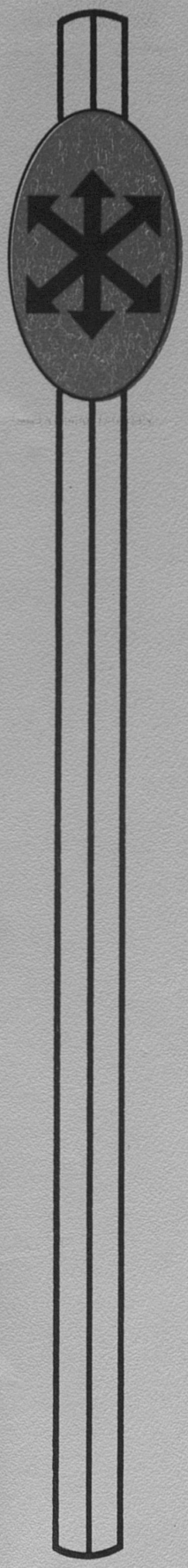

A Multiperiod Analysis of the Effects of Selected Variables on the Optimum Growth of Two Case Farms in the Mammoth Cave Area of Kentucky

by

David Raymond Humberd and Fred E. Justus, Jr.

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University of Kentucky :: College of Agriculture
Agricultural Experiment Station :: Department of Agricultural Economics
Lexington

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by

David Raymond Humberd and Fred E. Justus, Jr.[1]

INTRODUCTION

One agricultural trend that has received wide publicity is the decline in the number of farms. However, the emphasis on total number of farms tends to mask the adjustments that have occurred and continue to occur on the remaining farming units. In Kentucky, farms of 219 acres or less have declined greatly in number since the depression of the early 1930's, while farms having 220 or more acres of land have increased steadily from 13,886 in 1935 to 18,358 in 1964 [20, p. 8] Thus, some farm operators have been able to adjust to changing economic and technological environment and remain in agriculture, utilizing a larger resource base.

One of the important factors generally inherent in the adjustment process is the ability of the farm business to grow. A precise definition of growth is somewhat arbitrary if applied to a specific farm. Growth may merely mean an increase in amount such as "growth" in output, exports or sales. Penrose states that "its primary meaning is that of a process in which an interacting series of internal changes leads to increases in size accompanied by changes in the characteristics of the growing object" [14, p. 1].

For the purpose of this study, growth was defined as an increase in the size of the productive mechanism (acres of crops and/or animals) of the farm business. Growth could result from acquisition of additional resources, or from more intensive use of presently controlled resources.

Growth is a dynamic process because the variables that affect the process are constantly changing. Essentially, growth can occur through (1) internal financing, (2) external financing, (3) merger, (4) diversification into an unrelated business, or (5) a combination of these means. In this study, growth could occur only through internal and/or external financing.

There are internal and external determinants of the growth process. Internal determinants are those under the direct control of the decision-maker and include financial management strategies, family goals, internal capital rationing and family consumption. The decision-maker may also alter land and labor availability, self-imposed debt limits, livestock (number and quality), buildings, equipment and feed supply.

External determinants of growth are those not under the direct control of the farm decision-maker. These include input prices, output prices, taxes, availability of production inputs, windfall gains and

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[1]Assistant Agricultural Economist, Agricultural Extension Service, University of Tennessee; and Professor of Agricultural Economics, University of Kentucky. This report is based on research connected with Dr. Humberd's Ph.D. dissertation.

weather.[2] Unexpected family consumption requirements, such as a prolonged sickness or injury not adequately covered by insurance, can be an important external determinant. These determinants may be altered or affected by timing of decisions but not controlled. For a specific farm, an almost infinite combination of these and other factors may affect growth.

It is not logical to study farm growth without thorough consideration of the financing problems involved. Capital requirements for growth have increased greatly in the past decade. Moreover, large increases in the use of external capital have occurred because of the inability of individual farm families to provide the needed capital from savings and other internal sources. In Kentucky, during the period 1964-69, non-real estate loans from institutional sources increased 68 percent, to more than $294 million. Farm mortgage loans increased by 60 percent during the same time period to $468 million [17].[3]

Intermediate term credit, the kind typically used for expansion of internal farming activities, is unique and presents problems for lending agencies not encountered with real estate credit or short-term production credit. Real estate credit is secured by a fixed asset which has been steadily appreciating in value in the past three decades, while short-term credit is extended for a specific enterprise or purpose with specific payoff dates. But, intermediate credit may be used for items which depreciate in market value (e.g., machinery and equipment), for other items which are not marketable (e.g., buildings), or for some not even physically recoverable (e.g., land clearing).

Frequently, owing to the nature of the investment, a period of time elapses before returns achieve the level expected at the time the investment is made. The lag in net returns between investment and payoff is generally the result of two factors: (1) characteristics of the capital item involved and (2) time-loss in changes which accompany the capital investment. Capital items, because of their very nature, may result in a time lag between actual investment and potential benefits from that investment. For example, machinery may be purchased that is larger in capacity than presently needed because future expansion of the land resource is anticipated. Potential returns are not realized until added land is acquired. Similarly, crops grown on added cropland, whether added by internal clearing (or draining) or external acquisition may produce at lower-than-potential yields for several years. Many other examples could be given.

In addition to problems inherent with capital items, there are frequently major time-losses or lags because of adjustments that must be made by the human input. Major organizational changes may necessitate new work methods, greater supervisory functions and adoption of new technology. Time is normally required to make adjustments of this type. Indeed, some farm operators may not be able to cope with the greater managerial demands required by a larger business.

Time-losses add to the uncertainty of loan extension, and if the investment-returns time gap is longer than anticipated, the planned loan repayment schedule may be difficult or impossible for the farmer to meet. The result may be that additional borrowed capital is required to repay previous financial commitments, thus diverting internal capital from possible reinvestment to meeting additional interest charges and loan service fees.

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[2] Under some circumstances, price may be affected to some extent by purchases or sale in large quantities, or by contractual arrangements.

[3] The amount of non-real estate credit cited actually underestimates the total amount used because it excludes loans from merchants and dealers who are important sources of short-term credit.

A decision to attempt firm growth will likely encounter numerous alternatives of "how to" grow. Should the firm acquire more land or increase the productivity of owned land? Should livestock herds be increased to the desired size immediately or by a slower year-by-year expansion? Should land be purchased or rented? Should feed be purchased, or grown and stored? Would it be more profitable to expand current crop and/or livestock enterprises or change to other enterprises? Alternatives available on a given firm can, of course, only be known by examining the environment of that specific firm.

OBJECTIVES OF STUDY

The general purpose of this research was to investigate the anatomy of size and/or organizational adjustments of selected Kentucky farms in order to develop management guides for farmers anticipating adjustments.

The specific objectives were:

(1) to identify the problems associated with major size adjustments (growth).
(2) to determine the factors having the greatest impact on the speed and degree of success of farm growth.
(3) to determine how variations in these factors affect the capital investment-returns time lag.
(4) to determine factors which may reduce the impact of inefficiencies in size adjustments.

It is impossible to investigate all factors affecting the growth of a firm. To research a dynamic process such as growth it is necessary to concentrate on some variables (those that appear most important and can be quantified) and to relegate others to a controlled status. This study is primarily concerned with lags associated with the purchase of capital items, lags in the expansion of livestock enterprises and lags connected with the lumpiness of machinery and equipment purchase. Also, the effect on farm business growth of different family consumption patterns and different principal repayment schedules are analyzed.

GENERAL APPROACH

An in-depth study of firm growth requires detailed financial and production records. The very nature of growth dictates that data be available over a period of time. Initially, the decision was made to use data from actual farms which had recently experienced substantial growth and had used appreciable amounts of intermediate credit to do so. These data provide a realistic comparison for results obtained from abstract models. Moreover, such data were essential for establishing benchmarks and providing the main component data for programming coefficients.

A case study was selected because of the limited number of farm businesses in Kentucky on which detailed financial data over time is available. A case study is appropriate for a study of firm growth since direct inferences to other existing Kentucky farms will not be made.

Case farms were selected from clients of the Mammoth Cave Production Credit Association. The location of the Mammoth

Cave PCA is shown in Figure 1. Initially, 200 loan histories were selected from the population of 2,900 PCA cooperators on the basis that the size of loans indicated probably use for farm business expansion. These case histories were examined thoroughly. Farms considered for final selection were restricted to either grade A dairy, beef or beef-hog farms.

The following criteria were used in the final selection of three farms: (1) a full-time farm operator with no substantial off-farm income, (2) a substantial increase in the size of the farm business during 1964-66, (3) a subjective judgement that managerial ability was sufficient to permit successful expansion, and (4) willingness of the farm operator to answer detailed questions in a personal interview.

Three case farms were analyzed as described below, but the results of only two analyses are presented in this report. The decision to omit the third farm was based on two factors: (1) the desirability of keeping the report as short as possible and (2) the uniqueness of the third farm, particularly with regard to the farmer's economic goal, made the results less than completely reasonable.

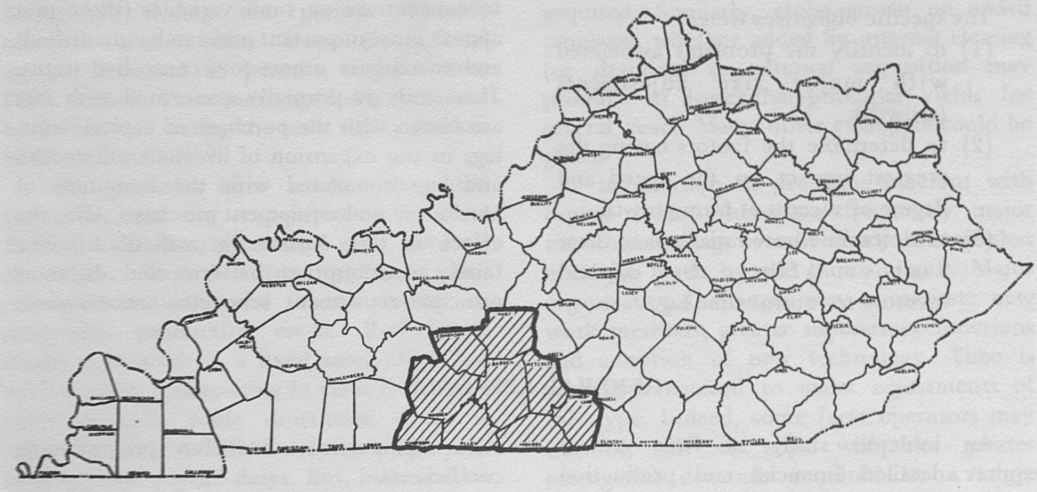

Fig. 1.--Location of Mammoth Cave Production Credit Association Area.

ANALYTICAL TECHNIQUE

The analysis for this study was divided into three distinct, but interrelated, segments. These segments were (1) obtain the profit maximizing organization on each farm using linear programming, (2) develop a multiperiod linear programming model and apply the model to each farm to determine an optimal growth pattern, and (3) introduce several lag-creating factors in the multiperiod model to determine their effect on the growth pattern.

The profit maximizing farm organization, using 1968 input-output data, permitted comparison of optimum farm business size (using existing technology and constraints) with actual farm size. These solutions were used for analyzing the present resource situation on each farm and provided one basis for selecting enterprises for inclusion in the multiperiod model. However, the static programming analysis provided a solution for period t without considering the effect of limitations that may exist in t + n, where n = 1, 2 ...., i production periods. A model that permits consideration of the resources and constraints of t + n (i.e. a multiperiod model) was essential for analyzing the impact of lag factors on the growth pattern, net returns, capital requirements and other financial indicators. Results of the static programming are not presented in this report.

The multiperiod linear programming model developed for this study included eight production periods. A production period was defined as one year. This model was solved simultaneously for eight periods and as such, resources and constraints for all eight periods were considered. The specific objective function selected for this study was the maximization of net returns to the operator's labor, owned capital and management for the entire 8 years. The growth pattern that was obtained in this programming is therefore the optimum growth pattern for the given farm for this specific goal (i.e. maximum net returns to these resources for 8 years), and within the stated constraints. A detailed description of this model is presented in Appendix A.

A model was desired that included the actual growth period plus an extension into the future. The extension past the actual data period (5 years) served two purposes. First, the last year of the model is essentially "lost" for comparison purposes since there is no transfer requirement for a succeeding period. Second, capital investments of the type being made on these farms need time to achieve their potential, thus a planning horizon of more than 5 years is probably desirable. However, as the model was not designed to predict future growth for these two farms, the 1968 price and production levels were used for the extension past the actual data period.

Enterprises permitted in the model were not allowed to vary extensively from the actual situation. For example, since dairy represented the livestock preference for farmer I, other livestock enterprises were not allowed to compete in the model.

The third phase of this analysis essentially involved the selection of appropriate internal and external determinants for use in determining their effects on the growth pattern and net returns of each case farm. Effects were analyzed over the 8-year period, and comparisons made with the optimum solution.

RESULTS OF ANALYSIS: Farm I

Farm I is a grade A dairy farm on which the dairy enterprise provided 67 and 76 percent of gross farm income in 1964 and 1968, respectively. There was a herd of 26 cows when the expansion program began, and the operator had a stated goal of achieving a 60-cow dairy herd.

Characteristics and Assumptions

Labor

Labor availability and timing is a critical formulation in an analysis of this type. It was estimated that the owner supplied 3,052 hours of labor per year. Beginning with the third production period (year) one full-time salaried employee supplied 3,468 hours per year, thus giving the farm a committed labor supply of 6,520 hours. The following total seasonal supply by operator and full-time hired labor was assumed.[4]

Season	Total Hours
February-April	1,576
May-July	1,684
August-October	1,684
November-January	1,576
Total	6,520

In addition, up to 600 hours of seasonal labor could be hired per quarter in the May-July and August-October periods. As wage rates have been increasing, the cost of seasonal labor increased from $1.00 to $1.60 per hour during the 8-year period (Appendix B, Table 1).

[4]While it may have been desirable to use monthly labor restrictions and requirements, the dimensions of the model matrix made this infeasible. There is enough flexibility in the timing of farm labor tasks to justify this amount of seasonal aggregation.

Capital

Two sources of capital funds were available for any specific production period. First, returns above operating expenses, overhead costs and family consumption were available for investment purposes, and were transferred to the succeeding period. Second, the operator could borrow capital.

Capital availability did not limit actual expansion on Farm I, although the actual growth pattern might have been different without real or imagined loan limits. For the purpose of the model, 60 percent of total farm assets minus the amount required to secure the existing real estate loan was used to establish the upper limit for borrowing capacity. Borrowing capacity was not mutually exclusive in each period. For example, if $1,000 was borrowed in period 1, the borrowing capacity in succeeding periods was also reduced by $1,000. When repayment of this loan was made the borrowing capacity would be increased by the amount of repayment. Repayment, unless otherwise stated, was required in five equal annual installments beginning with the second year of the loan.

Interest was charged on the declining balance of the loan. To approximate existing conditions, interest rates for borrowed capital were as follows: periods 1 and 2 (corresponding to 1964 and 1965)— 6 percent; period 3— 6.5 percent; period 4— 7 percent; period 5— 7.5 percent; and periods 6, 7 and 8— 8.5 percent.

Management

The actual management performance, as reflected in production response such as crop yields and milk production per cow, was integrated in the coefficients used in the model. It was assumed that this level of operational management performance would occur under all alternative growth patterns.

Land Use

Land use capability was divided into three categories: row cropland, other cropland and pastureland. It was assumed that all Class I and II land can grow continuous row crops, one-half of Class III land can be used for row crops and one-fourth of Class IV land can be row-cropped during any specific period. Farm I had 138 acres row cropland, 42 acres other cropland and 21 acres pastureland. Land suitable for a high-cropping intensity could be converted into a lower level of use; however, the reverse was not true.

In addition to land available at the start of the growth process, a land buying activity permitted purchase of up to 50 acres per year. Each acre purchased would add 0.5 acre row cropland, 0.25 acre other cropland and 0.25 acre pastureland. Only one-half of all cropland could be utilized during the purchase year. Per acre land purchase prices assumed were: periods 1 and 2—$250; periods 3 and 4—$260; periods 5 and 6—$280; and periods 7 and 8—$300.

