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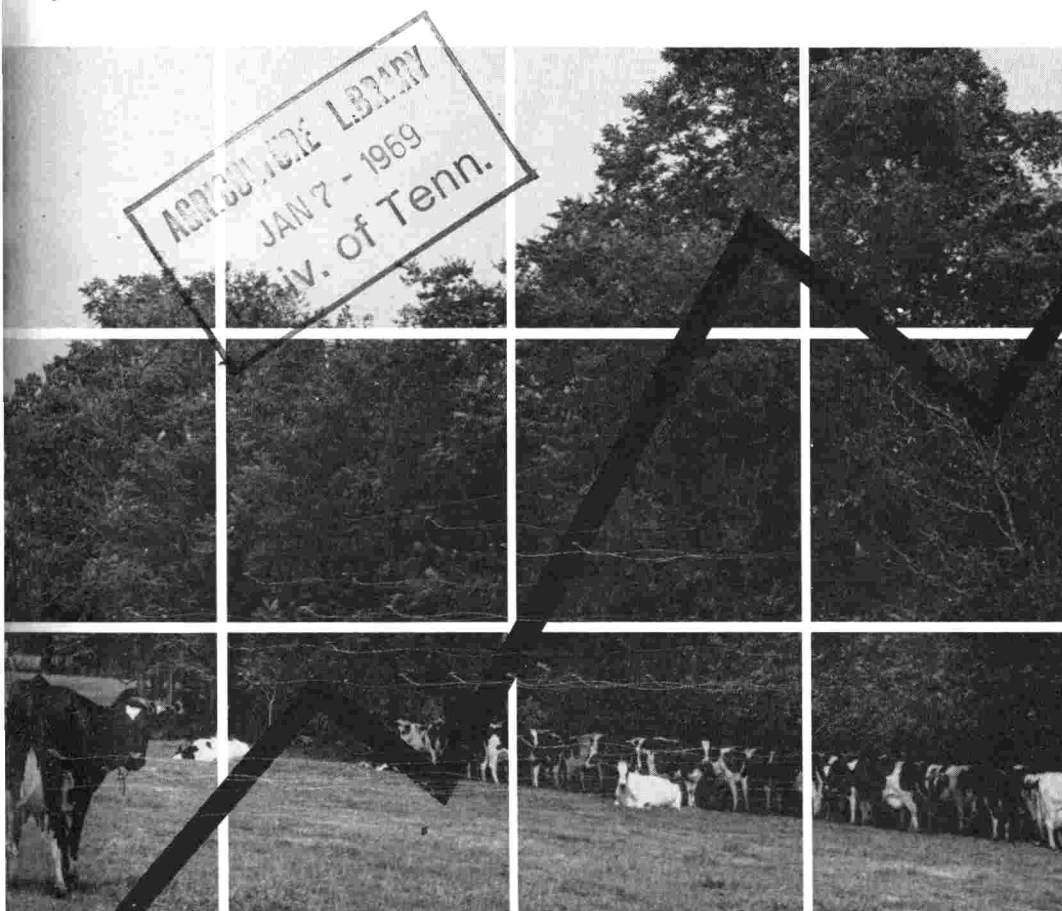
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An Economic Analysis Of Alternative Dairy Herd Replacement Policies On Grade A Dairy Farms In The Knoxville Milkshed

by Luther H. Keller and Thomas W. Little



THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION
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KNOXVILLE

SUMMARY

The objectives of this study were to determine herd replacement policies being used by Grade A dairy farmers in the Knoxville Milkshed, to estimate the actual cost of raising replacements, and to estimate the opportunity cost of various replacement policies.

Of the 153 Grade A dairy farm in the random sample selected for the study, 42% had milking herds of 30 cows or less; 32% had from 31 to 49 cows; and 26% had 50 or more cows. The average herd size for the small-farm grouping was 23 cows; for the medium-farm grouping, 39 cows; and for the large-farm grouping, 72 cows. Farmers reported 52% as many heifers as cows. About three-fifths of these were 1 year of age and over.

During the sample year, July 1, 1962, through June 30, 1963, 21% of the milk cows on the sample farms were removed from the herd for various reasons. Low production was the major reason for culling and accounted for about 61% of the animals removed. The next two most important reasons were disease and breeding difficulties, which accounted for 12% and 10% of the removals, respectively.

Approximately 74% of the replacements were raised heifers which freshened, 10% were purchased heifers which freshened, and 16% were purchased cows.

Sixty-nine percent of the farmers indicated they usually raise 100% of their replacements. Their major reasons for doing so were: 1) they know the breeding and ancestry of their replacements; 2) they feel it is cheaper to raise replacements than buy them; 3) they feel they cannot buy quality replacements; and 4) they feel that the risk of introducing disease is reduced. The remaining 31% usually purchased part or all of their replacements. The major reasons given for buying replacements were land limitations, improving the quality of the herd, and that it is cheaper to purchase than to raise replacements.

The actual cost of obtaining replacements varied not only by source, but with age as well. When replacements were purchased, the average prices paid by farmers in this sample were: \$225 for cows, \$246 for bred heifers, and \$175 for open heifers 1 year of age or older.

The cost of raising a replacement to 27 months of age was estimated to be \$239. Feed cost was the largest cost item, accounting for \$124 of the total.

To gain some insight into the opportunity cost of alternative replacement policies, a small, a medium, and a large case farm were

selected from the three farm-size categories. Two farm plans were developed for each case farm using budgeting techniques: first following a situation in which all replacements were raised, and second for a situation in which all replacements were to be purchased. In the second case the milking herd was increased by the number of cows which the released fixed resources — previously used for raising replacements — would support. It was assumed that the quality of purchased and raised replacements were equal.

On the small case farm, net returns to operator labor, capital, and management were estimated to be \$7,129 when a policy of raising all replacements was followed. The net returns on the same farm when following a policy of purchasing replacements was estimated to be \$7,926, or a net difference of \$797. In this case, the farmer could pay as much as \$414 for his replacements and still maintain the same return to operator labor, capital, and management as he would have received from a system of raising his own replacements.

On the medium case farm, net returns to operator labor, capital, and management was \$15,676 when a policy of raising all replacements was followed. A father-son partnership existed on this farm. The net returns of the farming system using purchased replacements was \$17,287. The difference in net returns was \$1,611. In this case the farmer could pay as much as \$434 each for his replacements and still maintain the same net returns as for the policy of raising replacements.

On the large case farm, net returns to operator labor, capital, and management was \$21,127 when a policy of raising replacements was followed. The net returns of the system using all purchased replacements was \$23,075. The difference in net returns was \$1,948. The farmer could pay \$403 per replacement.

Contractual arrangements involving a payment of either \$.25 per pound of gain or \$10 per month for each replacement would result in net returns approximately equal to that of the purchasing replacements alternative.

If the 69% of the dairy farmers in the Milkshed who currently raise their replacements were to shift to buying or contracting and expanded their herds by about 25% — as was done on the case farms in this study — the increased output of milk would likely lead to a decline in milk prices and an increase in price of purchased replacements. However, purchasing and contracting probably are not suited to all farms in this area. As replacement policies are evaluated on individual farms, existing conditions should be considered and the policy most suited to each particular farm and its operator adopted.

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An Economic Analysis of Alternative Dairy Herd Replacement Policies on Grade A Dairy Farms In The Knoxville Milkshed

by

Luther H. Keller and Thomas W. Little*

INTRODUCTION

Commercial dairy farmers in Tennessee replace between one-fourth and one-fifth of the cows in their milking herds annually. It is estimated that Grade A dairymen in Tennessee need about 40,000 milk cows annually for replacement animals. Total value of these animals would likely exceed \$10,000,000. These replacements are procured in one of the following ways: raising the replacements on the home farm; buying calves, bred heifers, or cows; contracting with a grower to raise the needed replacements; or some combination of these methods.

Traditionally dairy farmers have considered the dairy heifer enterprise an essential part of their operation. A general feeling has prevailed that the raising of replacement stock from the best cows is the only means of assuring quality replacements. In Tennessee, raising of replacements is by far the most common method of obtaining replacements; however, purchasing and contracting as alternative policies are becoming more acceptable with improved channels of marketing information, improved livestock health standards, more widespread use of production testing, and a greater degree of farm specialization.

Interest in growing heifers on contract has increased in recent years. A contractual arrangement permits a milk producer to acquire replacements of similar quality to the rest of his herd, thus avoiding buying animals of unknown ancestry. Under a contractual arrangement, the milk producer agrees to pay a grower a stated amount to raise heifers produced from his own cows or heifers which he has purchased. This arrangement or a purchasing policy should permit the milk producer to increase the size of his milking herd by releasing labor, management, land, buildings, equipment, capital, feed, and other factors of production required by the heifer enterprise.

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In an effort to provide useful information on alternative replacement policies to Tennessee dairy farmers, a study was made in 1963 to obtain data on replacement policies of Grade A dairy farms in the Knoxville Milkshed.

THE STUDY

Basic information for the study was obtained through personal interviews with 153 Grade A dairy farmers who market their milk products under the Knoxville Milk Marketing Order. The Knoxville Milkshed at the time of this study included all or parts of 23 East Tennessee counties. The counties included in the Milkshed and the number of producers per county as of December, 1963, are shown in Figure 1. A random sample of 20% of the farms were selected for this study. Data were obtained to provide information on the following: land resources and their use, characteristics and management of dairy herds, current replacement policies, attitudes of the farmers toward various replacement policies, physical resources of the farms, dairy heifer husbandry, and labor availability.

