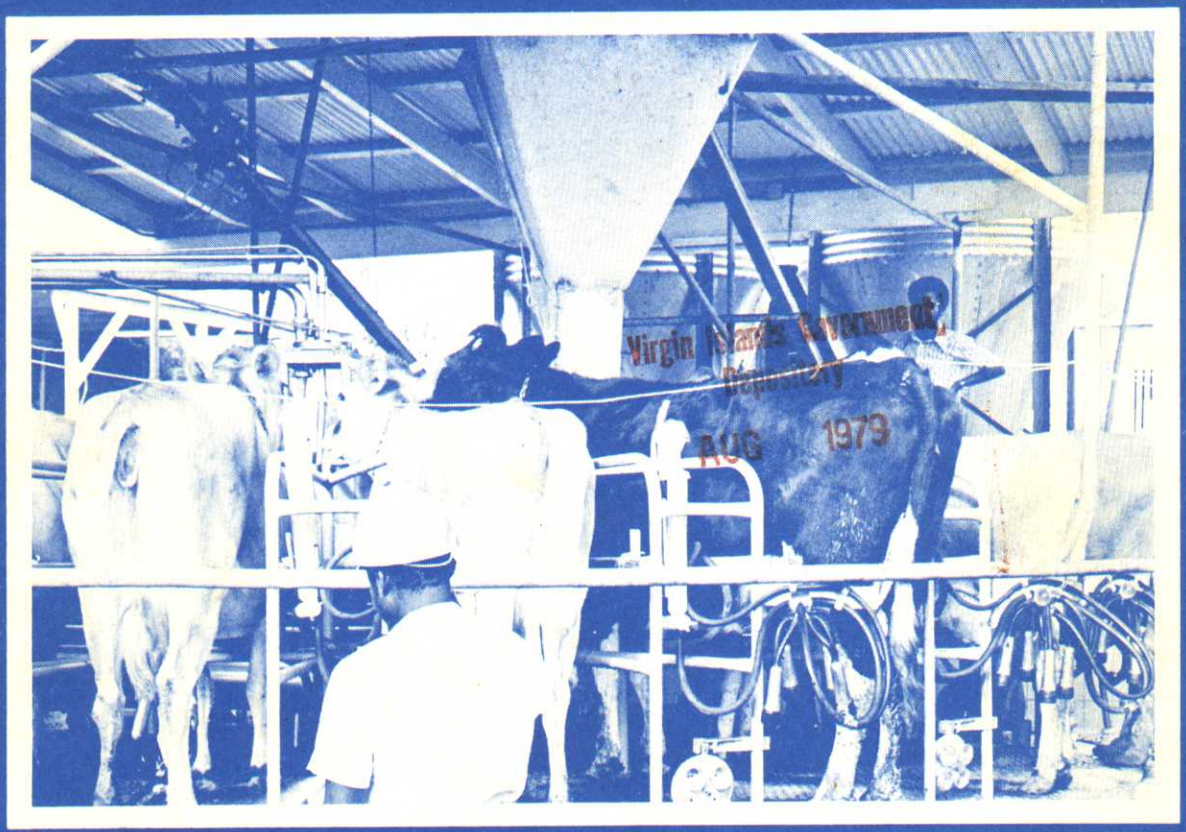
Virgin Islands
Agricultural Experiment Station
Report No. 4
August 1974

Profitability of

DAIRY FARMING

in St. Croix, U.S. Virgin Islands



VIRGIN ISLANDS AGRICULTURAL EXPERIMENT STATION
Fenton B. Sands, Director
St. Croix, U.S. Virgin Islands

Virgin Islands
Agricultural Experiment Station
Report No. 4
August 1974

Profitability of DAIRY FARMING

In St. Croix, U.S. Virgin Islands

College of the Virgin Islands
Virgin Islands Agricultural Experiment Station
Fenton B. Sands, Director
St. Croix, U.S. Virgin Islands

CONTENTS

COVER PHOTO: Senepol beef cattle on Pangola grass pasture, St. Croix, U.S. Virgin Islands

FOREWORD

This report, "Profitability of Dairy Farming in St. Croix, U.S. Virgin Islands," is one of a series of feasibility studies sponsored by the newly created Virgin Islands Agricultural Experiment Station, College of the Virgin Islands. These investigations were financed totally with Federal funds made available to the Station under the provisions of the Hatch Act, Amended.

Preparation of this report was accomplished by contracting for the services of the following team of specialists: Dr. Pritam S. Dhillon, Professor of Agricultural Economics and Marketing, Rutgers University, New Brunswick, N.J., and Dr. Robert L. Park, Professor of Animal Science, Brigham Young University, Provo, Utah. This team conducted the study and wrote the manuscript for this report.

The objective of these studies was to try to determine the agricultural enterprises, both plant and animal, that have economic potential on the Virgin Islands. It is my belief that the agricultural industry must be economically sound in order to be viable.

On the Virgin Islands, agriculture has been on the decline since the early part of the 1960's. The average number of farms, farmers, and production of agricultural commodities (with the exception of fluid milk) have all declined at a consistent rate. Among the questions which are uppermost in the minds of many people are: What factors have been responsible for these declines? Can these downward trends be stopped and perhaps reversed? What is the future of the agricultural industry, particularly on St. Croix where 85 percent of the farmland is located? This report on dairy farming, along with the others, sheds some light on these questions.

