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To the Graduate Council:

I am submitting herewith a thesis written by Roger Stanley Lyon entitled "The Economics of Forage and Concentrate Rations for East Tennessee Grade A Dairy Herds with High Production Records." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

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THE ECONOMICS OF FORAGE AND CONCENTRATE RATIONS FOR EAST TENNESSEE GRADE A DAIRY HERDS WITH HIGH PRODUCTION RECORDS

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

Roger Stanley Lyon

August 1966

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The author takes full responsibility for any errors made in this thesis.

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CHAPTER I

INTRODUCTION

The grade A milk industry has steadily developed into one of the major agricultural industries in Tennessee today. The volume of Grade A milk sold under Federal order increased 51 per cent between 1956 and 1963. Yet, along with this increase in milk production, the number of grade A milk producers has declined. The decline in the number of producers is due to the advancement of technology in dairying which has caused greater milk production per cow, larger herd sizes and a tremendous increase in capital investment. These factors have forced many small producers out of production.[1]

For years dairy farmers have used their own experiences and opinions as the primary basis for making important decisions, but with the recent advances in dairying technology, more scientific methods are needed. The most prevalent decisions concern machinery ownership and the most economical rations to feed under a given set of conditions. These decisions have become increasingly difficult to make in recent years. Dairy operations have become increasingly complicated with labor-saving devices and machinery whose costs tend to be dynamic in nature. They are dynamic because of the uncertainty of the many alternative

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[1]William Dale Given, Tennessee Grade A Milk Producers, Present and Potential, unpublished Master's thesis, The University of Tennessee, Knoxville, June, 1964.

uses they have and the dependence they have upon the availability of complementary resources affecting the extent of their use. If the complementary resources were unrestricted and the exact opportunity cost of all the existing alternatives were known, then the costs of these advancements in technology would be more predictable and static rather than dynamic. Yet, these conditions are virtually impossible to obtain and, therefore, this makes the situation a dynamic one. In regard to milk supply, technological improvements tend to make grade A dairying more stable because of the added certainty they give to production. This added certainty is due to the replacement of human controls with mechanical controls and the presence of scientific knowledge in the operation of the dairies.

I. OBJECTIVES

Although it is a well known fact that dairy farmers have several goals, only two were considered in this study. These were profit maximization and the efficient use of resources.

The objectives of this study were: (1) to determine the most economical forage system for different herd sizes at a given level of milk production; (2) to estimate the returns to scale with increases in herd size; (3) to determine the acreage needed in order to justify ownership of forage harvesting machinery; (4) to determine the resource requirements for each herd size and forage system; and (5) to obtain the most profitable forage rations for grade A dairy cows using specific resources and prices prevalent on East Tennessee grade A dairy farms.

II. THE PROBLEM

Considerable controversy has arisen in respect to ownership of forage harvesting machinery and the economics of forage and concentrate rations for dairy cattle at different levels of production. This study was conducted to determine: (1) the acreages needed to economically justify ownership of forage harvesting machinery; (2) the cost and resource requirement differences between the most popular high quality forage rations; and (3) the least cost rations for grade A dairy cattle when using different production levels and specific resource situations found on grade A dairy farms in East Tennessee. The farms considered are those which have had production levels per cow ranging from the State DHIA average of 9,400 pounds (4 per cent butterfat) to 3,600 pounds above this average. The analytical techniques used in this study were budgeting and linear programming.

A recent survey revealed that alfalfa hay and corn silage were the most popular forages used by grade A dairy farmers in East Tennessee.[2] A mixture of orchard grass with the alfalfa hay is also very popular for increasing the total digestible nutrient content of the forage ration. The popularity of these forages is due to their high yield of nutrients produced per acre. These forages are commonly fed in three alternative rations. They are: (1) a ration consisting almost entirely of corn

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[2] Thomas William Little, "An Economic Analysis of Alternative Replacement Policies on Grade A Dairy Farms in the Knoxville Milkshed," unpublished Master's thesis, The University of Tennessee, Knoxville, 1964, p. 19.

silage with a minimum of alfalfa-orchard grass hay and concentrates; (2) an all alfalfa-orchard grass hay forage ration and concentrates; or (3) a ration consisting of a mixture of the alfalfa-orchard grass hay and corn silage. Based upon the above information, a budgeting analysis of these three forage systems was performed in Chapters II and III of this thesis with emphasis being placed upon the costs of owning forage harvesting machinery. Chapter IV is devoted to obtaining a least cost feed ration for grade A dairy cows using three production levels and the resources and prices which are representative of grade A dairy farms in East Tennessee. Chapter V summarizes and draws conclusions from the findings of this study.

III. THE PROCEDURE

The budgeting analysis in Chapters II and III analyzes and compares (1) a corn silage forage system; (2) an all alfalfa-orchard grass hay forage system; and (3) a corn silage and alfalfa-orchard grass hay forage system. The forage systems were analyzed for three herd sizes consisting of thirty, sixty, and ninety cows. For each herd size and forage system, the alternative of owning all forage harvesting machinery was compared with the alternative of hiring the forage crops custom harvested. Chapter II is devoted to a comparison of the total resource requirements for each forage system and harvesting policy using the different herd sizes. Chapter III involves a revenue and cost analysis that concludes with a summary of the essential differences in the forage systems.

Chapter IV involves finding a least cost feed ration for Grade A dairy cows in East Tennessee using the techniques of budgeting and linear programming. Budgeting was used to develop the resource requirements for each of the crops and levels of milk production considered. The alternatives of buying and selling straw, hay, and concentrates were considered as intermediate activities.

The resources which were considered as constraints, to East Tennessee grade A dairy farmers, were labor and land. Operator labor was assumed to be available in fixed, monthly amounts. In addition, an activity for hiring labor for $1.25 per hour was included in the linear programming model. Land was restricted to the total acreage of cropland and the percentage of each class of soil available on the selected representative farm situation. The initial supply of annual investment capital in the model was set at zero, however, an activity of borrowing annual investment capital at 6 per cent interest annually was included as the means of supplying investment capital in the model. Neither hired labor nor total investment capital was assumed to be restricted in supply.

IV. THE ASSUMPTIONS

It was assumed that the dairy farm operators would possess the required managerial abilities for the various production levels.

Recent research by William Dale Givan has shown that upright silos are the most popular type of storage facility for silage on

grade A dairy farms in East Tennessee.[3] Also, upright silos have lower spoilage rates than trench and bunker silos. The estimated spoilage rate in upright silos is 5 to 10 per cent whereas it is 10 to 15 per cent in permanent trench and bunker silos.[4] Thus, upright silage storage was assumed throughout this study.

According to the findings of Thomas William Little, an opportunity cost for purchasing replacement heifers is involved when the grade A dairy farmer raises his own replacement stock. Little also revealed that 69 per cent of the grade A dairy farms in the Knoxville milkshed raised 100 per cent of their own replacement stock.[5] Since such a high proportion of the grade A dairy producers continue to raise their own replacement stock, all replacement heifers were assumed to be raised on the home farm in the budgeting analysis shown in Chapters II and III. In order to obtain a least cost feed ration for different production levels, it was assumed that all replacement heifers would be purchased in the linear programming analysis presented in Chapter IV.

Downen and Culver found that the average dairy heifer replacement rate used by Tennessee dairy farmers was approximately 20 per cent.[6]

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[3]Givan, op. cit., p. 47.

[4]H. K. Welch, Jr., J. N. Maddux, and W. H. McKinney, Silages for Dairy Cattle, Cooperative Extension Service Bulletin 616, University of Georgia, Athens, 1962, p. 13.

[5]Little, op. cit., pp. 105-108.

[6]M. Lloyd Downen and David W. Culver, The Dairy Cattle Replacement Markets of Tennessee and Florida, The University of Tennessee, Agricultural Experiment Station Bulletin 318, Knoxville, 1960, p. 2.

Therefore, a 20 per cent replacement rate for the cows was assumed in this study.

All concentrates, bedding, and minerals were assumed to be bought at current market prices in the budgeting analysis. The dairy operations analyzed in the linear programming phase of this study were given the possibilities of either growing or buying forages, concentrates and bedding.

Most farmers, who own forage harvesting machinery, harvest forage crops for both themselves and other farmers. In this way, many farmers can profitably own harvesting machinery. But, for the purposes of the budgeting analysis, it was assumed that the farmer would not be permitted to harvest crops other than those pertinent to the maintenance of the particular herd size and forage system under consideration. This is due to the uncertainties of estimating the amount of custom work the farmer could do, and also, it simplified the task of determining the number of acres that are necessary to profitably own harvesting machinery.

Custom rates were assumed for harvesting costs of all crops grown on the grade A dairy farm in the linear programming phase of this study. This assumption was made because, when the operator owns harvesting machinery, he is still foregoing an opportunity cost that he might obtain from custom harvesting. This opportunity cost is in the form of revenue he could obtain from custom harvesting crops for other farmers while he is harvesting his own crops.

V. SOURCES OF DATA

The data for this study were obtained from consultation with staff members in the Departments of Agricultural Economics, Agronomy, Agricultural Engineering, and Dairying at The University of Tennessee and from secondary sources.

The secondary data comes from unpublished data in the Department of Agricultural Economics at The University of Tennessee, bulletins and publications by The University of Tennessee Agricultural Experiment Station, theses written by graduate students as part of the requirements for an advance degree from The University of Tennessee, Department of Agricultural Economics, Morrison's Feeds and Feeding, and miscellaneous publications.

CHAPTER II

RESOURCE REQUIREMENTS FOR GRADE A DAIRY FARMS IN EAST TENNESSEE BY HERD SIZE, FORAGE SYSTEM, AND HARVESTING POLICY

I. INTRODUCTION

This part of the study is concerned with resource requirements for three forage systems, three herd sizes and two harvesting policies for grade A dairying. With changes in each herd size, forage system, and harvesting policy, many resource requirements change at a variable rate while others change at a constant rate. Consideration is given to both types of resources, but special attention is given to those which change at a variable rate. Also, there are resources, such as land, labor, and investment capital, whose supply tends to be fixed thereby limiting expansion of a highly profitable enterprise. Therefore, special consideration was given to these resources in Chapter IV.

Throughout the remainder of this thesis, where it was deemed practical to do so, the corn silage forage system was referred to as forage system A, the all alfalfa-orchard grass hay forage system as forage system B, and the corn silage and alfalfa-orchard grass hay forage system as forage system C.

II. FEED REQUIREMENTS

As stated in the previous chapter, the three herd sizes were

thirty, sixty, and ninety cows using a 20 per cent cow replacement policy. With a 20 per cent replacement policy, six 900-pound bred heifers and six 500-pound yearling heifers would be required as the young stock or replacements for the thirty-cow herd. Each of these numbers was increased to twelve for the sixty-cow herd and eighteen for the ninety-cow herd. The mature milk cows were assumed to have an average weight of 1,250 pounds and have an average annual production of 9,400 pounds of 4 per cent butterfat milk. This annual production level was the same as the average milk production per cow on DHIA records for the State of Tennessee in 1964.[1]

The total feed requirements by herd size and forage system are shown in Table I. The winter feeding period was assumed to be from October 15 until April 15 (183 days). Adequate ladino clover and orchard grass pasture was assumed as the forage for the summer feeding period from April 16 through October 14. It was assumed that a high proportion of the dairy cows would be dry through the summer months of July and August. This assumption was made because September through January is normally the "base building" period for producers of grade A milk, and the producers tend to have a greater percentage of the herd freshen from mid-August through October in order to build a larger base. Ladino-orchard grass pasture is uaually an adequate ration for dry cows and the young stock throughout the summer feeding period. In addition to pasture, approximately nine pounds of corn per day would be needed to

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[1]State of Tennessee Dairy Herd Improvement Association Summary, 1963-1964.

TABLE I

TOTAL ROUGHAGE AND CONCENTRATE REQUIREMENTS FOR GRADE A DAIRIES IN EAST TENNESSEE BY FORAGE SYSTEM AND HERD SIZE USING A 9,400 POUND PRODUCTION LEVEL PER COW, 1965

System	Herd Size (Cows)	Total Amount of Feed Required[a]				
		Corn Silage (Tons)	Alfalfa-Orchard Grass Hay (Tons)	Corn, Dent, Grade 1 (Bu.)	Molasses, Cane (Lbs.)	Soybean Oil Meal 44% Protein (Lbs.)
(A)	30	249	16	878	--[b]	10,980
	60	498	32	1,756	--	21,960
	90	747	48	2,634	--	32,940
(B)	30	--	59	1,937	6,588	--
	60	--	118	3,874	13,176	--
	90	--	177	5,811	19,764	--
(C)	30	180	47	878	--	--
	60	360	94	1,756	--	--
	90	540	141	2,634	--	--

[a]Feeding requirements and analysis of feeds were derived from Feeds and Feeding by Frank B. Morrison. Twenty-second edition; Clinton, Iowa: The Morrison Publishing Company, 1959.

[b]The dashes indicate that none of these ingredients were required.

provide ample energy requirements for the lactating cows during the remainder of the summer feeding period from September 1 to October 14. Following the arrangement for the cows to freshen in the late summer and early fall, milk production would tend to be low from April 16 until June 30. Approximately two pounds of corn per day, in addition to pasture, was needed to provide an adequate ration for the cows during this period. Throughout the summer feeding period, the rations were assumed to be the same for each forage system.

In the forage system A ration, it was necessary to include a minimum amount of alfalfa-orchard grass hay in order to provide adequate dry feed in a highly succulent forage ration for the winter feeding period, as shown in Table I.[2] The corn silage and alfalfa-orchard grass hay provided an adequate ration for the young stock throughout the winter feeding period. The lactating cows required from one to three pounds of soybean meal daily, depending upon the stage of lactation, to provide adequate digestible protein. Approximately two to five pounds of corn per day was mixed into the ration at the first of the lactation period to provide the energy requirements.

The forage system B ration required an average of nine pounds of corn daily throughout the winter feeding period to provide enough total digestible nutrients and energy in the ration for the lactating cows. The dairy young stock required a mixture of two pounds of corn and

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[2]This minimum hay requirement was based upon consultation with personnel of the Dairy Department, The University of Tennessee, Knoxville, July, 1965.

three pounds of molasses daily to provide an adequate amount of total digestible nutrients.

A mixture of corn silage and alfalfa-orchard grass hay balanced the ration for the dairy young stock in forage system C. The ration for the freshly lactating cows was supplemented with two to five pounds of corn daily. As the cows advanced further along in the lactation period and daily milk production decreased, the silage and hay provided a balanced ration without concentrates. The concentrates were only needed at the first of the lactation period to provide enough energy to prevent excessive weight loss.

III. LAND REQUIREMENTS

The land requirements were divided into cropland and pastureland acreages. No attempt was made to estimate other land requirements due to the lack of data indicating the amount of land East Tennessee dairy farmers devote to buildings, woodland, idle land, and for other purposes.

The pastureland was treated as a constant acreage for each forage system within a given herd size. The pastureland acreage required were as follows: (1) for the thirty-cow herd size, 50 acres; (2) the sixty-cow herd size, 100 acres, and (3) the ninety-cow herd size, 150 acres.

The cropland acreage varies with each forage system as well as herd size. A breakdown of the cropland requirements by crop, herd size, and forage system is given in Table II.

TABLE II

CROPLAND REQUIREMENTS FOR THREE ALTERNATIVE FORAGE SYSTEMS, AND THREE HERD SIZES ON GRADE A DAIRIES IN EAST TENNESSEE, 1965

System	Herd Size (Cows)	Crop			
		Corn Silage (Acres)	Alfalfa-Orchard Grass Hay (Acres)	Ladino Clover-Orchard Grass Pasture (Acres)	Total All Crops (Acres)
(A)	30	17[a]	6[b]	50	73
	60	34	11	100	145
	90	50	16	150	216
(B)	30	--	20	50	70
	60	--	40	100	140
	90	--	59	150	209
(C)	30	12	16	50	78
	60	24	32	100	156
	90	36	47	150	233

[a]Assumes a yield of 16 tons per acre and 1 ton spoilage.

[b]Assumes a yield of 3.5 tons per acre and 0.5 ton spoilage.

IV. BUILDING AND EQUIPMENT REQUIREMENTS

The building and equipment requirements vary with each assumed herd size, forage system, and harvesting policy.[3] The building and equipment requirements were analyzed by herd size, and the difference in such requirements with changes in the forage system and harvesting policy used are shown in Table III.

For each herd size, forage system C required the most investment capital and forage system B required the least amount of investment capital. This held true where custom harvesting was assumed or where it was assumed the operator owned all the harvesting machinery for the operation. The difference in building and equipment requirements for each forage system was greater where all harvesting machinery was assumed to be owned.

As herd size increased, the investment capital requirements for each forage system increased at a decreasing rate. The cost of harvesting equipment was assumed to remain constant at each herd size with one exception. With the ninety-cow herd, silage unloading equipment was necessary for two wagons rather than for one as was assumed for the other two herd sizes that used corn silage. Several other items, such as tillage equipment, were held constant for each herd size, forage system, and harvesting policy. Therefore, as herd size increased, average investment capital required per cow decreased.

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[3]The assumed building and equipment requirements are itemized in Appendix A, Tables XXI through XXXII.

TABLE III

TOTAL INVESTMENT CAPITAL REQUIREMENTS FOR BUILDINGS, EQUIPMENT, AND MACHINERY FOR THREE FORAGE SYSTEMS AND ALTERNATIVE HARVESTING POLICIES FOR GRADE A DAIRY FARMS IN EAST TENNESSEE, 1965

Size	Forage System	Alternative Harvesting Policy	
		Custom Harvest	Own All Machinery
Thirty Cow Herd	(A)[a]	$12,840.00[b]	$14,362.50
	(B)	11,029.00	12,515.50
	(C)	13,030.00	16,039.00
Sixty Cow Herd	(A)	20,934.50	22,457.00
	(B)	17,462.00	18,948.50
	(C)	21,438.00	24,347.00
Ninety Cow Herd	(A)	28,179.00	29,951.50
	(B)	23,835.50	25,322.00
	(C)	28,775.50	32,034.50

[a]In each corn silage forage system, the hay requirement needed such small acreage that it would not be economical to own hay harvesting machinery. Therefore, hay was assumed to be custom harvested in each corn silage forage system.

[b]Average investment was equal to approximately one-half the new cost. For further information, see Appendix A, Tables XXI through XXXII.