Small, medium, and large farms were defined in terms of the number of cows, both milking and dry, in the herds. A small farm was defined as a farm with 30 or fewer cows; a medium farm as one with from 31 to 49 milk cows; and a large farm as one with 50 or more milk cows. The sample of farms studied included 65 small, 49 medium, and 39 large farms.

Estimates of costs and returns on a small, a medium, and a large case farm were developed when raising, buying, and contracting were used as separate replacement policies on each of the farms.

DESCRIPTION OF THE CHARACTERISTICS AND ORGANIZATION OF DAIRY FARMS BY HERD-SIZE GROUPINGS

Dairy herds varied in size from 9 to 180 cows in the sample of farms studied. In the description of the characteristics and organization of the dairy farms which follows, contrasts will be made between the small, medium, and large farms.

Milking Herds

The average number of milk cows per herd on the small, medium, and large farms was 23, 39, and 72, respectively (Table 1). The small farms had an average of 8% registered cows, the medium

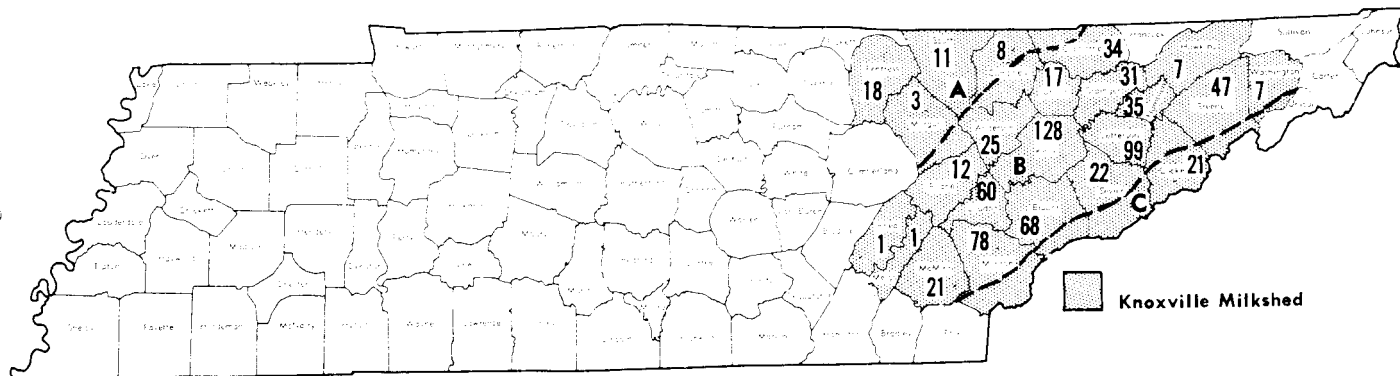


Figure 1. The Knoxville Milkshed and the number of Grade A producers by county, December, 1963.

Table 1. Numbers and kinds of dairy animals by size of herd, 153 Grade A dairy farms, Knoxville milkshed, June, 1963

Dairy animals	Small farms		Medium farms		Large farms		All farms	
	Average per farm	Percent per farm	Average per farm	Percent per farm	Average per farm	Percent per farm	Average per farm	Percent per farm
Cows								
Milking	17.8	77.3	27.7	71.8	54.0	74.6	30.2	74.4
Dry	5.2	22.7	10.9	28.2	18.3	25.4	10.4	25.6
Total	23.0	100.0	38.6	100.0	72.3	100.0	40.6	100.0
Heifers								
1 year of age or older	6.8	58.9	13.0	63.8	22.1	58.6	12.7	60.3
Less than 1 year of age	4.7	41.1	7.4	36.2	15.7	41.4	8.4	39.7
Total	11.5	100.0	20.4	100.0	37.8	100.0	21.1	100.0
Bulls								
All ages	.5	—	.8	—	2.1	—	1.0	—

farms 9%, and the large farms 25%. About 46% of the cows on the small and medium farms were bred artificially, while only 31% of the cows on the large farms were bred artificially.

Replacement Animals

Small farms reported an average of 12 dairy heifers per farm, the medium farms 20 and the large farms 38. This is an average of about 50% as many heifers as cows for all farms. Heifers over 1 year of age comprised about 59% of all heifers and averaged 31% of the total number of cows. The large farms had about 31% registered heifers, while the small and medium farms had only 7% each.

Breeds of Dairy Cattle

The Holstein breed was the major breed of dairy cattle on the sample farms. Of the 153 farms, 103 had a majority of Holstein in their herds. The distribution of cows by breed on the entire sample of farms was 62.9% Holstein, 16.5% Jerseys, 12.2% Guernseys, 3.7% Ayrshires, 0.6% Brown Swiss, and 4.1% crossbred animals.

Heifers on the sample farms were 68% Holsteins, 13% Jerseys, 10% Guernseys, and 9% other breeds of cattle. Since a somewhat higher proportion of replacement animals were Holstein than for the milking herd, some trend toward Holsteins was evident.

Milk Production

Milk production per cow per year averaged 6,748 pounds on the small farms, 7,007 pounds on the medium farms, and 7,595 pounds on the large farms. Butterfat test averaged 4.0% on the small farms, 3.9% on the medium farms, and 3.7% on the large farms. Differences in milk production and butterfat test reflect breed differences between sizes of farms. The Holstein was the major breed in each of the farm size groups, but Jerseys and Guernseys were relatively more prevalent on the small farms than on the medium and large farms (Table 2). About 66% of the

Table 2. Average milk production per farm, and per cow, 153 Grade A dairy farms, Knoxville milkshed, July 1, 1962 - June 30, 1963

Type of farm	Average production per farm		Average production per cow	
	Milk	Fat	Milk	Fat
Small farms	153,318	6,211	6,748	270
Medium farms	270,144	10,392	7,007	270
Large farms	549,336	20,770	7,595	287
All farms	292,528	12,424	7,212	278

Table 3. Total acreage owned and land use by size of farm, 153 Grade A dairy farms, Knoxville milkshed, 1963

Land use ¹	Small farms		Medium farms		Large farms	
	Farms reporting	Average acreage per farm	Farms reporting	Average acreage per farm	Farms reporting	Average acreage per farm
	No.	Acres	No.	Acres	No.	Acres
Uses						
Corn (grain)	22	3.9	19	6.2	16	9.9
(silage)	25	4.0	29	9.9	28	24.9
Grass silage	1	.2	3	.8	11	6.9
Tobacco	50	1.0	40	1.2	30	1.6
Other row crops	2	.2	4	.3	2	.1
Wheat	6	.9	3	1.1	5	1.6
Other small grain	13	3.4	18	10.1	19	16.0
Hay:						
Alfalfa	30	6.5	21	7.1	26	22.7
Lespedeza & oat	16	5.7	20	9.4	15	13.1
Other hay	44	14.0	28	23.1	21	22.4
Permanent pasture	62	51.9	47	99.0	39	152.2
Temporary pasture:						
Summer	5	.4	8	2.3	6	4.1
Winter	10	1.8	14	5.4	9	6.7
Woodland	51	25.5	42	28.1	34	54.4
Idle-waste	18	3.6	12	4.5	11	5.1
Farmstead	51	2.5	45	2.9	36	5.0
Total	65	125.5	49	179.5	39	307.2

¹The total acres obtained by adding the acreages by use is greater than the acres owned due to double cropping on some acreages.

cows on the medium and large farms were Holstein as compared to 54% on the small farms.

Land Resources

The farm ownership unit averaged 100 acres of openland for the small farms, 151 acres of openland for the medium farms, and 253 acres of openland for the large farms (Table 3). In terms of intensity, the average total openland acres per milk cow was 4.3 for the small farms, 3.9 for the medium farms, and 3.5 for the large farms. Including rented land, average acreage of openland per milk cow was 5.6 for small farms and 4.6 for medium and large farms.

Corn was grown for grain on 37% of the farms and for silage on 53% of the farms. Corn silage increased in importance as a source of feed as the farm size increased.

Grass silage was very limited on the small and medium farms with a combined total acreage of 49 acres being grown by four producers. Eleven producers on the large farms grew a total of 269 acres, or an average of about 25 acres each. For all large farms, grass silage averaged less than 7 acres per farm.

Tobacco, the principal cash crop grown, was produced on 78% of the farms. Tobacco acreage varied from an average of 1 acre on the small farms to 1.6 acres per farm on the large farms.

Hay was grown on about 20% of the owned openland, being exceeded only by acreage of permanent pasture. Alfalfa hay was grown by 50% of the farmers, but only on the large farms did the average alfalfa acreage per farm exceed what is termed "other hays," which includes the grasses and mixed grass-legume hays. Lespedeza and oats for hay were grown more often on the small and medium farms than on the large farms. Including rented land that was used for the production of hay, about 2.6 acres of hay was grown per milk cow including the associated replacement stock.

Permanent pasture was the predominant land use and accounted for 55% of openland on small farms, 69% on medium farms, and 63% on large farms. Including rented land used for pasture, about 2.8 acres of permanent pasture was provided for each cow and associated replacement stock. Usually permanent pasture on rented land was used to pasture heifers and dry cows, especially when the pasture was separated from the home tract.