These feasibility reports have also revealed the areas where lack of training and education on the part of farmers has adversely affected production. These subjects have now become part of the new program of the V.I. Extension Service. At the same time, the lack of information about the response of crops and livestock in this environment, which also limits production, has been recognized. These gaps in our knowledge have become the basis for the planned research program of the V.I. Agricultural Experiment Station. Thus, these studies have given more direction to the efforts of the Extension and research programs of this land-grant institution. More importantly, the results of these studies are expected to be beneficial to full- and part-time farmers, as well as to potential investors.

This series of reports rests squarely on the belief that a revival of agriculture would contribute substantially to the general welfare through increased output of goods and services and by providing additional employment. Moreover, expanded production and marketing of farm products could provide greater, and in some cases, cheaper sources of nutritious foods for consumers.

A more fully developed agriculture would complement the major industry—tourism—in two ways. First, visitors would be pleased to be served local products, especially tropical fruits and vegetables, by hotels and restaurants where such products are often not now available. Second—and perhaps more important—an expanded agriculture would tend to preserve the environment of exotic tropical islands. Most visitors and some permanent and semi-permanent residents come to the Virgin Islands to seek this environment. If this attraction is destroyed, the basis of the major industry of the Islands will be undermined.

The Virgin Islands Agricultural Experiment Station gratefully acknowledges the cooperative assistance and contributions from many St. Croix farmers; Rudolph Shulterbrandt, Commissioner, V.I. Department of Agriculture, and his staff; and Bennett S. White, Jr., project consultant and former USDA agricultural economist, now retired.

Fenton B. Sands, Director
March 1974

SUMMARY AND CONCLUSIONS

Under normal conditions, dairy farming in St. Croix and the Virgin Islands as a group is a viable enterprise. The distance between the Islands and other dairy-producing regions along with the suitability of land for pasture grazing favors this type of farming. Virtually the entire domestic market for fluid milk is available to the local producers. According to the 1969 census, the seven commercial dairy farms in the Islands held over one-quarter of the total land in farms and accounted for 69 percent of the value of all farm products sold. Furthermore, dairying, unlike other sectors of the agricultural economy, has been growing; rising population and incomes indicate a potential for further growth.

On a 75-cow benchmark farm, assuming milk production of 11,500 lbs. per cow, returns to operator's labor and management were estimated at $18,754. Rate of return on non-land investment was estimated at 12.7 percent. The net profit, representing excess of receipts above all production costs, amounted to $6,754.

There were significant economies of size in moving from the 50-cow operation to the 75-cow herd. On the 50-cow farm, returns to operator's labor and management were less than one-half of the returns on the 75-cow farm. Rate of return on non-land investment was estimated at 3.4 percent only. When all costs of production were considered, the 50-cow farm showed a loss of $4,106.

Prices of milk and feed were the major factors influencing returns and profit. On the 75-cow farm, an increase of one cent in milk price increased the net profit by $3,345.45, while an increase of $1 in feed price decreased the net profit by $3,722. Changes in land cost and wage rate were relatively less significant.

Cost of producing a quart of milk was estimated at 21 cents for the 75-cow farm and 24.8 cents for the 50-cow herd, assuming a feed price of $7.50 per hundredweight. Again, feed price was the most important variable affecting this cost. On the 75-cow farm an increase of $1 in feed price increased the per quart cost by 1.11 cents. Effect of changes in land cost and wage rate were less significant. Depending upon the productive ability of a cow, feeding at a higher level could increase profit. Underfeeding of cows saved the feed bill but resulted in severe reduction of returns and profit.

On the 75-cow farm, with 50 acres of sorghum, the per-pound cost of total digestible nutrients (TDN) from silage was estimated at 4.4 cents. This was based on a land cost of $20 and silage yield of 15 tons per acre. In contrast, the cost of a pound of TDN from pasture was estimated at 2.8 cents. Thus, silage feeding under these circumstances pointed toward reduced profit. However, if land costs were above $55.42 per acre or if silage yields were above 23 tons, silage became a cheaper source of forage compared to pasture. Production of 50 acres of sorghum silage on the 75-cow farm required an additional fixed investment of $15,250.

Finally, it should be emphasized that the apparent vitality of the dairy industry should not lead public agencies to take an attitude of complacency toward dairying. As noted in other publications in this series, tourism and expenditures of full and part-time residents who find the climate, vegetation, beaches and other characteristics of tropical islands attractive are the backbone of the Virgin Islands economy. It must also be recognized, however, that the development of the agricultural potential is important. It is important to the generation of income and employment, to provide food production for a growing population, both permanent and transient, to reduce costs of holding land, and perhaps most importantly, as a means of preserving island aesthetics. Without this last, the primary industry itself will be undermined.

The dairy industry, a key factor in the livestock feed economy, must be given every opportunity for profit and expansion. Since feed costs are an important determinant of profit, every alternative to importing expensive feed must be explored, especially the economic feasibility of local production of grain and high nutrient silage. Consequently, all of the research recommendations in the report on grain sorghum and forage production—in both their technological and economic aspects—have profound implications for the dairy industry.

PROFITABILITY OF DAIRY FARMING

in St. Croix, U.S. Virgin Islands

by

PRITAM S. DHILLON and ROBERT L. PARK

As a result of adjustment from a one-crop sugar economy to diversified farming, dairying has emerged as the most important agricultural enterprise on St. Croix. According to the 1969 Census of Agriculture, sales of milk and livestock from dairy farms accounted for about one-half of the total value of farm products sold on the island. In the U. S. Virgin Islands as a group, the relative importance of dairying is even greater. In 1969 there were only seven dairy farms, but they held over a quarter of the total land in commercial farms and accounted for 69 percent of the value of agricultural products sold (Table 1).