V. LABOR REQUIREMENTS

The labor requirements were computed on a man-equivalent basis. As in the investment capital requirements, the labor requirements per cow increased at a decreasing rate with increases in herd size. The factors responsible for this were labor for feeding, manure hauling, and milking (Table IV) which increased at a decreasing rate with increases in herd size. The remainder of the labor requirements, with a few exceptions, increased at a constant rate with additions in herd size. The exceptions were where the amount of labor was reduced in tillage operations with increased field size. As forage requirements increased, machinery use approached capacity and machinery repairs per acre decreased.

The total labor requirements were highest for forage system C, next highest for forage system A and lowest for forage system B. However, this is misleading. According to Morrison's Feeds and Feeding, one ton of alfalfa-orchard grass hay has approximately the same feed value as three tons of corn silage.[4] Using the assumed yields of fifteen tons of corn silage per acre and three tons of alfalfa-orchard grass hay per acre, after allowing for spoilage, corn silage from one acre would be equivalent in feed value to the production from 1.7 acres of alfalfa-orchard grass hay. Using custom harvesting, the labor requirements for corn silage were approximately the same as for alfalfa-orchard grass hay

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[4] Frank B. Morrison, Feeds and Feeding, 22nd edition, The Morrison Publishing Company, Clinton, Iowa, 1959, Appendix.

TABLE IV

ESTIMATED LABOR REQUIREMENTS BY ENTERPRISE AND LABOR PERIOD FOR GRADE A DAIRY FARMS IN EAST TENNESSEE, 1965[a]

Enterprise or Activity by Herd Size	No. Acres	Hours of Labor Required by Period of Year								Total for Year
		Jan. and Feb.	Mar. and Apr.	May	June	July	Aug.	Sep. and Oct.	Nov. and Dec.	
Milk cows)	--	400	330	168	168	168	169	340	410	2,153
Dairy heifers) Thirty-cow	--	110	48	--	--	--	--	27	93	278
Perm. pasture) herd size[b]	50	--	25	--	30	47	41	22	--	165
Repairs)	--[c]	26	21	12	12	12	12	27	26	148
Corn silage										
Custom harvest	10	--	43	7	7	--	30	--	--	87
Own all machinery	10	--	43	7	7	--	120	--	--	177
Milk cows)	--	648	534	255	255	259	260	533	666	3,410
Dairy heifers) Sixty-cow	--	161	61	--	--	--	--	38	138	408
Perm. pasture) herd size[b]	100	--	45	--	55	88	76	40	--	304
Repairs)	--[c]	36	32	17	17	17	17	37	36	209
Alfalfa-orchard grass hay										
Custom harvest	10	7	--	18	18	5	20	22	--	90
Own all machinery	10	7	--	36	36	5	32	40	--	156
Milk cows)	--	933	763	363	362	368	371	758	948	4,866
Dairy heifers) Ninety-cow	--	167	71	--	--	--	--	38	138	414
Perm. pasture) herd size[b]	150	--	67	--	82	132	114	60	--	455
Repairs)	--[c]	44	38	21	21	21	21	44	43	253

[a]See footnote at the end of Table XXXIV., Appendix B, for source of data.

[b]Adjustments were made for systems where silage was not fed.

[c]This is an average of the forage systems and harvesting alternatives. Adjustments were based upon the amount of buildings and machinery maintained.

on a per acre basis. Using the own all harvesting machinery policy, the per acre labor requirements were slightly more for the corn silage system than for the alfalfa-orchard grass hay, approximately 17.7 hours versus 15.6 hours. Thus, it would take more labor to produce one pound of feed equivalent from alfalfa-orchard grass hay than from corn silage. The reason labor requirements were less for forage systems A and B was that these forage rations were supplemented heavier with concentrates. The heavier a ration was supplemented with concentrates the lower the forage requirements were. Thus, this lowered the acreage and labor requirements for producing the forage required.

As shown in Table IV, the labor requirements for each forage crop, harvesting policy and herd size are broken down bi-monthly for the non-critical months and monthly for the critical summer months. The labor requirements in the critical summer months are compared in Figure 1. The total labor requirements by forage system, herd size, and harvesting policy are shown in Appendix B, Tables XXXIV through XXXVI.

For all forage systems and harvesting policies, the labor requirements were assumed to be highest for the month of August. In the two systems using corn silage, due to the assumption that corn silage is harvested in August, the harvesting of corn silage accounted for the large increases in labor requirements for August. Where custom harvesting was used, the requirements were not so great because the only labor the operator furnished for harvesting was for packing the silage in the silo. But, where the operator owned all harvesting machinery and harvested the silage himself, labor requirements per acre were four times

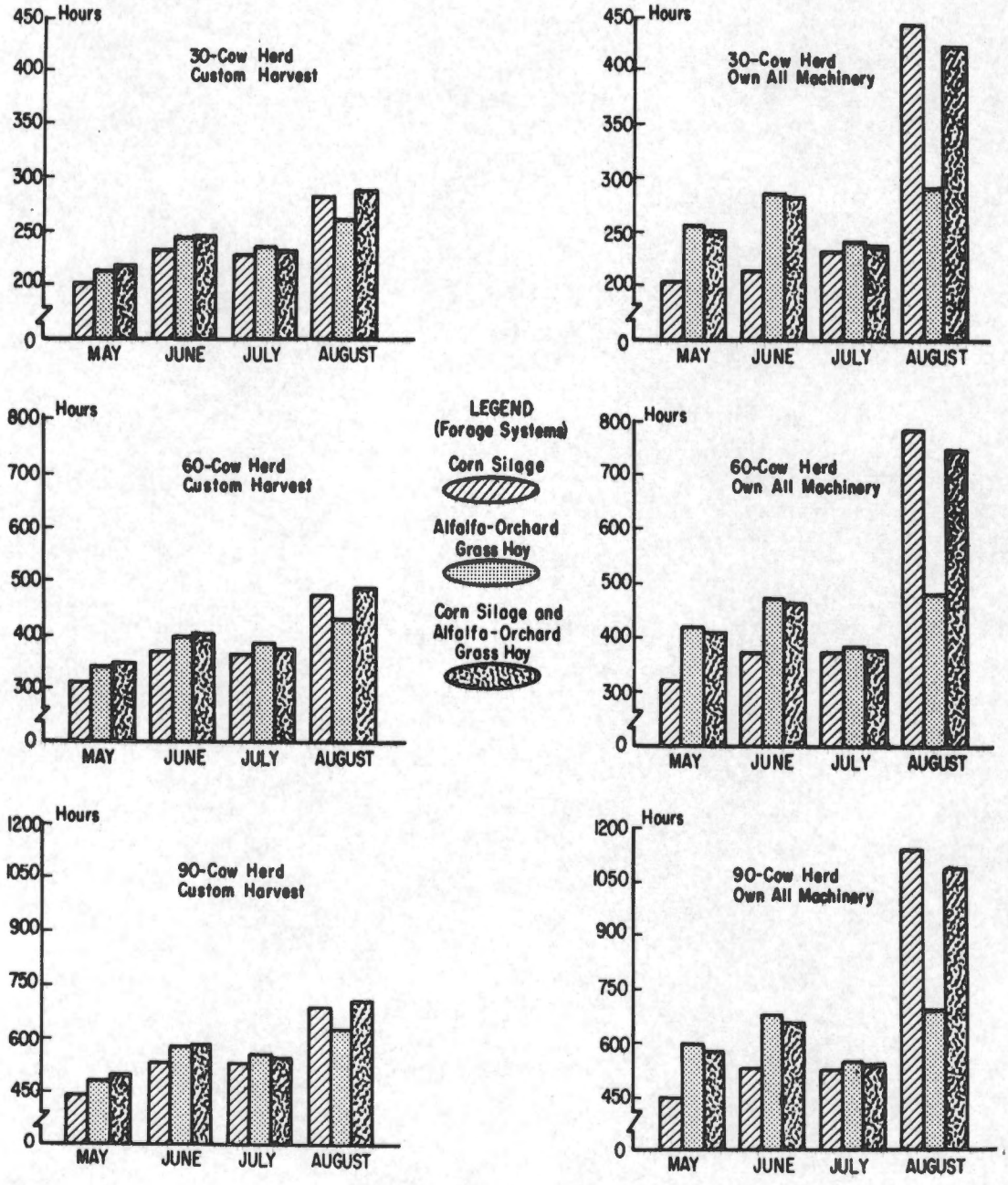


FIGURE 1

MONTHLY LABOR DISTRIBUTION THROUGHOUT THE SUMMER MONTHS BY HERD SIZE, FORAGE SYSTEM AND HARVESTING POLICY FOR GRADE A DAIRIES IN EAST TENNESSEE, 1965

as great as those where the silage was custom harvested. Assuming that March and April are the months for preparing the soil and planting corn, the majority of the remaining labor required for corn silage would come during March and April. At this time of the year, this should not present a large problem due to the decrease in the labor requirement for milking, feeding, and manure hauling which could release labor needed for planting corn for silage.

Although the labor requirements for alfalfa-orchard grass hay were very high in relation to those for corn silage, in terms of feed equivalents produced per acre, labor was evenly distributed throughout the summer months. It was assumed that alfalfa-orchard grass hay would be harvested four times a year with the first cutting in May, the second in June, the third in August, and the fourth in September. The yield was assumed to be highest for the first two cuttings and less for the remaining two cuttings. Thus, the labor requirements per acre for harvesting were greater for the first two cuttings than for the last two. In order to maintain a constant acreage of hay, each year new alfalfa-orchard grass hay must be sown to replace the old which died out. It is a common practice in East Tennessee to begin preparing the soil in July, periodically pulverize the soil throughout August and to sow alfalfa and orchard grass seed in September. This means that labor, in addition to that used for hay harvesting, was required for the months of August and September.[5]

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[5]W. P. Ranney, Labor Requirements on Tennessee Farms, The University of Tennessee Agricultural Experiment Station Bulletin 316, Knoxville, 1960.

In the hay harvesting operation, approximately 35 per cent of the total labor required, depending upon the yield per acre, was for hay hauling. Using custom harvesting, it was assumed that the operator would cut and haul the hay. The conditioning, raking, and baling were all custom hired. Where the operator was assumed to own all hay harvesting machinery, additional labor was required for conditioning, raking, and baling the hay. Raking and baling hay consumed approximately 50 per cent of the total labor required for hay harvesting.[6]

The labor required for permanent pasture was very evenly distributed over the summer months. In Table IV, page 18, the labor for 50 acres of permanent pasture and labor for 100 acres are listed separately. The reason for this is that as acreage increased from 50 to 100 acres, the field size tends to increase and results in a decrease in time required per acre for machinery operations. Therefore, it was assumed that labor per acre decreased when acreage increased from 50 to 100 acres. It was assumed that when the acreage increased from 100 to 150 acres the per acre labor requirements for permanent pasture would not substantially decrease in East Tennessee because of terrain and general field size throughout the area. Thus, the per acre labor requirements for 150 acres of permanent pasture were the same as for 100 acres.

VI. ANNUAL OPERATING CAPITAL REQUIREMENTS

Annual operating capital was assumed to be the cash expenses which the operator would be confronted with throughout the year. These

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[6] Ibid.

expenses are usually regarded as variable costs. These expenses may occur at regular intervals, such as weekly or monthly, or they may occur only once a year. The arrangements for financing these expenses are many and thus are not discussed in this thesis.

East Tennessee grade A milk producers, who sell to commercial milk plants, receive payment for their milk every two weeks. Assuming the operator maintains a uniform milk production level throughout the year, these payments should represent an even flow of revenue. Most variable expenses on grade A dairy farms are spread over the year so that the operator can meet these expenses with revenue from the dairy operation. Those expenses which occur once or twice a year, such as fertilizer and seed, can usually be financed through the dealer by allowing the dairyman to pay for them in bi-weekly payments. Although annual operating capital is considered to be an important requirement by grade A milk producers, it is not a restricting production factor in most cases.

The annual operating capital required for each forage system, herd size, and harvesting policy are summarized in Table V. Many of these expenses, such as seed and fertilizer, require capital for only six to eight months rather than for the entire year. But, for the purpose of the first phase of this study, the expenses were computed for the entire year.

For each herd size and forage system, the operating capital requirements were higher for the custom harvesting policy rather than for the own all harvesting machinery policy. For each herd size and

TABLE V

ANNUAL OPERATING CAPITAL REQUIREMENTS FOR THREE DAIRY HERD SIZES, THREE FORAGE SYSTEMS AND ALTERNATIVE HARVESTING POLICIES FOR GRADE A DAIRY FARMS IN EAST TENNESSEE, 1965

Forage System	Herd Size (Cow)	Total Operating Capital Required[a]	
		Custom Harvest	Own All Machinery
(A)	30	$ 9,791	$ 9,603
	60	17,877	17,303
	90	25,970	24,960
(B)	30	10,284	10,206
	60	18,865	18,616
	90	27,633	27,240
(C)	30	9,474	9,248
	60	17,289	16,671
	90	25,142	24,064

[a]For itemized expenses, see Tables VIII through X in Chapter III.

harvesting policy, forage system B had the highest operating capital requirements and forage system C had the lowest. The major factor accounting for the differences in operating capital requirements, between forage systems, was the cost of concentrates. Concentrates were assumed to be purchased and thereby increased the operating expenses for the forage systems that required large amounts of concentrates. But, in the forage systems that required less concentrates, the forage crop acreage was greater to supply the extra silage and hay needed. From this comes the question of whether the expense for producing the extra forage was greater than the expense of buying the concentrates or vice versa. This question is discussed in the following chapter.

CHAPTER III

A COMPARISON OF REVENUE AND COSTS FOR ALTERNATIVE FORAGE SYSTEMS ON GRADE A DAIRY FARMS IN EAST TENNESSEE

I. INTRODUCTION

Cost estimates were obtained for all variable expenses, annual depreciation and repairs on buildings and equipment. The values of the land, fencing, and dairy cows were not estimated due to the lack of adequate data. Thus, the returns were referred to as returns to land, investment capital, and management.

The annual depreciation and repairs on buildings and equipment were charged as part of the total costs for each forage system, herd size, and harvesting policy. The only costs charged for the replacement heifers were the expenses incurred in raising them.

II. REVENUE

A summarization of the revenue is shown in Table VI. For each herd size, the revenue per cow was the same for each forage system and harvesting policy. With increases in herd size from thirty to sixty cows and from sixty to ninety cows, the revenue increases were assumed to be linear. Since gross revenues are assumed equal for each alternative, the system with the least costs has the greatest net revenue.

TABLE VI

ASSUMED REVENUE FOR THREE HERD SIZES ON GRADE A DAIRY FARMS IN EAST TENNESSEE, 1965

Item	Unit	Price[a]	Quantity[a]	Value
THIRTY-COW HERD				
Milk[b]	Cwt.	$ 4.60	2,844	$13,082.40
Seven-day old calves[c]	Hd.	20.00	21	420.00
Culled cows[d]	Hd.	143.00	6	858.00
Total				$14,360.40
SIXTY-COW HERD				
Milk[b]	Cwt.	$ 4.60	5,688	$26,164.80
Seven-day old calves[c]	Hd.	20.00	42	840.00
Culled cows[d]	Hd.	143.00	12	1,716.00
Total				$28,720.80
NINETY-COW HERD				
Milk[b]	Cwt.	$ 4.60	8,532	$39,247.20
Seven-day old calves[c]	Hd.	20.00	63	1,260.00
Culled cows[d]	Hd.	143.00	18	2,574.00
Total				$43,081.20

[a] See footnote at end of Table XXXVII, Appendix C.

[b] 9,480 lb. production rate with 4 per cent butterfat was assumed for each cow per year. This was the DHIA average for Tennessee in 1964.

[c] A 90 per cent calf crop was assumed with enough heifer calves kept and raised to conduct a policy for culling 20 per cent of the cows each year. The remaining calves would be sold to other dairy farmers.

[d] It was assumed that each culled cow would weigh 1,300 lbs. and bring $0.11 per lb. when sold.

III. COSTS AND RETURNS

The costs are itemized by herd size, forage system, and harvesting policy. Building and equipment costs were assumed to be the only fixed costs. The remainder of the expenses were considered as variable costs.

Costs per ton of hay and silage by harvesting policy. The cost of producing corn silage and hiring the silage custom harvested was $5.27 per ton for all acreages in this study. The custom rate of $2.25 per ton for harvesting corn silage included cutting the silage, hauling it and putting it in the silo. The farmer furnished labor for packing the silage in the silo and for applying preservatives where needed.

The cost of producing alfalfa-orchard grass hay and hiring the hay custom harvested was assumed to be $21.16 per ton for all acreages in this study. It was assumed that the farmer would mow, haul, and store the hay. The conditioning, raking, and baling of the hay would be done by the custom operator.

The per ton costs of producing hay and silage, where ownership of all harvesting machinery was assumed, are listed in Table VII. Using the assumed yields per acre, approximately 24 acres of corn silage and 50 acres of alfalfa-orchard grass hay were necessary to make ownership of the harvesting machinery profitable. At different yields per acre, the acreage required would change. This would necessitate using a tonnage basis for decision making. An operator would have to harvest at least 360 tons of silage annually to justify owning a one-row silage chopper,

TABLE VII

THE PER TON COSTS OF PRODUCING EACH FORAGE BY FORAGE SYSTEM, ACREAGE AND HERD SIZE WHERE THE OPERATOR OWNS ALL HARVESTING MACHINERY FOR THREE SYSTEMS ON GRADE A DAIRIES IN EAST TENNESSEE, 1965

Forage System	Forage	Quantity of Forage (Acres)	Herd Size (Head)	Cost Per Ton	Difference[a] in Cost
C	corn silage	12	30	$ 6.27	$ +1.00
A	corn silage	17	30	5.71	+ .44
C	corn silage	24	60	5.13	- .14
A	corn silage	34	60	4.85	- .42
C	corn silage	36	90	4.78	- .49
A	corn silage	50	90	4.57	- .70
C	alf.-orc. gr. hay	16	30	25.48	+4.36
B	alf.-orc. gr. hay	20	30	24.13	+2.97
C	alf.-orc. gr. hay	32	60	22.24	+1.08
B	alf.-orc. gr. hay	40	60	21.59	+ .43
C	alf.-orc. gr. hay	47	90	21.21	+ .05
B	alf.-orc. gr. hay	59	90	20.70	- .46

[a]This is the difference in costs per ton where the operator owns all harvesting machinery rather than hiring the crops custom harvested. The plus sign signifies that the cost of owning all harvesting machinery is greater per ton than hiring the crop custom harvested and the minus sign indicates the cost is less per ton.

a silage blower, and silage unloading equipment. Approximately 150 tons of hay would have to be harvested annually to economically justify ownership of a hay baler, a rake, and a hay conditioner.