About 12% of the 153 farms reported use of temporary summer pasture and about 22% reported temporary winter pasture.

Average acreage per farm for each type of temporary pasture is shown in Table 3 for each of the three farm size groups.

About 54% of the farms rented additional land for their dairy operation. The 65 small farms rented an average of 30 acres per farm; the 49 medium farms an average of 25 acres; and the 39 large farms an average of 82 acres. Rented land was used primarily to grow small grain, corn, hay, and pasture. Of the 153 sample farms, 2 rented out a total of 30 acres to other people.

Labor Force

The average total days of farm labor available was 400 days for the small farms, 554 days for the medium farms, and 915 days for the large farms. Labor available per milk cow and associated replacement animals averaged 17, 14, and 13 days, respectively, for the small, medium, and large farms (Table 4).

Table 4. Average days of labor available by source and by farm size, 153 Grade A dairy farms, Knoxville milkshed, June, 1963

	Average labor supply per farm		
	Small farms	Medium farms	Large farms
	Number of days		
Operator	196	210	228
Family	70	79	110
Tenant	72	128	317
Regular hired	19	82	180
Seasonal labor	43	55	80
All sources	400	554	915
Days per milk cow	17	14	13

Hired labor became a more important proportion of the total labor supply as the size of the dairy herd increased. Operator and family labor accounted for 67% of the labor force on the small farms, 52% of the labor force on the medium farms, and 37% of the labor force on the large farms.

Feed Supply

On the larger farms a greater proportion of the grain-feed supply was produced on the farm as compared to the small farms where grain supply was more generally purchased. The percentage of farmers buying 90% or more of their concentrate rations was 64%, 55%, and 43% for the small, medium, and large farms, respectively.

Milking Facilities

Among the dairy farms, 103 used a conventional stanchion milking barn, while 50 used some form of walk-through parlor.

At current production rates, bulk tank capacity appeared to be adequate. On a per cow basis, tank capacity averaged 10 gallons per cow on the small farms, 8.4 gallons per cow on the medium farms, and 7.6 gallons per cow on the large farms. Since milk collection was every other day, in most cases capacity per day would be one-half these amounts.

EXISTING REPLACEMENT POLICIES

Rate of Replacement

During the 12-month period of July 1, 1962, to June 30, 1963, 20.5% of the milk cows included in the sample of farms were replaced (Table 5). If we assume the sample of 153 farms included in the survey is representative of all farms in the Knoxville Milkshed, the estimated number of replacement animals needed per year in this market area would be about 6,300.

Reasons for Culling Cows

Low production was the major reason given for culling and accounted for 56% of the animals removed from the herd on the small farms, 59% on the medium farms, and 66% on the large farms (Table 5). Twenty-two percent of the small farms used some form of production testing: the Dairy Herd Improvement Association program, the Holstein Improvement Registry program, the Weigh-a-Day-a-Month program, or a self-conducted program of testing. On the medium farms, 29% used production testing and on the large farms, 100% followed some program of production testing.

Disease and breeding difficulties were important culling factors and accounted for 12% and 10%, respectively, of all animals removed from the herd during the 12-month period. About 7% of the removals were due to death.

Source of Replacements

The cows that were removed were replaced by animals from three sources: 1) raised heifers which freshened, 2) purchased heifers which freshened, and 3) purchased cows. From July 1, 1962, through June 30, 1963, 1,259 cows were removed from the herds and 1,330 cows were added. This was a 1% increase in the total number of milk cows during the period (Table 6).

Table 5. Number of cows removed by farm size groups and reasons for their removal, 153 Grade A dairy farms, Knoxville milkshed, July, 1962 through June, 1963

Reason for removal	Small farms		Medium farms		Large farms		All farms	
	Number removed	Percent of total removed	Number removed	Percent of total removed	Number removed	Percent of total removed	Number removed	Percent of total removed
Low production	166	55.6	218	53.6	386	65.5	770	61.1
Disease	47	15.7	47	12.6	54	9.2	148	11.8
Breeding difficulties	22	7.3	36	9.7	70	11.9	128	10.2
Died	30	10.0	25	6.7	36	6.1	91	7.2
Age	27	9.1	42	11.3	20	3.4	89	7.1
Other	6	2.3	4	1.1	23	3.9	33	2.6
Total ^a	298	100.0	372	100.0	589	100.0	1,259	100.0

^aDuring the 12 months, removals for all reasons average 20.0% of the dairy cows on the small farms, 20.3% on the medium farms, 20.9% on the large farms, and 20.5% on all farms.

Of the 1,330 cows added on the sample farms, 74% were heifers raised on the farm, 10% were purchased heifers which freshened after purchase, and 16% were purchased as cows. Raised replacement heifers accounted for 73% of the total replacements on the small and large farms and for 76% of the total replacements on the medium farms.

Farmers' Reasons for Following a Particular Replacement Policy

Sixty-nine percent of the farmers indicated they usually raised all of their herd replacements. This method was preferred because of a better knowledge of the breeding of their replacements, and a general feeling that it was cheaper to raise replacements than to buy them. Objections to buying included: 1) "can't buy quality replacements," 2) "don't know the breeding of purchased replacements," 3) "run greater risk of introducing disease with purchased animals," and 4) "purchased animals are too expensive."

Of the 31% of farmers who regularly bought part or all of their replacements, their reasons for buying varied by size of farm. On the small farms, reasons given included a shortage of land and a desire to obtain new bloodlines which they believed would improve the quality of their herds and increase milk and/or butterfat production. On the medium farms, limited land was not a major reason. Reasons given were primarily a desire to improve the quality of the herds and to increase production. Some farmers felt that replacements could be purchased cheaper than they could be raised. On the large farms a shortage of land and the acquisition of breeding stock were reasons most often stated for buying replacement animals.

Prices Paid for Purchased Animals

The price of purchased replacement animals varied with age, pedigree, and breed. The average prices of purchased animals were based on prices paid by farmers in the sample for about 340 replacements during the year July 1, 1962, through June 30, 1963. Calves under 1 year of age averaged \$130 per head. The unbred heifers 1 year of age and older averaged \$175 per head. Bred heifers averaged \$246 per head and milk cows averaged \$225 per head.

Purchased Replacements Versus Raised Replacements

Of the 47 farmers who regularly buy some or all of their replacements, 77% said they experienced no problems or difficulties with purchased animals that were not experienced with raised

Table 6. Number of cows added by source and size of farm, 153 Grade A dairy farms, Knoxville milkshed, July 1, 1962 to June 30, 1963

Replacements and source	Small farms			Medium farms			Large farms		
	Cows added	Average per farm	Percent by source	Cows added	Average per farm	Percent by source	Cows added	Average per farm	Percent by source
Total number of cows added to the milking herd for the year July 1, 1962, to June 30, 1963	311	4.8	100.0	429	8.8	100.0	590	15.1	100.0
Number of raised heifers which freshened and were added to the milking herd	228	3.5	72.9	328	6.7	76.1	433	11.1	73.4
Number of purchased heifers which freshened and were added to the milking herd	21	.3	6.3	49	1.0	11.4	61	1.6	10.3
Number of purchased cows added to the herd	62	1.0	20.8	52	1.1	12.5	96	2.4	16.3

dairy replacements. Eleven percent said purchased animals were more temperamental and 6% felt that disease and poor quality were more of a problem with purchased animals than raised animals. About 92% felt that purchased replacements produced as well or better than raised replacements. At the time of the study, 34% of all milk cows on the sample farms had been purchased as replacements.

Acquiring Replacements on a Contractual Basis

During the interviews farmers were presented with the hypothetical proposition:

In some cases farmers are having their replacement animals produced on a contract basis, i.e., heifer calves to be kept for replacement purposes are raised by another farmer from shortly after birth to shortly before the first calving on a contract basis. The usual cost of having replacements produced in this manner is from \$175-\$200. If you could find a farmer whom you feel would do a good job of raising your replacements, would you be willing to pay to have your replacements raised by another farmer?

Thirty-nine percent of the operators of small and medium farms, and 38% of the large farms gave a "Yes" answer to this question. Farmers who said "No" to this question generally felt they could raise replacements for less than \$175-\$200, and/or the quality of replacements could be controlled adequately only if they were raised on his own farm.

Feeding of Replacements

The age at which calves were taken from their dams varied, but averaged about 9 days for the sample farms. Milk replacer was used by about 65.7% of the farmers to feed calves to an average weaning age of from 60-75 days. A nurse cow or whole milk fed from a teat bucket was the method of feeding by the other 35% of the farmers.

The weaning period was generally followed by a period of 4.5 to 5.5 months of concentrate feeding of the heifers. A home-mixed ration was the most commonly used concentrate. Home-mixed rations generally consisted of corn, oats, a protein supplement, and salt. Hay, bran, and purchased concentrates were used occasionally. About 50% of the farmers reported a period of concentrate feeding before freshening.

Hay was fed to heifers in some cases at less than 1 month of age and by all farmers by the age of 4 months. Mixed grass and legume hay and alfalfa hay were the two predominant kinds of

hay fed to heifers. Silage was not commonly fed to heifers before 1 year of age. It was fed to those over a year old on 26% of the small farms, 47% of the medium farms, and 54% of the large farms.