Besides relative growth due to the demise of the sugar industry, dairying in St. Croix experienced a sizeable expansion in the 1960's. As shown in Table 2, the number of cows milked doubled between 1960 and 1970; milk sales increased over four-fold; and milk sold per milking cow more than tripled. The number of farms decreased but herd size increased, resulting in larger and presumably more efficient operations.

The location of St. Croix in relation to other dairy producing regions of the U.S. and the suitability of much of its farmland for pasture favor dairy production. Under the existing technology use of farmland is primarily restricted to pasture, and dairying is well-suited for its utilization. Due to the perishable and bulky nature of milk, coupled with the great distance between St. Croix and other producing centers, the domestic market for fluid milk is strongly insulated from foreign competition. In short, the entire fluid market of the Virgin Islands is available to the local dairy producers, barring any dumping of milk by the other producing regions. Production of selected manufactured milk products might also be feasible.

The domestic market for fluid milk in the Vir-

Table 1.—Relative importance of dairying in the commercial agriculture of the U.S. Virgin Islands

Item	*All commercial farms*	*Commercial dairy farms*	*Dairy farms as percent of all farms*
Number of farms	58	7	12
Total land in farms (acres)	16,877	4,796	28
Cropland (acres)	8,995	1,588	
Pasture (acres)	6,401	3,144	
Other land (acres)	1,481	64	
	Dollars		
Value of farm products sold [1]	1,301,977	894,588	69
Milk sold	808,758	803,718	
Livestock sold	273,466	90,870	
Poultry and eggs sold	119,753	—	
Vegetables and fruit sold [1]	100,000	—	

Source: *1969 U. S. Census of Agriculture,* Bureau of the Census, U. S. Department of Commerce.

[1] Estimated from the Census data.

Table 2.—Trends in the St. Croix dairy industry, U.S. Virgin Islands

Item	1960	1964	1970	1973
Number of dairy farms	13	11	7	6 [2]
Dairy cows	409	580	N.A.	612 [2]
Cows milked daily	262	277	530 [1]	438 [2]
Milk sold (1,000 qts.) [3]	399	880	1,895	2,007 [4]
Milk sold per milking cow (qts.)	1,523	3,177	3,574	4,582

Source: Most of the figures in this table were obtained from the *U. S. Census of Agriculture,* Bureau of the Census, U. S. Department of Commerce.

[1] Based on a Census by the V. I. Department of Agriculture cited by Harold V. Clum, "Agriculture and Food Production", *Agriculture and Food Fair of St. Croix,* 1971, V. I. Department of Agriculture.
[2] Based on a survey conducted by P. S. Dhillon in June, 1973.
[3] Milk received by the Island Dairies from the producers.
[4] Sales relate to calendar 1972.

gin Islands has great potential for expansion. The current level of per-capita consumption is about one half of the U. S. mainland level, and as incomes of the islanders increase the domestic fluid market should expand. Any increase in the population, of course, will be an additional force in market expansion. Finally, the continued growth of tourism is likely to enlarge the market still further. Thus, dairying in St. Croix could be poised for a significant growth in the coming years.

The purposes of this study were to evaluate the profitability of dairying under the prevailing economic conditions in St. Croix, and to investigate the impact of changes in herd size, feeding levels, forage systems and other related variables on the profits and costs of dairy farming. Such information is expected to benefit the farmers in making profitable adjustments on their farms.

Specific objectives of this study were: (1) to identify the typical benchmark dairy farms under St. Croix conditions and to determine costs and returns on such farms, (2) to determine the effect of changes in herd size and prices of inputs and outputs on returns and costs, (3) to determine the effect of alternate feeding levels of cows on profits, and (4) to assess the feasibility of producing sorghum silage.

Information on herd size, farm resources, input-output coefficients and related data was obtained through personal interviews with dairy farmers. On the basis of this information, two benchmark farms were constructed, and, by budgeting procedures, returns and costs were estimated. By leaving some of the costs and prices as variables in the budgets, their effects on returns and costs were analyzed.

BENCHMARK FARMS

According to information provided by the farmers, St. Croix dairy farms fall into three size categories. The more plentiful, middle-sized farms were chosen for intensive analysis, and a 75-cow dairy farm was constructed to serve as a benchmark for these farms. Also, to give guidance to new entrants to dairying who might prefer to start a smaller operation, a 50-cow benchmark dairy farm was analyzed. On the basis of the survey of dairy farmers, the following resources were assumed on the benchmark farms.

Land

The 75-cow dairy farm was assumed to operate 225 acres of land. On the average, dairymen were actually using 3 acres of pasture for every cow. The 50-cow model was assumed to operate 150 acres of pasture land. An acre of pasture was assumed to yield 1,475 pounds of injested total digestible nutrients (TDN).

Livestock

The composition of the two herds is shown in Table 3. The 50-cow farm had 85 animals with an approximate value of $51,800. The 75-cow farm had 127 animals representing an average investment of $77,600.

Culling rate of cows was assumed to be 25 percent of the herd.