In the corn silage forage system, the hay acreage was so small that it was considered impractical to own hay harvesting machinery. Also, as shown in Tables VIII through X, it was assumed that the hay conditioner was used for only three of the four cuttings of hay. This assumption was made because drying conditions are sufficiently favorable for the August cutting of hay to eliminate use of the conditioner.

Costs by alternative forage systems. The factors causing differences in costs between forage systems (itemized in Tables VIII through X) were: (1) concentrates; (2) acreage required for corn silage and/or alfalfa-orchard grass hay; (3) tractor hours; (4) hired machinery; (5) custom harvesting; (6) electricity; (7) equipment; (8) buildings, and (9) labor. Concentrates and labor caused the major differences in costs. The entire amounts of each required were assumed to be purchased. Even though the farm operator furnished most of the labor, an opportunity cost was assumed for his labor, so a charge of $1.25 per hour was included for all labor. Therefore, the net returns are computed as returns to land, investment capital, and management.

Forage system B had the highest costs for each herd size and harvesting policy. This system required less of the factors listed in the above paragraph, with the exception of concentrates, than did either of the other two systems. The extra concentrates, required for forage

TABLE VIII

A COMPARISON OF COSTS FOR THE THIRTY-COW HERD SIZE ON GRADE A DAIRIES IN EAST TENNESSEE USING THREE FORAGE SYSTEMS AND TWO HARVESTING POLICIES, 1965

Expense Item[a]	Harvesting Policy and Forage System					
	Custom Harvest			Own All Machinery		
	A Value	B Value	C Value	A Value	B Value	C Value
Corn	$1,098	$2,421	$1,098	$1,098	$2,421	$1,098
Soybean oil meal, 44%	549	--	--	549	--	--
Molasses, cane	--	231	--	--	231	--
Salt	12	12	12	12	12	12
Corn silage (var.exp.)[b]	419	--	296	419	--	296
Alfalfa-orch. gr. hay (var. exp.)[b]	140	466	373	140	466	373
Permanent pasture (var. exp.)[b]	590	590	590	590	590	590
Milk replacer[c]	51	51	51	51	51	51
Breeding fees	180	180	180	180	180	180
DHIA testing	197	197	197	197	197	197
Milk hauling	626	626	626	626	626	626
Veterinary fees & drugs	163	163	163	163	163	163
Dairy supplies	120	120	120	120	120	120
Bedding	720	720	720	720	720	720
Electricity	145	120	145	145	120	145
Tractor: gas, etc.	173	163	182	198	256	274
Hired tractor (fill silo)	--	--	--	102	--	72
Hired silage wagon (fill silo)	--	--	--	38	--	27
Harvest silage (custom)	612	--	432	--	--	--
Harvest hay (custom)	137	456	365	137	--	--
Truck: gas, etc.	160	160	160	200	200	200
Baling twine	--	--	--	--	40	32
Marketing fees[d]	38	38	38	38	38	38
Equipment cost[e]	1,149	1,149	1,149	1,492	1,460	1,805
Building cost[e]	811	623	835	811	623	835
Labor	3,661	3,570	3,726	3,880	3,775	4,034
Total Expenses =	$11,751	$12,056	$11,458	$11,906	$12,289	$11,888

[a]The prices used are shown in Appendix C, Table XXXVII.

[b]Variable costs of crop production, Appendix C, Table XXXVIII.

[c]Assumed to be fed for 60 days.

[d]Three per cent of gross value of culled cows, calves marketed.

[e]See Appendix A, Tables XXI through XXXII, for assumed needs and annual cost.

TABLE IX

A COMPARISON OF COSTS FOR THE SIXTY-COW HERD SIZE ON GRADE A DAIRIES IN EAST TENNESSEE USING THREE FORAGE SYSTEMS AND TWO HARVESTING POLICIES, 1965

Expense Item[a]	Harvesting Policy and Forage System					
	Custom Harvest			Own All Machinery		
	A	B	C	A	B	C
	Value	Value	Value	Value	Value	Value
Corn	$2,195	$4,841	$2,194	$2,195	$4,841	$2,194
Soybean oil meal, 44%	1,098	--	--	1,098	--	--
Molasses, cane	--	461	--	--	461	--
Salt	24	24	24	24	24	24
Corn silage (var.exp.)[b]	838	--	591	838	--	591
Alfalfa-orch. gr. hay (var. exp.)[b]	257	933	746	257	933	746
Permanent pasture (var. exp.)[b]	1,180	1,180	1,180	1,180	1,180	1,180
Milk replacer[c]	102	102	102	102	102	102
Breeding fees	360	360	360	360	360	360
DHIA testing	328	328	328	328	328	328
Milk hauling	1,251	1,251	1,251	1,251	1,251	1,251
Veterinary fees & drugs	300	300	300	300	300	300
Dairy supplies	240	240	240	240	240	240
Bedding	1,440	1,440	1,440	1,440	1,440	1,440
Electricity	215	190	215	215	190	215
Tractor: gas, etc.	352	333	371	454	519	592
Hired silage wagon (fill silo)	--	--	--	77	--	54
Harvest silage (custom)	1,224	--	864	--	--	--
Harvest hay (custom)	251	912	730	251	--	--
Truck: gas, etc.	250	250	250	300	300	300
Baling twine	--	--	--	--	80	64
Marketing fees[d]	77	77	77	77	77	77
Equipment cost[e]	1,705	1,705	1,705	2,048	2,015	2,358
Building cost[e]	1,413	1,100	1,468	1,413	1,100	1,468
Labor	5,895	5,643	6,026	6,316	5,990	6,613
Total Expenses =	$20,995	$21,166	$20,462	$20,764	$21,731	$20,497

[a,b,c,d,e] Same as in Table VIII.

TABLE X

A COMPARISON OF COSTS FOR THE NINETY-COW HERD SIZE ON GRADE A DAIRIES IN EAST TENNESSEE USING THREE FORAGE SYSTEMS AND TWO HARVESTING POLICIES, 1965

Expense Item[a]	Harvesting Policy and Forage System					
	Custom Harvest			Own All Machinery		
	A Value	B Value	C Value	A Value	B Value	C Value
Corn	$3,293	$7,264	$3,293	$3,293	$7,264	$3,293
Soybean oil meal, 44%	1,647	--	--	1,647	--	--
Molasses, cane	--	692	--	--	692	--
Salt	36	36	36	36	36	36
Corn silage (var.exp.)[b]	1,233	--	887	1,233	--	887
Alfalfa-orch. gr. hay (var. exp.)[b]	373	1,376	1,096	373	1,376	1,096
Permanent pasture (var. exp.)[b]	1,770	1,770	1,770	1,770	1,770	1,770
Milk replacer[c]	153	153	153	153	153	153
Breeding fees	540	540	540	540	540	540
DHIA testing	419	419	419	419	419	419
Milk hauling	1,877	1,877	1,877	1,877	1,877	1,877
Veterinary fees & drugs	450	450	450	450	450	450
Dairy supplies	360	360	360	360	360	360
Bedding	2,160	2,160	2,160	2,160	2,160	2,160
Electricity	300	270	300	300	270	300
Tractor: gas, etc.	521	490	552	671	769	878
Harvest silage (custom)	1,800	--	1,296	--	--	--
Harvest hay (custom)	365	1,346	1,072	365	--	--
Truck: gas, etc.	360	360	360	420	420	420
Baling twine	--	--	--	--	108	94
Marketing fees[d]	115	115	115	115	115	115
Equipment cost[e]	2,284	2,319	2,318	2,628	2,629	3,020
Building cost[e]	1,950	1,527	1,983	1,950	1,527	1,983
Labor	8,198	7,955	8,406	8,778	8,461	9,216
Total Expenses =	$30,204	$31,479	$29,443	$29,538	$31,396	$29,067

[a,b,c,d,e] Same as in Table VIII.

system B, cost more than was saved on the reduced requirements for the other factors.

Forage system C had the lowest costs for each herd size and harvesting policy. The differences in concentrate requirements also caused this difference in costs. The requirements for each of the above listed factors, with the exception of concentrates, were higher for forage system C than for either of the other two forage systems. But, the difference in the costs of the concentrates was greater than the differences in the costs of other factors.

The feed costs per hundred weight of milk produced are shown in Figure 2. The most profitable harvesting alternative was used in each cost estimation.

Returns to land, investment capital, and management. Since the revenue was assumed (1) to be the same for each forage system and harvesting policy for a given herd size, and (2) to increase at a linear rate with increases in herd size, then the forage systems and harvesting policies having the lowest costs also had the highest net returns. Thus, forage system C had the highest net returns for each herd size and harvesting policy, whereas, forage system B had the lowest net returns for each herd size and harvesting policy. These results would not change even if a 6 per cent interest charge was included for the investment capital required.

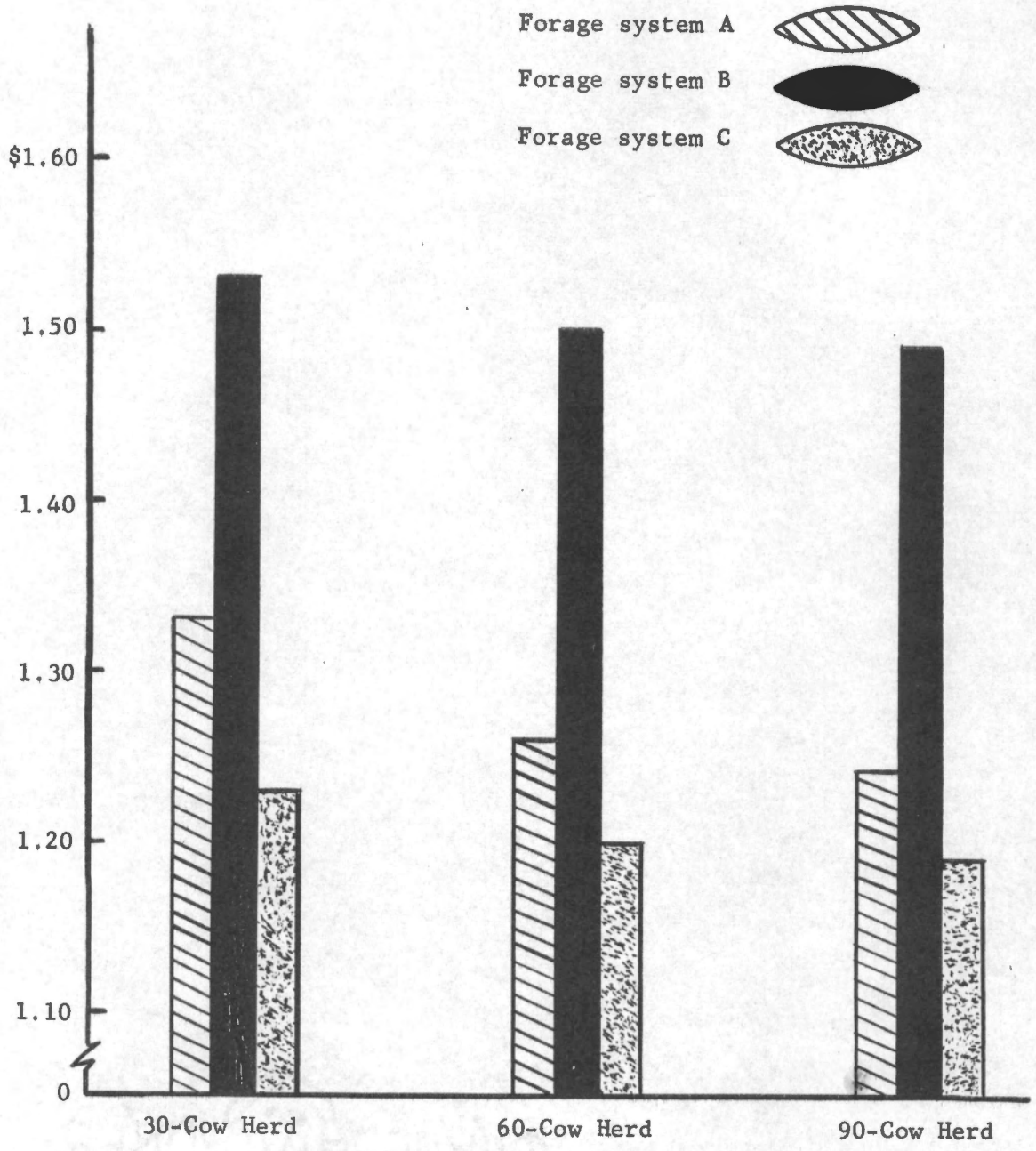


FIGURE 2

THE TOTAL FEED COST PER HUNDREDWEIGHT OF MILK PRODUCED FOR THREE FORAGE SYSTEMS, USING THE LEAST COST HARVESTING POLICIES AND ASSUMING A 9,400 POUND PER COW MILK PRODUCTION LEVEL, ON GRADE A DAIRY FARMS IN EAST TENNESSEE, 1965

IV. SUMMARY

When the ration was balanced with either corn silage or alfalfa-orchard grass hay as the sole forage fed, purchase of the extra concentrates needed was more expensive than the cost of growing a mixture of the two forages where a greater tonnage was required but less concentrates were fed. Yet, where a mixture of corn silage and alfalfa-orchard grass hay was fed, the requirements for labor, land, and investment capital increased. And, the alternative of growing the concentrates, as well as the forages, on the home farm should be considered. If restrictions were placed upon the quantities of land and labor resources used, forage systems A and B could prove to be more profitable than forage system C. Also, there is the possibility that an entirely different feeding system could prove to be more profitable than either of the systems reported thus far in this study. Therefore, as a second phase of this study, the linear programming, farm planning technique was used to find a least cost ration for grade A dairy herds in East Tennessee using specified resource situations and production levels. The following chapter reports the findings of this phase of the study.

CHAPTER IV

LEAST COST COMBINATIONS OF FEED RATIONS FOR GRADE A DAIRY HERDS IN EAST TENNESSEE USING VARIOUS RESOURCE SITUATIONS

I. INTRODUCTION

Using the techniques of budgeting and linear programming, least cost feed rations were determined for grade A dairy cows in East Tennessee. Consideration was given to changes in milk production level and herd size, hired seasonal labor availability, and the inclusion of a tobacco enterprise. All other resources in the model were set at specified levels and were assumed to have the same use and input-output coefficients throughout the study.

The grade A dairy model was considered on an entire farm basis. It was assumed that the entire farming operation would be built around the dairying enterprise with the cropland used primarily for producing feed for the dairy herd. However, the opportunity to sell feed produced on the farm was included as an alternative activity. Also, the opportunity to buy feeds was included in the programming model. The only cash crops grown were soybeans and tobacco. A list of prices for all resources and products used in this analysis are listed in Appendix C, Table XXXVII.

II. RESOURCE SITUATION

The resource situation was designed to represent the medium size grade A dairy farms in East Tennessee with milk production per cow at

levels of 9,000, 11,000, and 13,000 pounds per year. Herd size was set at sixty cows, increased to seventy cows, and decreased to fifty cows to show the effects of resource limitations on the optimal feed rations.

Cropland and soil group assumptions. A typical medium size grade A dairy farm in East Tennessee consists of approximately 150 acres of open cropland.[1] This open cropland is composed of several different soil groups and land use patterns. For this study, the total soil groups and land uses were divided into five classifications. They are as follows:[2]

Soil I - Level to undulating, high in water-supplying capacity, well-drained, no erosion evident and 0 to 5 per cent slope.

Soil II - Level to undulating, medium to high in water-supplying capacity, not well-drained or subject to overflow, no erosion evident and 0 to 3 per cent slope.

Soil III - Level to undulating, medium in water-supplying capacity, well-drained, eroded phase and 5 to 12 per cent slope.

Soil IV - Level to undulating, low to medium in water-supplying capacity, eroded phase and 12 to 25 per cent slope or severely eroded phase and 5 to 12 per cent slope.

Soil V - Rolling to hilly, low to medium in water-supplying capacity, eroded phase and 25 to 60 per cent slope or severely eroded phase and 12 to 25 per cent slope.

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[1]Thomas Little, "An Economic Analysis of Alternative Replacement Policies on Grade A Dairy Farms in the Knoxville Milkshed," unpublished Master's thesis, The University of Tennessee, Knoxville, 1964, p. 19.

[2]W. P. Ranney, Expected Returns from Selected Specialized Farming Systems in the Northern Highland Rim Area of Tennessee, Agricultural Experiment Station Bulletin No. 357, The University of Tennessee, Knoxville, 1963, p. 45.

The percentage of the total open cropland in each soil group was derived from two grade A dairy farms considered to be representative of the East Tennessee area. Farm "A" was located in Bradley County and Farm "B" in Marion County.[3] The percentage of land in each soil group was estimated through use of the Soil Survey by the United States Department of Agriculture for each of these counties.[4]

An average of the two farms showed that their total open cropland consisted of: 12 per cent Soil I, 12 per cent Soil II, 36 per cent Soil III, 20 per cent Soil IV, and 20 per cent Soil V. By relating these to the 150 acres of open cropland restriction, the acreages for each soil group would be: Soil I = 18 acres; Soil II = 18 acres; Soil III = 54 acres; Soil IV = 30 acres, and Soil V = 30 acres. The acreage in each soil group was held constant at these levels throughout the study.

Crop enterprises considered and their assumed yields. The crops considered for this analysis and their yields are listed in Table XI. Although it was assumed that all the grain, straw, and hay produced could be sold, Burley tobacco and soybeans were the only cash crops included in the model.

The average Burley tobacco allotment on medium size grade A dairy

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[3]Dick Wayland Smith, "Economic Levels of Forage and Grain Production on Dairy Farms in East Tennessee," unpublished Master's thesis, The University of Tennessee, Knoxville, 1956, pp. 22-24.

[4]United States Department of Agriculture, Soil Survey of Bradley and Marion Counties, Tennessee (Washington: Government Printing Office, 1961 and 1958).