Special pasture was provided young replacement stock on 26% of the small farms, 82% of the medium farms, and 67% of the large farms. The pasture used for heifers could be used for pasturing milk cows on about two-thirds of the farms. In the other cases, the pasture was too inaccessible to be used for milking cows. Farmers estimated that these acreages now being used only for replacement stock would provide pasture for an average of 1.8, 5.3, and 6.1 cows per farm, respectively, on the small, medium, and large farms.

Special Building Facilities for Heifers

Thirty-four percent of the small farms, 53% of the medium farms, and 56% of the large farms had special building facilities for heifers. In each farm-size group, more than half of the farms with such facilities could use them to house milk cows. On the small farms, an average of 3 additional cows could be accommodated in these specialized facilities, on the medium farms 4 additional cows, and on the large farms, 11 additional cows.

ESTIMATED COST OF RAISING A DAIRY HERD REPLACEMENT TO A CALVING AGE OF 27 MONTHS

The actual cost of raising a dairy heifer to a calving age of 27 months was estimated to be \$238.60 (Table 7), assuming the more common practices found on the survey farms.

The initial value of the calf was assumed to be \$30. The average price received by farmers in the study for calves from 3 to 10 days of age was only \$20, but good quality calves which are saved for replacements were likely to be somewhat more valuable.

Feed cost was the largest cost item of raising a replacement animal.

It was estimated that 37.5 pounds of milk replacer, 1,100 pounds of grain, 552 pounds of a legume hay, 3,065 pounds of a grass and legume or grass hay, and 2.4 acres of orchardgrass and white clover pasture were needed to raise a heifer calf to a calving age of 27 months. Milk replacer was valued at \$19.50 per hundred-weight, concentrate at \$68.00 per ton, legume hay at \$33 per ton, grass hay or grass and legume hay at \$28 per ton, and pasture,

at \$11.20 per acre. The resulting total feed cost for the 27-month period was \$123.60 per replacement.

It was assumed that 37 hours of labor were required per calf over the 27-month period. With an assumed labor cost of \$1.00 per hour, labor cost amounted to \$37.00 per replacement. Other expenses such as bedding, buildings and equipment, breeding fees,

Table 7. Estimated cost of raising a dairy heifer to 27 months of age

Item	Amount	Unit price	Cost	Amount
				\$ 30.00
Value of calf at birth				
Feed ^a				
Milk replacer ^b	37.5 lbs.	\$19.50 cwt.	\$ 7.31	
Concentrate ^c	1100.0 lbs.	68.00 per ton	37.40	
Hay (0-6 months of age) ^d	552.0 lbs.	33.00 per ton	9.10	
Hay (6-27 months of age) ^e	3065.0 lbs.	28.00 per ton	42.91	
Pasture ^f	2.4 acres	11.20 per acre	26.88	
Total feed cost				123.60
Labor	37.0 hrs.	1.00 hr.		37.00
Other^g			10.00	
Bedding			6.00	
Buildings & equipment			7.00	
Breeding fees			9.00	
Veterinary fees & drugs			13.00	
Interest on investment			3.00	
Miscellaneous				48.00
Total other cost				\$238.60
Estimated total cost of raising a replacement				

^aFeeding requirements were derived from Morrison's "Feeds and Feeding" for a Holstein heifer which was assumed to weigh around 1200 pounds at about 27 months of age. Feeding practices of farmers in this study were assumed and supplemented by recommended practices to provide the necessary nutrient requirements specified by Morrison.

^bMilk replacer fed approximately 60 days.

^cA home-mixed dairy ration containing corn, oats, cottonseed oil meal, and salt, providing approximately 11.6% digestible protein was assumed to be fed.

^dA legume hay was assumed to be fed to calves less than 6 months of age.

^eGrass or mixed grass and legume hay was assumed to be fed to calves over 6 months of age.

^fPasture was calculated on a hay-equivalent basis. Since 281 days of pasture are required to raise a calf to 24 months of age, it was assumed that 300 cow-acre days would be required to raise a 27-month-old heifer if it was born in the fall. It was assumed that 125 cow-acre days would be provided per acre of pasture at a cost of \$11.20 per acre. One cow-acre day equals 25 pounds of dry-feed equivalent.

^gEstimates were synthesized from survey data and the following studies: **Cost and Returns in Raising Dairy Heifers, Six Farms, Orange County, Florida, 1960**, by A. F. Cribbett and R. E. L. Green, University of Florida; **Cost and Returns in Raising Dairy Heifers**, by L. C. Cunningham, Cornell University; **Cost and Methods of Obtaining Holstein Heifers on Oklahoma Dairy Farms**, by Clark Edwards, Oklahoma State University; and **Economic Considerations in Raising Dairy Replacements**, by John W. Jack, Cornell University.

veterinary fees and drugs, interest, and miscellaneous cost amounted to \$48 per replacement.

If the replacements cost \$238.60 to raise and \$300.00 to purchase, it would appear that raising would be the most profitable replacement policy to follow. This, however, is not necessarily the case. In raising replacements, resources are allocated to this enterprise which might have a higher opportunity cost or more profitable alternative.

OPPORTUNITY COST

The opportunity cost of using a resource in one way is the return that would be received from the resource when used in its most profitable alternative.

An illustration of opportunity cost is presented in the following example. Assume a farmer raising his replacements had a return to operator labor, capital, and management of \$6,000. If the farmer could switch to a policy of 100% purchased replacements and his net return to operator labor, capital, and management would increase to \$6,500, he is foregoing the opportunity to operate under a policy of purchasing and the associated \$6,500 income — his opportunity cost of raising his replacements. The net difference in returns of \$500 is the reduction in income as a result of not using the most profitable replacement alternative.

COMPARISON OF COSTS AND RETURNS FOR ALTERNATIVE REPLACEMENT POLICIES ON A SMALL, MEDIUM, AND LARGE CASE FARM

Farm budgeting techniques were used to estimate the opportunity cost of raising, buying, and contracting replacement policies on different sizes of farms.

Case farms were selected from each size group to typify farms of that group as much as possible with respect to such factors as acreage, number of dairy cows, size of labor force, and production of feed grains. Budgeting techniques were then used to estimate the most profitable resource use for the farm under 1) a policy of raising all of the replacement heifers and 2) a policy of purchasing all of the replacements. Each of the plans was developed within the limits imposed by the particular soils, present acreage limitations, labor force, and building space on the case farm. A comparison of a contracting policy with the purchasing policy was also made.

A herd production rate of 10,000 pounds of milk per cow was assumed, and replacement animals whether raised or purchased were assumed to be of sufficient quality to maintain output at this level. In shifting from the use of raised to purchased replacements, milk cow numbers on the case farms were expanded to utilize the resources "released" from heifer production but within the limits of the land, labor, and building space assumed for the plan developed when all replacements were raised. The comparisons which follow are highly dependent on the input-output and cost-price relationships assumed for the study.

In developing the comparisons of the cost and returns of the three replacement policies, it was necessary to develop estimates of crop production capabilities, feed requirements, and labor needs. The survey provided the basic information on labor availability, field layouts, buildings, equipment, and other physical resources.

SMALL CASE FARM

Land Use. The small case farm contained 120.4 acres of land including 100 acres of openland. Soils on the farm varied from shallow sloping soils with outcropping rock to bottom soils which were moderately deep. To determine the productive capacity of the cropland, a soil map was obtained from the soil conservation agent in the county in which the farm was located. The estimated productivity of each field was then based on the predominant soil type with the assumption that the management level was above average. It was estimated that the 100 acres of productive land would yield 6,757 cow-acre days of grazing, 35 tons of alfalfa hay, 41 tons of clover-orchardgrass hay, 165 tons of corn silage, and 2,530 pounds of burley tobacco per year (Table 8).

Changes in cropland use when shifting from a policy of raising replacements to buying them would be minor. The limited capacity of the silo prevented expansion of the silage enterprise. Thus, to fulfill the additional roughage requirements when the milking herd was expanded under a policy of purchasing, the amount of hay fed per cow was increased. To grow the additional hay required, a temporary field boundary was changed. This provided 2.8 additional acres for hay production which was enough to provide the additional hay requirements.

Livestock numbers under a policy of raising and a policy of purchasing. It was estimated that 26 cows, 6 yearling heifers, and 8 heifer calves was the maximum number of animals that could be

**Table 8. Estimated production of crops, small case farm,
Knoxville milkshed, 1963**

Crop	Unit	Average yield ^a per acre	Acres	Expected production
Permanent pasture	CAD ^b	110.6	61.1	6,757
Hay:				
Alfalfa	Tons	3.5	10.1	35
Clover-Orchard grass	Tons	2.5	16.7	41
Corn silage	Tons	15.0	11.0	165
Burley tobacco	Lbs.	2,300	1.1	2,530
Total acres of cropland			100.0	

^aAdapted from **Knox County, Tennessee Soil Survey** by Wallace Roberts and others of the Soil Conservation Service, U. S. Department of Agriculture, U. S. Government Printing Office, 1955.

^bCow-acre days of grazing.

carried on this farm when raising all needed replacements. When a policy of contracting or buying replacements was followed, it was estimated that 32 milk cows could be carried.

