were based on the assumptions stated in Chapter II. They can only serve as general guides to aid in farm adjustments. The more variability there is between the farm situation under consideration and the assumed situation in this study, the less applicable are these conclusions. However, these conclusions should prove useful in making farm adjustments in the mixed soil group of Henderson County and in other areas with similar situations.

Farmers in the mixed soil group of Henderson County have an opportunity to increase their net income by utilizing the resources, enterprises, and markets available to them.

Cotton was found to be the highest income crop and should be produced to its full allotment when priced at thirty cents per pound or higher. If the cotton price is decreased to twenty-six cents per pound, corn acreage begins to be more profitable.

This study indicated that the first investment capital could most profitably be utilised by putting the most productive row-crop land, soil Group II, into production. This land should be in the highest state of production, or to where inputs are used to the point where the marginal value productivity of inputs such as fertiliser and seed are equal, before any other land is brought into production or before livestock are added. Additional investment capital available could be used profitably to balance hog and corn production. Then soil Group I land suitable for corn could be brought profitably into production along with sows to utilise it. After all the cornland was utilised, then corn purchased and fed to sows producing market hogs could be added. This study indicated that corn could be purchased profitably until the twenty-five sow restriction limit was reached. As more investment capital is made available, additional land can be brought into production and additional livestock enterprises added.

From study of the eighteen schedules in the mixed soil group it appeared that most of the farm operators were operating at about the one-fourth investment capital level. If we assumed that the farm operator was presently at the one-fourth capital level, the preceding discussions indicate how he can profitably expand his farming operation.

By referring to Table XXI the income produced and investment capital required at the one-fourth capital situation in Plan V can be

TABLE XXI

NET INCOME, INVESTMENT, AND NET PAYOUT PERIODS FOR VARIOUS LEVELS OF INVESTMENT CAPITAL IN THE ONE-MAN RESIDENT LABOR SITUATION

Item	Unit	Plan V	Plan VI	Plan VII	Plan I
New value investment capital	Dollar	6,420	10,152	12,698	16,348
Net income	Dollar	3,220	4,506	5,379	5,650
Additional investment capital	Dollar	xx	3,732	2,546	3,650
Additional net income produced	Year	xx	1,286	873	271
Net payout period	Year	xx	2.9	2.9	13.4

observed. If the farmer desired to invest an additional one-fourth segment of capital, $3,732 would be required. This amount of additional capital would return $1,286 to land, labor and capital. The net payout period would be about three years.[29]

The net payout period on the second additional fourth segment of investment capital (Plan VII) would also be about three years. Thus, the farm operator, based on the assumptions of this study, could move from Plan V to Plan VII in approximately six-years time and pay back the new value investment.

The net payout period on the third additional fourth of investment capital (Plan I) would be 13.4 years. This indicated a return on this quarter-segment of investment capital of about 7.5 per cent.

Indications were that farmers were operating in the stage of production that the production economist would call an irrational one or that they were operating at a point at which each additional dollar invested returned as much or more than the one previously invested.[30]

If the farm operator had improvements, other than those indicated by the one-fourth capital situation, it might be profitable to add enterprises in a sequence other than that indicated in the preceding discussion. For example, if the operator had a barn suitable for feeding

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[29] Joel Dean, Managerial Economics (New York: Prentice-Hall, Inc., 1951), pp. 565-567. (Joel Dean defines the payout period as, ". . . the time required to pay back the investment from gross earnings." In this study the net payout period is defined as the time required to pay back the investment from net income.)

[30] Earl O. Heady, Economics of Agricultural Production and Resource Use (New York: Prentice-Hall, Inc., 1952), pp. 90, 91. (Economists usually refer to variable costs in this manner; however, in this study the application is to long-run variable or fixed costs.)

steers or handling sheep, the cost of the barn would not be an added cost in determining the return on added investment costs for the net payout period. By partial budgeting, the additional investment and net payout period for any additional enterprise can be determined. Obviously, the farmer must start from his present position and must plan additional investment accordingly.