TABLE XI

ASSUMED CROP AND PASTURE YIELDS PER ACRE, BY SOIL GROUPS FOR GRADE A DAIRIES IN EAST TENNESSEE WITH HIGH PRODUCTION RECORDS, 1965

Crop or Pasture	Unit	Soil Groups				
		I	II	III	IV	V
Corn for grain	bu.	90.0	80.0	85.0	65.0	--
Corn silage[a]	tons	16.0	14.0	15.0	12.0	--
Barley for grain)	bu.	50.0	--	45.0	35.0	30.0
barley straw) double	tons	1.0	--	0.8	0.7	0.6
lespedeza hay) crop	tons	1.0	--	0.8	0.7	0.6
Alfalfa hay	tons	3.5	--	3.2	--	--
Ladino clover & orchard)						
grass hay)	tons	2.8	3.0	2.6	2.3	2.0
Alfalfa hay)	tons	1.5	--	1.3	--	--
& silage)	tons	5.0	--	4.6	--	--
Lespedeza hay	tons	2.0	1.8	1.6	1.4	1.2
Oats for grain)	bu.	65.0	--	60.0	50.0	45.0
oat straw) double	tons	1.2	--	1.0	0.8	0.7
lespedeza hay) crop	tons	1.0	--	0.8	0.7	0.6
Millet hay	tons	3.0	2.9	2.7	2.2	1.8
Soybeans for grain	bu.	35.0	32.0	27.0	20.0	--
Millet pasture[b]	tons	8.0	7.7	7.0	5.8	4.8
Ladino clover & orchard)						
grass pasture)	tons	7.5	8.0	7.0	6.0	5.5
Crimson clover-oats)						
pasture &)double	tons	4.8	--	4.3	3.7	2.6
lespedeza pasture)crop	tons	4.3	--	3.7	3.2	2.6
Millet silage	tons	8.3	8.0	7.4	6.1	5.0
Ladino clover & orchard)						
grass hay)	tons	1.2	1.2	1.1	0.9	0.8
& pasture)	tons	4.3	4.8	4.0	3.7	3.2
Red clover & orchard)						
grass hay)	tons	2.8	3.0	2.6	2.2	1.8
Ladino clover & orchard)						
grass silage)	tons	4.8	5.4	4.5	4.2	3.6
& pasture)	tons	3.2	3.2	2.9	2.4	2.2

Source: Unpublished data from The University of Tennessee Department of Agricultural Economics, Knoxville, 1965, and Expected Returns from Selected Specialized Farming Systems in the Northern Highland Rim Area of Tennessee, by W. P. Ranney, University of Tennessee Agricultural Experiment Station Bulletin 357, Knoxville, 1963.

[a]The silage yields allow for 7 per cent spoilage and the hay yields allow 10 per cent loss due to weather and barn shrinkage.

[b]The pasture yields allow 33.3 per cent loss of the total growth due to trampling and desiccation of the plants. The tonnage is computed on a green weight basis.

farms in East Tennessee is 1.2 acres.[5] This allotment acreage was assumed for the study. The model was first set up with tobacco as a possible enterprise and then set up without the tobacco enterprise.

Labor situation. According to a survey taken by Thomas Little in 1964, a two-man full-time labor force is typical of the medium size grade A dairy farms in East Tennessee.[6] It was assumed that each man could work a maximum of 240 hours per month or approximately 2,865 hours per year.

As in Table IV, page 18, the labor resources and requirements for the linear programming analysis were divided into eight labor periods. The months of May, June, July, and August were regarded as the months where labor would be most critical and were thereby listed as separate labor periods. In the first labor situation, it was assumed that seasonal labor could be hired at $1.25 per hour in unlimited amounts for any of these four months. In the second labor situation, it was assumed that no seasonal labor could be hired and the two full-time men would be the only labor available.

The labor requirements by periods for each crop enterprise and milk production level used in the model are shown in Table XII.

Milk production requirements and feed composition. For the purposes of estimating the total feed requirements per cow, for each production level, it was assumed that the cows producing 9,000 pounds of milk

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[5]Little, loc. cit. [6]Ibid.

TABLE XII

HOURS OF LABOR REQUIRED PER ACRE AND COW BY SOIL GROUP AND PRODUCTION LEVEL FOR EACH LABOR PERIOD ON GRADE A DAIRIES IN EAST TENNESSEE, 1965

Enterprises by Soil Group	Labor Period by Months								Total Labor
	J-F	M-A	M	J	J	A	S-O	N-D	
	Hours per acre[a]								
SOIL GROUP I									
Soybeans	--	1.6	1.6	1.2	--	--	2.0	--	6.4
Corn for grain	--	3.9	.9	.6	--	--	2.0	--	7.4
Corn silage	--	3.9	.9	.6	--	4.8	--	--	10.2
Barley gn., les. hay	.5	.5	--	3.6	--	1.9	3.4	--	9.9
Oats gn., les. hay	.5	.5	--	3.9	--	1.9	3.4	--	10.2
Alfalfa hay	.5	--	2.5	2.7	.4	2.1	1.8	--	10.0
Alfalfa hay & silage	.5	--	1.2	1.1	.4	2.1	1.8	--	7.1
Millet pasture	--	1.6	2.2	.3	--	--	--	--	4.1
Millet hay	--	1.6	2.2	3.3	--	3.0	--	--	10.4
Millet silage	--	1.6	2.2	1.6	--	1.2	--	--	6.6
Cr. c.-oats & l. p.	.5	.5	--	--	--	--	3.1	--	4.1
Burley tobacco	16.5	4.5	30.4	18.2	14.7	99.4	6.0	157.0	346.7
SOIL GROUP II									
Soybeans	--	1.6	1.6	1.2	--	--	2.0	--	6.4
Corn for grain	--	3.9	.9	.6	--	--	2.0	--	7.4
Corn for silage	--	3.9	.0	.6	--	4.8	--	--	10.2
Lespedeza hay	.5	1.0	--	.6	--	3.0	--	--	5.1
Millet pasture	--	1.6	2.2	.3	--	--	--	--	4.1
Millet hay	--	1.6	2.2	3.3	--	2.8	--	--	9.9
Millet silage	--	1.6	2.2	1.5	--	1.2	--	--	6.5
Lad.cl.-orc.gr. hay	.5	--	3.6	--	.7	2.4	.5	--	7.7
Lad.cl.-orc.gr. past.	.4	--	--	.6	.7	1.3	.5	--	3.5
Lad.cl.-orc.gr. hay and past.	.4	--	2.5	--	.7	1.3	.5	--	5.4
Lad.cl.-orc.gr. sil. and past.	.4	--	1.6	--	.7	1.3	.5	--	4.5
Red cl.-or.gr. hay	.3	.8	4.0	--	--	3.0	--	--	8.1
SOIL GROUP III									
Soybeans	--	1.6	1.6	1.2	--	--	2.0	--	6.4
Corn for grain	--	3.9	.9	.6	--	--	2.0	--	7.4
Corn silage	--	3.9	.9	.6	--	4.8	--	--	10.2
Barley gn., les. hay	.5	.5	--	3.3	--	1.6	3.4	--	9.3
Oats gn., les. hay	.5	.5	--	3.6	--	1.6	3.4	--	9.6
Alfalfa hay	.5	--	2.4	2.5	.4	2.0	1.7	--	9.5
Alfalfa hay & silage	.5	--	1.0	.9	.5	2.0	1.7	--	6.6
Lespedeza hay	.5	1.0	--	.6	--	2.7	--	--	4.8
Millet pasture	--	1.6	2.2	.3	--	--	--	--	4.1

TABLE XII (continued)

Enterprises by Soil Group	Labor Period by Months J-F	M-A	M	J	J	A	S-O	N-D	Total Labor
SOIL GROUP III (cont.)	Hours per acre[a]								
Millet hay	--	1.6	2.2	3.1	--	2.7	--	--	9.6
Millet silage	--	1.6	2.2	1.4	--	1.1	--	--	6.3
Lad.cl.-or.gr. hay	.5	--	3.3	--	.7	2.0	.5	--	7.0
Lad.cl.or.gr. past.	.4	--	--	.6	.7	1.3	.5	--	3.5
Lad.cl.-or.gr. hay and past.	.4	--	2.3	--	.7	1.3	.5	--	5.2
Lad.cl.-or.gr. sil. and past.	.4	--	1.4	--	.7	1.3	.5	--	4.3
Cr. cl.-oats & l. p.	.5	.5	--	--	--	--	3.1	--	4.1
Red. cl.-or.gr. hay	.3	.8	3.6	--	--	2.8	--	--	7.5
Burley tobacco	16.5	4.5	30.4	18.2	14.7	99.4	6.0	157.0	346.7
SOIL GROUP IV									
Barley gn. & les. hay	.5	.5	--	3.2	--	1.4	3.4	--	9.0
Oats gn. & les. hay	.5	.5	--	3.4	--	1.4	3.4	--	9.2
Millet pasture	--	1.6	2.2	.3	--	--	--	--	4.1
Millet hay	--	1.6	2.2	3.0	--	2.0	--	--	8.8
Millet silage	--	1.6	2.2	1.4	--	1.1	--	--	6.4
Cr. cl.-oats & l. p.	.5	.5	--	--	--	--	3.1	--	4.1
Red cl.-or.gr. hay	.3	.8	3.3	--	--	2.5	--	--	6.9
Lad. cl.-or.gr. hay	.5	--	3.1	--	.7	1.8	1.5	--	7.6
Lad. cl.-or.gr. past.	.4	--	--	.6	.7	1.3	.5	--	3.5
Lad. cl.-or.gr. hay and past.	.4	--	2.1	--	.7	1.3	.5	--	5.0
Lad. cl.-or.gr. sil. and past.	.4	--	1.3	--	.7	1.3	.5	--	4.2
Lespedeza hay	.5	1.0	--	.6	--	2.4	--	--	4.5
SOIL GROUP V									
Barley gn. & les. hay	.5	.5	--	3.0	--	1.3	3.4	--	8.7
Oats gn. & les. hay	.5	.5	--	3.2	--	1.3	3.4	--	8.9
Lespedeza hay	.5	1.0	--	.6	--	2.1	--	--	4.2
Red cl.-or.gr. hay	.3	.8	2.9	--	--	2.3	--	--	6.3
Lad.cl.-or.gr. hay	.5	--	2.8	--	.7	1.6	.5	--	6.1
Lad.cl.-or.gr. past.	.4	--	--	.6	.7	1.3	.5	--	3.5
Lad.cl.-or.gr. hay and past.	.4	--	1.9	--	.7	1.3	.5	--	4.8
Lad.cl.-or.gr. sil. and past.	.4	--	1.1	--	.7	1.3	.5	--	4.0
Annual Milk production Per Cow	Hours per cow								
9,000 lbs.(4% BFCM)	10.8	8.9	4.3	4.3	4.3	4.3	8.9	11.1	56.9
11,000 lbs.(4% BFCM)	11.3	9.4	4.6	4.6	4.6	4.6	9.4	11.6	60.1
13,000 lbs.(4% BFCM)	11.8	9.9	4.8	4.8	4.8	4.8	9.9	12.1	62.9

[a]For the source, see footnotes in Tables XI and XXXIV.

would weigh 1,200 pounds, those producing 11,000 pounds would weigh 1,450 pounds and those producing 13,000 pounds would weigh 1,700 pounds.[7] The estimated annual nutrient and bedding requirements per cow are listed in Table XIII. Also, all feeds considered in the linear programming model and their estimated composition are shown in Table XIII.

III. THE ESTIMATED VARIABLE AND FIXED EXPENSES

The variable expenses are those expenses which vary with the amount of production and production factors used. These expenses include the cost of items such as seed, fertilizer, gasoline, grease, oil, and hired labor.

The fixed expenses are those expenses which, regardless of production, are constant for the production period. These expenses are computed as annual depreciation on buildings, equipment and livestock and annual repairs to the buildings and equipment. The total costs for repairs and depreciation assumed for each unit of enterprise are shown in Table XIV. These estimated expenses are based upon the proportion a unit of the enterprise is of the total annual use capacity of the machine or building.

In the model, the variable expenses were charged against each individual enterprise. A 6 per cent interest charge was made against each individual enterprise for the total fixed expenses the enterprise

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[7] "Milk production is more nearly proportional to the .75 power of the live weight." Source: Kleiher and Mead, Cal., Journal of Dairy Science, Volume 28, 1945, pp. 49-55.

TABLE XIII

TOTAL FEED AND BEDDING REQUIREMENTS PER COW FOR EACH PRODUCTION LEVEL AND THE COMPOSITION OF FEEDS USED ON GRADE A DAIRIES IN EAST TENNESSEE, 1965

Nutrient Required[a]	Unit	Milk Production Level Per Cow		
		9,000	11,000	13,000
Total digestible nutrients (TDN)	lbs.	6,405	7,474	8,578
Digestible protein (DP)	lbs.	775	914	1,073
Energy	therms	5,542	6,401	7,458
Bedding (straw)[b]	lbs.	2,000	2,000	2,000
Minimum amount of alfalfa hay	lbs.	800	1,100	1,400

Feed Used[a]	Consumption[c]		
	TDN	DP	Energy
Corn, dent, grade no. 1	80.1	6.7	80.1
Corn silage, dent, well eared	19.8	1.3	15.2
Barley, common, not incl. Pacific St.	77.7	10.0	80.1
Lespedeza hay, before bloom, annual	46.4	6.4	36.5
Alfalfa hay, all analyses	50.7	10.9	40.6
Ladino clover-orchard grass hay	57.4	11.3	45.9
Alfalfa silage, wilted	21.5	4.3	17.6
Oats, not incl. Pacific coast states	70.1	9.4	72.1
Millet hay, pearl or cat-tail	49.8	4.2	37.4
Millet pasture, pearl or cat-tail	12.8	1.3	12.2
Ladino clover-orchard grass pasture	14.2	3.3	12.5
Crimson clover-oats pasture	13.4	2.4	9.0
Millet silage, wilted	19.9	1.7	15.0
Lespedeza pasture, annual, before bloom	14.2	2.0	12.4
Red clover-orchard grass hay	52.2	6.1	39.8
Ladino clover-orchard grass silage	21.4	3.9	18.2
Soybean oil meal, 44% protein	78.0	42.0	79.6

[a]The Feed requirements and the composition of feeds were adapted from: Feeds and Feeding, by F. B. Morrison and Associates. Twenty-second edition; Clinton Iowa: Morrison Publishing Company, 1959.

[b]Bedding requirements were adapted from: Expected Returns from Selected Specialized Farming Systems in the Northern Highland Rim Area of Tennessee, by W. P. Ranney, Tennessee Agricultural Experiment Station Bulletin 357, January, 1963, p. 55.

[c]The figures for TDN and DP are the percentages per pound of dry feed. The figures for energy are the therms of energy per pound of dry feed.

TABLE XIV

TOTAL VARIABLE AND FIXED EXPENSES ASSUMED PER ACRE AND PER COW FOR MEDIUM SIZE GRADE A DAIRIES IN EAST TENNESSEE, 1965

Enterprise	Soil Group I		II		III		IV		V	
	Var.	Fixed	Var.	Fixed	Var.	Fixed	Var.	Fixed	Var.	Fixed
	$ Per Acre									
Corn for grain	$ 45	$ 14[a]	$ 42	$ 13	$ 44	$ 14	$ --[b]	$ --	$ --	$ --
Corn silage	74	9	67	9	71	9	--	--	--	--
Soybeans	20	7	20	7	20	7	--	--	--	--
Barley gr. & lesp. hay	45	13	--	--	41	12	36	10	32	9
Oats gr. & lesp. hay	46	15	--	--	42	14	37	12	33	11
Alfalfa hay	56	10	--	--	52	9	--	--	--	--
Alfalfa hay & silage	51	7	--	--	47	6	--	--	--	--
Lespedeza hay	--	--	20	5	17	5	16	4	14	4
Millet pasture	19	3	19	3	18	3	16	3	--	--
Millet hay	41	10	41	9	38	9	33	8	--	--
Millet silage	38	6	37	6	25	5	30	5	--	--
Cr.cl.-oats & lesp. past.	33	3	--	--	31	3	29	3	--	--
Red.cl.-or.gr. hay	--	--	37	8	34	7	28	7	27	6
Lad.cl.-or.gr. hay	--	--	46	8	41	7	37	7	32	6
Lad.cl.-or.gr. past.	--	--	24	3	22	3	20	3	16	3
Lad.cl.-or.gr. hay & past.	--	--	31	5	29	5	26	5	21	5
Lad.cl.-or.gr. sil. & past.	--	--	36	4	32	4	30	4	24	4
Burley tobacco	228	54	--	--	225	54	--	--	--	--
	Milk Production Level Per Cow									
	9,000				11,000				13,000	
Total Expenses Per Cow =	49	87			53	97			58	107

[a]The assumed costs per unit of use are shown in Appendix A, Table XXXIII.

[b]The dashes indicate that the crop or pasture is not considered practical for this particular soil.

required. The total fixed expenses were charged against the entire operation when the net returns to land, labor, investment capital, and management were computed.

The total variable and fixed expenses for each enterprise are shown in Table XIV.

IV. THE RESULTS

In this study, three milk production levels and three herd sizes were used. Each milk production level and herd size was programmed with and without the opportunity to hire seasonal labor for the months of May, June, July, and August. These situations were then compared with and without a tobacco enterprise. First, herd size was alloted to a maximum of sixty cows and each of the milk production levels were programmed for each of the seasonal labor and tobacco enterprise alternatives. Second, maximum herd size was increased to seventy cows and each of the resource situations contrasted on the same basis as above in order to compare the differences encountered with an increase in herd size. Third, herd size was decreased to a maximum of fifty cows and the differences caused by a decrease in herd size were measured.

The optimum solution for each herd size, milk production level, and seasonal labor and tobacco enterprise alternative yielded a least cost feed ration per cow. When the assumption was made that no tobacco enterprise was present, the optimum solutions differed very little from those where tobacco was assumed as a possible enterprise. For this reason, the least cost combinations of activities, assuming no tobacco

enterprise, are shown in Appendix D, Tables XXXIX through XLI. Each of the least cost combinations of activities, assuming a tobacco enterprise, and all of the least cost feed rations are presented by individual herd sizes and the essential differences are discussed in the following pages.

Sixty-cow herd size. The least cost combinations of activities, when maximum herd size was alloted to sixty cows, is shown in Table XV. The least cost feed rations per cow are shown in Table XVI.