Feed requirements. The yearly feed requirements for a milk cow were estimated to be 2,215 pounds of concentrate, 6.2 tons of silage, 2.0 tons of alfalfa hay or its equivalent, and 180 cow-acre days of pasture. For a yearling 1 year of age or older, feed requirements were estimated to be 242 pounds of concentrate, 1.6 tons of alfalfa hay, and 130 cow-acre days of pasture. For a calf less than 1 year of age, it was estimated that 805 pounds of concentrate, 1.1 tons of alfalfa hay, and 80 cow-acre days of pasture would be required, assuming the calf is born in the fall. These feeding rates, when combined, resulted in a total feed requirement for a herd of 26 cows and 18 heifers of 65,482 pounds of concentrate, 161 tons of corn silage, 70.4 tons of alfalfa hay or its equivalent, and 6,100 cow-acre days of pasture (Table 9). Concentrates would be purchased.

If replacements were purchased, 6 additional cows could be added to the herd to use the released resources. This new total of 32 cows would require 70,880 pounds of concentrate, 160 tons of silage, 77 tons of alfalfa hay or its equivalent, and 5,760 cow-acre days of pasture. With the silo capacity limiting the available supply of silage, each cow now would receive only 5 tons of silage per year. The reduction of 1.2 tons in silage per cow was compensated for by an increase of .4 ton of alfalfa hay per animal.

The shift from a raising policy to a purchasing policy brought

Table 9. Estimated feed requirements for dairy herd when raising replacements and when purchasing replacements, small case farm, Knoxville milkshed, 1963

Type of replacement policy	Number of animals	Concentrate requirements		Silage		Roughage requirements		Pasture	
		Pounds per animals	Total pounds	Tons per animal	Total tons	Hay		CAD ^a per animal	Total CAD needed
						Tons per animal	Total tons		
100% raised				6.2	161	2.0	64.0	180	4,680
Milk cows	26	2,215	57,590						
Yearlings (1 yr. of age or older)	6	242	1,452	—	—	1.6	9.6	130	780
Calves (less than 1 yr. of age)	8	805	6,440	—	—	1.1	8.8	80	640
Total requirements	—	—	65,482	—	161	—	70.4	—	6,100
100% purchased				5.0 ^b	160	2.4	77.0	180	5,760
Milk cows	32	2,215	70,880						
Change in requirement when shifting from a policy of raising to purchasing			+5,398 lb.		—1 Ton		+6.6 Ton		—340 CAD

^aCow-acre days of grazing.

^bNo additional silage is produced, therefore, the quantity fed per head is reduced; hay is increased to compensate for the reduction in silage.

about the following change in feed requirements after the milking herd was expanded under the purchasing policy: a need for an additional 5,398 pounds of concentrate, 1 ton less of silage, 6.6 additional tons of alfalfa hay, and 340 less cow-acre days of pasture.

The change in concentrate requirements would pose no production problem as all concentrates would be purchased, and the additional hay requirement would be met by shifting 2.8 acres of surplus pasture to hay production.

Labor force requirements. To produce the crops and care for the livestock enterprises under a policy of raising replacements, an estimated total of 3,115 hours of labor would be required (Table 10). The 26 cows required a total of 1,949 hours of labor and the

Table 10. Estimated annual labor requirements when purchasing or raising replacements, small case farm, Knoxville milkshed, 1963^a

Enterprise	Raising replacements		Purchasing replacements	
	Size of enterprise	Labor requirements (Hours)	Size of enterprise	Labor requirements (Hours)
Milk cows	26 head	1,949	32 head	2,240
Heifers and calves	14 head	323	None	None
Clover and orchardgrass hay	16.8 acres	97	19.5 acres	114
Alfalfa hay	10.1 acres	106	10.1 acres	106
Corn silage	11.0 acres	66	11.0 acres	66
Burley tobacco	1.1 acres	422	1.1 acres	422
Permanent pasture	61.1 acres	152	58.3 acres	146
All enterprises		3,115		3,094

^aAdapted from "Labor Requirements on Tennessee Farms," by W. P. Ranney, University of Tennessee Agricultural Experiment Station, Bulletin No. 316, Knoxville, 1960.

heifers 323 hours. Tobacco, the second largest user of labor, required 422 hours for the year. Labor requirements for this system would be fairly evenly distributed throughout the year.

When the replacement policy was changed from raising to purchasing, the milking herd could be expanded from 26 to 32 cows. After the crop adjustments were made, the total labor requirements declined 21 hours. The four enterprises affected were: cows, heifers, white clover and orchardgrass hay, and pasture. The labor requirements for caring for heifers was removed, and pasture labor requirements were reduced. Labor requirements for hay and milk cows increased (Table 10).

The total labor required when buying replacements was 3,094 hours or 21 hours less than the requirement for the system involving raising of replacements. This was 906 hours less than the

average amount of labor available on the farms in the small farm grouping. Since labor was required for maintenance of facilities, equipment, etc., 4,000 man hours was assumed to be the necessary labor force on this farm. Assuming that the operator supplies 2,600 hours, 1,400 hours of hired labor would be required when raising replacements, and 21 hours less would be required when buying replacements.

Opportunity costs. In developing budgets from which the opportunity costs and a comparison of the costs and returns could be derived, it was necessary to make additional assumptions. The assumptions which were made and which apply as well in the planning of the medium and large case farms are as follows: 1) 10,000 pound production rate with 9,900 pounds of marketable milk per cow; 2) 3.7% butterfat test for the milk; 3) culled cows would weigh 1,300 pounds and bring \$0.12 per pound; 4) heifers would be culled at 1 year of age¹; 5) a 14% total protein concentrate ration consisting of corn, oats, a protein supplement, molasses, and salt was assumed to be fed; 6) labor could be hired for \$1.00 per hour; and 7) purchased replacements would cost \$300 per head.

Using these assumptions, budgets for the small farm when raising 100% of the needed replacements and when purchasing 100% of the needed replacements were developed (Table 11). The total revenue when raising 26 cows, 6 yearling heifers, and 8 heifer calves was estimated to be \$16,081. Total expenses were estimated to be \$8,953 which meant that the net return to operator labor, capital, and management was \$7,129 (Table 11).

When the farm operation plan included a purchasing replacement policy, the maximum herd size was 32 cows and the total revenue was estimated to be \$19,347. Total expenses were estimated to be \$11,421 and net return to operator labor, capital, and management was \$7,926 (Table 11).

The net difference in returns of the two systems for this case farm was \$797. Based on the estimates used in this analysis, purchasing would be the most profitable alternative for this farm. The farmer in this instance would be able to pay as much as \$414 for his replacements and still maintain the same returns to operator labor, capital, and management as he would have received from a system using raised replacements.

¹Some farmers keep only the number of heifer calves necessary for replacements, while others keep more than needed for replacements and cull after the first lactation when production potential can be more accurately determined.

Table 11. Comparison of cost and returns for the small case farm with alternate replacement policies,
Knoxville milkshed, 1963

Item	Unit	Price ^a	100% raised replacements		100% purchased replacements	
			Quantity ^a	Value	Quantity ^a	Value
Revenue:						
Milk	Cwt.	\$ 5.10	2,574	\$13,127.40	3,168	\$16,156.80
7-day old calves	Head	20.00	15	300.00	29	580.00
Culled cows	Head	156.00	6	936.00	7	1,092.00
Culled heifers	Head	100.00	2	200.00	—	—
Tobacco	Lbs.	.60	2,530	1,518.00	2,530	1,518.00
Total				16,081.40		19,346.80
Expenses:						
Concentrate	Ton	64.00	32.7	2,092.80	35.4	2,265.60
Corn silage	Acre	24.65	11.0	271.15	11.0	271.15
Alfalfa hay	Acre	22.32	10.1	225.43	10.1	225.43
Grass & clover hay	Acre	11.20	16.7	187.04	19.5	218.40
Pasture	Acre	11.20	61.0	683.20	58.3	652.96
Milk replacer	Cwt.	19.50	3.0	58.50	—	—
Breeding fees	Head	7.00	26.0	182.00	32.0	224.00
DHIA testing ^b	Year	—	—	170.40	—	202.80
Milk hauling	Cwt.	.22	2,574	566.28	3,168	696.96
Vet. fee & drugs	Year	—	—	160.00	—	165.00
Dairy supplies	Year	—	—	104.00	—	128.00
Bedding	Year	—	—	160.00	—	175.00
Electricity	Year	—	—	140.00	—	148.00

Table 11 (continued)

Item	Unit	Price ^a	100% raised replacements		100% purchased replacements	
			Quantity ^a	Value	Quantity ^a	Value
Tractor fuel	Year	—	—	288.00	—	288.00
Trucking fees	Year	—	—	14.00	—	14.00
Marketing fees ^c	Year	—	—	28.74	—	30.03
Harvesting silage	Ton	2.50	165	412.50	165	412.50
Tobacco	Acre	199.54	1.1	219.49	1.1	219.49
Replacements	Head	300.00	—	—	7	2,100.00
Subtotal				5,963.53		8,437.32
Equipment cost				1,274.16		1,289.66
Building cost				314.90		314.90
Hired labor ^d				1,400.00		1,379.00
Total expenses				8,952.59		11,420.88
Net returns to operator labor, capital, and management				7,128.81		7,925.90
Difference in net returns						797.09

^aEstimates of prices and quantities were adapted primarily from the following sources: unpublished data of the Department of Agricultural Economics, University of Tennessee; **Agricultural Prices**, Statistical Reporting Service, U. S. Department of Agriculture; **Cost and Returns from Livestock Production in the Limestone Valley Areas of Alabama**, Agricultural Experiment Station, Auburn University; **Production Requirements and Estimated Returns from Selected Crop and Livestock Enterprises in the Piedmont Area** by Charles P. Butler and Thomas A. Burch, South Carolina Agricultural Experiment Station; **Estimated Cost and Returns for Selected Crop and Livestock Enterprises in the Southern Piedmont Area of Virginia**, Virginia Agricultural Experiment Station; and **Farm Management Manual**, Department of Agricultural Economics, North Carolina State University.