Table 3.—Livestock and average investment in livestock on benchmark farms

Item	Beginning of year	End of year	Average	Average value per head	Average investment
50-cow herd		*Number*		*Dollars*	
Dairy cows	50	50	50	800	40,000
Heifers over 1 year[1]	18	14	16	500	8,000
Heifers under 1 year[1]	20	18	19	200	3,800
Total			85		51,800
75-cow herd					
Dairy cows	75	75	75	800	60,000
Heifers over 1 year[1]	27	21	24	500	12,000
Heifers under 1 year[1]	30	27	28	200	5,600
Total			127		77,600

[1] Changes in the number of animals during the year are due to deaths and culling.

Annual death rate for cows was assumed to be 2 percent, resulting in 1 death on the smaller farm and 2 deaths on the larger farm.

Milk production of a cow was assumed to be 11,500 pounds during a 365-day lactation period.

The breeding cycle of a cow was assumed to be 14 months, which included a dry period of 2 months.

Bred cows were assumed to produce 95 percent live calves—one-half of which were males and one-half females. Males were sold for veal soon after their birth and all females were raised as heifers. Mortality rate for heifers was assumed to be 10 percent during the first year and 3 percent during the second year. After breeding the required number of heifers to meet replacement needs, the remaining heifers were sold as culls at about 18 months of age. In applying the percentage rates, the resulting animal numbers were rounded to whole numbers.

Buildings and Structures

Initial investment in buildings and structures is shown in Table 4. Buildings were modelled after the system being recently adopted in the island. In this system, milk room, compressor room and milking parlor are located on the ground floor, the feed room is constructed above the parlor. Before every milking, feed is dumped into the two large receptacles located along the walls of the feed room and by pulling cords from the parlor, feed is delivered to the cows. There are four milking units in the double-four herring bone milking parlor, The perimeter of the farm was assumed to be fenced by a 4-strand barbed wire fence, quatering the farm into four sections. Further sub-division into smaller fields was done with an electric fence. The average investment in buildings and structures was estimated at $28,730 on the 50-cow farm, $32,592 on the 75-cow farm (Table 4).

Machinery and Equipment

The complement of machinery and equipment for operating the two farms is shown in Table 5. The same equipment and machines were assumed for both farms. Any error on this account should be negligible because the same chores need to be performed on both farms and machines are seldom completely divisible. The average investment in machinery and equipment was estimated at $19,825.

Labor

On the basis of information supplied by the farmers, the 75-cow dairy needed 1 full-time operator and 2 hired workers. The 50-cow farm was assumed to need 1 full-time operator and 1½ hired workers.

Feed

The entire concentrates were purchased from outside the farms. This also included small quanti-

Table 4.—Initial and average investment in buildings and other structures on benchmark farms

Item	Units	Initial investment	Annual depreciations [1]	Annual repairs [2]
50-cow herd			Dollars	
Buildings and pens [3]		30,000	1,500	600
Fence [4]		7,800	390	156
Well	1	1,660	83	—
Ponds	3	9,000	—	—
Total		48,460	1,973	756
Average investment [5]		28,730		
75-cow herd				
Buildings and pens [3]		30,000	1,500	600
Fence [4]		9,525	476	190
Well	1	1,660	83	—
Ponds	4	12,000	—	—
Total		53,185	2,059	790
Average investment [5]		32,592		

[1] Buildings, well and fence were assumed to last 20 years.
[2] Repairs were assumed at 2 percent of initial investment.
[3] Based on the system found on Nelthropp farm.
[4] See Appendix table 2 for initial investment.
[5] Average investment was assumed to equal one half of initial investment in the case of depreciable items plus initial investment in ponds which did not depreciate.

Table 5.—Initial and average investment in equipment and machinery on benchmark farms [1]

Item	Unit or type	Initial investment [2]	Annual depreciation [3]	Annual repairs [4]
			Dollars	
Bulk tank	400–500 gal.	5,000	500	150
Parlor equipment	4 milking units	15,000	1,500	450
Troughs	3	900	90	27
Generator	1 PTO	500	42	15
Tick control equipment		3,000	300	90
Front-end loader		1,000	100	30
Tractor	1	6,500	542	195
Subsoiler	1	500	42	15
Brush cutter	1	1,400	140	42
Pick-up truck	1	4,500	450	135
Water pump	1	350	35	10
Tools		1,000	200	—
Total		39,650	3,941	1,159
Average investment [5]		19,825	—	—

[1] Basically the same equipment and its usage were assumed for the 50-cow and 75-cow dairies.
[2] Investment in parlor and equipment was based on the most recently developed dairy farm. Investment in all other items was based on the survey of dairy farmers and the approximate current prices.
[3] Based on straight line depreciation of assets assuming 10 to 12 year life for the various items. Tools were assumed to last 15 years.
[4] Repairs were assumed at 3 percent of initial investment.
[5] Average investment was assumed to equal one half of initial investment.

ties of specially formulated feed for the calves. The entire forage needs of the herds were supplied by pasture.

ANALYSIS AND RESULTS

Receipts, Expenses and Profits

The benchmark farms were budgeted to determine returns to the operator, management and investment. Prices used in the basic budgets are given in Appendix Table 1.

Sale of milk was the main source of revenue on benchmark farms. Annual milk production of the smaller herd was estimated at 224,773 quarts and that of the larger herd was estimated at 334,545 quarts. These amounts are based on the daily milking of 43 cows and 64 cows for the 50-cow and 75-cow farms respectively. The f.o.b. price of milk was assumed to be 23 cents per quart. In addition to milk sales, income also came from the sale of cull cows, cull heifers and male calves. Total receipts amounted to $58,025 on the 50-cow farm and $86,390 on the 75-cow farm (Table 6).