As milk production per cow increased, each feed ration required more concentrates. Where seasonal labor was available, barley was purchased to furnish these concentrate requirements. Without seasonal labor, the extra concentrates were furnished by additional corn acreage harvested for grain and by the purchase of corn. The additional corn acreage replaced the acreage used for soybeans as a cash crop. The ladino clover-orchard grass silage and pasture acreage also increased as milk production increased. In both labor situations, oats for grain double cropped with lespedeza hay and, in the situation assuming no seasonal labor, millet silage were replaced by the ladino clover-orchard grass silage and pasture.

High acreages of corn silage came into the optimum solutions where hiring of seasonal labor was assumed to be unlimited. When seasonal labor was not available, corn silage was replaced by millet silage, corn for grain acreage replaced corn silage acreage, and oats for grain double cropped with lespedeza hay increased at the lower milk production levels.

TABLE XV

A LEAST COST COMBINATION OF ACTIVITIES FOR ALTERNATIVE PRODUCTION LEVELS AND LABOR SUPPLIES ON EAST TENNESSEE GRADE A DAIRY FARMS CONSISTING OF 150 ACRES OF OPEN CROPLAND AND A SIXTY-COW HERD SIZE WITH A TOBACCO ENTERPRISE, 1965

Activity	Soil Group	Unit	Milk Production Per Cow in Pounds (4% BFC)					
			With Seasonal Labor			Without Seasonal Labor		
			9,000	11,000	13,000	9,000	11,000	13,000
Soybeans for grain	II	acre	5.7	--	--	10.8	--	--
Corn for grain	I	acre	--	--	--	17.0	17.2	17.4
Corn for grain	II	acre	12.3	18.0	18.0	7.1	18.0	18.0
Corn for grain	III	acre	15.0	9.3	8.3	21.0	21.0	21.0
Corn silage	I	acre	16.8	16.8	16.8	--	--	--
Corn silage	III	acre	6.0	11.7	12.7	--	--	--
Alfalfa hay	III	acre	15.0	14.6	11.8	7.5	10.3	13.1
Alfalfa hay & silage	III	acre	--	0.4	3.1	--	--	--
Oats (grain) & lesp. hay	III	acre	18.0	18.0	18.0	--	0.7	10.3
Oats (grain) & lesp. hay	IV	acre	8.1	--	--	--	--	--
Oats (grain) & lesp. hay	V	acre	--	--	--	17.0	14.1	3.0
Millet silage	III	acre	--	--	--	25.5	22.0	9.6
Millet silage	IV	acre	--	--	--	4.2	--	--
Lad.cl.-or.gr. sil. & p.	IV	acre	21.9	30.0	30.0	25.8	30.0	30.0
Lad.cl.-or.gr. sil. & p.	V	acre	30.0	30.0	30.0	13.0	15.9	27.0
Bor. annual invest. cap.	-	$	6,575.5	7,125.7	7,721.1	6,528.9	7,185.3	7,792.5
Hire August labor	-	hr.	146.4	188.0	207.7	--	--	--
Sell oats	-	bu.	1,483.6	1,080.0	1,080.0	763.7	675.5	752.9
Sell alfalfa hay	-	ton	24.0	14.2	--	--	--	--
Sell lespedeza hay	-	ton	20.1	14.4	13.5	--	--	--
Buy straw	-	ton	35.5	42.0	42.0	48.1	49.4	47.6
Buy corn	-	bu.	--	--	--	--	457.6	1,994.6
Buy barley	-	bu.	--	47.1	1,353.9	--	--	--
Burley tobacco	I	acre	1.2	1.2	1.2	1.0	0.8	0.6
Net Returns to Land, Labor, Investment. Cap. & Mgt.	=		$14,641	$17,363	$20,962	$13,852	$16,140	$19,579

TABLE XVI

LEAST COST FEED RATIONS PER COW FOR ALTERNATIVE PRODUCTION LEVELS, LABOR SUPPLIES AND CROP ENTERPRISES ON EAST TENNESSEE GRADE A DAIRY FARMS CONSISTING OF 150 ACRES OF CROPLAND AND A SIXTY-COW HERD SIZE, 1965

Feed Per Cow	Unit	Milk Production Per Cow in Pounds (4% BFC)					
		With Seasonal Labor			Without Seasonal Labor		
		9,000	11,000	13,000	9,000	11,000	13,000
WITH TOBACCO ENTERPRISE							
Corn (grain)	bu.	37.68	37.14	37.14	64.76	87.15	113.10
Barley (grain)	bu.	--	0.78	22.56	--	--	--
Corn silage	ton	5.98	7.41	7.65	--	--	--
Millet silage	ton	--	--	--	3.57	2.71	1.18
Alfalfa silage	ton	--	0.03	0.23	--	--	--
Lad.cl.-or.gr. silage	ton	3.33	3.90	3.90	2.58	3.05	3.72
Lad.cl.-or.gr. pasture	ton	1.97	2.30	2.30	1.50	1.78	2.19
Alfalfa hay	ton	0.40	0.55	0.70	0.40	0.55	0.70
Lespedeza hay	ton	--	--	0.01	0.17	0.15	0.16
WITHOUT TOBACCO ENTERPRISE							
Corn (grain)	bu.	37.67	37.83	35.16	43.33	57.37	92.21
Barley (grain)	bu.	--	--	23.31	--	--	--
Corn silage	ton	5.97	7.37	7.70	4.80	4.16	2.98
Millet silage	ton	--	--	--	--	1.16	--
Alfalfa silage	ton	--	0.05	0.24	--	--	0.01
Lad.cl.-or.gr. silage	ton	3.33	3.90	3.90	2.87	3.41	3.90
Lad.cl.-or.gr. pasture	ton	1.97	2.30	2.30	1.67	2.00	2.30
Alfalfa hay	ton	0.40	0.55	0.70	0.40	0.55	0.70
Lespedeza hay	ton	--	--	--	0.51	0.25	0.25

This forced part of the ladino clover-orchard grass silage and pasture acreage out of the optimal organization. All of the lespedeza hay produced was fed when seasonal labor could not be hired, whereas lespedeza hay was sold when seasonal labor could be hired. With the assumption of no seasonal labor, as milk production increased, less tobacco was grown and the ladino clover-orchard grass silage and pasture replaced the oats for grain and lespedeza hay acreage. Another important observation is that, when seasonal labor was available, alfalfa was grown on Soil III to the full extent of the rotation allotment set up for alfalfa and, when the amount of alfalfa hay produced exceeded the minimum alfalfa hay requirements for the dairy herd, the remaining tonnage was sold. Without seasonal labor, the alfalfa hay acreage was decreased to one-half the amount at the 9,000 pound milk production level, but steadily increased as milk production increased. This acreage was interchanged with millet silage as a result of higher digestible protein requirements per cow as milk production increased.

Tobacco competed with each of the enterprises for seasonal labor. The feed rations remained essentially the same regardless whether seasonal labor was available or not and a tobacco enterprise was present or not. But, when seasonal labor was not available and a tobacco enterprise was present, less of the tobacco allotment was produced and corn silage was replaced by corn for grain and millet silage. Without the tobacco enterprise, corn silage again was produced thereby decreasing the corn for grain acreage. Also, oats for grain double cropped with lespedeza hay

and ladino clover-orchard grass silage and pasture replaced most of the millet silage acreage.

As land and labor were the most restrictive factors, whenever one of the two was not as restrictive as before, the value of an extra unit of the other increased. For instance, the value of another unit of Soil I was approximately $66 when seasonal labor was available and decreased approximately $1 to $2 per acre when seasonal labor was not available. The value of each of the other soils varies progressively more extensively, as one goes from Soil I through V, and the value of an additional unit of Soil V decreases from $35.48 to $20.73 per acre with a decrease in the labor supply.

Labor was only restrictive for the months of May and August with August the most restrictive because of the high demand corn silage had for August labor. Whenever seasonal labor was available, corn silage was the predominant ration and was profitable enough that $1.25 could be paid for each hour of August labor hired. Without the availability of seasonal labor, the value of another hour of August labor went as high as $10.87 for the sixty-cow herd size.

Seventy-cow herd size. The least cost combination of activities and the least cost feed rations per cow are shown in Tables XVII and XVIII.

With an increase in maximum herd size from sixty to seventy cows, labor became more restrictive and land tended to be less restrictive than at the sixty-cow herd size. In each resource situation, more

TABLE XVII

A LEAST COST COMBINATION OF ACTIVITIES FOR ALTERNATIVE PRODUCTION LEVELS AND LABOR SUPPLIES ON EAST TENNESSEE GRADE A DAIRY FARMS CONSISTING OF 150 ACRES OF OPEN CROPLAND AND A SEVENTY-COW HERD SIZE WITH A TOBACCO ENTERPRISE, 1965

Activity	Soil Group	Unit	Milk Production Per Cow in Pounds (4% BFC)					
			With Seasonal Labor			Without Seasonal Labor		
			9,000	11,000	13,000	9,000	11,000	13,000
Corn for grain	I	acre	--	--	--	17.5	17.7	17.8
Corn for grain	II	acre	18.0	18.0	16.8	18.0	18.0	18.0
Corn for grain	III	acre	11.2	2.6	2.4	21.0	21.0	21.0
Corn silage	I	acre	16.9	17.1	17.3	--	--	--
Corn silage	III	acre	9.8	18.4	18.6	--	--	--
Alfalfa hay	III	acre	8.8	10.4	15.0	8.8	12.0	6.6
Alfalfa hay & silage	III	acre	--	4.1	--	--	--	8.4
Oats (grain) & lesp. hay	III	acre	24.3	18.5	16.1	8.6	16.9	5.9
Oats (grain) & lesp. hay	V	acre	--	--	--	15.1	7.5	11.7
Cr.cl.-oats & lesp. past.	III	acre	--	--	--	--	0.6	12.1
Millet silage	III	acre	--	--	--	15.6	3.5	--
Lad.cl.-or.gr. sil. & p.	II	acre	--	--	1.2	--	--	--
Lad.cl.-or.gr. sil. & p.	III	acre	--	--	1.9	--	--	--
Lad.cl.-or.gr. sil. & p.	IV	acre	30.0	30.0	30.0	30.0	30.0	30.0
Lad.cl.-or.gr. sil. & p.	V	acre	30.0	30.0	30.0	14.9	22.5	18.3
Bor. annual invest. cap.	-	$	7,424.5	8,045.1	8,725.4	7,500.8	8,224.1	8,832.9
Hire May labor	-	hr.	--	19.6	41.1	--	--	--
Hire August labor	-	hr.	198.1	238.2	236.6	--	--	--
Sell oats	-	bu.	1,483.7	1,112.2	965.3	1,199.1	1,348.7	881.6
Sell lespedeza hay	-	ton	19.8	14.8	--	--	--	--
Buy straw	-	ton	45.3	51.5	53.9	50.8	47.8	55.9
Buy corn	-	bu.	186.6	--	--	863.5	2,645.2	3,749.5
Buy barley	-	bu.	113.6	1,273.2	2,780.7	--	--	--
Buy alfalfa hay	-	ton	--	--	1.0	--	--	16.9
Burley tobacco	I	acre	1.1	0.9	0.7	0.5	0.3	0.2
Net Returns to Land, Labor, Invest. Cap. & Mgt.		=	$15,774	$18,716	$22,679	$14,381	$17,067	$21,129

TABLE XVIII

LEAST COST FEED RATIONS PER COW FOR ALTERNATIVE PRODUCTION LEVELS, LABOR SUPPLIES AND CROP ENTERPRISES ON EAST TENNESSEE GRADE A DAIRY FARMS CONSISTING OF 150 ACRES OF CROPLAND AND A SEVENTY-COW HERD SIZE, 1965

Feed Per Cow	Unit	Milk Production Per Cow in Pounds (4% BFC)					
		With Seasonal Labor			Without Seasonal Labor		
		9,000	11,000	13,000	9,000	11,000	13,000
WITH TOBACCO ENTERPRISE							
Corn (grain)	bu	36.82	23.67	22.08	80.89	106.65	122.46
Barley (grain)	bu.	1.62	18.18	39.72	--	--	--
Corn silage	ton	5.96	7.85	7.94	--	--	--
Millet silage	ton	--	--	--	1.64	0.37	--
Alfalfa silage	ton	--	0.27	--	--	--	0.55
Lad.cl.-or.gr. silage	ton	3.34	3.34	3.55	2.56	2.95	2.74
Lad.cl.-or.gr. pasture	ton	1.97	1.97	2.10	1.49	1.73	1.60
Crimson cl.-oats pasture	ton	--	--	--	--	0.03	0.74
Lespedeza pasture	ton	--	--	--	--	0.03	0.64
Alfalfa hay	ton	0.40	0.55	0.70	0.40	0.55	0.70
Lespedeza hay	ton	--	--	0.18	0.22	0.25	0.16
WITHOUT TOBACCO ENTERPRISE							
Corn (grain)	bu.	38.10	25.21	21.63	55.47	92.81	120.22
Barley (grain)	bu.	0.07	16.43	40.33	--	--	--
Corn silage	ton	5.91	7.80	7.92	2.44	1.25	0.25
Millet silage	ton	--	--	--	1.81	0.55	--
Alfalfa silage	ton	--	0.32	--	--	--	0.68
Lad.cl.-or.gr. silage	ton	3.34	3.34	3.52	2.86	3.14	3.21
Lad.cl.-or.gr. pasture	ton	1.97	1.97	2.08	1.67	1.85	1.89
Alfalfa hay	ton	0.40	0.55	0.70	0.40	0.55	0.70
Lespedeza hay	ton	--	--	0.20	0.16	0.21	0.22

concentrates per cow were fed in the feed rations for the seventy-cow herd size than for the sixty-cow herd size. A large part, in some cases as much as nearly one-half, of these concentrates were purchased. Where seasonal labor was available, barley was purchased, and without seasonal labor, corn was purchased. Also, in the two resource situations in which labor was the most restricting, crimson clover-oats pasture double cropped with lespedeza pasture was produced. This definitely indicated that labor was very restrictive.

A very interesting observation is made in regard to the tobacco enterprise. Where a tobacco enterprise was permitted to enter the optimal farm organization, the full 1.2 acres of tobacco allotment was not used in any combination of activities at the seventy-cow herd size. The November-December labor was restrictive in the cases where seasonal labor was not as the dairy cow enterprise took almost all of the November-December labor to reach the maximum herd size of seventy and the tobacco enterprise competed for the remainder. This indicated that the dairy enterprise, up to seventy-cow herd size, was more profitable than the tobacco, in terms of the value of an hour of November-December lator, and that some of the other crop enterprises could possibly utilize an hour of seasonal labor more profitably than could tobacco.

Fifty-cow herd size. The least cost combinations of activities and the least cost feed rations are shown in Tables XIX and XX. When maximum herd size was decreased to fifty cows, land became more restrictive than labor as the cash crops, such as soybeans, were grown in

TABLE XIX

A LEAST COST COMBINATION OF ACTIVITIES FOR ALTERNATIVE PRODUCTION LEVELS AND LABOR SUPPLIES ON EAST TENNESSEE GRADE A DAIRY FARMS CONSISTING OF 150 ACRES OF OPEN CROPLAND AND A FIFTY-COW HERD SIZE WITH A TOBACCO ENTERPRISE, 1965

Activity	Soil Group	Unit	Milk Production Per Cow in Pounds (4% BFC)					
			With Seasonal Labor			Without Seasonal Labor		
			9,000	11,000	13,000	9,000	11,000	13,000
Dairy cows	-	cow	50.0	50.0	50.0	50.0	50.0	50.0
Soybeans for grain	II	acre	14.6	9.6	1.0	11.3	--	4.0
Corn for grain	I	acre	--	--	--	13.9	16.6	16.8
Corn for grain	II	acre	3.4	8.4	17.0	6.7	18.0	14.0
Corn for grain	III	acre	18.6	13.9	15.3	21.0	21.0	21.0
Corn silage	I	acre	16.8	16.8	16.8	2.9	0.2	--
Corn silage	III	acre	2.4	7.1	5.7	--	--	--
Alfalfa hay	III	acre	15.0	15.0	15.0	6.3	8.6	10.9
Oats (grain) & lesp. hay	III	acre	18.0	18.0	18.0	21.9	16.2	--
Oats (grain) & lesp. hay	IV	acre	16.2	8.9	1.1	--	--	--
Oats (grain) & lesp. hay	V	acre	--	--	--	30.0	26.3	3.9
Millet silage	III	acre	--	--	--	4.8	8.2	22.1
Millet silage	IV	acre	--	--	--	2.2	--	7.5
Lad.cl.-or.gr. sil. & p.	IV	acre	13.8	21.1	28.9	27.8	30.0	22.5
Lad.cl.-or.gr. sil. & p.	V	acre	30.0	30.0	30.0	--	3.7	26.1
Bor. annual invest. cap.	-	$	5,734.3	6,191.8	6,692.8	5,919.9	6,439.9	6,642.1
Hire August labor	-	hr.	86.9	121.1	126.3	--	--	--
Sell oats	-	bu.	1,888.4	1,527.3	1,136.8	2,664.4	2,157.5	176.8
Sell alfalfa hay	-	ton	28.0	20.5	13.0	--	--	--
Sell lespedeza hay	-	ton	25.7	20.7	15.2	--	--	--
Buy straw	-	ton	19.1	24.8	31.1	7.1	15.4	47.2
Burley tobacco	I	acre	1.2	1.2	1.2	1.2	1.2	1.2
Net Returns to Land, Labor, Invest. Cap. & Mgt.	=		$13,426	$15,696	$18,714	$12,853	$14,850	$18,073

TABLE XX

LEAST COST FEED RATIONS PER COW FOR ALTERNATIVE PRODUCTION LEVELS, LABOR SUPPLIES AND CROP ENTERPRISES ON EAST TENNESSEE GRADE A DAIRY FARMS CONSISTING OF 150 ACRES OF CROPLAND AND A FIFTY-COW HERD SIZE, 1965

Feed Per Cow	Unit	Milk Production Per Cow in Pounds (4% BFC)					
		With Seasonal Labor			Without Seasonal Labor		
		9,000	11,000	13,000	9,000	11,000	13,000
WITH TOBACCO ENTERPRISE							
Corn (grain)	bu.	36.99	37.05	53.24	71.48	94.34	88.46
Corn silage	ton	6.09	7.50	7.08	0.92	0.06	--
Millet silage	ton	--	--	--	0.98	1.21	4.19
Lad.cl.-or.gr. silage	ton	3.32	3.93	4.59	2.34	2.79	3.77
Lad.cl.-or.gr. pasture	ton	1.98	2.33	2.71	1.33	1.60	2.23
Alfalfa hay	ton	0.40	0.55	0.70	0.40	0.55	0.70
Lespedeza hay	ton	--	--	--	0.71	0.57	0.04
WITHOUT TOBACCO ENTERPRISE							
Corn (grain)	bu.	36.99	37.05	53.24	36.99	37.26	54.22
Corn silage	ton	6.09	7.50	7.08	6.09	7.41	6.66
Lad.cl.-or.gr. silage	ton	3.32	3.32	4.59	3.32	3.87	4.28
Lad.cl.-or.gr. pasture	ton	1.98	1.98	2.71	1.98	2.29	2.53
Alfalfa hay	ton	0.40	0.55	0.70	0.40	0.55	0.70
Lespedeza hay	ton	--	--	--	--	0.07	0.32

larger quantities. Along with the appearance of sizable acreages of soybeans, oats for grain double cropped with lespedeza hay were grown on a much larger acreage for the fifty-cow herd size than for the sixty-cow herd size, and in every case the tobacco enterprise was permitted to enter the model, the entire allotment was grown. All lespedeza hay was sold in the resource situations where labor was not as restrictive, but was fed where labor was restrictive. In every optimum solution in the study, including the sixty- and seventy-cow herd sizes, all of the oats produced would be sold, thereby indicating that it was more profitable to sell oats and purchase corn and barley.