^bDHIA monthly production testing charges were computed on the basis of \$0.45 per head for 21-40 cows, \$0.40 per head for 41 or more cows, plus \$2.50 for technician travel expenses.

^cThree percent of the gross value of culled cows.

^dFourteen hundred hours of labor were hired at the rate of \$1.00 per hour when raising replacements. Twenty-one hours less were required when a change in policy was made from raising to purchasing replacements.

MEDIUM CASE FARM

Land Use. This farm contained 234.4 acres of land and included 195.8 acres of openland. The predominance of moderately sloping land made the use of a cover crop a recommended practice for conservation purposes and resulted in some double cropping. Most of the soils were well suited to the production of forage crops and small grains. The cropping system developed would yield a total of 11,569 cow-acre days of pasture, 216.4 tons of hays, 286 tons of corn silage, and 890 bushels of oats (Table 12).

Table 12. Estimated production of crops, medium case farm, Knoxville milkshed, 1963

Crop	Unit	Average yield per acre ^a	Acres	Expected production
Permanent pasture	CAD ^b	113.8	91.3	10,390
Annual pasture	CAD ^b	78.0	15.1	1,179
Hay:				
Alfalfa	Tons	3.37	57.3	193.1
Clover-orchardgrass	Tons	2.30	8.3	19.1
Lespedeza	Tons	.90	4.7	4.2
Corn silage	Tons		19.1	286
Oats	Bu.	45.00	(19.8) ^c	890
Total acres of cropland			195.8	

^aAdapted from the **Blount County, Tennessee, Soil Survey** by Joe A. Elder and others of the Soil Conservation Service, U. S. Department of Agriculture, U. S. Government Printing Office, 1959.

^bCow-acre days of grazing.

^cDouble cropped acreage.

The same land-use system would be adequate both for the policy of raising and that of buying replacements. In the system involving raising of replacements, about 100 tons of surplus hay could be sold. When changing to a policy of buying replacements, about 78 tons of hay could be sold.

Livestock numbers under a replacement policy of raising and a policy of purchasing. Under a policy of raising replacements, the number of milk cows that could be carried was estimated to be 45. In order to provide adequate replacements, 10 yearlings 1 year of age and older and 13 calves less than 1 year of age would be needed.

Table 13. Estimated feed requirements for the dairy herd when raising replacements and when purchasing replacements, medium case farm, Knoxville milkshed, 1963

Type of replacement policy	Number of animals	Concentrate requirements		Roughage requirements					
				Silage		Hay		Pasture	
		Pounds per animals	Total pounds	Tons per animal	Total tons	Tons per animal	Total tons	CAD per animal	Total CAD needed
100% raised:									
Cows	45	2,215	99,675	6.2	279	2.0	90.0	180	8,100
Yearlings (1 yr. of age or older)	10	242	2,420	—	—	1.6	16.0	130	1,300
Calves (less than 1 yr. of age)	13	805	10,465	—	—	1.1	14.3	80	1,040
Total requirements	—	—	112,560	—	279	—	120.3	—	10,440
100% purchased:									
Cows	58	2,215	128,470	4.8	279	2.45	142.0	180	10,440
Change in requirements when shifting from a policy of raising to purchasing			+15,910	—	—	—	+21.7		

*Since no additional silage is produced, the quantity fed per head is reduced. The quantity of hay fed is increased to compensate for the reduction in silage.

If the replacement policy was changed from raising to purchasing and the herd expanded to utilize resources previously used for heifers, 13 additional cows could be added, which would increase the milking herd to 58 cows.

Feed requirements. Using the same feed requirements for each animal as used on the small case farm, the medium case farm would require a total of 112,560 pounds of concentrate, 279 tons of silage, 120.3 tons of hay, and 10,440 cow-acre days of pasture for all livestock for the system involving raising of replacements (Table 13). The concentrate ingredients other than oats would be purchased. The roughage requirements would be adequately met by farm-produced forages.

Silage storage capacity on the farm was fixed at about 280 tons. When the replacement policy was changed to one of purchasing and the size of the milking herd increased from 45 to 58 cows, the available silage per cow was reduced to 4.8 tons. To compensate for the 1.4 tons drop in silage fed per cow, hay was increased to 2.45 tons per cow. Concentrates per cow were held constant at 2,215 pounds per cow and cow-acre days of pasture were held constant at 180 days per cow. The total feed requirements for the system involving purchasing of all herd replacements were 128,470 pounds of concentrate, 279 tons of silage, 142 tons of alfalfa hay or its equivalent, and 10,440 cow-acre days of pasture.

The change in replacement policies with no changes in the cropping system would result in the purchasing of 15,190 additional pounds of concentrate ingredients and would reduce the amount of hay available for sale by 21.7 tons. No change would occur in the total amount of pasture or silage required.

Labor force requirements. There was an average of 5,540 hours of labor available on the medium-size farms. It was estimated that 4,361 hours of labor would be required on this case study farm for all enterprises when using a policy of raising all replacements (Table 14). When the replacement policy was changed from raising to purchasing and the milking herd was expanded from 45 to 58 cows, the required labor force was estimated to be 4,576 hours, an increase of 215 hours. An average of 1,070 hours of labor would be available to make repairs and maintain the equipment, etc.

On this particular farm, a father-son partnership existed. The father and son provided 4,410 hours of the 5,540 hours available for farm work. The additional labor force was hired. One hundred and three days or 1,030 hours of labor was assumed hired

Table 14. Estimated annual labor requirements when purchasing or raising replacements, medium case farm, Knoxville milkshed, 1963^a

Enterprise	Raising replacements		Purchasing replacements	
	Size of enterprise	Labor requirements	Size of enterprise	Labor requirements
		(Hours)		(Hours)
Milk cows	45 head	2,700	58 head	3,306
Heifers and calves	23 head	392	—	—
Clover-orchardgrass hay	8.3 acres	48	8.3 acres	49
Alfalfa hay	57.3 acres	602	57.3 acres	602
Corn silage	21.1 acres	270	21.1 acres	270
Oats followed by lespedeza	19.9 acres	121	19.9 acres	121
Pasture	91.3 acres	228	91.3 acres	228
All enterprises		4,361		4,576

^aAdapted from "Labor Requirements on Tennessee Farms" by W. P. Ranney, University of Tennessee Agricultural Experiment Station Bulletin No. 316, Knoxville, 1960.

when replacements were raised. When the replacement policy changed from raising to purchasing, an additional 214 hours of labor was required.

Opportunity costs. The total revenue of the farming operation when raising 45 cows, 10 yearlings, and 13 heifer calves was estimated to be \$28,325 and total expenses \$12,649. Net returns to operator's labor, capital, and management was, therefore, \$15,676. On this particular farm, net returns were to a two-man, father-son partnership (Table 15).

A farm operation was planned to include a purchasing replacement policy. This farming system would have an estimated total revenue of \$34,675, and total expenses of \$17,388. Net returns to operator(s) labor, capital, and management would be \$17,287 (Table 15).

The difference in net returns between the two systems was \$1,611. This would indicate that purchasing would be the more profitable alternative for this farm. The farmer in this instance would be able to pay as much as \$434 for his replacements and still maintain the same returns to operator labor, capital, and management as he would receive from a system using raised replacements.

Table 15. Comparison of cost and returns for the medium case farm with alternate replacement policies,
Knoxville milkshed, 1963

Item	Unit	Price ^a	100% raised requirements		100% purchased requirements	
			Quantity ^a	Value	Quantity ^a	Value
Revenue:						
Milk	Lbs.	\$ 5.10	4,455	\$22,720.50	5,742	\$29,284.20
7-day old calves	Head	20.00	27	540.00	52	1,040.00
Culled cows ^b	Head	156.00	10	1,560.00	12	1,872.00
Culled heifers	Head	100.00	3	300.00	—	—
Hay: alfalfa,	Ton	33.00	81	2,673.00	59	1,947.00
clover, and grass	Ton	28.00	19	532.00	19	532.00
Total revenue				28,325.00		34,675.20
Expenses:						
Oats	Bu.	.70	—	—	—	87.50
Corn	Bu.	1.25	805.0	1,006.25	919	1,148.75
Cotton seed oil meal	Cwt.	5.00	197.0	985.00	225	1,125.00
Molasses	Cwt.	3.50	56.3	197.05	64.3	225.05
Salt	Cwt.	1.64	11.3	18.53	13.0	21.32
Corn silage	Acre	24.65	21.1	520.12	21.1	520.12
Alfalfa hay	Acre	22.32	57.3	1,278.94	57.3	1,278.94
Clover-orchardgrass hay	Acre	11.80	8.3	97.94	8.3	97.94
Pasture	Acre	11.20	91.3	1,022.56	91.3	1,022.56
Oats and lespedeza	Acre	25.05	19.9	498.50	19.9	498.50
Combining	Acre	6.00	19.9	119.40	19.9	119.40
Milk replacer	Cwt.	19.50	3.3	64.35	—	—
Breeding fees	Head	7.00	45.0	315.00	58	406.00
DHIA ^b	Year	—	45.0	246.00	58	308.40
Milking hauling	Cwt.	.22	4,455	980.10	5,742	1,263.24
Vet. fees & drugs	Year	—	—	270.00	—	285.00