Annual production costs on the farms consisted of current production expenses, land and labor costs, depreciation and interest on capital. Current production expenses were estimated at $23,755 for the 50-cow farm and $34,139 for the 75-cow farm (Table 7). (Expenses corresponding to different levels of milk production have been included in Table 7 for a later analysis. For this section, the relevant expenses correspond to the production level of 11,500 pounds of milk.) Included in current production expenses are such items as purchased feed, fuel, chemicals, veterinary services, insurance, repairs and other miscellaneous recurring expenses. Most of these items vary with the number of cows in the herd. These expenses constituted the most important category in the costs of the two farms. Within the group, feed was the largest single expense. The quantity of purchased concentrates was derived by substracting pasture TDN from the total feed needs of the herds (Table 8.) In order to simplify analysis, purchased feed for the young stock and cows was handled as a single item. Feed allowances for death losses were included in the feed budgets. Price of delivered feed was assumed at $7.50 per hundredweight.

Labor costs for hired workers were based on the number of workers employed on each farm. In the basic analysis, a wage of $92 per week was used. In addition to the cash wage, farmers provided unemployment insurance at the rate of 1.5 percent of the cash wage, workmen's compensation at the rate of 2.5 percent, social security at the rate of 5.85 percent, a rent free house with a

Table 6.—Estimated annual receipts on benchmark farms

	50-cow herd		*75-cow herd*	
	Quantity	*Amount Dollars*	*Quantity*	*Amount Dollars*
Milk [1]	224,773 qt.	51,698	334,545 qt.	76,945
Cull cows [2] @ 1200 lbs.	15,600 lbs.	4,680	22,800 lbs.	6,840
Cull heifers @ 800 lbs.	2,400 lbs.	912	4,000 lbs.	1,520
Calves	21 head	735	31 head	1,085
Total		58,025		86,390

[1] A cow was assumed to yield 11,500 pounds of milk during a lactation period of 365 days. Following lactation, a dry period of 60 days was allowed. (A quart equals 2.2 pounds of milk)

[2] Culling rate was assumed at 25 percent.

Breeding cycle of cows was assumed to be 14 months long, and 95 percent of the pregnant cows were assumed to produce live calves. Out of the resulting calves, the males were sold within the week of their birth and the females were raised as heifers. After allowing 10 percent mortality rate during the first year and three percent mortality rate during the second year, the remaining heifers were assumed to reach maturity. Fourteen of these heifers were bred to replace the culled and dead cows on the 50-cow farm. Similarly, 21 of these heifers were bred to meet the death and culling losses on the 75-cow farm. The remaining heifers were sold for beef.

Table 7.—Current production expenses on benchmark farms [1]

Item	Rate per cow	50-cow herd		75-cow herd	
		Quantity of feed	Amount	Quantity of feed	Amount
	Dollars	Cwt.	Dollars	Cwt.	Dollars
Purchased feed [2]					
Prod. @ 9,200 lbs. milk		2,094	15,705	3,129	23,468
Prod. @ 11,500 lbs. milk		2,492	18,690	3,722	27,915
Prod. @ 13,800 lbs. milk		2,890	21,675	4,313	32,348
Fuel	7		350		525
Chemicals for tick control	3		150		225
Miscellaneous supplies	10		500		750
Veterinary & medicines	5		250		375
Semen and breeding	10		500		750
Utilities	10		500		750
Dues of association			50		50
License fees			50		50
Office supplies			50		50
Insurance			750		750
Repairs [3]			1,915		1,949
Total expenses					
Prod. @ 9,200 lbs. milk			20,770		29,692
Prod. @ 11,500 lbs. milk			23,755		34,139
Prod. @ 13,800 lbs. milk			26,740		38,572

[1] Most of the expenses in this table were based on the survey of dairy farmers and farm data manuals.
[2] See table 8.
[3] Obtained from tables 4 and 5.

rental value of $100 per month and two quarts of milk per day. The annual labor cost of a hired worker amounted to $6,623. Total labor cost was estimated at $9,935 for the 50-cow farm and $13,246 for the 75-cow dairy operation (Table 9).

Annual land cost on each farm was determined by using a rental value of $20 per acre (Table 9). The usual procedure of charging interest on the market value of land was not followed. Current market values of land in St. Croix are completely separated from the agricultural productivity of land. On the basis of market value, perhaps, production of no agricultural product could be justified in St. Croix. On the other hand, rentals of land for agricultural use seem to reflect the agricultural value of land. Current rents varied from $10 to $30 an acre.

Interest cost was measured by applying an interest rate of 7.5 percent to the average investment in livestock, buildings, structures, machinery, and equipment. The average investment in non-land assets was estimated at $100,355 for the 50-cow farm and $130,017 for the 75-cow farm. Depreciation on the two farms amounted to $5,914 and $6,000 respectively (Table 9).