The most significant difference in the feed rations, when herd size was decreased from sixty to fifty cows, was the sharp decrease in the amount of concentrates fed per cow for each resource situation. Further, all of the concentrates fed were grown on the home farm and none were purchased.

V. SUMMARY

The feed costs per hundredweight of milk produced are shown in Figure III. The costs were obtained only for the assumptions that seasonal labor and a tobacco enterprise are present.

In the cases where labor was not the restricting factor, a ration consisting of corn silage, ladino clover-orchard grass silage, and pasture and the minimum amount of alfalfa hay required in the feed rations was the forage ration used. Also, as labor became less restrictive, soybeans and oats for grain double cropped with lespedeza hay

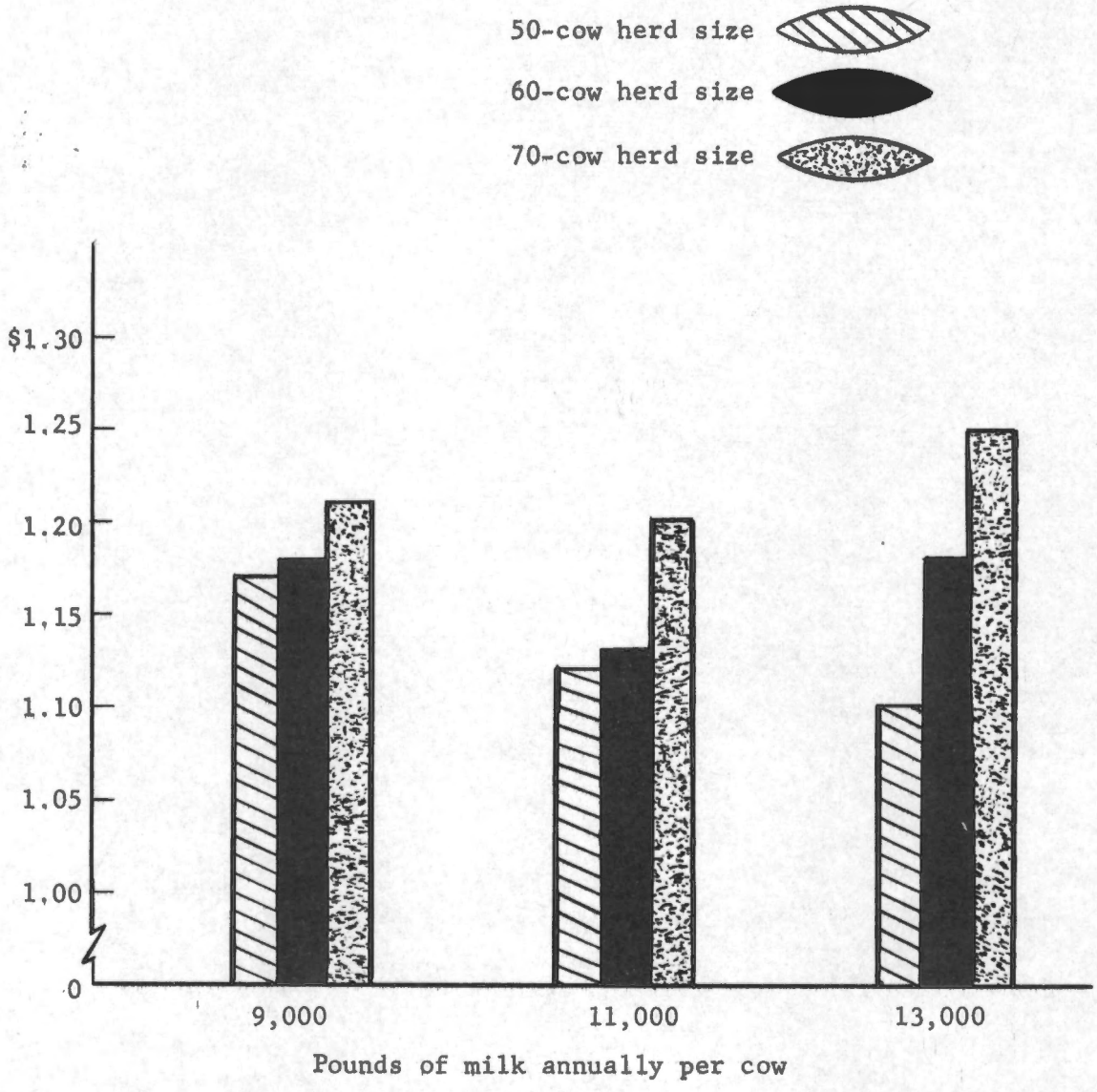


FIGURE 3

TOTAL FEED COST PER HUNDREDWEIGHT OF MILK PRODUCED, ASSUMING AVAILABILITY OF SEASONAL LABOR AND A TOBACCO ENTERPRISE, FOR THREE HERD SIZES AND THREE MILK PRODUCTION LEVELS ON GRADE A DAIRY FARMS IN EAST TENNESSEE, 1965

acreage became larger. With the exception of straw, which was used to furnish part of the bedding requirements, the soybeans, oats for grain, and lespedeza hay were used entirely as cash crops.

As labor became more restrictive in the resource situations, the corn silage, soybeans, and oats for grain double cropped with lespedeza hay acreage on Soils I, II, and III tended to be replaced by corn for grain, millet silage, and crimson clover-oats pasture double cropped with lespedeza pasture. This yielded a forage ration consisting of millet and ladino clover-orchard grass silage, crimson clover-oats, lespedeza hay and the minimum amount of alfalfa hay required in the rations. It was noted that, when seasonal labor was not available, all the lespedeza hay produced was fed instead of sold. Also, concentrates were fed in larger amounts with as much as one-half of the concentrates being purchased in the cases where labor was the most restrictive and milk production was the highest.

Pursuing the labor restrictions further, whenever labor was very restrictive, the dairy enterprise and the crop enterprises used to produce feed for the dairy herd would force the tobacco enterprise out of the optimum solutions. An hour of seasonal labor or November-December labor was worth more when applied to the dairy operations than when applied to the tobacco enterprise.

CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

The primary objective of this study was to determine the most economical forage and concentrate rations for highly productive grade A dairy herds in the East Tennessee area where the operators have alternative resource situations, machinery ownership patterns, herd sizes, and milk production levels. Also, special attention was given to resource requirements and the economies or diseconomies of scale with increases in herd size.

The techniques of budgeting and linear programming were used to obtain the objectives of this study. Three forage rations, namely, corn silage with a minimum of hay, all alfalfa-orchard grass hay and a combination of both, were evaluated to determine the resource requirements, production costs and which of the three forage rations would be the most economical if resources were unlimited. By using those feed and crop enterprises normally used and/or grown on grade A dairy farms in East Tennessee, linear programming was employed to determine the least cost feed rations for different resource situations, herd sizes, and milk production levels.

I. SUMMARY

When only considering the three forage rations named above, with the assumptions that all concentrates would be purchased and land and

labor resources were unlimited, the most economical forage ration was a mixture of corn silage and alfalfa-orchard grass hay. When the assumptions were changed to allow the alternatives of growing concentrates, purchasing them and fixing land and labor supplies, different forage rations were found to be the most economical. When seasonal labor could be hired, corn silage fed with ladino-orchard grass silage and pasture was found to be the most economical forage ration. If seasonal labor was not permitted to be hired, millet silage and lespedeza hay would substitute for corn silage in the forage rations as labor became more restrictive. Also, concentrates would be fed in heavier amounts. In each forage ration, a minimum amount of alfalfa hay was required. Only the minimum requirement of alfalfa hay was fed in all of the optimum forage rations in the linear programming solutions.

When resources were not limited, the net returns to land, investment capital and management increased from $97 per cow to $156 per cow as herd size increased from thirty to ninety cows. When limitations were assumed for land and labor, the net returns to land, labor, investment capital and management decreased from $374 per cow to $324 per cow with an increase in herd size from fifty to seventy cows. In each of the above calculations, the net returns are calculated from the most profitable resource situation for that particular herd size.

The budgeting phase of this study indicated that ownership of silage harvesting machinery would be profitable if a minimum of 360 tons of silage was harvested annually. Also, a minimum of 150 tons of hay harvested annually would be needed for profitable ownership of hay

harvesting machinery. Throughout the analysis, it was assumed that all machinery would be purchased new.

The land and labor resource requirements were found to be restrictive to the grade A dairies in East Tennessee. For dairymen who are just beginning, investment capital would be the major restricting resource. But, once the dairyman is established, as assumed in this study, the investment capital required annually would not be a restriction, as shown in this study. Annual operating capital is a restriction in many other types of farming operations, but the even flow of revenue from dairying would furnish the required annual operating capital in each resource situation considered in this study.

Corn silage has a high labor requirement for the month of August. In cases where seasonal labor could not be hired, the corn silage enterprise was forced out of the optimum solution because of this high labor requirement. The labor requirements for alfalfa hay were also high but were evenly spread out over the summer months. In the linear programming model, corn for grain replaced alfalfa hay acreage in several resource situations. Throughout the linear programming phase of the study, corn for grain was constantly a major crop enterprise and large acreages were specified in the solution whenever seasonal labor could not be hired. Ladino clover-orchard grass silage and pasture tended to be predominant on Soils IV and V. Oats for grain double cropped with lespedeza hay and millet silage were competitive for these soils, but the high productivity of nutrients and low labor requirements characteristic of ladino

clover-orchard grass silage and pasture continually caused ladino clover-orchard grass silage and pasture to replace these crops on Soils IV and V.

The least cost feed rations for grade A dairy farms in East Tennessee, consisting of 150 acres of open cropland and a labor force of two full-time men, varied with seasonal labor availability, milk production per cow, herd size and the availability of a tobacco enterprise.

When seasonal labor was available, corn silage was the major forage fed in the rations. Without the availability of seasonal labor, corn silage was eliminated from the rations in most cases and millet silage and lespedeza hay entered into the rations in moderate amounts. This change was accompanied by increased quantities of corn and barley specified for the rations.

As milk production increased from 9,000 pounds per cow to 13,000 pounds per cow, the only major change in the rations was an increase in the quantity of concentrates included in the optimal ration.

The increase in herd size was accompanied by a change in the rations fed as labor became more restrictive. Labor restrictions necessitated the substitution of millet silage and additional concentrates in place of corn silage. As herd size decreased, the solution specified a maximum amount of corn silage in the optimum rations. As the feed requirements were met by corn silage and the other feeds, any extra Soil II acreage was used for soybeans for grain. This indicated that only a set portion of the ration could consist of corn silage because of the ratio of nutrients required. This is because corn silage is high in

total digestible nutrients and energy and low in digestible protein. This means, for a ration with a high digestible protein requirement, the corn silage must be fed as a mixture with another feed which is high in digestible protein. The feed used in the optimal rations for this study, which was high in digestible protein, was found to be ladino clover-orchard grass silage and pasture.

The tobacco enterprise competed with corn silage for Soil I and August labor. When the tobacco enterprise was not allowed, the corn silage acreage increased and the corn for grain acreage decreased. When tobacco was allowed, the corn silage acreage decreased and the corn for grain acreage increased. Whenever corn silage or corn for grain was not grown, the other was grown on the acreage to provide the extra nutrients.

II. CONCLUSIONS

The evidence from this study indicates that corn silage, corn for grain and ladino clover-orchard grass silage and pasture are the most economical feed crops to grow on grade A dairy farms in East Tennessee that have high milk production records. But, whenever labor becomes restrictive, different crop enterprises enter the optimum solution and the forage and concentrate rations change. Millet silage, lespedeza hay, and corn for grain are substituted for corn silage as labor becomes restrictive. Also, oats for grain double cropped with lespedeza hay serves as an important rotation crop with emphasis placed upon the cash value of oats and lespedeza hay and the amount of straw the oats furnish for bedding purposes. As herd size decreases and more land becomes

available for row crops, soybeans become an important cash crop as sizable acreages enter into the optimum solutions. Tobacco is a very profitable cash crop and will likely continue to be grown on these farms as long as labor is available and market conditions remain favorable. But, wherever farm labor is not available in a sufficient quantity, a highly productive grade A dairy enterprise in East Tennessee would probably eliminate the tobacco enterprise from the most profitable farm organization.

III. LIMITATIONS OF THE RESULTS AND THEIR IMPLICATIONS

There are limitations to the application of the results of this study to actual farm situations. One must remember that these results are based upon and restricted by the assumptions of the study and the particular resource situations described. Yet, when the resource situations and conditions of a particular producer differ from those made in this study, one may have to make adjustments and allowances in order to obtain a feasible program recommendation. There are many reasons why the optimum farm organizations, combinations of activities, and optimal feed rations specified in this study may differ from what farmers will actually do. First of all, farmers may have goals other than profit maximization and efficient resource use. He may also have goals such as maximum milk production per cow, maximum beautification of the farm landscape by having a large acreage of pastures and meadows, and prize winning. Also, farmers often have beliefs and values which would hinder the application of the most economical farming program. Further, as

perfect knowledge does not exist, risk and uncertainty will affect the extent to which farmers are willing to undertake change.

The results of the analyses indicate that more emphasis could be placed upon the linear programming phase of this study for further research. Additional activities and restrictions would need to be included in the model to give more precision to the predictions and to analyze other situations which may be present on grade A dairy farms in East Tennessee. In order to obtain a more comprehensive analysis of dairying, the research should also be expanded to include other areas of the State to give an estimate of the effects of changes in resource situations and other conditions.

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APPENDIXES

APPENDIX A

BUILDING AND EQUIPMENT ASSUMPTIONS AND COST ESTIMATES

TABLE XXI

ASSUMED BUILDINGS AND EQUIPMENT WITH ANNUAL COST ESTIMATES FOR THIRTY-COW HERD USING CUSTOM HARVESTING FOR EACH FORAGE SYSTEM ON GRADE A DAIRIES IN EAST TENNESSEE, 1965

Item[a]	New Cost[b]	Salv. Value	Yrs. Life	Depre. Per Year	Reps. Per Yr.	Tot. Cost Per Year
Milking parlor (2-stall)	$2,000	$ 200	15	$ 120	$ 24	$ 144
Milker: double unit	435	44	15	26	21	47
Bulk tank: 300 gal.	2,300	230	20	104	29	133
Water heater	65	7	16	4	3	7
Loafing area (paved)	300	--	30	10	4	14
Loafing shed 30x60 ft.	2,000	200	30	60	20	80
Calf barn	300	30	30	9	4	13
Water system	400	--	20	20	8	28
Tool shed	450	45	30	14	6	20
Tractor 40-45 DHP	3,556	356	15	213	256	469
Moldboard plow 3-bottom	420	42	15	25	20	45
Disk (tandem) 8 ft.	500	50	15	29	12	41
Cultipacker 8 ft.	300	30	20	14	2	16
Fertilizer distr. 8 ft.	275	28	12	20	7	27
Grain drill 8 ft.	860	86	15	51	18	69
Corn planter 2-row	435	44	20	19	8	27
Cultivater 2-row	225	23	15	28	12	40
Mower 7 ft. no pitman	450	45	15	27	21	48
Wagon 5-ton	334	33	15	20	11	31
Spray rig 21 ft. boom	198	20	10	18	6	24
Manure spreader	475	48	15	29	9	38
Truck 1/2 ton	2,000	200	10	180	60	240
Hammer mill	450	45	15	27	7	34
TOTALS =	$18,953	$1,825		$1,066	$567	$1,634

[a]Assumptions and estimates were synthesized from the following references: "An Economic Analysis of Alternative Dairy Herd Replacement Policies on Grade A Dairy Farms in the Knoxville Milkshed," by Thomas William Little, unpublished Master's thesis, The University of Tennessee, Knoxville, 1964; Consultation with S. A. Hinton, Associate Professor, Dairy Department, The University of Tennessee, Knoxville, July, 1965; Farm Planning Manual, by Estel H. Hudson and Robert M. Ray, University of Tennessee Agricultural Economics Extension Service, Knoxville, 1964; National Farm Power Equipment Dealer's Association Official Tractor and Farm Equipment Guide, published by NRFEA Publications, Inc., St. Louis, Missouri; and The Cost and Use of Machinery and Equipment in a Silage Feeding Program, by John M. Johnson, University of Tennessee Agricultural Engineering Extension Circular No. 550, Knoxville, 1959.

[b]Investment at any given time will equal approximately one-half the total estimated new cost.