Table 15 (Continued)

Item	Unit	Price ^a	100% raised requirements		100% purchased requirements	
			Quantity ^a	Value	Quantity ^a	Value
Dairy supplies	Year	—	—	180.00	—	232.00
Bedding	Year	—	—	280.00	—	310.00
Electricity	Year	—	—	175.20	—	211.70
Tractor fuel	Year	—	—	576.00	—	576.00
Trucking fees	Year	—	—	26.00	—	24.00
Marketing fees	Year	—	—	42.90	—	51.48
Replacements	Head	—	—	—	12	3,600.00
Subtotal				8,899.84		13,412.90
Equipment cost				2,275.41		2,286.91
Building cost				443.85		443.85
Hired labor ^b				1,030.00		1,244.00
Total expenses				12,649.10		17,387.66
Net returns to operator labor, capital, and management				15,676.40		17,287.54
Difference in net returns ^c						+1,611.14

^aEstimates of prices and quantities were adapted primarily from the following sources: unpublished data of the Department of Agricultural Economics, University of Tennessee; **Agricultural Prices**, Statistical Reporting Service, U. S. Department of Agriculture; **Cost and Returns from Live-stock Production in the Limestone Valley Areas of Alabama**, Agricultural Experiment Station, Auburn University; **Production Requirements and Estimated Returns from Selected Crop and Livestock Enterprises in the Piedmont Area** by Charles P. Butler and Thomas A. Burch, South Carolina Agricultural Experiment Station; **Estimated Cost and Returns for Selected Crop and Livestock Enterprises in the Southern Piedmont Area of Virginia**, Virginia Agricultural Experiment Station; and **Farm Management Manual**, Department of Agricultural Economics, North Carolina State University.

^bDHIA monthly production charges were computed on the basis of 0.15 per head for 21-40 cows, \$0.40 per head for 41 or more cows, plus \$2.50 for technician travel expenses.

^cWhen raising replacements, it was assumed that 1,030 hours of hired labor were required. When buying replacements, 1,244 hours of labor were required. Cost of hired labor was assumed to be \$1.00 per hour.

^dSince this was a father-son partnership, opportunity cost and net returns pertain to capital, father-son's labor, and management.

LARGE CASE FARM

Land use. The large farm contained two parcels of land, a tract owned by the farm operator and a parcel rented within the community. The topography of the land varied from flat, river-bottom land to steep hillsides. The owned tract contained 191.3 acres of land including 172.8 acres of openland. This tract, it was estimated, would annually produce 16,951 cow-acre days of grazing, 454 tons of corn silage, 594 bushels of corn, and 2,760 pounds of burley tobacco (Table 16).

Table 16. Estimated production of crops, large case farm, Knoxville milkshed, 1963

Crop	Acres	Unit	Average yield per acre	Expected production
Operator's farm:				
Permanent pasture	142.3	CAD ^a	119.12	16,951
Corn silage	22.7	Tons	20.00	454
Corn for grain	6.6	Bu.	90.00	594
Burley tobacco	1.2	Lbs.	2,300	2,760
Rented land:				
Alfalfa hay	36.0			
Clover-orchardgrass hay	36.0	Tons	3.0	108
Lespedeza hay	22.5 ^b	Tons	2.5	90
Oats for grain	22.5 ^b	Tons	.8	18
Corn for grain	11.5	Bu.	53	1,193
Total acres cropland	278.8	Bu.	60	690

^aCow-acre days of grazing.

^bDouble cropped acres.

If a policy of raising all replacements is followed, land use on the 100 acres of rented land would consist of 36 acres of alfalfa hay, 36 acres of orchardgrass and white clover hay, 22.5 acres of oats and lespedeza, and 11.5 acres of corn. The expected total yields were: 108 tons of alfalfa hay, 90 tons of orchardgrass and white clover hay, 18 tons of lespedeza hay, 1,193 bushels of oats, and 690 bushels of corn (Table 16).

When the replacement policy was changed from raising to purchasing, the only alteration in land use was a shift of the 22.5 acres used for oats and lespedeza to orchardgrass and white clover hay production. Even though this was the only shift in land use, in order to meet the needed concentrate requirement additional quantities of grain would be bought.

Livestock numbers under a policy of raising and a policy of purchasing. When following a policy in which all needed replacements were raised on this farm, it was estimated that with the cropping system outlined in the previous section, 72 cows, 15 yearling heifers 1 year of age or older, and 19 heifer calves less than 1 year of age would be the optimum herd size.

When the replacement policy was changed from raising to purchasing, it was estimated that a milking herd of 91 cows would be the optimum herd size, an increase of 19 cows.

Feed requirements. Using the same feed requirements for each animal as were used on the small and medium case farms, the large case farm would require a total of 178,405 pounds of concentrate, 446 tons of corn silage, 189 tons of alfalfa hay or its equivalent, and 16,430 cow-acre days of pasture per year (Table 17).

To meet the concentrate feed requirements, 200 bushels of oats, 31,230 pounds of cotton seed oil meal, 8,920 pounds of molasses, and 1,780 pounds of salt were purchased.

The feed requirements for the 91-cow milking herd maintained under a policy in which all replacements were bought consisted of a total of 201,565 pounds of concentrate, 446 tons of silage, 220 tons of alfalfa hay or its equivalent, and 16,380 cow-acre days of pasture. Silage production was held constant when shifting from raising to buying replacements due to the limit of silo facilities. Silage available per cow was, thus, reduced from 6.2 tons to 4.9 tons. To compensate for the decrease in silage fed, a .4-ton increase in the amount of hay fed per cow was made.

The only changes in feed requirements were in the amount of concentrate, hay, and pasture required. Concentrates requirements increased 23,160 pounds, hay requirements increased 31 tons, and pasture requirements decreased by 50 cow-acre days. The increased hay requirement was met by the shift of the acreage used for oats to orchardgrass and ladino clover hay production.

Labor requirements. The large farms had an average of 9,150 hours of labor available for farm work. When the farming system included raising of replacements, it was estimated that 6,306 hours of labor would be needed to meet the crop and livestock requirements alone (Table 18). Additional labor would be needed to maintain fences, buildings, equipment, etc. When a purchasing replacement policy was used, the labor requirements were estimated to be 6,845 hours plus the labor requirements of fence, building, and equipment maintenance, etc. (Table 18). This was an increase of 540 hours.

Table 17. Estimated feed requirements for dairy herd when raising replacements and when buying replacements, large case farm, Knoxville milkshed, 1963

Type of replacement policy	Number of animal	Concentrate requirements		Roughage requirements					
		Pounds per animals	Total pounds	Silage		Hay		Pasture	
				Tons per animal	Total tons	Tons per animal	Total tons	CAD per animal	Total CAD needed
100% raised:									
Milk cows	72	2,215	159,480	6.2	446	2.0	144	180	12,960
Yearlings (1 yr. of age or older)	15	242	3,630	—	—	1.6	24	130	1,950
Calves (less than 1 yr. of age)	19	805	15,295	—	—	1.1	21	80	1,520
Total replacements	—	—	178,405	—	446	—	189	—	16,430
100% purchased:									
Milk cows	91	2,215	201,565	4.9	446	2.41	220	180	16,380
Change in requirements when shifting from a policy of raising to purchasing	—	—	+23,160	—	—	—	+31	—	—50

^aSince no additional silage is produced, the quantity fed per head is reduced. The quantity hay fed is increased to compensate for the reduction in silage.

Table 18. Estimated annual labor requirements when raising and when purchasing replacements, large case farm, Knoxville milkshed, 1963^a

Enterprise	Raising replacements		Purchasing requirements	
	Size of enterprise	Labor requirements (Hours)	Size of enterprise	Labor requirements (Hours)
Milk cows	72 head	3,960	91 head	4,914
Heifers and calves	34 head	408	—	—
Clover-orchardgrass hay	30.0 acres	174	52.5 acres	304
Alfalfa hay	36.0 acres	378	36.0 acres	378
Corn silage	22.7 acres	304	22.7 acres	304
Burley tobacco	1.2 acres	403	1.2 acres	403
Permanent pasture	142.3 acres	355	142.3 acres	355
Corn for grain	22.5 acres	138	18.1 acres	186
Oats and lespedeza	18.1 acres	186	—	—
All enterprises	—	6,306	—	6,844

^aAdapted from "Labor Requirements on Tennessee Farms" by W. P. Ranney, University of Tennessee Agricultural Experiment Station, Bulletin No. 316, Knoxville, September 1960.

On this particular farm, the operator furnished 300 days or 3,000 hours of labor. Therefore, to provide the average available labor force of 9,150 hours under a policy of raising replacements, 6,150 hours of labor would have to be hired unless family labor was available. An additional 540 hours would have to be hired if the operator changed to a policy in which all replacements were purchased.

Opportunity costs. The total revenue of the farming operation — when raising 72 cows, 15 yearlings, and 19 heifer calves — was estimated to be \$41,668. Total expenses were estimated to be \$20,542 and the net return to operator labor, capital, and management was \$21,126 (Table 19).