Total costs add up to $50,131 on the 50-cow farm and $67,636 on the 75-cow farm (Table 9). These costs include all expenses except a charge for operator's labor and managing effort. Consequently, by subtracting these costs from the gross receipts, returns to operator's labor and management were estimated. On the smaller farm, these returns amounted to $7,894 as compared with $18,754 on the larger farm. Net profits were arrived at by charging an opportunity cost of $12,000 for operator's labor and management. The smaller farm showed a net loss of $4,106 while the 75-cow farm produced a net profit of

Table 8.—Annual TDN requirements on benchmark farms[1]

Class of livestock	50-cow herd		75-cow herd	
	Number	TDN lbs.	Number	TDN lbs.
Lactating cows				
Prod. @ 9,200 lbs. milk	43	257,398	64	383,104
Prod. @ 11,500 lbs. milk	43	287,240	64	427,520
Prod. @ 13,800 lbs. milk	43	317,039	64	471,872
Dry cows	7	29,127	11	45,771
Heifer calves 0—12 mo.	18	36,000	27	54,000
Death allowance for heifer calves 0—6 mo.[2]	2	1,000	3	1,500
Heifers 12—24 mo.	14	49,000	21	73,500
Death and culling allowance for heifers 12—18 mo.[2]	4	5,800	6	8,700
Total requirements for herd				
Prod. @ 9,200 lbs. milk		378,325		566,575
Prod. @ 11,500 lbs. milk		408,167		610,991
Prod. @ 13,800 lbs. milk		437,966		655,343
TDN obtained from pasture @ 1,475 lbs. per acre[3]		221,250		331,875
TDN obtained from concentrates[4]				
Prod. @ 9,200 lbs. milk		157,075		234,700
Prod. @ 11,500 lbs. milk		186,917		279,116
Prod. @ 13,800 lbs. milk		216,716		323,468
Concentrates purchased[5]				
Prod. @ 9,200 lbs. milk		209,433		312,933
Prod. @ 11,500 lbs. milk		249,222		372,155
Prod. @ 13,800 lbs. milk		288,955		431,290

[1] This table is based on Appendix table 3.
[2] Carried for six months only.
[3] Based on estimates provided by William L. Park.
[4] Obtained by subtracting TDN from pasture from the total herd requirements.
[5] Obtained by assuming 75 percent TDN in concentrates.

$6,754. The rate of return on non-land investment was estimated at 3.4 percent for the 50-cow farm and 12.7 percent for the 75-cow farm (Table 9).

All of the above measures indicate significant economies of size in dairy production. These economies mainly stemmed from the indivisibilities of equipment and structures. Varying numbers of cows could be handled with the milk handling and feeding facilities considered in the benchmark models. In fencing and pen construction, there were obvious economies of size. Labor economies were also realized by expansion of size. The larger farm handled 33 percent more cows with only 20 percent additional labor force.

Effects of Price Changes on Returns

In the foregoing analysis, fixed prices for inputs and outputs were used. However, because of rapid increases in input prices in recent years, one might be interested in knowing the effect of price changes on the returns and profits of the farms.

To conserve space, this analysis was carried out in the form of simple equations. Also, the analysis was restricted to the study of changes in milk price, land cost, wage rate and feed price in relation to the net profit on the 75-cow dairy farm.

The equations for total revenue (gross receipts),

Table 9.—Summary of income and expenses of benchmark farms [1]

Item	50-cow herd	75-cow herd
	----Dollars----	
Gross income	58,025	86,390
Interest on aver. invest. @ 7.5%	7,527	9,751
Depreciation [2]	5,914	6,000
Land cost [3]	3,000	4,500
Cost of hired labor	9,935	13,246
Current production expenses	23,755	34,139
Total expenses	50,131	67,636
Returns to operator's labor and to management	7,894	18,754
Rate of return on aver. investment [4] (excluding land investment)	3.4%	12.7%
Net profit [5]	−$4,106	$6,754

[1] For cows yielding 11,500 pounds of milk.

[2] Assembled from Tables 4 and 5.

[3] Cost of land for agricultural use, including taxes, was assumed at $20 per acre.

[4] Capital is considered to be the residual claimant. The reward of capital was estimated by subtracting depreciation, land cost, cost of hired labor, current production expenses and operator's opportunity cost from the gross income. The opportunity cost of operator's labor and management was assumed to be $12,000 per year.

[5] Net profit is the reward of the entrepreneur. It was estimated by subtracting interest, depreciation, land cost, cost of hired labor, current production expenses and operator's opportunity cost from the gross income.

total cost and net profit are as follows:

(1) $TR = 3{,}345.45P_m + 9{,}445$

(2) $TC = 225R + 114.244W + 3{,}722P_f + 36{,}711$

(3) $N = 3{,}345.45P_m - 225R - 114.244W - 3{,}722P_f - 27{,}266$

Where TR = Total revenue or gross receipts in dollars

P_m = f.o.b. price of milk in cents per quart

TC = Total cost in dollars including salary of the operator-manager

R = Rent of land in dollars per acre

W = Wage rate in dollars per worker per week

P_f = Price of feed in dollars per hundredweight

N = Net profit in dollars representing excess of receipts above all costs of production

Equation (3) shows the effect of the variables on net profit. Every one-cent change in milk price changes the profit by $3,345.45 in the same direction. Every one-dollar change in rent per acre, wage rate per week and feed price changes the profit by $225, $114.244 and $3,722, respectively, in the opposite direction. The effect of prices of feed and milk on the net profit is illustrated in figure 1. Obviously, changes in the prices of feed and milk have an enormous influence on the profit. The break-even price of feed was estimated at $6.60 and $9.30 corresponding to the milk price of 20 cents and 23 cents, respectively.