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APPENDIX

TABLE XXII

PRODUCT AND INPUT PRICES USED

Item	Unit	Price
Products sold		
Cotton lint	Pound	$ .26
Cotton seed	Ton	50.00
Corn	Bushel	1.10
Oats	Bushel	.70
Soybeans	Bushel	1.95
Pulpwood	Cord	12.00
Top market hogs	Cwt.	14.50
Cull sows	Cwt.	11.00
Feeder pigs (40 pounds)	Head	9.00
Lambs	Cwt.	21.00
Cull ewes	Head	6.00
Cull rams	Head	8.80
Wool	Pound	.51
Milk for processing	Cwt.	3.30
Cull cows	Cwt.	13.45
Heifers	Head	175.00
Calves (3 days)	Head	7.50
Feeder steers (450-500 pounds)	Cwt.	21.00
Steers (High-Standard, 800-900 pounds)	Cwt.	19.75
Steers (Good-Choice, 900-1,050 pounds)	Cwt.	22.50
Cull beef cows	Cwt.	15.00
Cull beef heifers	Cwt.	20.00
Products bought		
Cotton	Cwt.	8.40
Alfalfa	Pound	.45
Ladino clover	Pound	.65
Kobe lespedeza	Pound	.20
Orchard grass	Pound	.32
Oats, certified	Bushel	1.40
Corn, hybrid	Bushel	10.00
Soybeans	Bushel	4.25
Fescue	Pound	.20
Bermuda	Pound	.20

TABLE XXII (continued)

PRODUCT AND INPUT PRICES USED

Item	Unit	Price
Corn	Bushel	$ 1.20
Cottonseed meal	Cwt.	3.70
Soybean meal	Cwt.	3.95
Salt minerals	Cwt.	2.00
Salt (loose)	Cwt.	1.60
Phenathiazine	Pound	1.00
Calf starter	Cwt.	5.00
Tankage	Cwt.	5.25
Alfalfa meal	Cwt.	3.60
Ammonium nitrogen	Pound	.12
Phosphate	Pound	.06
Potash	Pound	.05
Lime	Ton	5.00
Day labor (supervised)	Hour	.75
Bale hay (custom)	Ton	5.00
Combine grain (custom)	Acre	6.00
Harvest cotton (machine, custom)	Bale	30.50
Haul milk (custom)	Cwt.	.50

TABLE XXIII

MACHINERY PRICES USED[a]

Item	Price
Tractor (2-plow)	$2,223.50
Corn picker (1-row)	1,100.00
Planter (2-row)	350.50
Mower (tractor)	375.50
Grain drill	500.00
Cultivator (tractor)	300.00
Disk harrow	320.00
Drag harrow	90.00
Plow (2-bottom)	285.00
Fertilizer distributor	200.00
Wagon	200.00
Cultipacker	225.00
Cotton duster (4-row)	100.00
Side delivery hay rake	460.00
Miscellaneous tools	150.00

[a]This group of machinery was used for all plans, except that the side delivery rake was not charged against plans that did not produce hay.

TABLE XXIV

LIVESTOCK, BUILDINGS, AND MISCELLANEOUS EQUIPMENT

FOR A TWELVE-SOW UNIT

Item	Number	Price per unit	Value
Sows	12	$ 50.00	$600.00
Boar	1	75.00	75.00
Farrowing house	1	600.00	600.00
Shelter (hogs)	2	37.50	75.00
Shelter (boar)	1	50.00	50.00
Feeders (12-hole)	3	75.00	225.00
Feeders (20-inch)	12	7.50	90.00
Farrowing lamps	7	4.00	28.00
Automatic waterers	6	15.00	90.00
Loading chute	1	25.00	25.00
Grain storage (bushels)	1,500	.40	600.00
Water hose, spray, etc.	1	50.00	50.00
Fence (rods)	370	1.80	666.00

TABLE XXV

LIVESTOCK, BUILDINGS, AND MISCELLANEOUS EQUIPMENT

FOR A TWENTY-STEER BEEF (2) UNIT

Item	Number	Price per unit	Value
Steers	20	$94.50	$1,890.00
Shed and hay storage (square feet)	500	1.25	625.00
Fence (rods)	400	1.15	460.00

TABLE XXVI

LIVESTOCK, BUILDINGS, AND MISCELLANEOUS EQUIPMENT

FOR A TEN-COW DAIRY UNIT

Item	Number	Price per unit	Value
Cows	10	$200.00	$2,000.00
Milk parlor, shed, hay storage	1	500.00	500.00
Milking machine	1	225.00	225.00
Milk cans, miscellaneous[a]		161.00	161.00
Milk cooler	1	160.00	160.00
Fence (rods)	575	1.15	661.25
Heifers (over one year)	2	175.00	350.00
Heifers (under one year)	2.5	50.00	125.00

[a]Includes four milk cans, thirty-gallon water heater, washing vat, and miscellaneous milkhouse equipment.

TABLE XXVII

LIVESTOCK, BUILDINGS, AND MISCELLANEOUS EQUIPMENT

FOR A THIRTY-SHEEP UNIT

Item	Number	Price per unit	Value
Ewes	30	$ 25.00	$750.00
Ram	1	80.00	80.00
Shed and hay storage	1	600.00	600.00
Fence (rods)	300	1.15	345.00
Miscellaneous equipment	1	10.00	10.00