TABLE XXII

ASSUMED BUILDINGS AND EQUIPMENT WITH ANNUAL COST ESTIMATES FOR THIRTY-COW HERD USING A CORN SILAGE FORAGE SYSTEM AND ALTERNATIVE HARVESTING POLICIES ON GRADE A DAIRIES IN EAST TENNESSEE, 1965

Item[a]	New Cost[b]	Salvage Value	Years Life	Deprec. Per Year	Repairs Per Year	Tot. Cost Per Year
Standard buildings & equipment assumed[c]	$18,953	$1,825	--	$1,066	$567	$1,634
Silo 48x18 ft. (279 tons)	2,580	--	40	65	15	80
Silage shed 40x20 ft., concrete, open pole type	1,080	108	30	32	10	42
Silage bunker 40 ft.	200	20	20	9	5	14
Silo unloader & auger	1,832	183	15	110	35	145
Hay shed 15x46x13 ft., concrete, open pole type with feed racks & shed on either side	1,035	104	30	31	15	46
Forage harvester PTO 1-row	1,945	195	12	146	87	232
Silage blower	600	60	12	45	17	62
Silage equipment for wagon, false tailgate with ratchet on blower	500	50	15	30	18	48
TOTALS (own all machinery) =	$28,725	$2,545		$1,534	$770	$2,303
(minus harvesting equipment) TOTALS (custom harvest) =	$25,680	$2,240		$1,313	$647	$1,960

[a,b] See the footnotes in Table XXI.

[c] See Table XXI.

TABLE XXIII

ASSUMED BUILDINGS AND EQUIPMENT WITH ANNUAL COST ESTIMATES FOR THIRTY-COW HERD USING AN ALL ALFALFA-ORCHARD GRASS HAY FORAGE SYSTEM AND ALTERNATIVE HARVESTING POLICIES ON GRADE A DAIRIES IN EAST TENNESSEE, 1965

Item[a]	New Cost[b]	Salvage Value	Years Life	Deprec. Per Year	Repairs Per Year	Tot. Cost Per Year
Standard buildings & equipment assumed[c]	$18,953	$1,825	--	$1,066	$567	$1,634
Hay shed 45x46x13 ft., concrete, open pole type with feed racks & shed on either side	3,105	310	30	93	45	138
Hay baler PTO 18x14 bale	1,667	167	12	125	50	175
Rake 7 ft., side delivery	556	56	15	32	17	49
Hay conditioner, 7 ft.	750	75	10	67	19	86
TOTALS (own all machinery) =	$25,031	$2,443		$1,383	$699	$2,082
(minus harvesting equipment) = TOTALS (custom harvest)	$22,058	$2,135		$1,159	$613	$1,772

[a,b] See the footnotes in Table XXI.

[c] See Table XXI.

TABLE XXIV

ASSUMED BUILDINGS AND EQUIPMENT WITH ANNUAL COST ESTIMATES FOR THIRTY-COW HERD USING A CORN SILAGE AND ALFALFA-ORCHARD GRASS HAY FORAGE SYSTEM WITH ALTERNATIVE HARVESTING POLICIES ON GRADE A DAIRIES IN EAST TENNESSEE, 1965

Item[a]	New Cost[b]	Salvage Value	Years Life	Deprec. Per Year	Repairs Per Year	Tot. Cost Per Year
Standard buildings & equipment assumed[c]	$18,953	$1,825	--	$1,066	$567	$1,634
Silo 44x16 ft. (198 tons)	1,971	--	40	49	12	61
Silage shed 40x20 ft., concrete, open pole type	1,080	108	30	32	10	42
Silage bunker 40 ft.	200	20	20	9	5	14
Silo unloader & auger	1,786	179	15	107	34	141
Hay shed 30x46x13 ft., concrete, open pole type with feed racks & shed on either side	2,070	207	30	62	30	92
Rake 7 ft., side delivery	556	56	15	32	17	49
Hay conditioner 7 ft.	750	75	10	67	19	86
Forage harvester PTO 1-row	1,945	194	12	146	87	233
Silage blower	600	60	12	45	17	62
Silage equipment for wagon, false tailgate with ratchet on blower	500	50	15	30	18	48
TOTALS (own all machinery) =	$32,078	$2,941		$1,771	$867	$2,638
(minus harvesting equipment) TOTALS (custom harvest) =	$26,060	$2,339		$1,326	$658	$1,984

[a,b] See the footnotes in Table XXI.

[c] See Table XXI.

TABLE XXV

ASSUMED BUILDINGS AND EQUIPMENT WITH ANNUAL COST ESTIMATES FOR SIXTY-COW HERD USING CUSTOM HARVESTING FOR EACH FORAGE SYSTEM ON GRADE A DAIRIES IN EAST TENNESSEE, 1965

Item[a]	New Cost[b]	Salvage Value	Years Life	Deprec. Per Year	Repairs Per Year	Tot. Cost Per Year
Milking parlor (4 stalls)	$ 3,500	$ 350	15	$ 210	$ 42	$ 252
Pipeline milker	2,150	215	15	129	45	174
Bulk tank: 600 gal.	2,800	280	20	126	33	159
Water heater	65	6	16	4	3	7
Loafing area (paved)	600	--	30	20	8	28
Loafing shed 30x120 ft., concrete	4,000	400	30	120	40	160
Calf barn	600	60	30	18	8	26
Water system	600	--	20	30	10	40
Tool shed	600	60	30	18	7	25
Tractors 40-45 DHP (2)	7,112	711	15	427	512	939
Moldboard plow 3-bottom	420	42	15	25	20	45
Disk (tandem) 8 ft.	500	50	15	26	12	41
Cultipacker 8 ft.	300	30	20	14	2	16
Fertilizer distributer 8 ft.	275	27	12	20	7	27
Grain drill 8 ft.	860	86	15	51	18	69
Corn planter 2-row	435	43	20	19	8	27
Cultivater 2-row	225	23	15	28	12	40
Mower 7 ft., no pitman	450	45	15	27	21	48
Wagon 5-ton	334	33	15	20	11	31
Spray rig 21 ft. boom	198	20	10	18	6	24
Manure spreader	475	48	15	28	10	38
Manure loader	400	40	12	30	8	38
Truck 1-ton	2,400	240	10	216	72	288
Hammer mill	450	45	15	27	7	34
TOTALS =	$29,749	$2,854		$1,655	$920	$2,575

[a,b] See the footnotes in Table XXI.

TABLE XXVI

ASSUMED BUILDINGS AND EQUIPMENT WITH ANNUAL COST ESTIMATES FOR SIXTY-COW HERD USING A CORN SILAGE FORAGE SYSTEM AND ALTERNATIVE HARVESTING POLICIES ON GRADE A DAIRIES IN EAST TENNESSEE, 1965

Item[a]	New Cost[b]	Salvage Value	Years Life	Deprec. Per Year	Repairs Per Year	Tot. Cost Per Year
Standard buildings & equipment assumed[c]	$29,749	$2,854	--	$1,655	$ 920	$2,575
Silos (2) 48x18 ft. (279 tons ea.)	5,160	--	40	129	30	159
Silage shed 80x20 ft., concrete, open pole type	2,160	216	30	65	20	85
Silage bunker 80 ft.	400	40	20	18	9	27
Silo unloader & auger	2,330	233	15	140	40	180
Hay shed 30x46x13 ft., concrete, open pole type with feed racks & shed on either side	2,070	207	30	62	30	92
Forage harvester PTO 1-row	1,945	194	12	146	87	233
Silage blower	600	60	12	45	17	62
Silage equipment for wagon, false tailgate with ratchet on blower	500	50	15	30	18	48
TOTALS (own all machinery) =	$44,914	$3,855		$2,289	$1,193	$3,461
(minus harvesting equipment) TOTALS (custom harvest) =	$41,869	$3,551		$2,068	$1,049	$3,118

[a,b] See the footnotes in Table XXI.

[c] See Table XXV.

TABLE XXVII

ASSUMED BUILDINGS AND EQUIPMENT WITH ANNUAL COST ESTIMATES FOR SIXTY-COW HERD USING AN ALL ALFALFA-ORCHARD GRASS HAY FORAGE SYSTEM AND ALTERNATIVE HARVESTING POLICIES ON GRADE A DAIRIES IN EAST TENNESSEE, 1965

Item[a]	New Cost[b]	Salvage Value	Years Life	Deprec. Per Year	Repairs Per Year	Tot. Cost Per Year
Standard buildings & equipment assumed[c]	$29,749	$2,854	--	$1,655	$920	$2,575
Hay shed 75x46x13 ft., concrete, open pole type with feed racks & shed on either side	5,175	517	30	155	75	230
Hay baler PTO 18x14 bale	1,667	167	12	125	50	175
Rake 7 ft., side delivery	556	56	15	32	17	49
Hay conditioner	750	75	10	67	19	86
TOTALS (own all machinery) =	$37,897	$3,669		$2,034	$1,081	$3,115
(minus harvesting equipment) TOTALS (custom harvest) =	$34,924	$3,372		$1,809	$ 995	$2,805

[a,b] See the footnotes in Table XXI.

[c] See Table XXV.

TABLE XXVIII

ASSUMED BUILDINGS AND EQUIPMENT WITH ANNUAL COST ESTIMATES FOR SIXTY-COW HERD USING A CORN SILAGE AND ALFALFA-ORCHARD GRASS HAY FORAGE SYSTEM WITH ALTERNATIVE HARVESTING POLICIES ON GRADE A DAIRIES IN EAST TENNESSEE, 1965

Item[a]	New Cost[b]	Salvage Value	Years Life	Deprec. Per Year	Repairs Per Year	Tot. Cost Per Year
Standard buildings & equipment assumed[a]	$29,749	$2,854	--	$1,655	$ 920	$2,575
Silos (2) 44x16 ft. (198 tons ea.)	3,942	--	40	99	23	122
Silage shed 80x20 ft., concrete, open pole type	2,160	216	30	65	20	85
Silage bunker 80 ft.	400	40	20	18	9	27
Silo unloader & auger	2,285	228	15	138	40	178
Hay shed 60x46x13 ft., concrete, open pole type with feed racks & shed on either side	4,140	414	30	124	60	184
Hay baler PTO 18x14 bale	1,667	167	12	125	50	175
Rake 7 ft., side delivery	556	56	15	32	17	49
Hay conditioner 7 ft.	750	75	10	67	19	86
Forage harvester PTO 1-row	1,945	194	12	146	87	233
Silage blower	600	60	12	45	17	62
Silage equipment for wagon, false tailgate with ratchet on blower	500	50	15	30	18	48
TOTALS (own all machinery) =	$48,694	$4,355	...	$2,544	$1,282	$3,826
(minus harvesting equipment) TOTALS (custom harvest) =	$42,676	$3,748		$2,099	$1,074	$3,173

[a,b] See the footnotes in Table XXI.

[c] See Table XXV.

TABLE XXIX

ASSUMED BUILDINGS AND EQUIPMENT WITH ANNUAL COST ESTIMATES FOR NINETY-COW HERD USING CUSTOM HARVESTING FOR EACH FORAGE SYSTEM ON GRADE A DAIRIES IN EAST TENNESSEE, 1965

Item[a]	New Cost[b]	Salvage Value	Years Life	Deprec. Per Year	Repairs Per Year	Tot. Cost Per Year
Milking parlor (6 stalls)	$ 5,000	$ 500	15	$ 300	$ 60	$ 360
Pipeline milker	3,150	315	15	190	65	255
Bulk tank: 750 gal.	3,100	310	20	139	36	175
Water heater	90	9	16	5	4	9
Loafing area (paved)	900	--	30	30	12	42
Loafing shed 60x120 ft., concrete	6,000	600	30	180	60	240
Calf barn	900	90	30	27	12	39
Water system	800	--	20	40	12	52
Tool shed	750	75	30	24	8	32
Tractors (3) 40-45 DHP	10,668	1,067	15	640	768	1,408
Moldboard plows (2) 3-bottom	840	84	15	51	40	91
Disk (tandem) 8 ft.	500	50	15	29	12	41
Cultipacker 8 ft.	300	30	20	14	2	16
Fertilizer distributer 8 ft.	275	28	12	20	7	27
Grain drill 8 ft.	860	86	15	51	17	68
Corn planter 2-row	435	44	20	19	8	27
Cultivater 2-row	225	23	15	28	12	40
Mower 7 ft., no pitman	450	45	15	27	21	48
Wagons (2) 5-ton	668	67	15	40	22	62
Spray rig 21 ft. boom	198	20	10	18	6	24
Manure spreader	475	47	15	28	10	38
Manure loader	400	40	12	30	8	38
Truck 2-ton	3,000	300	10	270	86	356
Hammer mill	450	45	15	27	7	34
TOTALS	$40,426	$3,873		$2,227	$1,296	$3,512

[a,b] See the footnotes in Table XXI.

TABLE XXX

ASSUMED BUILDINGS AND EQUIPMENT WITH ANNUAL COST ESTIMATES FOR NINETY-COW HERD USING A CORN SILAGE FORAGE SYSTEM AND ALTERNATE HARVESTING POLICIES, 1965

Item[a]	New Cost[b]	Salvage Value	Years Life	Deprec. Per Year	Repairs Per Year	Tot. Cost Per Year
Standard buildings & equipment assumed[c]	$40,426	$3,873	--	$2,227	$1,295	$3,523
Silos (2) 56x20 ft. (412 t. ea.)	7,090	--	40	177	42	220
Silage shed 120x20 ft. (conc.) open pole type	3,240	324	30	97	30	127
Silage bunker 120 ft.	600	60	20	27	14	40
Silo unloader and auger	2,832	283	15	170	50	220
Hay shed 30x46x13 ft. (conc.) open pole type with feed racks & shed on either side	3,105	311	30	93	45	138
Forage harvester PTO 1-row	1,945	195	12	145	88	233
Silage blower	600	60	12	45	18	63
Silage equipment for 2 wagons, false tailgate with ratchet on blower	1,000	100	15	30	18	48
TOTALS (owns all machinery) =	$60,938	$5,206		$3,013	$1,600	$4,612
(minus harvesting equipment) TOTALS (custom harvest) =	$56,993	$4,852		$2,792	$1,478	$4,268

[a,b] See the footnotes in Table XXI.

[c] See Table XXIX.

TABLE XXXI

ASSUMED BUILDINGS AND EQUIPMENT WITH ANNUAL COST ESTIMATES FOR NINETY-COW HERD USING AN ALL ALFALFA-ORCHARD GRASS HAY FORAGE SYSTEM AND ALTERNATE HARVESTING POLICIES, 1965

Item[a]	New Cost[b]	Salvage Value	Years Life	Deprec. Per Year	Repairs Per Year	Tot. Cost Per Year
Standard buildings & equipment assumed[c]	$40,426	$3,873	--	$2,227	$1,296	$3,523
Hay shed 105x46x13 ft. (conc.) open pole type with feed racks & shed on either side	7,245	725	30	217	105	322
Hay baler PTO 18x14	1,667	167	12	125	50	175
Rake 7 ft. side delivery	556	55	15	32	17	49
Hay conditioner 7 ft.	750	75	10	67	19	86
TOTALS (own all machinery) =	$50,644	$4,895		$2,669	$1,487	$4,156
(minus harvesting equipment) TOTALS (custom harvest) =	$47,671	$4,598		$2,445	$1,401	$3,845

[a,b] See the footnotes in Table XXI.

[c] See Table XXIX.

TABLE XXXII

ASSUMED BUILDINGS AND EQUIPMENT WITH ANNUAL COST ESTIMATES FOR NINETY-COW HERD USING A CORN SILAGE AND ALFALFA-ORCHARD GRASS HAY FORAGE SYSTEM WITH ALTERNATIVE HARVESTING POLICIES ON GRADE A DAIRIES IN EAST TENNESSEE, 1965

Item[a]	New Cost[b]	Salvage Value	Years Life	Deprec. Per Year	Repairs Per Year	Tot. Cost Per Year
Standard buildings & equipment assumed[c]	$40,426	$3,873	--	$2,227	$1,296	$3,523
Silos (2) 50x18 ft. (293 t. ea.)	5,350	--	40	134	32	166
Silage shed 120x20 ft., concrete, open pole type	3,240	324	30	97	30	127
Silage bunker 120 ft.	600	60	20	27	14	41
Silo unloader & auger	2,760	276	15	166	48	214
Hay shed 75x46x13 ft., concrete, open pole type with feed racks & shed on either side	4,175	517	30	155	75	230
Hay baler PTO 18x14 bale	1,667	167	12	125	50	175
Rake 7 ft., side delivery	556	56	15	32	17	49
Hay conditioner 7 ft.	750	75	10	67	19	86
Forage harvester PTO 1-row	1,945	194	12	146	87	233
Silage blower	600	60	12	45	17	62
Silage equipment for 2 wagons, false tailgate with ratchet on blower	1,000	100	15	60	36	96
TOTALS (own all machinery) =	$64,069	$5,703		$3,281	$1,722	$5,003
(minus harvesting equipment) TOTALS (custom harvest) =	$57,556	$5,051		$2,806	$1,495	$4,301

[a,b] See the footnotes in Table XXI.

[c] See Table XXIX.

TABLE XXXIII

ASSUMED DEPRECIATION AND REPAIRS PER UNIT OF USE FOR BUILDINGS, MACHINERY AND REPLACEMENT STOCK ON GRADE A DAIRIES IN EAST TENNESSEE, 1965

Item[a]	Unit	Cost/Unit
Tractor 3-bottom	hr.	$ .56
Plow 3-bottom	hr.	.34
Disk, tandem	hr.	.31
Cultipacker	hr.	.16
Fertilizer distributor 8 ft.	hr.	.27
Grain drill 8 ft.	hr.	.86
Corn planter 2-row	hr.	.45
Cultivator	hr.	.13
Mower 7 ft., no pitman	hr.	.36
Wagon 5 ton	hr.	.09
Spray rig 21 ft.	hr.	.16
Harrow 2 section	hr.	.17
Grain storage	bu.	.10
Hay storage	ton	1.64
Silage storage	ton	.31
Tobacco storage[b]	acre	43.33
Milking parlor	cow	4.20
Pipeline milker	cow	2.90
Bulk tank	cwt.	.0075
Water heater & system	cow	.77
Loafing shed & area	cow	3.13
Tool shed	cow	.42
Manure spreader & loader	cow	1.28
Truck 1-ton	cow	4.80
Hammer mill	cow	.56
Silage shed	cow	1.41
Silo unloader & auger	cow	3.00
Replacement stock/yr. 9,000 prod. level	cow	60.00
Replacement stock/yr. 11,000 prod. level	cow	70.00
Replacement stock/yr. 13,000 prod. level	cow	80.00

[a]The machinery and building costs are based upon a sixty-cow herd size. The new cost, depreciation and repair estimates for the machinery and buildings are shown in Appendix A, Tables XXI through XXXII.