Farming Program

Basically, the crop enterprises included in the model were those actually grown during the past 5 years. No purchased feed, other than supplements, was permitted. Crops produced for cash sale limited corn to 50 acres; soybeans, 35 acres; and wheat, 40 acres. Burley tobacco was limited by the allotment level. The acreage of corn for feed was limited only by the land use capability.

The dairy herd was the only livestock enterprise on Farm I. Replacement of culled cows was accomplished by internal retention of calves. Other than 10 heifers on hand in 1964, herd expansion was accomplished by purchasing animals. The purchase of a cow adds one productive unit to the herd in the year of purchase and each year thereafter, while the purchase of a heifer adds 0.95 productive unit in the year following purchase and one unit thereafter.[5] Production returns and costs per cow reflected, as closely as possible, the actual performance on Farm I.

Buildings and Equipment

Initially, buildings and equipment were assumed adequate for a dairy herd of 40 cows. Expansion beyond 40 cows required the purchase of additional equipment. For simplification and because of the difficulty of allocating buildings and equipment use to specific enterprises in a multiperiod model of this type, all additional investment in buildings and equipment was a function of dairy herd size. Coefficients for equipment purchase were established such that total investment in equipment would approximate that required for anticipated optimum herd size (based on static programming).

Overhead Cost

The withdrawal of funds for payment of overhead costs was required for each production period. Overhead costs include principal and interest payments on real estate controlled at the start of the expansion, farm insurance, real estate taxes, depreciation and repairs for initial buildings and equipment, and family consumption. The salary for the full-time employee is added in period 3 and thereafter. Production periods 1 through 5 also include the repayment of principal and interest for the intermediate-term debt outstanding in 1964.

Actual Farm Organization

The existing 1964 and 1969 organizations on Farm I are shown in Table 1. No additional land was purchased, and changes revolved around dairy cow expansion

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[5] A productive unit is defined as one cow with milk production equal to the herd average.

TABLE 1

RESOURCES, ENTERPRISE ORGANIZATION AND OVERHEAD COSTS, FARM 1, JANUARY 1964 AND JANUARY 1969

Item	Unit	1964	1969
Total land	Acres	201	201
Row cropland	Acres	138	138
Other cropland	Acres	42	42
Pastureland	Acres	21	21
Operator labor	Hours	3,052	3,052
Hired labor	Hours	a	3,468[b]
Borrowing capacity	Dollars	27,500[c]	43,907[c]
Operating capital on hand	Dollars	1,000	a
Dairy cows	Animals	26	73
Dairy heifers	Animals	18	39[d]
Equipment and buildings	Animals	40[c]	80[c]
Cropland organization			
Corn (grain)	Acres	30	83[e]
Corn (silage)	Acres	5	17
Wheat	Acres	15	13
Hay	Acres	30	20
Tobacco	Acres	3.74	2.58
Soybeans	Acres	0	10
Pasture	Acres	117	120
Overhead costs			
Real estate payment	Dollars	1,525	1,425
Family consumption	Dollars	4,000[c]	4,501[c]
Real estate taxes	Dollars	150	328
Farm insurance	Dollars	300	300
Salaried labor	Dollars	0	3,200[c]
Depreciation and repairs on buildings and equipment	Dollars	1,490[c]	1,490[c]
Outstanding operating debt	Dollars	17,045	34,548
Total real estate debt	Dollars	20,500	18,643

[a]Unknown.

[b]Represents salaried labor. Other seasonal labor was also used.

[c]Calculated or estimated by author.

[d]Heifers and calves.

[e]Eighty-five acres cropland located at some distance from the main farm was rented in 1968. The operator, however, gave up the lease on this land in 1969.

and corresponding feed crops. Outstanding operating debt more than doubled while real estate indebtedness decreased slightly during the period. Even though dairy herd size increased by 47 cows in these 5 years, total debt load also increased by $15,646.

Optimum Solution

The "primary solution" for Farm I represents the optimum expansion pattern under the assumptions used. The primary solution uses the existing situation in 1964 as a starting point, and as stated earlier, coefficients are based on empirical data taken from production and financial records on Farm I.

In the primary solution (and all alternative solutions unless otherwise stated), the crop yields used for period 1 were those achieved on Farm I in 1964. Period 2 represents a transition period with some yield increase, while periods 3 through 8 assume a constant "improved" yield level.

Results of the primary solution are shown in Table 2. Under the assumptions of the primary solution, the dairy herd expands to 83 cows. Actual herd size was 73 cows in 1969. Most of the expansion occurs in the first 4 periods. Owing to earlier borrowing in periods 1 and 2, the $15,301 is the maximum available capital for borrowing in period 3 (i.e., all of borrowing capacity is utilized), so that the expansion in period 3 represents the maximum attainable level.

Credit balance represents the total amount of outstanding debt at the end of each period. Real estate indebtedness is included. Therefore, a debt of $21,239 is outstanding at the end of the eighth period.

The objective function, representing net returns to the operator's labor, owned capital and management over the total 8-year period is $106,847.

Since there is no requirement for corn and hay transfer to succeeding years for feed, the *income* data for the eighth period are slightly overstated.

As mentioned earlier, family expenditures increase to reflect the increase in cost of living during these years. Net returns after family consumption increase from a $-719 to $17,144. Total net returns after family consumption for the 8-year period equals $71,851. This total does not equal the sum of the annual figures due primarily to the cost of money borrowed for family consumption in the years when farm business returns do not exceed family living expenses.

Even though dairy herd size in the optimum solution exceeds the actual expansion by only 6 cows in period 6 (the last relevant period for comparison) the financial situation is considerably improved over the actual situation. Outstanding borrowed capital is $16,530 less, and, moreover, actual borrowing is increasing while borrowing in the primary solution is decreasing.

Selected Variables Affecting Growth on Farm I

Alternatives 1, 2—Increased Family Consumption

One factor hypothesized to affect the growth process is the withdrawal of funds for family consumption. Two adjustments were made from the primary solution to determine the effect of consumption withdrawals. All other coefficients are the same as the primary solution.

Alternative 1, summarized in Table 3, represents a $1,000 increase in family consumption per production period over that assumed in the primary solution. The resulting growth pattern is essentially the same as that of the primary solution except a smaller dairy herd size is attained. Total borrowing in the 8-year period increased by $11,630 over the primary solution. Total net returns were decreased $4,266, but net

TABLE 2

FARM ORGANIZATION, FINANCIAL SUMMARY AND GROWTH ON FARM I, PRIMARY SOLUTION

Item		Production Period							
		1 (1964)	2	3	4	5	6	7	8
Farm Business									
Land Operated	Ac.	201	201	201	201	201	201	201	201
Corn (all)	Ac.	84	92	69	88	88	64	86	88
Corn (sell)	Ac.	50	47	14	24	24	0	20	50
Tobacco	Ac.	3.74	3.74	3.04	2.58	2.58	2.58	2.58	2.58
Soybeans	Ac.	35	0	35	0	0	24	0	10
Wheat	Ac.	1	0	0	0	0	0	0	0
Hay	Ac.	32	36	28	31	31	31	32	16
Pasture	Ac.	46	69	64	79	79	79	80	83
Dairy	An.	26	46	64	79	79	79	80	83
Cows Purchased	An.	0	10	18	15	0	0	1	3
Heifers Purchased	An.	0	0	0	0	0	0	0	0
Financial Summary									
Gross Income	Dol.	22,279	31,000	44,066	50,359	50,359	49,683	50,555	55,538
Operating Costs	Dol.	11,101	15,885	21,630	26,722	26,550	25,343	25,551	26,408
Overhead Costs	Dol.	7,897	7,667	10,616	10,486	10,357	6,818	6,893	7,068
Net Returns	Dol.	3,281	7,448	11,820	13,151	13,452	17,522	18,111	22,062
Family Consumption	Dol.	4,000	4,120	4,243	4,370	4,501	4,636	4,775	4,918
Net after Family Consumption	Dol.	-719	3,328	7,577	8,781	8,951	12,886	13,336	17,144
Seasonal Labor (all)	Hrs.	606	1,129	0	71	71	76	95	193
Capital Expenditures	Dol.	0	6,131	17,357	15,688	0	0	1,026	3,432
Capital Borrowed in Period	Dol.	13,321	6,666	15,301	13,877	3,315	230	0	0
Credit Balance End of Period (all)	Dol.	38,253	41,549	52,148	58,262	51,040	36,661	28,283	21,239
Total Capital Borrowed	Dol.	52,710							
Total Net Returns[a]	Dol.	106,847							
Total Net After Family Consumption[b]	Dol.	71,851							

[a]Total net returns to owner's labor, owned capital and management for the entire 8-year period.

[b]Total net after family consumption will not equal the sum of annual nets after family consumption, due primarily to cash needed for borrowed money required for family consumption during years when business returns do not exceed family living expenses.

TABLE 3

FARM ORGANIZATION, FINANCIAL SUMMARY AND GROWTH ON FARM I, ALTERNATIVE 1[a]

Item		Production Period							
		1 (1964)	2	3	4	5	6	7	8
Farm Business									
Land Operated	Ac.	201	201	201	201	201	201	201	201
Corn (all)	Ac.	83	93	76	92	92	92	61	72
Corn (sell)	Ac.	50	50	22	31	31	31	0	37
Tobacco	Ac.	3.74	3.74	3.04	2.58	2.58	2.58	2.58	2.58
Soybeans	Ac.	35	0	35	0	0	0	31	35
Wheat	Ac.	1	0	0	0	0	0	0	0
Hay	Ac.	32	34	27	30	30	30	30	15
Pasture	Ac.	46	69	60	76	76	76	76	76
Dairy	An.	26	46	60	76	76	76	76	76
Cows Purchased	An.	0	10	14	16	0	0	0	0
Heifers Purchased	An.	0	0	0	0	0	0	0	0
Financial Summary									
Gross Income	Dol.	22,291	31,309	42,728	49,492	49,492	49,492	48,622	52,200
Operating Costs	Dol.	11,161	16,997	20,662	26,143	26,114	25,745	24,324	24,097
Overhead Costs	Dol.	7,897	7,667	10,616	10,486	10,357	6,818	6,893	7,068
Net Returns	Dol.	3,233	6,645	11,450	12,863	13,021	16,929	17,405	21,035
Family Consumption	Dol.	5,000	5,120	5,243	5,370	5,501	5,636	5,775	5,918
Net after Family Consumption	Dol.	-1,767	1,525	6,207	7,493	7,520	11,293	11,630	15,117
Seasonal Labor (all)	Hrs.	606	1,131	0	31	31	31	22	12
Capital Expenditures	Dol.	0	11,000	7,480	16,890	0	0	0	0
Capital Borrowed in Period	Dol.	14,321	12,870	9,738	16,626	5,619	3,761	1,405	0
Credit Balance, End of Period (all)	Dol.	39,253	48,553	52,149	60,684	54,887	42,700	33,881	25,954
Total Capital Borrowed	Dol.	64,340							
Total Net Returns[b]	Dol.	102,581							
Total Net After Family Consumption[c]	Dol.	57,853							

[a]Family consumption increased by $1,000 each production period.

[b]Total net returns to owner's labor, owned capital and management for the entire 8-year period.

[c]Total net after family consumption will not equal the sum of annual nets after family consumption, due primarily to cash needed for borrowed money required for family consumption during years when business returns do not exceed family living expenses.

returns after family consumption were $57,853, a decrease of $13,998. Increased consumption in the early periods made additional borrowing necessary, thus increasing cash outlays for interest and repayment of loans, and reducing the borrowing potential (and herd growth) in later periods.

Alternative 2 assumed that the family expenditures amounts to the base level indicated earlier, plus 50 percent of the annual income available for transfer to each succeeding year (Table 4). The growth potential of Farm I is reduced considerably as borrowing is necessary to satisfy family consumption in the first period, and family consumption uses most of the net returns in the other seven periods (thus borrowed capital had to supply a large portion of the cash needed for growth).

Net returns for alternative 2 are only about 70 percent of total net returns for the primary solution (Table 2). Net returns are reduced to $75,176, while total borrowing for the entire period increased to $118,334 (more than twice as much as needed in the primary solution), the dairy herd expands to 57 cows, which is 26 cows fewer than the primary solution. Another important factor shown in Table 4 is that the credit balance is increasing slightly in the eighth period. Since all available credit is used in periods 3, 4 and 5, the farm business is forced into the lower cost but lower return enterprises, soybeans and wheat. The upper limit on borrowing and increased consumption forced idle land and labor into this solution. Leaving these resources idle is not realistic, but the reduced ability of Farm I to grow was demonstrated.

These solutions indicate the need to account adequately for the cash requirements for family living when making arrangements to finance a growing farm business. To underestimate this demand for cash could result in far less than the expected growth goal and disappointment with loan load repayment. Inference can also be drawn from this solution for other lump-sum withdrawals of cash from the business.

Alternative 3—Using Heifers in Dairy Herd Expansion

Another alternative to the primary solution is allowing the purchase of dairy heifers as the only means of herd expansion. Essentially, this alternative (Table 5) introduces a lag in the dairy enterprise since the capital expenditure and operating costs must be met one year prior to a return from the animal. All other coefficients are the same as the primary solution. The lag is shown empirically by comparing net returns for periods 2 and 3 in the primary solution (Table 2) and Table 5. Eighteen heifers were purchased in period 2, but net returns are $3,414 less than in the comparable period in the primary solution. Period 3 also shows $4,352 less net returns for expansion by heifers only. The impact of the lag is almost eliminated by the eighth year as net returns in that year are only $620 less than the primary solution. The total impact of this growth procedure is appreciable as more capital had to be borrowed (although herd size is six cows smaller in year 8), net returns for the total growth period are over $9,800 lower and net returns after family consumption was about $10,800 lower than for the primary solution.

Alternatives 4, 5—Effect of Land Purchasing

Farm I did not expand land resources under actual conditions, nor did land-buying enter any programming solution where this activity was optional. However, a farmer sometimes decides to buy land as soon as it becomes available (land may be available only once per generation) and add the necessary equipment, livestock, etc., later.

A growth lag is often the result of such a decision, because with a limited borrowing

TABLE 4

FARM ORGANIZATION, FINANCIAL SUMMARY AND GROWTH ON FARM I, ALTERNATIVE 2[a]

Item		Production Period							
		1	2	3	4	5	6	7	8
Farm Business									
Land Operated	Ac.	201	201	201	201	201	201	201	201
Corn (all)	Ac.	34	84	41	45	45	84	84	76
Corn (sell)	Ac.	0	44	0	0	0	39	39	50
Tobacco	Ac.	3.74	3.74	3.04	2.58	2.58	2.58	2.58	2.58
Soybeans	Ac.	35	0	35	35	35	35	35	35
Wheat	Ac.	0	0	40	40	38	0	0	19
Hay	Ac.	32	32	20	22	22	22	22	11
Pasture	Ac.	45	72	48	56	57	57	57	57
Dairy	An.	26	48	48	56	57	57	57	57
Cows Purchased	An.	0	12	0	8	1	0	0	0
Heifers Purchased	An.	0	0	0	0	0	0	0	0
Financial Summary									
Gross Income	Dol.	19,232	31,735	36,375	40,104	40,439	41,532	41,532	43,742
Operating Costs	Dol.	8,965	16,457	16,625	20,098	21,003	22,412	22,869	23,284
Overhead Costs	Dol.	7,897	7,667	10,616	10,486	10,357	6,818	6,893	7,068
Net Returns	Dol.	2,370	7,611	9,134	9,520	9,079	12,302	11,770	13,390
Family Consumption	Dol.	4,000	5,745	6,445	6,575	8,539	8,433	7,997	8,236
Net After Family Consumption	Dol.	-1,630	1,866	2,689	1,945	540	3,869	3,773	5,154
Seasonal Labor (all)	Hrs.	413	1,144	0	0	0	0	0	0
Capital Expenditures	Dol.	0	6,990	0	8,548	846	0	0	0
Capital Borrowed in Period	Dol.	11,306	15,430	9,498	18,437	15,024	15,197	16,295	17,147
Credit Balance, End of Period (all)	Dol.	36,238	48,701	52,148	62,543	66,018	63,163	64,239	65,999
Total Capital Borrowed	Dol.	118,334							
Total Net Returns[b]	Dol.	75,176							
Total Net After Family Consumption[c]	Dol.	19,991							

[a]Family consumes 50 percent of annual income available for transfer to each succeeding period.

[b]Total net returns to owner's labor, owned capital and management for the entire 8-year period.