When the farming operation plan included a purchasing policy, the farming system had an estimated total revenue of \$52,206 and total expenses of \$29,130. Net return to operator labor, capital, and management was \$23,076.

In considering changing to a system with a different replacement policy, the difference in the revenue of the two systems would be a primary concern. The net differences in returns between the two systems for this farm was \$1,950 (Table 19) and purchasing

Table 19. Comparison of cost and returns for the large case farm with alternate replacement policies,
Knoxville milkshed, 1963

Item	Unit	Price ^a	100% raised requirements		100% purchased requirements	
			Quantity ^a	Value	Quantity ^a	Value
Revenue:						
Milk	Cwt.	\$ 5.10	7,128	\$36,352.80	9,009	\$45,945.00
7-day old calves	Head	20.00	46	920.00	82	1,640.00
Culled cows ^b	Head	156.00	15	2,340.00	19	2,964.00
Culled heifers	Head	100.00	4	400.00	—	—
Tobacco	Lbs.	.60	2,760	1,656.00	2,760	1,656.00
Total				41,668.28		52,205.90
Expenses:						
Corn	Bu.	1.25	—	—	165	206.25
Oats	Bu.	.70	200.0	140.00	1,578	1,104.60
Cotton seed oil meal	Cwt.	5.00	312.3	1,561.50	360.0	1,800.00
Molasses	Cwt.	3.50	89.2	312.20	101.0	353.50
Salt	Cwt.	1.64	17.8	29.19	30.0	32.80
Corn for grain	Acre	24.65	18.1	446.16	18.1	446.16
Oats & lespedeza	Acre	25.05	22.5	563.63	—	—
Pasture	Acre	11.20	142.2	1,592.64	142.2	1,592.64
Corn silage	Acre	24.65	22.7	559.56	22.7	559.55
Tobacco	Acre	199.54	1.2	239.45	1.2	239.45
Hay: alfalfa,	Acre	22.32	36.0	803.52	36.0	803.52
clover and grass	Acre	11.20	30.0	336.00	52.5	588.00
Combining	Acre	6.00	22.5	135.00	—	—
Milk replacer	Cwt.	19.50	4.8	93.60	—	—
Breeding fees	Head	7.00	72.0	504.00	91.0	637.00
DHIA	Year	—	—	360.96	—	423.00
Milk hauling	Cwt.	.22	7,128	1,568.16	9,009	1,981.98
Corn picking	Acre	6.00	18.1	108.60	18.1	108.42

Table 19 (Continued)

Item	Unit	Price ^a	100% raised requirements		100% purchased requirements	
			Quantity ^a	Value	Quantity ^a	Value
			—	420.00	—	441.50
Vet. fees & drugs	Year		—	288.00	—	364.00
Dairy supplies	Year	—	—	372.00	—	396.00
Electricity	Year	—	—	648.00	—	648.00
Tractor fuel	Year	—	—	38.00	—	38.00
Trucking charges	Year	—	—	76.35	—	81.51
Marketing fees ^c	Year	—	—	440.00	—	475.00
Bedding	Year		—	—	19	5,700.00
Replacements	Year	300.00	—	10,989.07		19,020.88
Subtotal				2,587.46		2,604.46
Annual equipment cost				815.00		815.00
Annual building cost				6,150.00		6,690.00
Hired labor expense ^d				20,541.53		29,130.34
Total cost						
Net returns to capital, operator labor, and management ^e				21,126.75		23,075.96
Difference in net returns						+1,949.21

^aEstimates of prices and quantities were adapted primarily from the following sources: unpublished data of the Department of Agricultural Economics, University of Tennessee; *Agricultural Prices*, Statistical Reporting Service, U. S. Department of Agriculture; *Cost of Returns from Livestock Production in the Limestone Valley Areas of Alabama*, Agricultural Experiment Station, Auburn University; *Production Requirements and Estimated Returns from Selected Crop and Livestock Enterprises in the Piedmont Area* by Charles P. Butler and Thomas A. Burch, South Carolina Agricultural Experiment Station; *Estimated Cost and Returns for Selected Crop and Livestock Enterprises in the Southern Piedmont Area of Virginia*, Virginia Agricultural Experiment Station; and *Farm Management Manual*, Department of Agricultural Economics, North Carolina State University.

^bIn computing net returns, rent paid for the use of rented land was not deducted. It was, however, the same for both plans and, therefore, does not affect the difference in net returns.

^cThree percent of gross sales value of cattle sold at auction markets.

^dThree hundred days of labor were furnished by the operator. Six hundred fifteen days of labor were hired at \$1.00 per hour when raising replacements. When buying replacements, 54 additional days of labor were required.

would seem to be the more profitable alternative. The farmer in this instance would be able to pay up to \$403 for his replacements, and still maintain the same returns to operator labor, capital, and management as he would have received from a system using raised replacements.

CONTRACTUAL REPLACEMENT POLICIES

Contractual replacement policies were practically nonexistent in the study area. The few existing contractual arrangements were not formal, usually consisting of a verbal agreement to give a specified percent of the heifers as payment to the grower.

Contractual arrangements in other areas are sometimes more formal. Usually the arrangements are set forth in a written contract which specifies the obligations and responsibilities of both the grower and dairyman. Such items as relationship of parties, terms of contract, termination of contract, provision for supplies furnished, management decisions, identification, routine veterinarian care, liability for death loss, liability for fire insurance, assignment of contract, age or weight at delivery and recall, and breeding should be considered in the formation of contracts.² Provisions for these items would be helpful in preventing later disagreements between the grower and dairyman.

Contractual arrangements provide some of the advantages of buying and some of the advantages of raising. The primary objection of farmers to buying and primary reason given for raising their replacements related to lack of knowledge of breeding quality. A contractual policy permits a farmer to replace his cows with replacements of known ancestry. When his calves are a few days old, he transfers them to a grower who raises them until they are ready to freshen, when they are returned. This permits the dairyman to specialize and expand his operation and increase herd size to use the released resources.

Contracting also has some disadvantages. A good grower may be difficult to locate in the immediate area and, as in purchasing, a large out-of-pocket-payment may be required. Various arrangements have been initiated to minimize this problem.

There are two basic types of contractual arrangements which have been followed. Under a direct-contract-to-grow arrangement, the dairyman retains title to the heifers. The heifer grower raises the heifer and supplies all or a major portion of the inputs for a

²John W. Jack, *Economics Considerations in Raising Dairy Replacements*, A. E. Res. 123, Agricultural Experiment Station (Ithaca, New York: Cornell University Press, 1963), pp. 22, 23.

monthly cash payment. Essentially the dairy farmer obtains use of facilities without owning them, and the responsibility for day-to-day chores in tending the heifers is transferred to the grower.

The rate of the specified monthly payment will vary according to the inputs and the services the grower provides. The grower usually supplies all roughage, grain, bedding, housing, and labor. The responsibility for other cost, such as veterinarian expense, is specified in the agreement between the dairyman and grower.

Most direct-contract growers receive the same monthly rate per heifer regardless of age. One variation to this system is payment based on rate of gain. Following this arrangement, the dairyman makes a specified monthly payment of \$9 or \$10 per heifer, but the final price paid for the heifer is a specified payment per pound of gain — usually in the range of 20-30 cents per pound.³

The second type of arrangement is the option-to-purchase contract. In this case the title to the heifer passes to the grower who is responsible for raising the heifer. The only restriction on the disposition of the heifer is that the original owner has the first option to purchase. Under this system the grower has the disadvantage of having to pay all expenses incurred in growing a heifer without any compensation until the animal is ready to sell. Here there are two common arrangements for payment. The first is for the dairyman to sell the calf to the grower at about 1 week of age and then repurchase the heifer near freshening time at the current market price. Due to disagreements over the market price of calves and heifers, a second method of payment has evolved. This method specifies uniform prices to be paid by the grower when buying either registered or grade calves, and also specifies a price and age at which the dairyman is entitled to repurchase the heifers.⁴

COMPARISON OF THE COST OF PURCHASING AND CONTRACTING

The two most common forms of contractual arrangements, as described previously, were a per-pound-of-gain agreement and a monthly payment agreement.

Assuming replacements to weigh 100 pounds when delivered to the grower and 1,200 pounds when returned to the farm, a farmer paying \$.25 per pound of gain would pay \$275 per replacement to have his heifers raised for him. By not selling his replacements as calves, there would also be a reduction of \$30 per replacement in

³Jack, pp. 20-21.

⁴Jack, pp. 20-21.

revenue. The total cost of the replacement would be \$305. If allowances are made for death losses, which are normally assumed by the heifer owner, the cost would be somewhat higher.

If the farmer paid a flat rate per month of \$10 per replacement and the replacement freshened at 27 months of age, the cost per replacement by this contractual arrangement would be \$270, plus the value of the calf at birth or about \$300 (plus allowance for death losses).

When compared to the replacement policies of raising and buying on the small, medium, and large farms just budgeted, contracting or purchasing would appear to be the most profitable alternative, under the assumed conditions. A policy of buying replacements indicated an additional net return to operator labor, capital, and management of \$797 for small farms, \$1,611 for medium farms, and \$1,948 for large farms above that received when operating under a system where all replacements were raised. Contractual arrangements, under the terms specified above, would result in about the same additional returns above the policy of raising replacements, but milk production rates might be easier to maintain than under a purchase replacement policy.

iJack, pp. 20-21.

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