[b]The costs for a tobacco shed are not shown in Appendix A. The figures assumed for the tobacco shed per acre are: $2,000 initial cost with an expected life of 20 years. The salvage value would be $200 and repairs over the life of the building would equal 40 per cent of the initial cost.

APPENDIX B

LABOR REQUIREMENTS FOR THREE FORAGE SYSTEMS WITH ALTERNATIVE FORAGE HARVESTING POLICIES

TABLE XXXIV

ESTIMATED LABOR REQUIREMENTS FOR THIRTY-COW DAIRY HERD USING ALTERNATIVE FORAGE SYSTEMS AND HARVESTING POLICIES ON GRADE A DAIRIES IN EAST TENNESSEE, 1965[a]

Alternative Forage System and Harvesting Policy	Hours of Labor Required by Period of Year								
	Jan. and Feb.	Mar. and Apr.	May	June	July	Aug.	Sep. and Oct.	Nov. and Dec.	Total for Year
Corn silage									
Custom harvest	539	496	201	231	228	283	427	528	2,929
Own all machinery	541	498	204	234	231	441	429	530	3,104
Alfalfa-orchard grass hay									
Custom harvest	534	407	214	244	235	260	450	512	2,856
Own all machinery	536	409	255	285	240	291	490	514	3,020
Corn silage and alfalfa-orchard grass hay									
Custom harvest	546	475	216	246	233	288	449	528	2,981
Own all machinery	548	477	250	280	238	422	482	530	3,227

[a]Adapted from Labor Requirements on Tennessee Farms, by W. P. Ranney, University of Tennessee Agricultural Experiment Station Bulletin No. 316, Knoxville, 1960, and Farm Planning Manual, by Estel H. Hudson and Robert M. Ray, University of Tennessee Agricultural Extension Service, Knoxville, April, 1964.

TABLE XXXV

ESTIMATED LABOR REQUIREMENTS FOR SIXTY-COW DAIRY HERD USING ALTERNATIVE FORAGE SYSTEMS AND HARVESTING POLICIES ON GRADE A DAIRIES IN EAST TENNESSEE, 1965[a]

Alternative Forage System and Harvesting Policy	Hours of Labor Required by Period of Year								
	Jan. and Feb.	Mar. and Apr.	May	June	July	Aug.	Sep. and Oct.	Nov. and Dec.	Total for Year
Corn silage									
Custom harvest	852	826	315	370	369	476	670	839	4,716
Own all machinery	857	831	317	372	371	786	675	844	5,053
Alfalfa-orchard grass hay									
Custom harvest	824	623	343	398	383	432	716	795	4,514
Own all machinery	824	625	416	472	385	482	790	797	4,792
Corn silage and alfalfa-orchard grass hay									
Custom harvest	866	784	347	402	379	488	716	839	4,821
Own all machinery	871	794	408	461	381	746	774	844	5,290

[a]See Table V, page 24.

TABLE XXXVI

ESTIMATED LABOR REQUIREMENTS FOR NINETY-COW DAIRY HERD USING ALTERNATIVE FORAGE SYSTEMS AND HARVESTING POLICIES ON GRADE A DAIRIES IN EAST TENNESSEE, 1965[a]

Alternative Forage System and Harvesting Policy	Hours of Labor Required by Period of Year								
	Jan. and Feb.	Mar. and Apr.	May	June	July	Aug.	Sep. and Oct.	Nov. and Dec.	Total for Year
Corn silage									
Custom harvest	1,156	1,148	447	528	528	687	936	1,128	6,558
Own all machinery	1,156	1,151	449	530	530	1,139	936	1,131	7,022
Alfalfa-orchard grass hay									
Custom harvest	1,137	898	489	570	550	623	1,011	1,086	6,364
Own all machinery	1,139	900	597	678	552	696	1,119	1,088	6,769
Corn silage and alfalfa-orchard grass hay									
Custom harvest	1,178	1,094	495	576	544	707	1,004	1,128	6,725
Own all machinery	1,178	1,097	581	662	546	1,089	1,089	1,131	7,373

[a]See Table V, page 24.

APPENDIX C

ASSUMED PRICES OF PRODUCTS SOLD AND ITEMS PURCHASED AND VARIABLE COST OF CROP PRODUCTION FOR THREE FORAGE SYSTEMS

TABLE XXXVII

ASSUMED PRICES OF PRODUCTS SOLD AND ITEMS PURCHASED FOR GRADE A DAIRY FARMS IN EAST TENNESSEE, 1965[a]

	Unit	Price
PRODUCTS SOLD		
Grade A milk (4% butterfat)	cwt.	$ 4.60
7-day old calves	head	20.00
Culled cows	cwt.	11.50
Corn (grain)	bu.	1.15
Oats (grain)	bu.	.80
Barley (grain)	bu.	1.00
Soybeans (grain)	bu.	2.40
Alfalfa hay	ton	32.00
Lespedeza hay	ton	24.00
Straw	ton	20.00
Ladino clover & orchard grass hay	ton	25.00
Red clover & orchard grass hay	ton	25.00
Tobacco	cwt.	60.00
ITEMS PURCHASED		
Barley seed	bu.	2.50
Oat seed	bu.	1.25
Hybrid seed corn	bu.	10.08
Alfalfa seed	lb.	.45
Orchard grass seed	lb.	.50
Ladino clover seed	lb.	.75
Crimson clover seed	lb.	.20
Lespedeza seed	lb.	.20
Millet seed	lb.	.18
Inoculation of legume seeds	acre	.50
Limestone	ton	4.00
Fertilizer 6-12-12	ton	53.00
Fertilizer 5-20-20	ton	60.00
Fertilizer 0-9-27	ton	56.00
Fertilizer 30-0-0	ton	84.00
Fertilizer 0-20-20	ton	44.00
Borax	cwt.	4.25
Salt	cwt.	1.64
Soybean oil meal, 44% protein	cwt.	5.00
Molasses, cane	cwt.	3.50
Milk replacer	cwt.	17.00
Corn (grain)	bu.	1.25
Barley (grain)	bu.	1.10
Oats (grain	bu.	.90

TABLE XXXVII (continued)

	Unit	Price
ITEMS PURCHASED (continued)		
Straw	ton	$ 24.00
Alfalfa hay	ton	36.00
Lespedeza hay	ton	28.00
Red clover & orchard grass hay	ton	29,00
Labor (seasonal & full time)	hr.	1.25
Labor	hr.	1.25
Interest on capital	$1.00	.06
Dairy cows (wt. = 1,200 lb.;prod. = 9,000)	head	300.00
Dairy cows (wt. = 1,450 lb.;prod. = 11,000)	head	350.00
Dairy cows (wt. = 1,700 lb.;prod. = 13,000)	head	400.00
Milk hauling	cwt.	.22
Breeding fees	cow	6.00
Tractor: gas, oil & grease	hr.	.50
Truck, 1/2-ton: gas, oil & grease	mile	.08
Truck, 1-ton: gas, oil & grease	mile	.10
Truck, 2-ton: gas, oil & grease	mile	.12
Hired tractor	hr.	2.00
Hired silage wagon	hr.	.75
Harvest silage (custom)	ton	2.25
Condition hay (custom)	acre	2.10
Rake & bale hay (custom)	ton	5.50
Tobacco setting (custom)	acre	6.00
Combining grain (custom)	acre	6.00
Pick corn (custom)	acre	6.00
Plastic for tobacco bed	sq. yd.	.10
Cheesecloth for tobacco bed	sq. yd.	.05
Tobacco seed	acre	1.50
D.D.T.	lb.	.07
Fermate	lb.	.15
Tobacco insecticides	lb.	.60
Tobacco insurance	acre	25.00
Tobacco marketing fees	acre	50.60

[a]Estimates of the prices and quantities were adapted from the following sources: Unpublished data of the Department of Agricultural Economics, The University of Tennessee; Agricultural Prices, Statistical Reporting Service, United States Department of Agriculture; "An Economic Analysis of Alternative Dairy Herd Replacement Policies on Grade A Dairy Farms in the Knoxville Milkshed," by Thomas William Little, unpublished Master's thesis, The University of Tennessee, Knoxville, 1964; Costs and

TABLE XXXVII (continued)

Returns from Livestock Production in the Limestone Valley Areas of Alabama, Agricultural Experiment Station, Auburn University; Farm Planning Manual, by Estel H. Hudson and Robert M. Ray, University of Tennessee Agricultural Economics Extension Service, Knoxville, April, 1964; and Labor Requirements on Tennessee Farms, by W. P. Ranney, University of Tennessee Agricultural Experiment Station Bulletin No. 316, Knoxville, 1960.

TABLE XXXVIII

ESTIMATED ANNUAL VARIABLE COST OF CROP PRODUCTION FOR THREE ALTERNATIVE FORAGE SYSTEMS ON GRADE A DAIRIES IN EAST TENNESSEE, 1965

Crop	Item	Quantity Per Acre[a] (lbs.)	Prorated Cost Per Acre Per Year
Alfalfa-orchard grass hay 3.0 tons/acre[b] (5-year stand)	Seed:		
	Alfalfa	20	$ 1.80
	Orchard grass	10	1.00
	Fertilizer:		
	Establishment (5-20-20)	500	3.00
	Maintenance (0-9-27)	2,000	11.20
	Insecticide		3.85
	Borax	100	.85
	Lime	4,000	1.60
		Total Cost =	$23.32
Corn silage 15 tons/acre[c]	Seed:		
	Corn	12	$ 2.16
	Fertilizer:		
	6-12-12	500	13.25
	30-0-0	160	7.64
	Lime	800	1.60
		Total Cost =	$24.65
Permanent pasture Ladino clover-orchard grass 2.5 tons/acre or 6 months grazing (5-year stand)	Seed:		
	Ladino clover	2	$ .30
	Orchard grass	10	1.00
	Fertilizer:		
	Establishment (5-20-20)	500	3.00
	Maintenance (0-20-20)	1,350	5.94
	Lime	4,000	1.60
		Total Cost =	$11.80

[a]Adapted from Tennessee's 1965 Fertilizer Recommendations, Agricultural Experiment Station, Publication 381 (revised), The University of Tennessee, Knoxville, January, 1965.

[b]Assumed that 0.5 tons/acre will be lost due to weather, spoilage, and so forth.

[c]Assumed that 1 ton/acre will be lost due to spoilage.

APPENDIX D

THE LEAST COST COMBINATIONS OF ACTIVITIES FOR FIFTY, SIXTY AND SEVENTY COW HERD SIZE WITHOUT A TOBACCO ENTERPRISE

TABLE XXXIX

A LEAST COST COMBINATION OF ACTIVITIES FOR ALTERNATIVE PRODUCTION LEVELS AND LABOR SUPPLIES ON EAST TENNESSEE GRADE A DAIRY FARMS CONSISTING OF 150 ACRES OF OPEN CROPLAND AND A SIXTY-COW HERD SIZE WITHOUT A TOBACCO ENTERPRISE, 1965

Activity	Soil Group	Unit	Milk Production Per Cow in Pounds (4% BFC)					
			With Seasonal Labor			Without Seasonal Labor		
			9,000	11,000	13,000	9,000	11,000	13,000
Soybeans for grain	II	acre	7.0	1.0	1.6	7.9	--	--
Corn for grain	I	acre	--	--	--	--	2.4	6.8
Corn for grain	II	acre	11.0	17.0	16.4	10.2	18.0	18.0
Corn for grain	III	acre	16.3	10.7	9.4	21.0	21.0	21.0
Corn silage	I	acre	18.0	18.0	18.0	18.0	15.6	11.2
Corn silage	III	acre	4.7	10.3	11.6	--	--	--
Alfalfa hay	III	acre	15.0	14.3	11.8	7.5	10.3	12.6
Alfalfa hay & silage	III	acre	--	0.7	3.2	--	--	1.3
Oats (grain) & lesp. hay	III	acre	18.0	18.0	18.0	25.5	13.2	19.1
Oats (grain) & lesp. hay	IV	acre	8.1	--	--	--	--	--
Oats (grain) & lesp. hay	V	acre	--	--	--	17.1	8.1	--
Millet silage	III	acre	--	--	--	--	9.4	--
Lad.cl.-or.gr. sil. & p.	IV	acre	21.9	30.0	30.0	30.0	30.0	30.0
Lad.cl.-or.gr. sil. & p.	V	acre	30.0	30.0	30.0	12.9	21.9	30.0
Bor. annual invest. cap.	-	$	6,519.0	7,071.9	7,663.0	6,628.7	7,139.3	7,766.3
Hire August labor	-	hr.	26.7	67.8	88.9	--	--	--
Sell oats	-	bu.	1,483.4	1,080.0	1,080.0	2,298.7	1,158.5	1,146.3
Sell alfalfa hay	-	ton	24.0	13.7	--	--	--	--
Sell lespedeza hay	-	ton	20.0	14.4	14.4	--	--	--
Buy straw	-	ton	35.5	42.0	42.0	22.5	41.1	40.9
Buy corn	-	bu.	--	--	--	--	--	1,693.7
Buy barley	-	bu.	--	--	1,392.7	--	--	--
Net Returns to Land, Labor, Invest. Cap. & Mgt. =			$13,547	$16,267	$19,872	$13,375	$15,878	$19,381

TABLE XL

A LEAST COST COMBINATION OF ACTIVITIES FOR ALTERNATIVE PRODUCTION LEVELS AND LABOR SUPPLIES ON EAST TENNESSEE GRADE A DAIRY FARMS CONSISTING OF 150 ACRES OF OPEN CROPLAND AND A SEVENTY-COW HERD SIZE WITHOUT A TOBACCO ENTERPRISE, 1965

Activity	Soil Group	Unit	Milk Production Per Cow in Pounds (4% BFC)					
			With Seasonal Labor			Without Seasonal Labor		
			9,000	11,000	13,000	9,000	11,000	13,000
Corn for grain	I	acre	--	--	--	7.3	12.5	16.9
Corn for grain	II	acre	18.0	18.0	15.6	18.0	18.0	18.0
Corn for grain	III	acre	12.6	3.8	3.2	21.0	21.0	21.0
Corn for silage	I	acre	18.0	18.0	18.0	10.7	5.5	1.1
Corn for silage	III	acre	8.4	17.2	17.8	--	--	--
Alfalfa hay	III	acre	15.0	10.1	15.0	8.8	12.0	4.6
Alfalfa hay & silage	III	acre	--	4.9	--	--	--	10.4
Oats (grain) & lesp. hay	III	acre	18.0	18.0	18.0	7.1	15.7	18.0
Oats (grain) & lesp. hay	V	acre	--	--	--	9.4	3.8	2.5
Millet silage	III	acre	--	--	--	17.2	5.2	--
Lad.cl.-or.gr. sil. & p.	II	acre	--	--	2.4	--	--	--
Lad.cl.-or.gr. sil. & p.	IV	acre	30.0	30.0	30.0	30.0	30.0	30.0
Lad.cl.-or.gr. sil. & p.	V	acre	30.0	30.0	30.0	20.6	26.2	27.5
Bor. annual invest. cap.	-	$	7,349.5	8,005.7	8,706.1	7,375.6	8,152.8	8,871.6
Hire May labor	-	hr.	--	--	19.0	--	--	--
Hire August labor	-	hr.	86.4	182.7	170.0	--	--	--
Sell oats	-	bu.	1,080.0	1,080.0	1,080.0	846.7	1,115.4	1,193.6
Sell alfalfa hay	-	ton	20.0	0.3	--	--	--	--
Sell lespedeza hay	-	ton	14.4	14.4	--	--	--	--
Buy straw	-	ton	51.7	52.0	52.0	56.4	51.7	50.2
Buy corn	-	bu.	153.3	--	--	--	2,148.7	3,668.0
Buy barley	-	bu.	5.4	1,150.6	2,823.4	--	--	--
Buy alfalfa hay	-	ton	--	--	1.0	--	--	20.7
Net Returns to Land, Labor, Invest. Cap. & Mgt. =			$14,772	$17,908	$22,067	$14,316	$17,042	$21,074

TABLE XLI

A LEAST COST COMBINATION OF ACTIVITIES FOR ALTERNATIVE PRODUCTION LEVELS AND LABOR SUPPLIES ON EAST TENNESSEE GRADE A DAIRY FARMS CONSISTING OF 150 ACRES OF OPEN CROPLAND AND A FIFTY-COW HERD SIZE WITHOUT A TOBACCO ENTERPRISE, 1965

Activity	Soil Group	Unit	Milk Production Per Cow in Pounds (4% BFC)					
			With Seasonal Labor			Without Seasonal Labor		
			9,000	11,000	13,000	9,000	11,000	13,000
Soybeans for grain	II	acre	16.0	11.0	2.3	16.0	11.2	3.2
Corn for grain	II	acre	2.0	7.0	15.7	2.0	6.8	14.8
Corn for grain	III	acre	19.9	15.2	16.6	19.9	15.5	18.0
Corn silage	I	acre	18.0	18.0	18.0	18.0	18.0	18.0
Corn silage	III	acre	1.1	5.8	4.4	1.1	5.5	3.0
Alfalfa hay	III	acre	15.0	15.0	15.0	15.0	15.0	15.0
Oats (grain) & lesp. hay	III	acre	18.0	18.0	18.0	18.0	18.0	18.0
Oats (grain) & lesp. hay	IV	acre	16.2	8.9	1.1	16.2	9.7	4.7
Lad.cl.-or.gr. sil. & p.	IV	acre	13.8	21.1	28.9	13.8	20.3	25.3
Lad.cl.-or.gr. sil. & p.	V	acre	30.0	30.0	30.0	30.0	30.0	30.0
Bor. annual invest. cap.	-	$	5,678.6	6,136.1	6,637.0	5,678.6	6,142.6	6,667.0
Hire August labor	-	hr.	--	1.4	6.7	--	--	--
Sell oats	-	bu.	1,888.3	1,527.1	1,136.7	1,888.3	1,565.6	1,314.1
Sell alfalfa hay	-	ton	28.0	20.5	13.0	28.0	20.5	13.0
Sell lespedeza hay	-	ton	25.7	20.7	15.2	25.7	17.6	1.2
Buy straw	-	ton	19.1	24.8	31.1	19.1	24.2	28.3
Net Returns to Land, Labor, Invest. Cap. & Mgt. =			$12,292	$14,603	$17,621	$12,292	$14,594	$17,579