[c]Total net after family consumption will not equal the sum of annual nets after family consumption, due primarily to cash needed for borrowed money required for family consumption during years when business returns do not exceed family living expenses.

TABLE 5

FARM ORGANIZATION, FINANCIAL SUMMARY AND GROWTH ON FARM I, ALTERNATIVE 3[a]

Item		Production Period							
		1 (1964)	2	3	4	5	6	7	8
Farm Business									
Land Operated	Ac.	201	201	201	201	201	201	201	201
Corn (all)	Ac.	79	70	76	89	89	86	61	85
Corn (sell)	Ac.	50	26	19	29	29	24	0	50
Tobacco	Ac.	3.74	3.74	3.04	2.58	2.58	2.58	2.58	2.58
Soybeans	Ac.	35	0	0	0	0	5	29	21
Wheat	Ac.	6	0	0	0	0	0	0	0
Hay	Ac.	31	37	29	30	30	30	30	15
Pasture	Ac.	46	91	92	76	77	77	77	77
Dairy	An.	26	36	53	76	77	77	77	77
Cows Purchased	An.	0	0	0	0	0	0	0	0
Heifers Purchased	An.	0	18	23	0	0	0	0	0
Financial Summary									
Gross Income	Dol.	22,532	24,758	36,481	49,134	49,767	49,631	48,945	52,917
Operating Costs	Dol.	11,100	13,057	18,397	26,160	26,267	25,660	24,281	24,407
Overhead Costs	Dol.	7,897	7,667	10,616	10,486	10,357	6,818	6,893	7,068
Net Returns	Dol.	3,535	4,034	7,468	12,488	13,143	17,153	17,771	21,442
Family Consumption	Dol.	4,000	4,120	4,243	4,370	4,501	4,636	4,775	4,918
Net after Family Consumption	Dol.	-465	-86	3,225	8,118	8,642	12,517	12,996	16,524
Seasonal Labor (all)	Hrs.	623	938	0	42	42	40	33	29
Capital Expenditures	Dol.	0	2,520	11,450	16,650	0	0	0	0
Capital Borrowed in Period	Dol.	13,320	7,486	14,645	18,280	4,553	2,284	0	0
Credit Balance, End of Period (all)	Dol.	38,252	42,639	51,968	62,489	55,628	42,177	32,263	23,848
Total Capital Borrowed	Dol.	60,568							
Total Capital Borrowed	Dol.	60,568							
Total Net Returns[b]	Dol.	97,034							
Total Net After Family Consumption[c]	Dol.	61,078							

[a]Only heifers could be purchased for herd expansion. This activity adds no production in purchase year, 0.95 cow in second year, and 1.0 cow in all succeeding years.

[b]Total net returns to owner's labor, owned capital and management for the entire 8-year period.

[c]Total net after family consumption will not equal the sum of annual nets after family consumption, due primarily to cash needed for borrowed money required for family consumption during years when business returns do not exceed family living expenses.

capacity the additional investment for other capital items necessary to adequately use the added land may not be available. To determine the effect of this possibility on the growth process of Farm I, alternatives 4 and 5 were programmed.

Data in Table 6 illustrate the effects of the purchase of 50 acres of land in period 5. This land purchase occurs after the dairy herd has undergone its major growth. In this model one change was made in one of the coefficients. It was assumed that during the year a cow was purchased for expansion she would contribute only 6 months' milk production.

The lag impact of land-buying is not well documented empirically in this model because once land is purchased in the model, the land resource is fully utilized and other adjustments are stymied. The assumption of only seasonal labor being available for hire prevents expansion into land and dairy at the same time. Since land purchase is forced into the model, labor is utilized for land rather than dairy herd growth. Therefore, dairy herd size is eight cows smaller than in the primary solution. The purchase of 50 acres in period 5 results in a reduction of only $1,682 in total net returns. Net returns after family consumption, however, is reduced by $7,626, showing the competition between family cash and business cash needs.

Alternative 5 (Table 7) shows the results when 50 acres of land is purchased in period 2 before dairy herd expansion has occurred. The lag in the production of purchased cows is not included in this alternative; therefore, a cow purchased adds one unit to herd production during the year of purchase.

The early purchase of land prevents dairy herd expansion to the level of the primary solution or even to the level of alternative 4 (Table 6). Under the assumption of early land purchase, almost half of the dairy expansion occurred through heifer purchases. This is also in contrast to alternative 4. However, because all available capital is borrowed in periods 2, 3 and 4, the purchase of heifers represents a method of dairy expansion that requires a smaller capital expenditure in the early periods of the model.

As expected, since land purchase did not enter the primary solution, the buying of land results in reduced herd size and net returns (from the primary solution) and makes additional borrowing necessary. However, appreciation in the value of purchased land is not accounted for in this model, and in actuality, total asset position may be improved through land-buying. Thus, the goals of the farmer have to be considered in stating whether or not land should be purchased. For Farm I, under the stated goals of dairy expansion, and maximum farm business returns the buying of land would have reduced herd size and net returns (about $10,500) during the 8-year period.

Alternative 6—Slow Dairy Herd Expansion

This alternative (presented in Table 8) shows the results of placing upper bounds on the dairy enterprise to prevent expansion at a rate greater than the actual expansion. This permits a comparison of optimum expansion (primary solution) with expansion at a slower rate.

The slower rate of growth requires less total borrowed capital than the optimum solution, but since expansion is slower, the stream of net returns is reduced and total returns are $8,969 less than the primary solution. Moreover, as all capital is borrowed as required by dairy expansion, a larger total credit balance exists at the end of the eighth period. Under the stated assumptions, the faster expansion utilizing more borrowed capital would have achieved greater net returns and a slightly larger herd size at the end of 8 years.

TABLE 6

FARM ORGANIZATION, FINANCIAL SUMMARY AND GROWTH ON FARM I, ALTERNATIVE 4[a]

Item		Production Period							
		1 (1964)	2	3	4	5	6	7	8
Farm Business									
Land Operated	Ac.	201	201	201	201	251	251	251	251
Corn (all)	Ac.	83	92	53	102	107	107	107	83
Corn (sell)	Ac.	50	47	0	47	50	50	50	50
Tobacco	Ac.	3.74	3.74	3.04	2.58	2.58	2.58	2.58	2.58
Soybeans	Ac.	35	0	35	0	23	35	35	35
Wheat	Ac.	1	0	17	0	0	7	7	40
Hay	Ac.	32	36	26	27	28	28	28	14
Pasture	Ac.	46	69	65	68	71	71	71	71
Dairy	An.	26	46	65	68	71	71	71	71
Cows Purchased	An.	0	29	0	6	0	0	0	1
Heifers Purchased	An.	0	0	0	0	0	0	0	0
Financial Summary									
Gross Income	Dol.	22,293	31,043	44,763	46,519	49,803	50,960	50,942	53,284
Operating Costs	Dol.	11,106	16,521	21,612	23,513	26,182	26,569	25,919	25,128
Overhead Costs	Dol.	7,897	7,667	10,616	10,486	10,357	6,818	6,893	7,068
Net Returns	Dol.	3,290	6,855	12,445	12,520	13,264	17,573	18,130	21,088
Family Consumption	Dol.	4,000	4,120	4,243	4,370	4,501	4,636	4,775	4,918
Net after Family Consumption	Dol.	-710	2,735	8,202	8,150	8,763	12,937	13,355	16,170
Seasonal Labor (all)	Hrs.	607	1,128	0	0	26	72	71	187
Capital Expenditures	Dol.	0	11,780	11,700	4,060	16,090	0	0	810
Capital Borrowed in Period	Dol.	13,321	12,479	10,650	5,190	19,784	4,268	1,885	0
Credit Balance, End of Period (all)	Dol.	38,253	47,362	52,148	49,343	60,095	47,964	38,875	30,021
Total Capital Borrowed	Dol.	67,577							
Total Net Returns[b]	Dol.	105,165							
Total Net After Family Consumption[c]	Dol.	64,225							

[a]Solution forces purchase of 50 acres land in period 5. Purchased cows add only one-half production in purchase year.

[b]Total net returns to owner's labor, owned capital and management for the entire 8-year period.

[c]Total net after family consumption will not equal the sum of annual nets after family consumption, due primarily to cash needed for borrowed money required for family consumption during years when business returns do not exceed family living expenses.

TABLE 7

FARM ORGANIZATION, FINANCIAL SUMMARY AND GROWTH ON FARM I, ALTERNATIVE 5[a]

Item		Production Period							
		1 (1964)	2	3	4	5	6	7	8
Farm Business									
Land Operated	Ac.	201	251	251	251	251	251	251	251
Corn (all)	Ac.	79	82	93	100	102	102	102	79
Corn (sell)	Ac.	50	50	50	50	50	50	50	50
Tobacco	Ac.	3.74	3.74	3.04	2.58	2.58	2.58	2.58	2.58
Soybeans	Ac.	35	35	35	35	35	35	35	35
Wheat	Ac.	9	0	40	28	20	20	20	40
Hay	Ac.	28	28	22	25	26	26	26	13
Pasture	Ac.	46	56	59	61	65	65	65	65
Dairy	An.	26	37	41	61	65	65	65	65
Cows Purchased	An.	0	1	3	10	4	0	0	0
Heifers Purchased	An.	0	0	10	0	0	0	0	0
Financial Summary									
Gross Income	Dol.	22,676	29,157	36,827	46,439	48,465	48,465	48,465	49,681
Operating Costs	Dol.	11,164	14,331	17,441	24,065	25,665	25,267	24,781	23,321
Overhead Costs	Dol.	7,897	7,667	10,616	10,486	10,357	6,818	6,893	7,068
Net Returns	Dol	3,615	7,159	8,770	11,888	12,443	16,380	16,791	19,292
Family Consumption	Dol.	4,000	4,120	4,243	4,370	4,501	4,636	4,775	4,918
Net after Family Consumption	Dol	-385	3,039	4,527	7,518	7,942	11,744	12,016	14,374
Seasonal Labor (all)	Hrs.	636	925	0	0	0	0	0	0
Capital Expenditures	Dol.	0	12,800	2,970	14,120	3,360	0	0	0
Capital Borrowed in Period	Dol.	13,381	14,335	9,130	18,559	9,999	4,767	3,758	788
Credit Balance, End Period (all)	Dol.	38,313	49,266	52,149	62,634	60,848	48,420	40,324	31,367
Total Capital Borrowed	Dol.	74,717							
Total Net Returns[b]	Dol.	96,338							
Total Net After Family Consumption[c]	Dol.	54,381							

[a]Solution forces purchase of 50 acres land in period 2.

[b]Total net returns to owner's labor, owned capital and management for the entire 8-year period.

[c]Total net after family consumption will not equal the sum of annual nets after family consumption, due primarily to cash needed for borrowed money required for family consumption during years when business returns do not exceed family living expenses.

TABLE 8

FARM ORGANIZATION, FINANCIAL SUMMARY AND GROWTH ON FARM I, ALTERNATIVE 6[a]

Item		Production Period							
		1 (1964)	2	3	4	5	6	7	8
Farm Business									
Land Operated	Ac.	201	201	201	201	201	201	201	201
Corn (all)	Ac.	83	87	90	98	96	95	91	86
Corn (sell)	Ac.	50	50	50	50	38	36	30	50
Tobacco	Ac.	3.74	3.74	3.04	2.58	2.58	2.58	2.58	2.58
Soybeans	Ac.	35	11	35	21	0	0	0	16
Wheat	Ac.	2	0	0	0	0	0	0	0
Hay	Ac.	31	31	20	25	29	29	30	16
Pasture	Ac.	46	67	52	53	73	73	76	80
Dairy	An.	26	45	47	53	73	73	76	80
Cows Purchased	An.	0	9	2	3	20	0	3	4
Heifers Purchased	An.	0	0	3	0	0	0	0	0
Financial Summary									
Gross Income	Dol.	22,343	31,367	37,867	39,583	47,216	48,297	49,089	54,100
Operating Costs	Dol.	11,069	15,553	16,893	18,628	25,476	25,210	25,243	26,100
Overhead Costs	Dol.	7,897	7,667	10,616	10,486	10,357	6,818	6,893	7,068
Net Returns	Dol.	3,377	8,147	10,358	10,469	11,383	16,269	16,953	20,922
Family Consumption	Dol.	4,000	4,120	4,243	4,370	4,501	4,636	4,775	4,918
Net after Family Consumption	Dol.	-623	4,027	6,115	6,099	6,882	11,663	12,178	16,004
Seasonal Labor (all)	Hrs.	610	1,104	0	0	0	0	24	100
Capital Expenditures	Dol.	0	5,200	1,900	5,270	23,030	260	3,000	4,570
Capital Borrowed in Period	Dol.	13,329	5,842	3,406	3,876	18,860	0	0	0
Credit Balance, End of Period (all)	Dol.	38,261	40,732	39,599	38,254	51,118	37,943	31,047	25,319
Total Capital Borrowed	Dol.	45,313							
Total Net Returns[b]	Dol.	97,878							
Total Net After Family Consumption[c]	Dol.	62,557							

[a]Solution forces dairy cows to equal actual numbers in each period. Initial debt load is included.

[b]Total net after family consumption will not equal the sum of annual nets after family consumption, due primarily to cash needed for borrowed money required for family consumption during years when business returns do not exceed family living expenses.

Alternative 7—No Initial Intermediate Term Debt

Removal of the actual initial intermediate-term debt load of $17,045 is the only difference between the primary solution and alternative 7. The objective of this change was to ascertain the effect that the financial position at the start of an expansion program has on the expansion process utilizing the same resource base. Table 9 shows the results of making this assumption. Total net returns increased by $32,826 while total borrowing decreased by $17,291 when compared to the primary solution. Dairy herd size expands more rapidly to 81 cows in the third year and 88 cows in the fourth year. The stream of net returns available over the remainder of the total period allows all borrowed capital to be repaid with the exception of real estate debt.

Summary for Farm I Alternatives

Table 10 presents a summary of total net returns, total borrowing, credit balance and dairy herd size for all solutions on Farm I. There is a range of $74,043 in total net returns, $82,915 in total capital borrowed, $48,999 in credit balance and a range in ending dairy herd size of 32 cows. The range in net returns above family consumption is $84,043.

Alternative 7, which assumes no initial intermediate-debt load provides the largest total net returns and also has the lowest credit balance at the end of the eight periods. Alternative 2, which allows an annual base family consumption plus 50 percent of annual net returns, requires the largest amount of total borrowing, and results in lower total returns than any other alternative considered. Other solutions result in intermediate values between the extremes.

Figures 2, 3 and 4 depict the relationships between alternatives 2 and 7, the primary solution and the actual situation for growth in dairy herd size, capital borrowed and net returns. No actual net returns data are available and dairy herd size and actual borrowing are known only through period 6.

The dairy herd size for the primary solution exceeds the actual expansion by only six cows for period 6 (the last relevant period for comparison). Yet $16,530 less borrowed capital is outstanding for the primary solution, and even more significant, actual borrowing is increasing while borrowing for the primary solution is decreasing (see Figure 3). No additional land is added to the 1964 base in either the primary solution or during the actual expansion. The cropping program for the optimum solution is similar to that actually grown. Burley tobacco remains in solution at the allotment level for all periods and acreage actually used for wheat is diverted to corn, a higher return enterprise.

Of the alternatives considered on Farm I, family consumption has the largest impact on total net returns. The withdrawal of funds for consumption not only removes internal funds from potential farm business reinvestment but causes increased borrowing and its accompanying service charges. Although family consumption is selected as the obvious example for "draining-off" capital funds, other requirements for funds outside the business would affect the growth pattern in essentially the same manner. All things being equal, the total amount of funds withdrawn, of course, affects the level of growth achieved. Other examples of fund withdrawals are natural-element damage to buildings not covered by insurance, fire loss not totally covered by insurance, and unplanned expenditures caused by accidents, prolonged sickness or death.