Production Costs Per Quart of Milk

Farmers and policymakers are often interested in knowing the average cost of producing a quart of milk. At this stage of the analysis, such an estimate can be readily derived from the total costs listed in Table 9. As shown in Table 10, per-quart cost amounted to 21 cents on the 75-cow farm. A similar estimate for the 50-cow dairy showed this cost to be 24.8 cents.

The effect of changes in input prices on the per quart cost was analyzed for the 75-cow farm. By leaving input prices as variables, the following equation for the average cost was derived from the total cost equation of the last section:

Table 10.—Cost of producing milk on benchmark rfarms, per quart [1]

Item	50-cow herd	75-cow herd
Expenses (excluding operator's labor and management)	$50,131	$67,636
Plus cost of operator's labor and management	$12,000	$12,000
Less non-milk receipts	$ 6,327	$ 9,445
Equals total cost imputed to milk	$55,804	$70,191
Milk produced, qts.	224,773	334,545
Cost per quart	24.8¢	21.0¢

[1] For cows producing 11,500 pounds of milk.

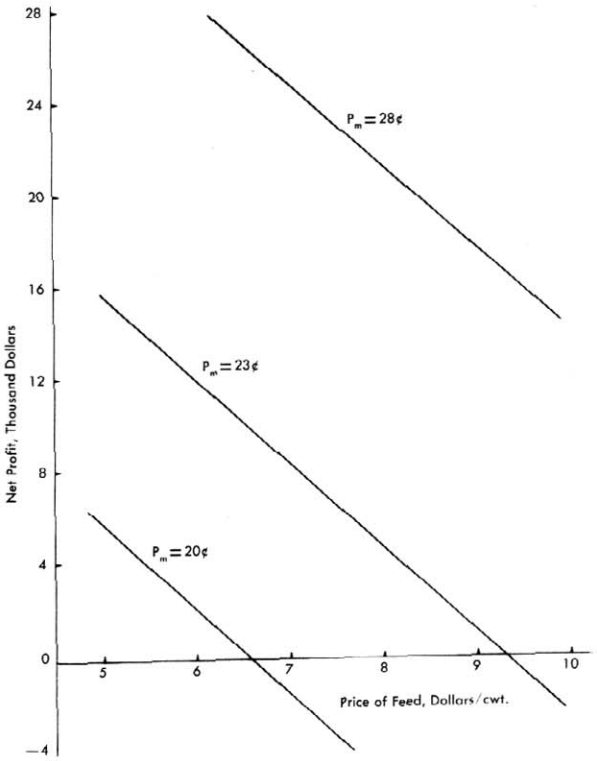


Figure 1.—Relationship between net profit, price of feed and price of milk, where P_m equals f.o.b. price of milk in cents per quart.

$$AC = .07R + .03W + 1.11P_f + 8.15$$

Where AC = Average cost of milk in cents per quart

R = Rent of land in dollars per acre

W = Wage rate in dollars per worker per week

P_f = Price of feed in dollars per hundredweight

According to this equation, every one dollar change in rent per acre, wage rate per week and feed price changes the per quart cost by 0.07 cents, 0.03 cents and 1.11 cents, respectively. The effect of these variables on the per quart cost is illustrated in figure 2. It is evident that the production cost is highly sensitive to the changes in feed price.

Effect of Level of Feeding on Returns

The preceding analysis has been based on the average level of feeding cows as now practiced in St. Croix. It should be of interest to see the effect of increased or decreased feeding on the returns and profits of the farm. Accordingly, returns to operator's labor and management were computed for two additional feeding levels—one corresponding to the yield of 9,200 lbs. of milk and the other to 13,800 lbs. This, of course, assumes that the average cow considered in the model was capable of producing higher milk yields when challenged with additional feed. The results showed that, on the 75-cow farm, returns to operator's labor and management increased by 58 percent by moving from 11,500 lbs. per cow to the higher level of feeding (Table 11).

On the other hand, these returns decreased by 58 percent by going from cows producing 11,500 lbs. to the lower level of feeding where the cows yield only 9,200 lbs. of milk. Rate of return on investment increased by 66 percent in the first case, but it decreased 66 percent in the second case. Without precise information about the pro-

Table 11.—Effect of level of feeding on milk production and returns (75-cow herd)

Item	*Milk production per cow*		
	9,200 lbs.	*11,500 lbs.*	*13,800 lbs.*
Milk produced, qts.	267,636	334,545	401,455
Receipts			
Milk	$61,556	$76,945	$ 92,335
Other	$ 9,445	$ 9,445	$ 9,445
Total	$71,001	$86,390	$101,780
Total cost excluding operator's labor and management	$63,189	$67,636	$ 72,069
Return to operator's labor and management	$ 7,812	$18,754	$ 29,711
Rate of return on average investment	4.3%	12.7%	21.1%

ductive ability of St. Croix cows, it would be presumptuous to say that farmers can increase their returns simply by heavier feeding. The analysis, however, does point out the dangers of underfeeding.

Feasibility of Silage Feeding

So far, pasture has been considered the only source of forage which is quite typical of the conditions prevailing in St. Croix. However, because of rising land values and rents, farmers are expressing interest in an alternate forage source such as sorghum silage. Apparently, switching over to silage can economize land, but at the same time it would require substantial outlays in forage handling equipment and increase the production expenses and labor requirements. Therefore, the farmers and research planners are interested in learning the overall effect of silage feeding on the profitability of dairying.