A gap between investment and potential net returns from the investment is demonstrated, using the alternative purchase plan of animals for dairy herd expansion Purchasing heifers results in total net returns below the level achieved in the primary

TABLE 9

FARM ORGANIZATION, FINANCIAL SUMMARY AND GROWTH ON FARM I, ALTERNATIVE 7[a]

Item		Production Period							
		1(1964)	2	3	4	5	6	7	8
Farm Business									
Land Operated	Ac.	201	201	201	201	201	201	201	201
Corn (all)	Ac.	83	89	67	70	70	70	70	58
Corn (sell)	Ac.	50	37	0	0	0	0	0	17
Tobacco	Ac.	3.74	3.74	3.04	2.58	2.58	2.58	2.58	2.58
Soybeans	Ac.	35	0	16	6	6	6	5	34
Wheat	Ac.	1	0	0	0	0	0	0	0
Hay	Ac.	32	39	33	34	34	34	35	17
Pasture	Ac.	46	69	81	88	88	88	88	89
Dairy	An.	26	46	81	88	88	88	88	89
Cows Purchased	An.	0	10	35	7	0	0	0	1
Heifers Purchased	An.	0	0	0	0	0	0	0	0
Financial Summary									
Gross Income	Dol.	22,301	30,238	51,131	53,448	53,448	53,448	53,403	57,462
Operating Costs	Dol.	10,836	18,364	25,651	27,229	26,871	26,438	26,040	26,089
Overhead Costs	Dol.	3,465	3,440	6,593	6,668	6,743	6,818	6,893	7,068
Net Returns	Dol.	8,000	8,434	18,887	19,551	19,834	20,192	20,470	24,305
Family Consumption	Dol.	4,000	4,120	4,243	4,370	4,501	4,636	4,775	4,918
Net after Family Consumption	Dol.	4,000	4,314	14,644	15,181	15,333	15,556	15,695	19,387
Seasonal Labor (all)	Hrs.	607	1,120	215	302	302	302	300	361
Capital Expenditures	Dol.	0	22,850	13,060	7,200	0	0	0	1,430
Capital Borrowed in Period	Dol.	8,890	17,927	8,602	0	0	0	0	0
Credit Balance, End of Period (all)	Dol.	29,390	45,039	47,777	40,193	32,609	25,025	19,220	17,000
Total Capital Borrowed	Dol.	35,419							
Total Net Returns[b]	Dol.	139,673							
Total Net After Family Consumption[c]	Dol.	104,034							

[a]Initial debt load of $17,045 intermediate-type credit removed.

[b]Total net returns to owner's labor, owned capital and management for the entire 8-year period.

[c]Total net after family consumption will not equal the sum of annual nets after family consumption, due primarily to cash needed for borrowed money required for family consumption during years when business returns do not exceed family living expenses.

TABLE 10

SUMMARY OF SELECTED FINANCIAL AND BUSINESS INDICATORS FOR ALL ALTERNATIVES, FARM I

Alternatives[a]	Total Net[b] Returns	Total Borrowing	Credit Balance	Dairy Herd Size Period 8
	----------Dol.----------			---An.---
Primary Solution	106,847	52,710	21,239	83
Alternative 1--$1,000 additional family consumption per year	102,581	64,340	25,954	76
Alternative 2--Family consumes 50 percent of annual net returns	75,176	118,334	65,999	57
Alternative 3--Dairy expansion by heifer purchase only	97,034	60,568	23,843	77
Alternative 4--50 acres land purchased in period 5	105,165	67,577	30,021	71
Alternative 5--50 acres land purchased in period 2	96,338	74,717	31,367	65
Alternative 6--Upper bounds on dairy herd expansion	97,878	45,313	25,319	80
Alternative 7--No initial intermediate debt load	139,673	35,419	17,000	89

[a]See preceding text for more detail on each alternative.

[b]Total net returns to owner's labor, owned capital and management for the entire eight-year period.

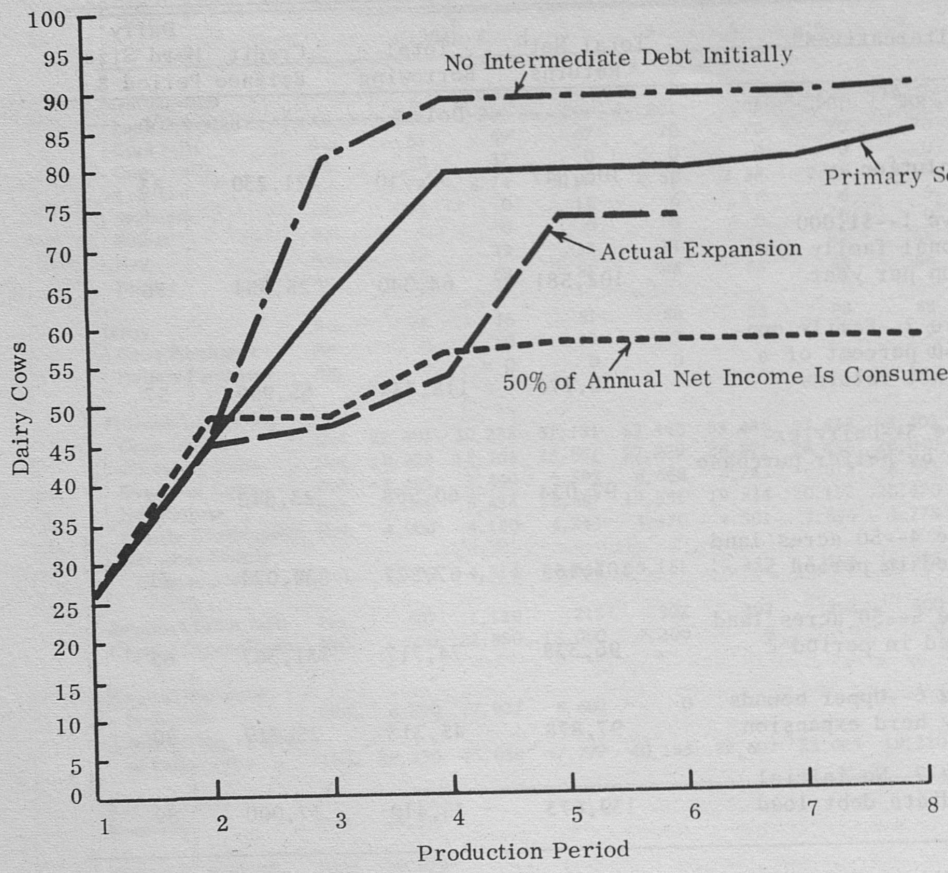

Fig. 2.--Growth in dairy herd size for the actual expansion, primary solution and alternatives 2 and 7 on Farm I

Annual Capital Borrowed (Thousands of Dollars)

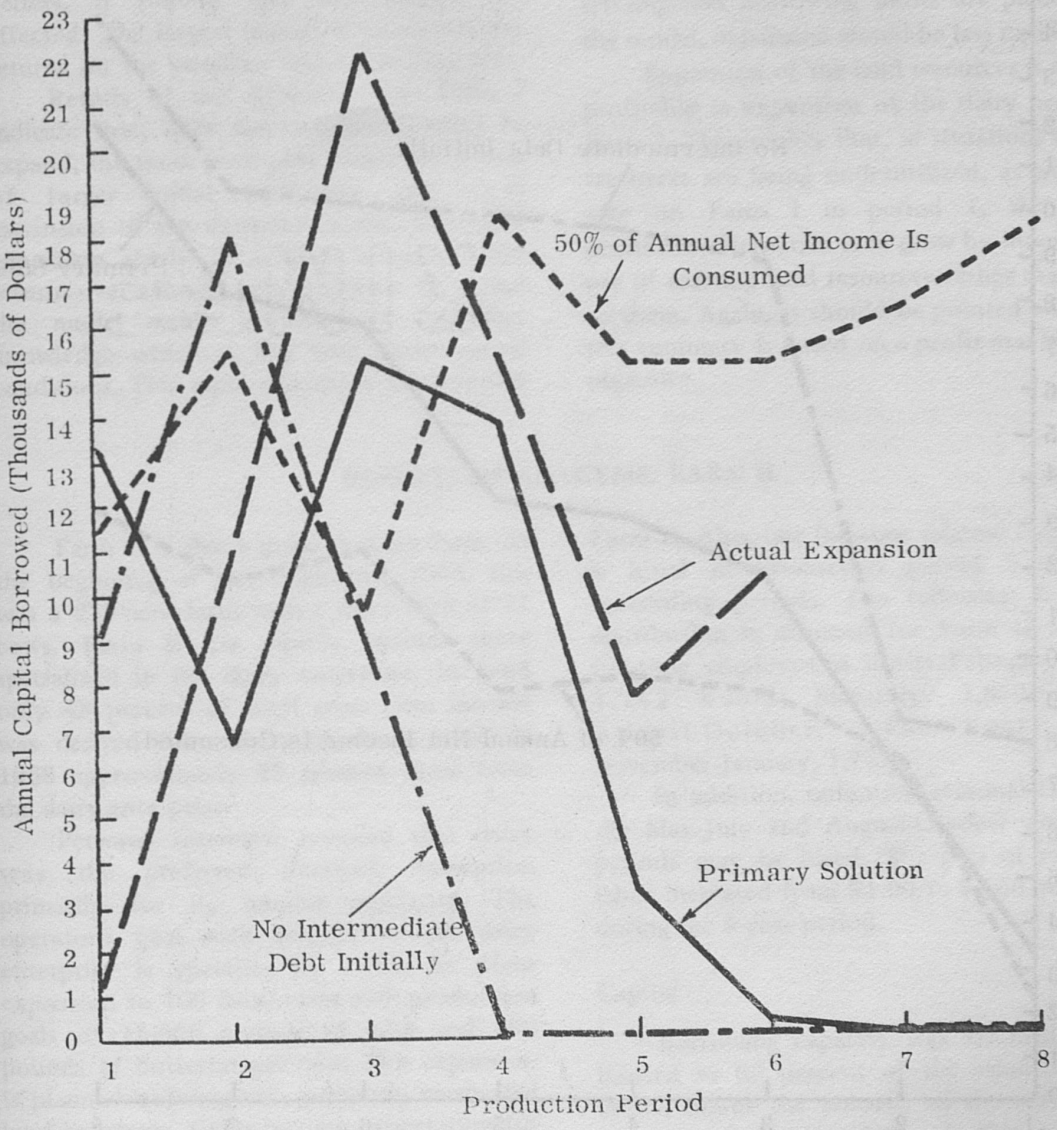

Fig. 3.--Annual capital borrowed for the actual expansion, primary solution and alternatives 2 and 7 on Farm I

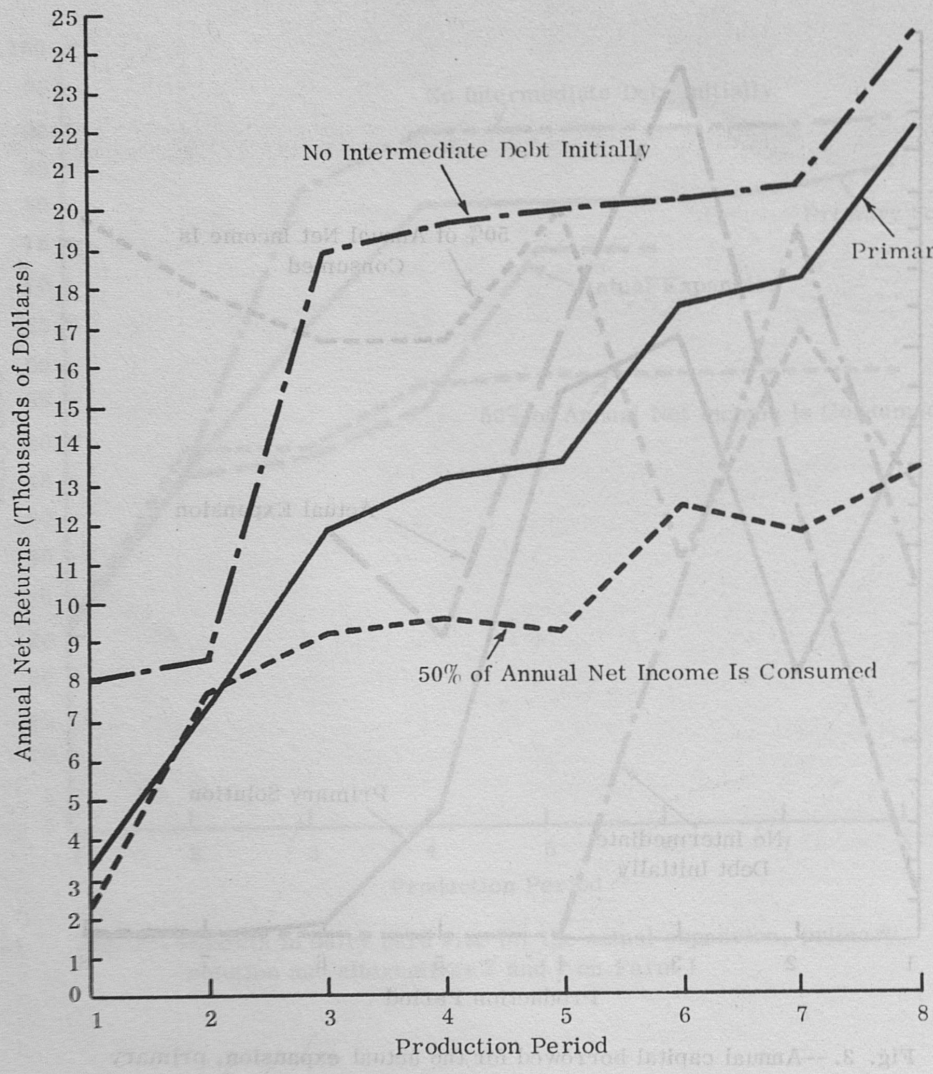

Fig. 4.--Annual net returns for the primary solution and alternatives 2 and 7 on Farm I

solution. Repayment of borrowed capital begins in the year following the capital expenditure for animals and, since there has been a lag in production from the purchased heifers, it follows that net returns are affected. The largest impact is on annual net returns for the purchase and succeeding year.

Results of the alternatives on Farm I indicate that, once the decision is made to expand, the most profitable procedure is that of larger initial borrowing and rapid expansion of the dairy enterprise. The rapid expansion results in a larger stream of net returns over a longer period of time. However, the model results are free of imperfect knowledge which is not true under actual conditions. This rapid expansion also requires that the maximum borrowing capacity be used in at least one of the early periods. Many owners prefer to "keep a little back" and not borrow to the maximum limit. If lower, self-imposed borrowing limits are placed on the model, expansion would be less rapid.

Expansion of the land resources is not as profitable as expansion of the dairy herd on Farm I. This implies that, in situations where resources are being underutilized, as was the case on Farm I in period 1, the most profitable alternative is to grow by intensified use of existing land resources rather than add to them. Again, it should be pointed out that this summary is based on a profit-maximizing objective.

RESULTS OF ANALYSIS: FARM II

Farm II is also a grade A dairy farm. At the beginning of the expansion, 1963, this was a 239-acre farm with a dairy herd of 31 cows. Farm II has rapidly become more specialized in the dairy enterprise. In 1963 only 48 percent of total gross farm income was derived from dairy products, while in 1968 approximately 85 percent came from the dairy enterprise.

Personal interview revealed that dairy was the preferred livestock enterprise, primarily for its income regularity. The operator's goal with respect to the dairy enterprise is specific. By 1973, he plans expansion to 100 dairy cows with production goals of 15,000 pounds of milk and 600 pounds of butterfat per cow. This expansion is planned utilizing only presently controlled land resources. Gross income expectation for the 100-cow dairy herd is $75,000.

Characteristics and Assumptions

Labor

Some family labor, in addition to the operator's own labor supply, is available on Farm II. Also, one full-time salaried employee is hired in production period 2 and all succeeding periods. The following seasonal distribution is assumed for Farm II after a full-time employee is hired: February-April, 1,742 hours; May-July, 1,860 hours; August-October, 1,860 hours; and November-January, 1,762.

In addition, unlimited seasonal labor in the May-July and August-October quarterly periods may be hired. The cost of seasonal labor increased from $1.00 to $1.60 per hour during the 8-year period.

Capital

Borrowing capacity was assumed to be limited to 60 percent of the value of total assets, minus the amount of the real estate loan at the beginning of the business expansion. Appreciation in value of initially owned real estate is included in the determination of the assets. Some variation in borrowing capacity occurs because of inventory valuation and change from year to year. Unless otherwise stated, the following

are the upper limits assumed for borrowing capacity:

Periods of Model	Borrowing Capacity
1 (1963)	$16,349
2	30,770
3	37,463
4	57,764
5	55,538
6	58,000
7	60,000
8	60,000

Loan repayment is specified to be five equal annual installments for the principal, plus interest on the declining balance. Repayment of the principal begins the second year of the loan. Variations in repayment schedules were used on Farm II and will be explained as individual solutions are discussed. Interest rates assumed for Farm II were the same as those for Farm I.

Land Use

Soil classification and potential were estimated from soil maps maintained by the local Soil Conservation Service office. Farm II has 160 acres row cropland, 32 acres other cropland and 47 acres pastureland.

Purchase of additional land was allowed in the model. Each acre purchased adds 0.5 acre to row cropland, 0.2 acre to other cropland, and 0.3 acre to pastureland. During the purchase year only one-half of purchased cropland could be used, but complete use was possible the following years. Land purchase prices assumed were:

Periods	Price per Acre
1,2	$250
3,4	260
5,6	280
7,8	300

Farming Program

On Farm II, as on Farm I, the crop enterprises considered are those actually grown in the past 5 years. Burley tobacco, corn, barley and wheat could be marketed as cash crops. Other crops grown had to be marketed through the dairy enterprise. All feed, except supplements had to be grown on the farm. Upper limits placed on the cash crops are as follows: burley tobacco, 0.94 acre (actual allotment level); corn, 50 acres; and barley, 35 acres. There is a 0.86 dark tobacco allotment on Farm II which is actually utilized. But, as dark tobacco failed to enter static programming solutions (i.e., larger net farm returns if this crop is omitted), the dark tobacco enterprise was not included in the multiperiod model.

Grade A dairy was the only livestock enterprise considered on Farm II. Based on the farm operator's stated preference and goals, this assumption seems realistic. The management of this dairy herd regarding expansion differed somewhat from that on Farm I. Between the initial herd purchase in 1963 and 1968, all additions to the herd and replacements for culled animals were raised. Seven replacements, purchased in 1968, are the only outside animals added.

Partial budgets developed for this enterprise reflect the ability of Farm II to expand the dairy enterprise by ten animals per year and also to replace culled animals. Culling rate was approximately 25 percent per year. If faster growth is more profitable and could occur within the restrictions established then dairy cows could be purchased. Purchase of dairy heifers was not included as an activity on Farm II. Unless otherwise stated, a purchased cow adds one production unit to the herd in the year of purchase. Raised additions also add one production unit in the

first year.[6] Cows can be purchased for the following prices: periods 1 and 2, $300; periods 3 and 4, $350; and the final four periods, $400.

Buildings and Equipment

Assumptions used for buildings and equipment on Farm II are the same as explained earlier for Farm I.[7] Initially, equipment is assumed sufficient for a dairy herd of 35 cows. Expansion of the herd, of course, requires capital expenditures for additional equipment and buildings. The addition of 1.33 cows requires the purchase of $1,000 equipment. On the average, this represents $750 total investment per cows, which is approximately the estimated amount required for the anticipated herd size.

Overhead Cost

Overhead costs for each production period were computed for Farm II. Included are real estate taxes, farm insurance, repayment of principal and interest on existing real estate loans, repayment of principal and interest on the intermediate term loan in effect at the beginning of expansion, salary for the full-time employee, depreciation and maintenance on initial buildings and equipment, and family consumption (Table 11). By using an equality constraint in the model, these costs are forced to be paid each period.

Overhead costs are not constant. Real estate payments decrease slightly each period, the salary of the full-time employee increases, family consumption expenditures increase by 3 percent each period to reflect the increasing cost of living, and the declining balance of the initial intermediate loan results in declining interest payments.

[6] A production unit is defined as one cow with milk production equal to the herd average for the year in which the addition occurs.

[7] For a discussion of these assumptions see p. 7.

Actual Organization on Farm II

The existing situations on Farm II for 1963 and 1968 are shown in Table 11. The dairy herd has more than doubled, increasing from 31 to 67 cows. Records indicate that milk production per cow was 10,291 pounds (401 pounds of butterfat) in 1967, while in 1968 production increased to 11,071 pounds (432 pounds of butterfat). Estimated production in 1964 was 9,130 pounds of milk per cow.

Sixty acres of additional land was purchased in 1968. Outstanding operating debt increased by $13,161, while real estate indebtedness has increased due to the land purchased. As was the case of Farm I, no data were available on annual net returns, thus preventing direct comparison with net returns obtained in the programming.

Primary (optimum) Solution

Period 1 for the primary solution, as well as for all alternative solutions, essentially represented the actual situation on Farm II when expansion began. Based on artificial constraints, the dairy herd size was forced to equal the actual 1963 herd size. This gives each alternative the same starting point, thus facilitating the comparison of results.

Table 12 presents the primary solution (optimal growth pattern) on Farm II, under the assumptions of the model. Optimal growth pattern is defined as that organization of enterprises based on the resources of Farm II, and assumed coefficients, which will result in the largest total net returns to operator's labor, owned capital and management over the 8-year period.

Expansion occurred in the dairy enterprise rapidly, and the results indicated that it would have been more profitable to

TABLE 11

RESOURCES, ENTERPRISE ORGANIZATION AND OVERHEAD COSTS, FARM II, JANUARY, 1963, AND DECEMBER, 1968

Item	Unit	1963	1968
Total land	Acres	239	299
Row cropland	Acres	160	194
Other cropland	Acres	32	48
Pastureland	Acres	47	47
Family labor	Hours	3,912	3,912
Hired labor	Hours	[a]	3,312[b]
Borrowing capacity	Dollars	16,349[c]	58,000[c]
Operating capital on hand	Dollars	1,800	[a]
Dairy cows	Animals	31	67
Dairy heifers	Animals	10	18
Equipment and buildings	Animals	35[c]	75[c]
Cropland organization			
Corn (grain)	Acres	15	48
Corn (silage)	Acres	5	25
Barley	Acres	10	36
Burley tobacco	Acres	0.94	0.94
Dark tobacco	Acres	0.86	0.86
Hay	Acres	32	15
Pasture	Acres	175	143
Wheat	Acres	0	30
Overhead costs			
Real estate payment	Dollars	3,894	3,022
Family consumption	Dollars	3,800[c]	4,404[c]
Real estate taxes	Dollars	350	428
Farm insurance	Dollars	450	737
Salaried labor	Dollars	0	3,200[c]
Depreciation and repairs on buildings and equipment	Dollars	1,915[c]	1,915[c]
Outstanding operating debt	Dollars	11,882	25,043
Total real estate debt	Dollars	34,900	60,400

[a]Unknown.

[b]Additional seasonal labor was hired in 1968.

[c]Calculated or estimated by author.

TABLE 12

FARM ORGANIZATION, FINANCIAL SUMMARY AND GROWTH ON FARM II, PRIMARY SOLUTION

Item		Production Period							
		1(1963)	2	3	4	5	6	7	8
Farm Business									
Land Operated	Ac.	239	239	239	239	239	239	239	239
Corn (all)	Ac.	90	94	101	117	125	114	114	83
Corn (sell)	Ac.	50	50	50	50	50	35	35	50
Tobacco	Ac.	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Barley	Ac.	35	35	35	21	0	0	0	35
Wheat	Ac.	33	24	12	0	0	0	0	9
Hay	Ac.	33	32	26	23	26	27	27	13
Pasture	Ac.	31	52	62	77	87	97	97	97
Dairy	An.	31	52	62	77	87	97	97	97
Cows Purchased	An.	0	11	0	5	0	0	0	0
Financial Summary									
Gross Income	Dol.	23,946	35,466	48,131	56,044	60,908	65,657	65,657	69,926
Operating Costs	Dol.	12,974	18,541	27,982	33,535	38,180	42,891	42,359	38,527
Overhead Costs	Dol.	9,698	12,448	12,197	11,964	11,821	10,015	9,031	9,201
Net Returns	Dol.	1,274	4,477	7,952	10,545	10,907	12,751	14,267	22,198
Family Consumption	Dol.	3,800	3,914	4,031	4,152	4,276	4,404	4,536	4,672
Net after Family Consumption	Dol.	-2,526	563	3,921	6,393	6,631	8,347	9,731	17,526
Seasonal Labor	Hrs.	119	0	0	0	90	286	286	89
Capital Expenditures	Dol.	0	15,731	7,510	13,307	7,510	7,510	0	0
Capital Borrowed in Period	Dol.	13,567	19,916	13,389	15,829	12,320	12,391	5,302	1,721
Credit Balance End of Period	Dol.	49,756	65,015	69,765	74,776	73,383	66,582	56,558	45,992
Total Capital Borrowed	Dol.	94,435							
Total Net Returns[a]	Dol.	84,371							
Total Net After Family Consumption[b]	Dol.	51,974							

[a]Total net returns to owner's labor, owned capital and management for the entire 8-year period.

[b]Total net after family consumption will not equal the sum of annual nets after family consumption, due primarily to cash needed for borrowed money for family consumption during years when business returns do not exceed family living expenses.

have bought dairy cows and added to the herd rather than using internal expansion exclusively. This reflects the underutilization of resources in period 1. All available capital was borrowed in periods 2 and 3, and thus the expansion in periods 2 and 3 was the maximum attainable with the farmer's borrowing capacity.

The dairy herd reached a herd size of 97 cows in the latter three periods, thus approaching the herd size of 100 cows anticipated by the farm operator for 1973. Actual dairy expansion had reached 67 cows in 1968.

No additional land was purchased in the primary solution, even though the operator of Farm II actually added 60 acres in 1968. Period 6, in the primary solution, is equivalent in time to 1968. Results from the primary solution indicated that total net returns for the 8-year period would be reduced by $336 if one acre of land is purchased in period 6. In other words, the net returns from adding one acre of land minus the sum of net returns lost from other activities which must be reduced to allow one unit of land to enter the optimal solution would have resulted in a $366 reduction in net returns.

Total net returns for the eight periods were $84,371, while total borrowing required was $94,435. A total debt, which includes real estate indebtedness, of $45,992 was outstanding at the end of the eighth period. It should be noted that total indebtedness was being reduced rapidly starting in period 5. In the actual farm situation total indebtedness was increasing throughout the 8 years (even without the additional real estate debt).

Relatively small amounts of seasonal labor were hired which supports another statement made by the owner. In the interview, he indicated that present (1968) labor resources were sufficient for expansion to 100 cows.

Since there is no requirement for animal feed (i.e., corn, hay) to be transferred to a ninth period, income is overstated in period 8. This results because the model shifts that acreage needed for feed crops to cash crops. This would not occur under actual conditions.

Selected Variables Affecting Growth on Farm II

Alternative 1—Delayed Repayment of Principal

One alternative that could be considered when planning for intermediate credit use is a method of principal repayment that differs from that used in the primary solution. One obvious difference is to delay repayment of principal and allow the borrower the use of the total amount borrowed for 2 years. Of course, interest is paid on the total amount for the 2 years.

Alternative 1 investigates a situation such as the above on Farm II and the results are shown in Table 13. The input-output data for this solution are the same as those used for the primary solution with the exception of loan repayment. Repayment of any principal in alternative 1 is delayed until the third year of the loan. For example, if $1,000 is borrowed in period 1, the borrower pays interest on $1,000 for the first two periods and then in the third period begins repayment on the original $1,000. Principal repayments are divided into five equal annual installments, and interest is paid each period on the declining balance.

One direct result of the ability to delay repayment of principal is that $30,464 less borrowed capital was needed to reach the same dairy herd size. The use of total borrowed capital for an additional period enables expansion to occur faster in the middle periods of the model and total net returns to the operator's labor, owned capital and management are $10,115 higher. Net returns for the first three periods were essentially the same but returns for periods 6 and 7 are approximately $3,000 higher per

TABLE 13

FARM ORGANIZATION, FINANCIAL SUMMARY AND GROWTH ON FARM II, ALTERNATIVE 1[a]

Item		Production Period							
		1(1963)	2	3	4	5	6	7	8
Farm Business									
Land Operated	Ac.	239	239	239	239	239	239	239	239
Corn (all)	Ac.	90	94	106	122	118	117	117	84
Corn (sell)	Ac.	50	50	50	50	41	40	38	50
Tobacco	Ac.	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Barley	Ac.	35	35	35	7	0	0	0	35
Wheat	Ac.	33	24	8	0	0	0	0	9
Hay	Ac.	33	32	27	25	26	26	27	14
Pasture	Ac.	31	52	62	84	94	95	95	97
Dairy	An.	31	52	62	84	94	95	95	97
Cows Purchased	An.	0	11	0	12	0	0	0	0
Financial Summary									
Gross Income	Dol.	23,946	35,461	47,978	59,347	64,263	64,770	64,629	70,023
Operating Costs	Dol.	12,973	19,211	27,800	35,722	38,922	38,967	38,355	37,566
Overhead Costs	Dol.	9,698	12,488	12,197	11,964	11,821	10,015	9,031	9,201
Net Returns	Dol.	1,275	3,762	7,981	11,661	13,520	15,788	17,243	23,256
Family Consumption	Dol.	3,800	3,914	4,031	4,152	4,276	4,404	4,536	4,672
Net after Family Consumption	Dol.	-2,525	-152	3,950	7,509	9,244	11,384	12,707	18,584
Seasonal Labor	Hrs.	119	0	0	32	184	199	201	92
Capital Expenditures	Dol.	0	15,830	7,620	20,670	7,510	810	0	1,740
Capital Borrowed in Period	Dol.	13,567	17,202	9,406	15,660	5,429	1,541	1,146	0
Credit Balance End of Period	Dol.	49,756	65,015	69,765	77,828	73,778	60,234	48,628	38,283

Total Capital Borrowed	Dol.	63,971
Total Net Returns[b]	Dol.	94,486
Total Net After Family Consumption[c]	Dol.	58,660

[a]Interest paid on borrowed capital for first two years of the loan after which principal is repaid in five equal installments with interest on the declining balance.

[b]Total net returns to owner's labor, owned capital and management for the entire 8-year period.

[c]Total net after family consumption will not equal the sum of annual nets after family consumption, due primarily to cash needed for borrowed money required for family consumption during years when business returns do not exceed family living expenses.

period under alternative 1 assumptions than under the primary solution assumptions. Net returns after family consumption were $58,660, which is $6,686 more than for the primary solution.

Since repayment is delayed, the balance outstanding at the end of eight periods is only $7,709 less for alternative 1 even though $30,469 less capital is borrowed.

Alternative 2—Larger Borrowing Capacity and Delayed Principal Repayment

Another alternative that can be considered by the lending agency for financing farm expansion is larger borrowing capacity in the early expansion periods when capital needs are likely to be most critical. In other words, the question investigated here is what would be the effect on the farm's growth if the lending agency analyzed the existing situation, the farmer's goals, projected the level of future borrowing potential and made that loan capacity amount available during earlier periods?

The results of alternative 2, shown in Table 14, indicate the effect of this provision when introduced into the model for Farm II. A borrowing capacity of $50,000 is available for periods 2 and 3. This amount exceeds previous borrowing capacity by $19,230 for period 2 and $12,537 for period 3. In addition, repayment of borrowed principal is delayed in the same manner as previously explained for alternative 1.

Total net returns increase by $13,303 over that achieved in the primary solution (Table 12) and by $3,188 over alternative 1 (Table 13) even though final dairy herd size is 97 cows for all three solutions.

Under the assumptions for increased borrowing capacity (alternative 2) all dairy expansion from external sources is accomplished in period 2 because of the availability of more capital for borrowing. Capital expenditures in period 2 almost doubled expenditures for the same period in the previous two alternatives. However, even though there is larger borrowing initially and herd size expands more rapidly, the maximum herd size is limited by availability of labor in the winter season.

Alternative 3—Lag Created by Equipment Purchase

Another source of lags in adjustment situations is the lumpiness of equipment purchases. Owing to the nature of this input, it is unlikely that the exact amount can be purchased annually to satisfy growth needs. The common practice is to purchase larger quantities or sizes than presently needed in anticipation of future expansion. The result of this decision is a capital expenditure without the immediate realization of potential returns to help repay borrowed capital. Table 15 presents the results of alternative 3 in which, by use of artificial constraints, $25,000 must be invested in equipment during periods 2 and 3, while assuming no dairy cows can be purchased in period 2 and only 10 cows can be purchased in period 3. Borrowing capacity is increased to $50,000 for periods 2 and 3.

A comparison of alternative 3 with the primary solution (Table 12) shows the effect of this type investment on annual net returns. Even though ending dairy herd size and total investment at the end of 8 years are the same in both solutions, the net returns and financial situation at the end of this time sequence is different. Net returns for the first three periods are $5,153 lower for alternative 3 than for the primary solution, but part of this difference is made up by the end of 8 years (total net returns for the 8 years are only $2,497 lower). The lower farm business returns in the early years also meant that more money had to be borrowed for family consumption, thus net returns after consumption for this alternative are $9,098

TABLE 14

FARM ORGANIZATION, FINANCIAL SUMMARY AND GROWTH ON FARM II, ALTERNATIVE 2[a]

Item		Production Period							
		1(1963)	2	3	4	5	6	7	8
Farm Business									
Land Operated	Ac.	239	239	239	239	239	239	239	239
Corn (all)	Ac.	98	107	112	125	113	113	113	84
Corn (sell)	Ac.	50	50	50	49	34	34	34	50
Tobacco	Ac.	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Barley	Ac.	35	23	17	0	0	0	0	35
Wheat	Ac.	20	0	0	0	0	0	0	5
Hay	Ac.	38	41	32	26	27	27	27	14
Pasture	Ac.	31	67	77	87	97	97	97	97
Dairy	An.	31	67	77	87	97	97	97	97
Cows Purchased	An.	0	26	0	0	0	0	0	0
Financial Summary									
Gross Income	Dol.	23,327	41,511	56,102	61,106	65,857	65,857	65,857	70,025
Operating Costs	Dol.	13,031	24,155	33,475	37,166	40,412	39,946	39,450	37,958
Overhead Costs	Dol.	9,698	12,448	12,197	11,964	11,821	10,015	9,031	9,201
Net Returns	Dol.	598	4,908	10,430	11,976	13,624	15,896	17,376	22,866
Family Consumption	Dol.	3,800	3,914	4,031	4,152	4,276	4,404	4,536	4,672
Net after Family Consumption	Dol.	-3,202	994	6,399	7,824	9,348	11,492	12,840	18,194
Seasonal Labor	Hrs.	169	0	0	97	302	302	302	94
Capital Expenditures	Dol.	0	32,306	7,510	7,510	7,510	0	0	0
Capital Borrowed in Period	Dol.	13,621	31,330	7,772	8,241	8,430	2,052	3,061	595
Credit Balance End of Period	Dol.	49,810	79,197	82,302	80,110	76,282	62,493	51,175	39,708
Total Capital Borrowed	Dol.	75,102							
Total Net Returns[b]	Dol.	97,674							
Total Net After Family Consumption[c]	Dol.	61,241							

[a]Assumes $50,000 borrowing capacity for periods 2 and 3. Interest paid on borrowed capital for first two years of the loan after which principal is repaid in five equal installments.

[b]Total net returns to owner's labor, owned capital and management for the entire 8-year period.

[c]Total net after family consumption will not equal the sum of annual nets after family consumption, due primarily to cash needed for borrowed money required for family consumption during years when business returns do not exceed family living expenses.

TABLE 15

FARM ORGANIZATION, FINANCIAL SUMMARY AND GROWTH ON FARM II, ALTERNATIVE 3[a]

Item		Production Period							
		1(1963)	2	3	4	5	6	7	8
Farm Business									
Land Operated	Ac.	239	239	239	239	239	239	239	239
Corn (all)	Ac.	85	91	102	118	125	115	114	84
Corn (sell)	Ac.	50	50	50	50	50	35	35	50
Tobacco	Ac.	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Barley	Ac.	35	35	35	21	0	0	0	35
Wheat	Ac.	42	36	14	0	0	0	0	9
Hay	Ac.	29	29	26	23	26	27	27	14
Pasture	Ac.	31	41	61	77	87	97	97	97
Dairy	An.	31	41	61	77	87	97	97	97
Cows Purchased	An.	0	0	10	6	0	0	0	0
Financial Summary									
Gross Income	Dol.	24,366	30,575	47,763	56,044	60,908	65,657	65,657	69,926
Operating Costs	Dol.	12,933	17,837	29,041	33,975	37,536	41,156	40,762	39,407
Overhead Costs	Dol.	9,698	12,448	12,197	11,964	11,821	10,015	9,031	9,201
Net Returns	Dol.	1,735	290	6,525	10,105	11,551	14,486	15,864	21,318
Family Consumption	Dol.	3,800	3,914	4,031	4,152	4,276	4,404	4,536	4,672
Net after Family Consumption	Dol.	-2,065	-3,624	2,494	5,953	7,275	10,082	11,328	16,646
Seasonal Labor	Hrs.	84	0	0	0	90	286	286	89
Capital Expenditures	Dol.	0	15,000	13,500	8,630	7,510	7,510	0	0
Capital Borrowed in Period	Dol.	13,529	20,650	21,093	14,100	14,102	14,664	8,230	5,339
Credit Balance End of Period	Dol.	49,718	65,719	78,034	79,636	78,420	72,272	63,280	53,683
Total Capital Borrowed	Dol.	111,707							
Total Net Returns[b]	Dol.	81,874							
Total Net After Family Consumption[c]	Dol.	42,876							

[a]Capital expenditures must be equal to or greater than $25,000 for equipment in periods 2 and 3. No cows can be purchased until period 3.

[b]Total net returns to owner's labor, owned capital and management for the entire 8-year period.

[c]Total net after family consumption will not equal the sum of annual nets after family consumption, due primarily to cash needed for borrowed money required for family consumption during years when business returns do not exceed family living expenses.

lower than for the primary solution. A total of $17,272 additional borowed capital is required for the lumpy equipment investment (alternative 3), and the ending credit balance is $8,691 higher.

Alternative 4—Removal of Burley Tobacco Allotment

One hypothesis advanced during the interview with the farm operator was that his tobacco allotments are small and the resources devoted to producing tobacco might be better utilized elsewhere. As mentioned earlier, the static programming supported this hypothesis with regard to dark tobacco and it was not included in the multiperiod model. However, burley tobacco enters all solutions at the allotment level of 0.94 acre.

In alternative 4, the burley tobacco allotment is removed to determine the effect of its loss on the growth of Farm II. Results of alternative 4 are shown in Table 16. In addition to burley tobacco removal, borrowing capacity is increased to $50,000 for periods 2 and 3, and capital expenditure for equipment in periods 2 and 3 must be equal to or greater than $25,000.

The difference in total net returns over the 8-year period cannot all be attributed to tobacco removal because other factors that affect the growth pattern are included. However, based on this model and its assumptions, burley tobacco allotment removal would reduce net returns to operator's labor, owned capital and management during the 8-year period ($2,045 less than for alternative 3, the most comparable solution which included burley tobacco). Because of the cash income provided by tobacco in the early stages of growth, its removal resulted in a somewhat greater loss in net returns after family consumption ($3,428).

Summary for Farm II Alternatives

Table 17 presents a comparison of total net returns, total capital borrowed, credit balance, and ending dairy herd size for all solutions on Farm II.

Maximum total net returns were attained on Farm II when borrowing capacity was increased to $50,000 for periods 2 and 3, and repayment of borrowed principal is delayed for one year. This combination of factors resulted in $97,674 total net returns for the 8 years, which is $3,188 greater than any other alternative.

The dairy herd size reached 97 cows in all solutions but one. Where no burley tobacco was grown (alternative 4) the dairy enterprise expanded to 103 cows.

The relationship of selected alternatives is shown graphically in Figures 5, 6 and 7. Figure 5 shows the expansion in dairy herd size for the actual change, the primary solution and alternatives 2 and 4. Depicted in Figure 6 is the relationship of total capital borrowed for the same alternatives. However, actual borrowing does not reflect the purchase of real estate in period 6. Data for actual net returns are not available; thus Figure 7 shows only the primary solution and alternatives 2 and 4.

In the optimal growth pattern, under the assumed conditions, dairy expansion exceeds the actual expansion for period 6 by 29 cows (see Figure 5). Therefore, Farm II was operating considerably below the optimum size dairy herd. However, as expressed earlier, planning is under way for actual expansion to 100 dairy cows in the near future. Therefore, it appears that Farm II will be operating near the optimum dairy herd level assuming the present labor restrictions remain in effect. With the 60 acres of land purchased in 1968 he would have feed to expand the dairy enterprise further.

TABLE 16

FARM ORGANIZATION, FINANCIAL SUMMARY AND GROWTH ON FARM II, ALTERNATIVE 4[a]

Item		Production Period							
		1(1963)	2	3	4	5	6	7	8
Farm Business									
Land Operated	Ac.	239	239	239	239	239	239	239	239
Corn (all)	Ac.	95	103	109	123	118	106	106	86
Corn (sell)	Ac.	50	50	50	50	36	22	22	50
Tobacco	Ac.	0	0	0	0	0	0	0	0
Barley	Ac.	35	35	25	7	0	0	0	35
Wheat	Ac.	26	1	0	0	0	0	0	0
Hay	Ac.	36	38	30	25	28	29	29	14
Pasture	Ac.	31	61	74	84	94	103	103	103
Dairy	An.	31	61	74	84	94	103	103	103
Cows Purchased	An.	0	23	0	0	0	0	0	0
Financial Summary									
Gross Income	Dol.	22,167	37,359	52,831	57,862	62,272	66,828	66,828	71,912
Operating Costs	Dol.	12,711	22,162	32,596	36,214	39,740	43,326	43,118	41,988
Overhead Costs	Dol.	9,698	12,448	12,197	11,964	11,821	10,015	9,031	9,201
Net Returns	Dol.	-242	2,749	8,038	9,684	10,711	13,487	14,679	20,723
Family Consumption	Dol.	3,800	3,914	4,031	4,152	4,276	4,404	4,536	4,672
Net after Family Consumption	Dol.	-4,042	-1,165	4,007	5,532	6,435	9,083	10,143	16,051
Seasonal Labor	Hrs.	66	0	0	0	115	308	308	115
Capital Expenditures	Dol.	0	26,249	10,000	7,510	7,510	7,200	0	0
Capital Borrowed in Period	Dol.	13,319	30,172	17,870	13,960	15,705	16,946	11,497	7,769
Credit Balance End of Period	Dol.	49,508	75,073	82,302	82,547	81,744	76,568	68,634	60,710
Total Capital Borrowed	Dol.	127,238							
Total Net Returns[b]	Dol.	79,829							
Total Net After Family Consumption[c]	Dol.	39,448							

[a]Tobacco production fixed at 0. Borrowing capacity is $50,000 in periods 2 and 3.

[b]Total net returns to owner's labor, owned capital and management for the entire 8-year period.

[c]Total net after family consumption will not equal the sum of annual nets after family consumption, due primarily to cash needed for borrowed money required for family consumption during years when business returns do not exceed family living expenses.

TABLE 17

SUMMARY OF SELECTED FINANCIAL AND GROWTH INDICATORS
ALL ALTERNATIVES, FARM II

Alternatives	Total Net Returns	Total Borrowing	Credit Balance	Dairy Herd Size Period 8
	----------Dol.----------			---An.---
Primary Solution	84,371	94,435	45,992	97
Alternative 1--delayed repayment of borrowed capital	94,486	63,951	38,283	97
Alternative 2--increased borrowing capacity; delayed repayment	97,674	75,102	39,708	97
Alternative 3--lag created by equipment purchase increased borrowing capacity; lag in adding dairy cows	81,874	111,707	53,683	97
Alternative 4--no burley tobacco; lag created by equipment purchase; larger borrowing capacity; no lag in adding dairy cows	79,829	127,238	60,710	103

[a]See preceding text for more detail on each alternative.

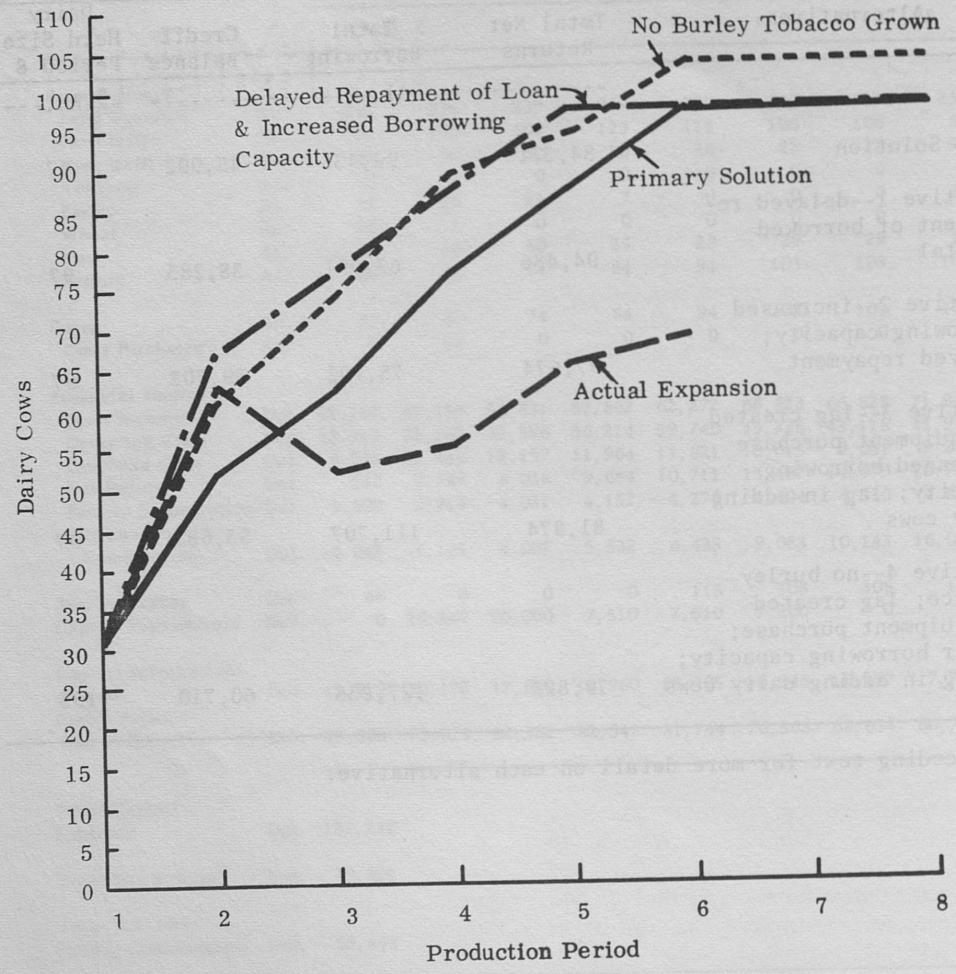

Fig. 5.--Growth in dairy herd size for the actual expansion, primary solution and alternatives 2 and 4 on Farm II.

Annual Capital Borrowed (Thousands of Dollars)

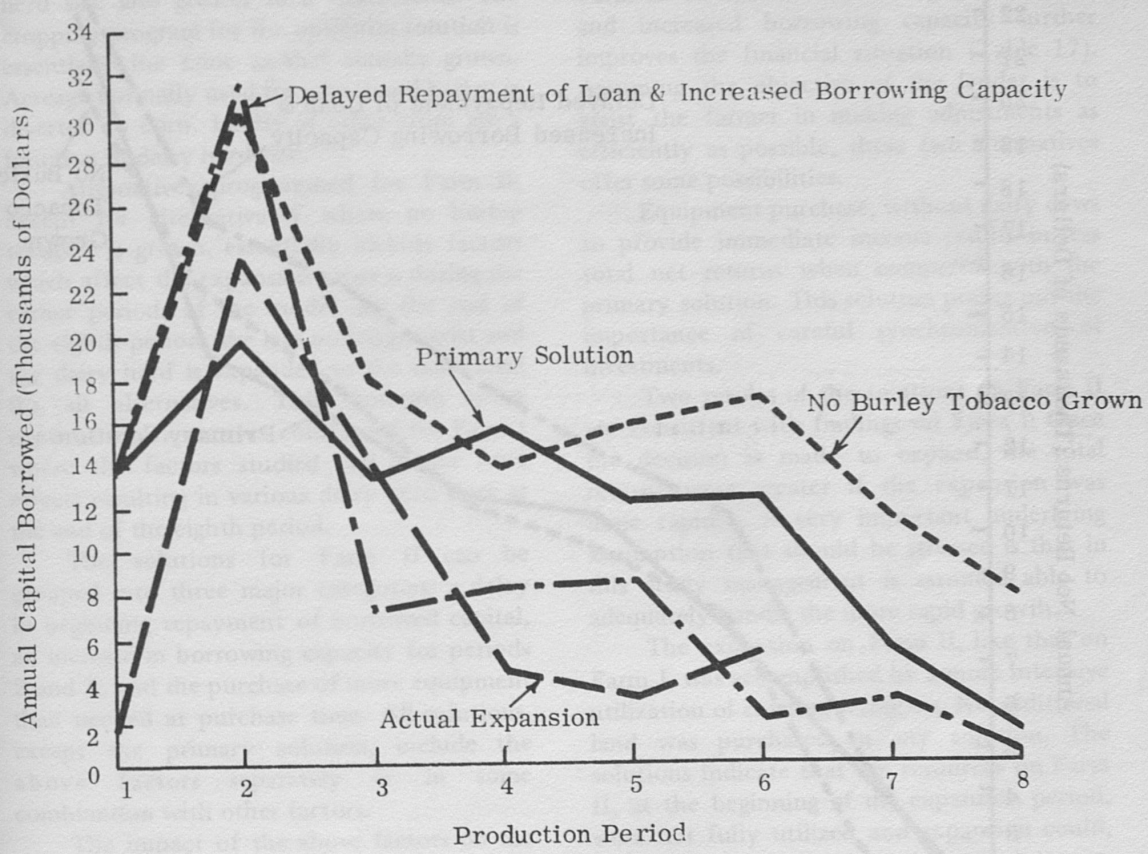

Fig. 6.--Annual capital borrowed for the actual expansion, primary solution, and alternatives 2 and 4 on Farm II

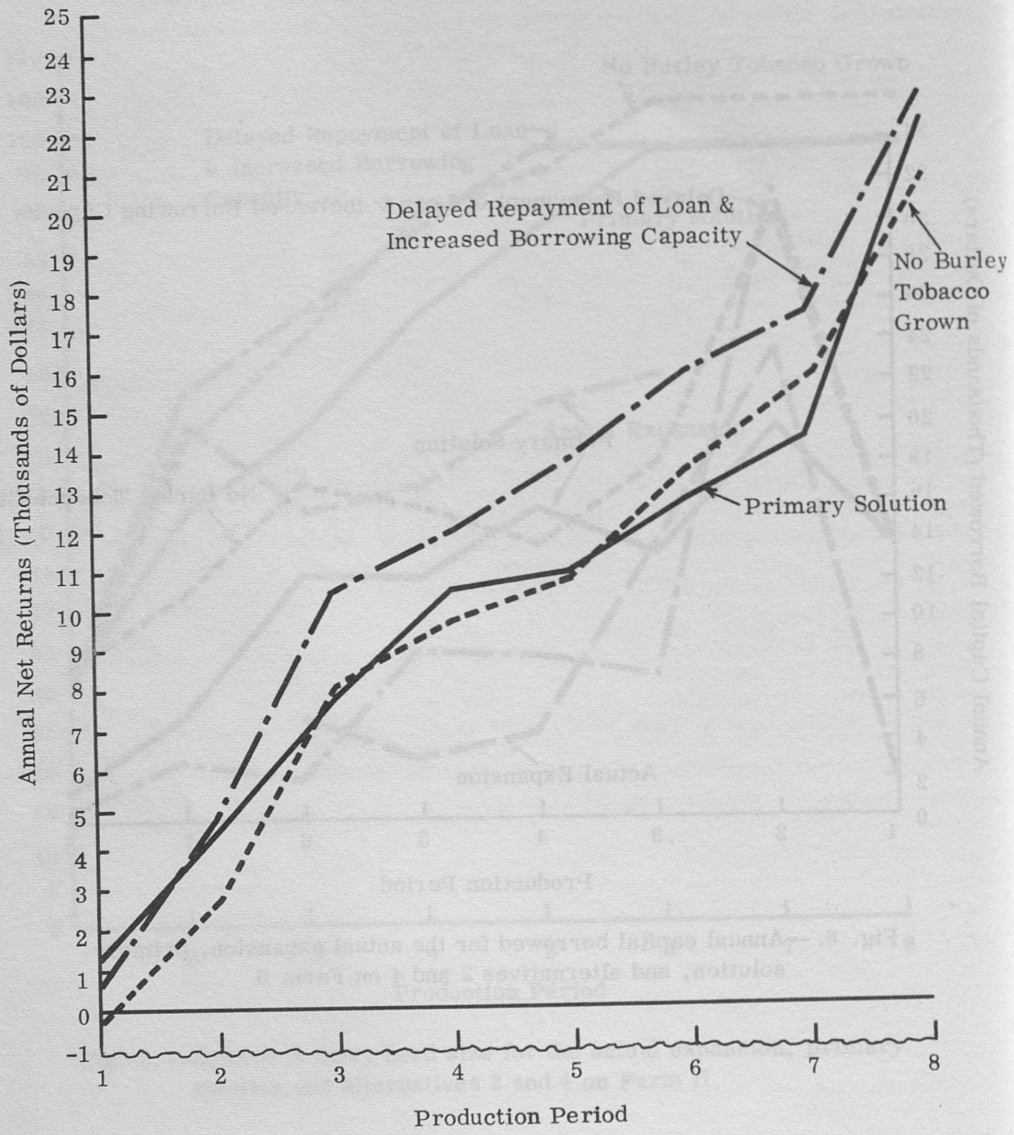

Fig. 7.--Annual net returns for the primary solution and alternatives 2 and 4 on Farm II

As shown in Figure 6, borrowing for the primary solution exceeds the amount actually borrowed for periods 3 through 6. This fact indicates that Farmer II probably had self-imposed lower borrowing limits on his operation. However, additional borrowing would permit a more rapid expansion in dairy herd size and greater total net returns. The cropping program for the optimum solution is essentially the same as that actually grown. Acreage normally used for wheat and barley is diverted to corn. Levels of other crops are a function of dairy herd size.

Alternatives programmed for Farm II, except for alternative 4 where no burley tobacco is grown, essentially include factors which affect the expansion process during the earlier periods of the model. By the end of the eighth period, the lags no longer exist and the dairy herd is expanded to the same level for all alternatives. This situation is in contrast to alternatives considered for Farm I where the factors studied had longer total effects resulting in various dairy herd sizes at the end of the eighth period.

The solutions for Farm II can be grouped into three major categories: a delay in beginning repayment of borrowed capital, an increase in borrowing capacity for periods 2 and 3, and the purchase of more equipment than needed at purchase time. All solutions, except the primary solution, include the above factors separately or in some combination with other factors.

The impact of the above factors on the growth process on Farm II are of two general types. Delay in repayment and increased borrowing capacity enhance growth opportunities, while large equipment purchase (with less than potential immediate returns) detracts from growth potential.

Based on the assumptions for Farm II, a 2-year delay in repayment of borrowed capital improves the financial position of Farm II. A combination of repayment delay and increased borrowing capacity further improves the financial situation (Table 17). Assuming the objective of the lender is to assist the farmer in making adjustments as efficiently as possible, these two alternatives offer some possibilities.

Equipment purchase, without dairy cows to provide immediate income results in less total net returns when compared with the primary solution. This solution points out the importance of careful synchronization of investments.

Two results of the solutions on Farm II are consistent with findings on Farm I. Once the decision is made to expand, the total returns were greater if the expansion was done rapidly. A very important underlying assumption that should be stressed is that in this study management is assumed able to adequately handle the more rapid growth.

The expansion on Farm II, like that on Farm I, was accomplished by a more intensive utilization of existing resources. No additional land was purchased in any solution. The solutions indicate that the resources on Farm II, at the beginning of the expansion period, were not fully utilized and expansion could, therefore, be made through more intensive use of existing resources.

SUMMARY AND CONCLUSIONS

The primary objective of this study was to analyze the character of size adjustments (growth) of Kentucky farms in order to gain insights necessary to provide management guidelines for farmers anticipating adjustments. More specifically, the working objectives were: (1) to identify problems associated with farm business growth, (2) to determine what factors have the greatest impact on the speed and success of size, (3) to

determine how variation in these factors affects the capital investment-returns time lag and (4) to offer suggestions which hopefully, will aid in reducing the impact of problems in major adjustments.

Two farms which had recently undergone growth and had used large quantities of intermediate credit were selected as case studies for this research. Both farmers were interviewed to obtain information on expansion goals, production levels, and other relevant variables. Information on credit use and repayment was obtained from the credit agency involved (Mammoth Cave PCA).

Estimates of crop yields, input-output coefficients, costs, prices and resource availability were developed for each farm. The estimates approximated, as closely as possible, the actual production performance and/or potential performance on the case farms.

A multiperiod linear programming model was developed for the analysis phase of the study. This type model reveals the accumulative multiperiod effects and permits comparison of actual expansion with optimal growth under different assumptions.

In this study, growth is defined as an increase in the size of the productive mechanism of the farm business. Growth, within the model, could occur through the purchase of additional resources or by a more intensive utilization of existing resources. Either internal capital or borrowed capital could be employed in the growth process.

The activities included in the model were adjusted to treat each farm as a separate entity. Realistic adjustment problems and opportunities were programmed for each farm.

The farms included in this study are family farms that depend on farm production to provide income needed for family living. As such, the family consumption requirements must be met from the cash generated by the farm business or by borrowing. Results on Farm I indicated that capital withdrawals for family consumption are of the utmost importance. When family consumption was allowed to equal 50 percent of annual net returns plus the annual base, total net returns for the 8-year period were only 70 percent of the level of total net returns achieved in the optimum solution. Adequate planning for family consumption (or other similar capital withdrawals) should be of major importance to those planning expansion either from the standpoint of borrowing or lending. Unplanned consumption withdrawals may require additional borrowing and also delay repayment of previous loans.

Two factors that would have aided Farm II to expand were, an increase in borrowing capacity during the early years of growth and a delay in beginning repayment of borrowed capital. These factors resulted in the same dairy herd size as the primary solution, but 20 percent less borrowed capital was required and a 15.8 percent increase in net returns over the 8-year period was achieved. The ability or willingness of lending agencies to make this type of loan adjustment may be limited. Reliable objective lending criteria may be required since estimates made on the basis of future expected productivity can vary widely. This study did not delineate lending criteria; however, based on this model, both of these adjustments should be seriously considered by lending agencies as ways to assist farmers make adjustments and make more efficient credit use.

The basis input-output data on the two case farms indicated that the land and labor resources were not being fully utilized at the start of expansion. Presumably, the owners recognized this fact and it contributed to their decision to expand. The results indicated that the most profitable method of expansion was to expand as quickly as possible to gain the returns from the larger business. Results on these farms also indicated that a more intensive utilization of land resources controlled in 1964 resulted in greater total net returns than buying more land. This is a

direct result of the starting situation of the firm. A different result would be expected for a firm that had already expanded to the limit of its resources, but farmers contemplating expansion should carefully consider whether or not his land resource is fully utilized.

The goal or management strategy of a farmer anticipating expansion is very important. The goal assumed for these farms was that of maximization of net returns over the 8-year period with the type livestock enterprise specified. This strategy appeared to be adequate to explain the actual expansion process on Farms I and II, but it was inadequate for a third farm that was studied (but not included in this research report). the third farmer seemed to be maximizing acreage controlled.

Based on the results of this research, the use of multiperiod linear programming models in firm growth planning appears to have considerable potential. This type of management tool can be developed to help farmers and their credit agencies determine the kinds and sizes of enterprises which will maximize returns for a given set of resources over a period of years, how fast and in what way the farm business should grow, what happens to farm growth and net returns if different rates of production are achieved, what happens to farm growth and net returns if alternative management practices are introduced, and what financial arrangements (including repayment schedules) will result in most efficient use of credit during the farm growth. The keys to successful, practical use of multiperiod models are obtaining from the farmer clear business objectives, and developing realistic estimates of the levels of production performance that the farmer can achieve.

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APPENDIX A

Multiperiod Model Framework

Multiperiod or polyperiod linear programming links several single-period models of successive time periods into one composite model which is solved simultaneously for all time periods. The solution thus traces out the optimal pattern given the set of restrictions and assumptions.

The theory of linear programming and its application as a research tool is available from many sources.[1] Multiperiod programming is an extension of linear programming in that time is considered in the analysis.

The usual linear programming problem may be stated as:

$$\text{Maximize } C'X$$

$$\text{Subject to:}$$

$$AX \leq b$$

$$X \geq 0$$

In the above formulation, A is a matrix of input-output or transformation coefficients; C is the choice indicator which may be net returns from each unit of the alternative products that can be produced; X represents the various activities included in the model; and b specifies the availability of scarce resources.

This conventional linear programming model can be modified to represent a dynamic multiperiod model by transforming the matrix A into submatrices as shown below:

$$A = \begin{bmatrix} a_1 & & \\ & a_2 & \\ & & \ldots a_t \end{bmatrix}$$

where $a_1, a_2 \ldots a_t$ become the input coefficients for products produced in time periods 1, 2, . . . t respectively, and overlap in some rows or columns or both. Overlapping of coefficients in rows means that certain commodities produced during time period t may also be required for the production of some other commodity in time period t + n. Overlapping of coefficients in columns indicates that products (or returns from these products) produced in time t can be used in the production of other products in time t + n.

The vector b of the static linear programming model is also transformed into subvectors for the dynamic model. Each subvector specifies the availability of scarce resources for a given production period. Availability of scarce resources is not likely to remain constant over time as additional resources can be added, used up or created during the production process. The vector C, the function being maximized, is extended over all p oduction periods.

Limitations of the Model

There are many alternatives and factors involved in a dynamic growth situation which are not included in the model used for this study. These factors should be recognized and the results of the analysis interpreted accordingly.

Briefly these factors are:

1. In an actual situation, risk is a very important consideration. This model can only be termed riskless in that future coefficients are assumed to be known with certainty.

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[1] A detailed analysis of the theory and its inherent procedures is not included here. For one excellent source see: Earl O. Heady and Wilfred Candler, *Linear Programming Methods* (Ames: Iowa State College Press, 1958).

2. This model assumes perfect knowledge exists for the entire 8-year period not only with respect to internal conditions but to external determinants as well.
3. The management factor is assumed to be adequate for expansion when in effect this may be a major factor contributing to the returns lag.
4. Factors which affect the farm firm over the planning period are reduced to a finite number. These, in fact, may be infinitely large and the factors included in this model may not even be the most relevant ones for the given farm situations.
5. Production technology is assumed constant as enterprise size increases. In reality, economies of scale may result and capital will likely be substituted for labor.
6. Optimal solutions obtained using this model represent a minimum time and minimum resource level needed to achieve the growth pattern. The simultaneous solution considers only lags imposed by the user or those created by the pattern of available scarce resources. Therefore, results are likely to be optimistic.

The following table illustrates the details of the multiperiod model using the first two periods on Farm I as an example.

TABLE 1

A TWO-YEAR ILLUSTRATION OF THE MULTI-PERIOD LINEAR PROGRAMMING MATRIX ON FARM I (FIRST YEAR OF PERIOD 1)

Code	Activity	N Row ID	Unit	Resource Level	Obj. Function → -32.72 Corn P_1	0 Corn Trans. P_2	-10.87 Hay P_3	0 Hay Trans. P_4	-52.68 Corn Silage P_5	1273.86 Tobacco P_6	-5.52 Pasture P_7	0 Convert Cr. Land P_8	-1.0 Overhead Cost P_9	-102.56 Buy Land P_{10}
Y_1	FMA Labor	L	Hr.	736	2.7		0.6		2.7	29.0	0.6			
Y_2	MJJ Labor	L	Hr.	790	2.3		2.9		5.0	88.0	1.5			
Y_3	ASO Labor	L	Hr.	790	1.5				6.0	122.0	0.8			
Y_4	NDJ Labor	L	Hr.	736	1.5					115.0				-.25
Y_5	Row Cr Land	L	Ac.	138	1.0				1.0	1.0				-.375
Y_6	Tot Cr Land	L	Ac.	180	1.0		1.0		1.0	1.0		1.0		-.25
Y_7	Past. Land	L	Ac.	21							1.0	-1.0		
Y_8	Tobacco Allot.	L	Ac.	3.74						1.0				
Y_9	Pasture	L	Ac.	0							-1.0			
Y_{10}	Corn (curr)	L	Bu.	0	-60.0	60.0								
Y_{11}	Corn (stor)	L	Bu.	739										
Y_{12}	Hay (curr)	L	Ton	0			-2.5	2.5						
Y_{13}	Hay (stor)	L	Ton	29										
Y_{14}	Corn Silage	L	Ton	0					-15.0					
Y_{15}	Borrow. Cap.	L	Dol.	27,500										
Y_{16}	Op. Capital	L	Dol.	1,000	32.72		10.87		52.68	226.14	5.52		1.0	250.0
Y_{17}	Overhead Cost	E	Dol.	11,897									1.0	
Y_{18}	Equipment	L	An.	40										
Y_{19}	An. Resource	L	An.	26										12.82
Y20	Returns	L	Dol.	0						-1500.0				

TABLE 1—Continued

(First Year of Period 1—Continued)

Code	Activity	N Row ID	Unit	Resource Level	Obj. Function→ -1040.0 Buy Equip. P_{11}	-.24 Borrow Capital P_{12}	301.95 Dairy P_{13}	-120.0 Buy Dairy Cows P_{14}	-56.0 Buy Dairy Heifers P_{15}	-1.0 Hire Labor P_{16}	-1.0 Hire Labor P_{17}	28.72 Soy-beans P_{18}	24.98 Wheat P_{19}	60.0 Sell Corn P_{201}	0 Transfer Capital P_{20}
Y_1	FMA Labor	L	Hr.	736			13.6		3.6			2.0	0.6		
Y_2	MJJ Labor	L	Hr.	790			13.3		2.0	-1.0		2.0	3.0		
Y_3	ASO Labor	L	Hr.	790			13.5		2.8		-1.0	2.0	4.0		
Y_4	NDJ Labor	L	Hr.	736			13.8		3.6						
Y_5	Row Cr Land	L	Ac.	138								1.0			
Y_6	Tot Cr Land	L	Ac.	180								1.0	1.0		
Y_7	Past. Land	L	Ac.	21											
Y_8	Tob. Allot.	L	Ac.	3.74											
Y_9	Pasture	L	Ac.	0			1.75		1.75					60.0	
Y_{10}	Corn (curr)	L	Bu.	0			14.22		0.93						
Y_{11}	Corn (stor)	L	Bu.	739			28.43		1.86						
Y_{12}	Hay (curr)	L	Ton	0			1.1		0.5						
Y_{13}	Hay (stor)	L	Ton	29			1.1		0.5						
Y_{14}	Corn Silage	L	Ton	0			3.27		5.0						
Y_{15}	Borrow. Cap.	L	Dol.	27,500		1.0									
Y_{16}	Op. Capital	L	Dol.	1,000	1000.0	-1.0	-150.38	300.0	158.87	1.0	1.0	22.78	22.32		
Y_{17}	Overhead Cost	E	Dol.	11,897											
Y_{18}	Equipment	L	An.	40	-2.0		1.0								
Y_{19}	An. Resource	L	An.	26			1.0	-1.0							
Y_{20}	Returns	L	Dol.	0	130.0	0.06	-151.52	15.0	7.0			-51.50	-47.30	-60.0	1.0

TABLE 1—Continued

(Second Year of Period 1)

Code	Activity	Row ID	Unit	Resource Level	Obj. Function→ -32.72 Corn P_1	0 Corn Trans. P_2	-10.87 Hay P_3	0 Hay Trans. P_4	-52.68 Corn Silage P_5	1273.86 Tobacco P_6	-5.52 Pasture P_7	0 Convert Cr Land P_8	-1.0 Overhead Cost P_9	-102.56 Buy Land P_{10}
Y_{21}	FMA Labor	L	Hr.	736										
Y_{22}	MJJ Labor	L	Hr.	790										
Y_{23}	ASO Labor	L	Hr.	790										
Y_{24}	NDJ Labor	L	Hr.	736										-.5
Y_{25}	Row Cr Land	L	Ac.	138										-.75
Y_{26}	Tot Cr Land	L	Ac.	180										-.25
Y_{27}	Past. Land	L	Ac.	21										
Y_{28}	Tobacco Allot.	L	Ac.	3.74										
Y_{29}	Pasture	L	Ac.	0										
Y_{30}	Corn (curr)	L	Bu.	0										
Y_{31}	Corn (stor)	L	Bu.	0		-60.0								
Y_{32}	Hay (curr)	L	Ton	0										
Y_{33}	Hay (stor)	L	Ton	0				-2.5						
Y_{34}	Corn Silage	L	Ton	0										
Y_{35}	Borrow. Cap.	L	Dol.	25,040										
Y_{36}	Op. Capital	L	Dol.	0										
Y_{37}	Overhead Cost	E	Dol.	11,787										
Y_{38}	Equipment	L	An.	40										
Y_{39}	An. Resource	L	An.	36										12.82
Y_{40}	Returns	L	Dol.	0										

TABLE 1—Continued

(Second Year of Period 1—Continued)

Code	Activity	Row ID	Unit	Resource Level	-1040.0 Buy Equip. P_{11}	-.24 Borrow Capital P_{12}	301.95 Dairy P_{13}	-120.0 Buy Dairy Cows P_{14}	-56.0 Buy Dairy Heifers P_{15}	-1.0 Hire Labor P_{16}	-1.0 Hire Labor P_{17}	28.72 Soy-beans P_{18}	24.98 Wheat P_{19}	60.0 Sell Corn P_{201}	0 Transfer Capital P_{20}
	Obj. Function →														
Y_{21}	FMA Labor	L	Hr.	736											
Y_{22}	MJJ Labor	L	Hr.	790											
Y_{23}	ASO Labor	L	Hr.	790											
Y_{24}	NDJ Labor	L	Hr.	736											
Y_{25}	Row Cr Land	L	Ac.	138											
Y_{26}	Tot Cr Land	L	Ac.	180											
Y_{27}	Past. Land	L	Ac.	21											
Y_{28}	Tob. Allot.	L	Ac.	3.74											
Y_{29}	Pasture	L	Ac.	0											
Y_{30}	Corn (curr)	L	Bu.	0											
Y_{31}	Corn (stor)	L	Bu.	0											
Y_{32}	Hay (curr)	L	Ton	0											
Y_{33}	Hay (stor)	L	Ton	0											
Y_{34}	Corn Silage	L	Ton	0											
Y_{35}	Borrow. Cap	L	Dol.	25,040	,	0.8									-1.0
Y_{36}	Op. Capital	L	Dol.	0		0.2									
Y_{37}	Overhead Cost	E	Dol.	11,787											
Y_{38}	Equipment	L	An.	40	-2.0										
Y_{39}	An. Resource	L	An.	36				-1.0	-.95						
Y_{40}	Returns	L	Dol.	0	130.0	.06		15.0	7.0						

TABLE 1—Continued

(First Year of Period 2)

Code	Activity	N Row ID	Unit	Resource Level	Obj. Function→ -32.72 Corn P_{21}	0 Corn Trans. P_{22}	-10.87 Hay P_{23}	0 Hay Trans. P_{24}	-52.68 Corn Silage P_{25}	1342.70 Tobacco P_{26}	-5.52 Pasture P_{27}	0 Convert Cr Land P_{28}	-1.0 Overhead Cost P_{29}	-89.79 Buy Land P_{30}
Y_{21}	FMA Labor	L	Hr.	736	2.7		0.6		2.7	29.0	0.6			
Y_{22}	MJJ Labor	L	Hr.	790	2.3		2.9		5.0	88.0	1.5			
Y_{23}	ASO Labor	L	Hr.	790	1.5				6.0	122.0	0.8			
Y_{24}	NDJ Labor	L	Hr.	736	1.5					115.0				
Y_{25}	Row Cr Land	L	Ac.	138	1.0				1.0	1.0				-.25
Y_{26}	Tot Cr Land	L	Ac	180	1.0		1.0		1.0	1.0		1.0		-.375
Y_{27}	Past. Land	L	Ac	21							1.0	-1.0		-.25
Y_{28}	Tobacco Allot.	L	Ac.	3.74						1.0				
Y_{29}	Pasture	L	Ac	0							-1.0			
Y_{30}	Corn (curr)	L	Bu.	0	-75.0	75.0								
Y_{31}	Corn (stor)	L	Bu.	0										
Y_{32}	Hay (curr)	L	Ton	0			-2.5	2.5						
Y_{33}	Hay (stor)	L	Ton	0										
Y_{34}	Corn Silage	L	Ton	0					-15.0					
Y_{35}	Borrow. Cap.	L	Dol.	25,040										
Y_{36}	Op. Capital	L	Dol.	0	32.72		10.87		52.68	226.14	5.52		1.0	250.0
Y_{37}	Overhead Cost	E	Dol.	11,787									1.0	
Y_{38}	Equipment	L	An.	40										
Y_{39}	An. Resource	L	An.	36										12.82
Y_{40}	Returns	L	Dol.	0						-1568.84				

TABLE 1—Continued

(First Year of Period 2—Continued)

Code	Activity	N Row ID	Obj. Unit	Function → Resource Level	-910.0 Buy Equip. P_{31}	-.24 Borrow Capital P_{32}	317.08 Dairy P_{33}	-105.0 Buy Dairy Cows P_{34}	-49.0 Buy Dairy Heifers P_{35}	-1.0 Hire Labor P_{36}	-1.0 Hire Labor P_{37}	34.90 Soy-beans P_{38}	24.98 Wheat P_{39}	75.0 Sell Corn P_{202}	0 Transfer Capital P_{40}
Y_{21}	FMA Labor	L	Hr.	736			13.6		3.6			2.0	0.6		
Y_{22}	MJJ Labor	L	Hr.	790			13.3		2.0	-1.0		2.0	3.0		
Y_{23}	ASO Labor	L	Hr.	790			13.5		2.8		-1.0	2.0	4.0		
Y_{24}	NDJ Labor	L	Hr.	736			13.8		3.6						
Y_{25}	Row Cr Land	L	Ac.	138								1.0			
Y_{26}	Tot Cr Land	L	Ac.	180								1.0	1.0		
Y_{27}	Past. Land	L	Ac.	21											
Y_{28}	Tob. Allot.	L	Ac.	3.74											
Y_{29}	Pasture	L	Ac.	0			1.5		2.0						
Y_{30}	Corn (curr)	L	Bu.	0			14.22		0.93					75.0	
Y_{31}	Corn (stor)	L	Bu.	0			28.43		1.86						
Y_{32}	Hay (curr)	L	Ton	0			1.1		0.5						
Y_{33}	Hay (stor)	L	Ton	0			1.1		0.5						
Y_{34}	Corn Silage	L	Ton	0			3.27		5.0						
Y_{35}	Borrow. Cap.	L	Dol.	25,040		1.0									
Y_{36}	Op. Capital	L	Dol.	0	1000.0	-1.0	-160.46	300.0	158.87	1.0	1.0	22.78	22.32		
Y_{37}	Overhead Cost	E	Dol.	11,787											
Y_{38}	Equipment	L	An.	40	-2.0		1.0								
Y_{39}	An. Resource	L	An.	36			1.0	-1.0	.						
Y_{40}	Returns	L	Dol.	0	130.0	0.06	-156.56	15.0	7.0			-57.68	-47.30	-75.0	1.0

APPENDIX B

TABLE 1

ESTIMATED CROP YIELDS PER ACRE, ANIMAL PRODUCTION PER COW AND ANNUAL VARIABLE COSTS PER UNIT ON FARM I

Enterprise	Unit	Production Period		
		1	2	3-8
		Yield (per unit)		
Burley tobacco	Lb	2500	2650	2800
Corn (grain)	Bu	60	75	90
Corn (silage)	Ton	15	15	18
Hay	Ton	2.5	2.5	3
Soybeans	Bu	25	28	30
Wheat	Bu	30	30	35
Dairy	Lb	9000	9500	9698
		Annual Variable Cost (per unit)		
		----------Dol.----------		
Burley tobacco		226.14	226.14	247.30
Corn (grain)		32.72	32.72	48.71
Corn (silage)		52.68	52.68	53.41
Hay		10.87	10.87	11.86
Pasture		5.52	5.52	6.51
Soybeans		22.78	22.78	23.93
Wheat		22.32	22.32	27.70
Dairy		152.66	152.66	177.91
Part-time labor		1.00	1.00	1.25-1.60

APPENDIX B--Continued

TABLE 2

ASSUMED PRICES PAID ON FARM I

Item	Unit	Production Period	
		1-2	3-8
		--------Dol.---------	
Seed			
Tobacco	Oz	4.00	4.00
Corn	Lb	0.18	0.18
Wheat	Bu	1.25	1.25
Soybeans	Lb	0.06	0.07
Ladino Clover	Lb	0.80	0.90
Orchard Grass	Lb	0.55	0.60
Alfalfa	Lb	0.65	0.65
Feed			
Salt	Cwt	2.60	2.80
Dairy Supplement	Cwt	5.75	6.44
Milk Replacer	Cwt	11.00	12.00
Calf Starter	Cwt	5.75	6.00
Fertilizer			
Nitrogen	Lb	0.11	0.11
K_2O	Lb	0.09	0.09
P_2O_5	Lb	0.06	0.06
Limestone, Spread	Ton	5.50	6.00

APPENDIX B--Continued

TABLE 3

ASSUMED PRICES RECEIVED ON FARM I

Product	Unit	Production Period	
		1-2	3-8
		---------Dol.--------	
Livestock and Livestock Products			
Grade A Milk	Cwt	4.50	5.32
Dairy Calves	Head	20.00	20.00
Dairy Cows (cull)	Cwt	14.25	15.00
Dairy Heifers (cull)	Head	100.00	100.00
Crops			
Tobacco	Lb	0.60	0.60
Soybeans	Bu	2.60	2.60
Wheat	Bu	1.16	1.16
Straw	Bale	0.35	0.35
Corn	Bu	1.00	1.00

APPENDIX C

TABLE 1

ESTIMATED CROP YIELDS PER ACRE, ANIMAL PRODUCTION PER COW AND ANNUAL VARIABLE COSTS PER UNIT ON FARM II

Enterprise	Unit	Production Period		
		1	2	3-8
		Yield (per unit)		
Burley tobacco	Lb	2,600	2,800	3,000
Corn (grain)	Bu	75	85	100
Corn (silage)	Ton	15	15	18
Hay	Ton	3	3.5	4
Barley	Bu	45	50	55
Wheat	Bu	30	32	35
Dairy	Lb	10,000	10,500	11,071
		Annual Variable Cost (per unit)		
		----------Dol.----------		
Burley tobacco		242.64	242.64	264.28
Corn (grain)		36.21	36.21	49.24
Corn (silage)		50.68	50.68	58.18
Hay		28.03	28.03	35.43
Pasture		6.21	6.21	6.21
Barley		29.96	29.96	34.72
Wheat		32.68	32.68	34.72
Dairy		167.92	167.92	232.33
Part-time labor		1.00	1.00	1.25-1.75

APPENDIX C--Continued

TABLE 2

ASSUMED PRICES PAID ON FARM II

Item	Unit	Production Period	
		1-2	3-8
		---------Dol.---------	
Seed			
Tobacco	Oz	4.00	4.00
Corn	Lb	0.18	0.18
Wheat	Bu	1.25	1.25
Barley	Bu	2.00	2.00
Alfalfa	Lb	0.65	0.65
Ladino Clover	Lb	0.90	0.90
Orchard Grass	Lb	0.60	0.60
Feed			
Salt	Cwt	2.60	2.80
Dairy Supplement	Cwt	5.75	7.16
Milk Replacer	Cwt	11.00	12.00
Calf Starter	Cwt	5.75	6.00
Fertilizer			
Nitrogen	Lb	0.11	0.11
K_2O	Lb	0.09	0.09
P_2O_5	Lb	0.06	0.06
Limestone, Spread	Ton	5.50	6.00

APPENDIX C--Continued

TABLE 3

ASSUMED PRICES RECEIVED ON FARM II

Product	Unit	Production Period	
		1-2	3-8
		-------Dol.----------	
Livestock and Livestock Products			
Grade A Milk	Cwt	4.50	5.41
Dairy Calves	Head	20.00	20.00
Dairy Cows (cull)	Cwt	14.00	15.00
Dairy Heifers (cull)	Head	100.00	100.00
Crops			
Tobacco	Lb	0.60	0.60
Barley	Bu	0.95	1.00
Wheat	Bu	1.30	1.25
Straw	Bale	0.25	0.35
Corn	Bu	1.00	1.00

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