Instead of measuring the impact of silage feeding on returns, cost of producing silage per pound of TDN was estimated. Such a cost figure when compared to the cost of TDN from pasture can enable one to draw inferences about the profitability of silage feeding. However, since cost of producing silage could vary with the acreage handled, the analysis was based on the forage needs of the 75-cow benchmark dairy operation. According to reasonable estimates of silage feeding, about 50 acres of sorghum silage and 86 acres of pasture could produce enough forage for the 75-cow herd. This assumes the sorghum yield at 15 tons of silage or 4,110 pounds of TDN (fed out) per acre.

The additional machinery required to handle 50 acres of sorghum silage is listed in Table 12. One-third of the dairy tractor was charged to the silage activity. The initial investment in additional machinery and silo was estimated at $15,250. The total annual cost of the silage activity was estimated at $9,017 (Table 13). These costs include land cost; production expense on seed, fertilizer and chemicals; variable machine operating costs including custom hire; fixed costs and labor costs. It was assumed that introduction of 50 acres of silage in the forage system would increase the labor requirements by half a worker. The resulting per-acre

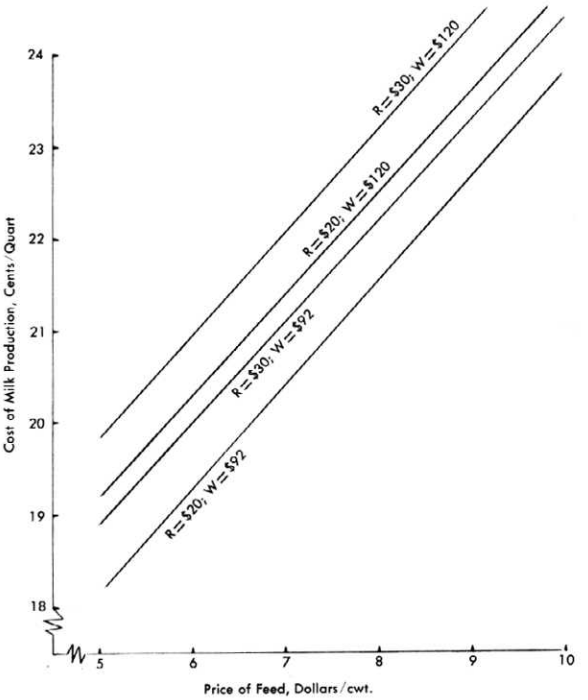


Figure 2.—Relationship between cost of milk production and price of feed and other variables, where R equals rent of land, $/acre and W equals wage rate, $ per worker per week.

cost was $180; the per-ton silage cost was $12. Cost per pound of TDN from silage was estimated at 4.4 cents (Table 13).

On the other hand, total costs incurred on an acre of pasture were estimated at $42 (Table 14). Included in these costs were land cost; pro-rated depreciation, interest and repairs on fence and brush control equipment; and labor cost for brush control. Cost per pound of TDN from pasture was estimated at 2.8 cents.

Thus, on the basis of this analysis, TDN from pasture proved to be considerably cheaper than the TDN from silage. However, at higher land costs and silage yields, sorghum silage could become an economical source of forage. Further analysis showed that when land costs increased above $55.42, sorghum silage with 15-ton yield became cheaper compared with pasture. Similarly, with silage yields above 23 tons and land cost remaining at $20 per acre, silage feeding was cheaper than pasture grazing.

Table 12.—Machinery and equipment for sorghum silage

Item	*Initial cost*	*Annual depreciation* [1]	*Annual Repairs* [2]
		Dollars	
Tractor (⅓ of dairy tractor)	2,167	217	65
Small tractor	4,000	400	120
Plow	800	53	16
Disc harrow	1,000	67	20
Fertilizer spreader	850	57	17
Planter	900	60	18
Forage harvestor	4,500	300	90
Wagons (2)	2,000	200	60
Trench silo, 800 tons	1,200	60	--
Total	17,417	1,414	406
Additional investment	15,250	--	--
Average investment	8,708	--	--

[1] Tractor and wagons were assumed to last 10 years; because of small acreage of silage other machinery was assumed to last 15 years and silo was depreciated over 20 years.
[2] Repair costs of tractor and wagons were estimated at 3 percent of initial costs; on other machinery at 2 percent.

Table 13.—Cost of making and feeding silage from a 50-acre field of sorghum

Item	*Rate per acre*	*Cost per acre*	*Total cost*
Land cost		$20.00	$1,000
Seed	9 lbs. @ $.23	2.07	104
Fertilizer	400 lbs. @ $6.50/bag	26.00	1,300
Herbicide	3.5 lbs. @ $1.80	6.30	315
Insecticide	1 pint @ $2.25	2.25	113
Variable machinery costs [1]		8.24	400
Fixed costs [2]			2,473
Labor, ½ man @ $6,623			3,312
Total			$9,017
Total silage produced			750 tons
Cost per ton			$12.00
Cost per acre			$180.00
Total TDN produced			205,500 lbs.
Cost of TDN, per pound			4.4¢

[1] This includes cost of hiring a tractor
[2] Fixed costs include interest on average investment in machinery and silo, depreciation and machinery repair costs.

Table 14.—Cost of maintaining pasture, per acre basis

Item	*Cost*
Land cost	$ 20.00
Fencing cost[1]	4.50
Fuel and machinery cost for brush control	2.50
Labor for brush control[1]	15.00
Total	42.00
TDN, amount produced per acre	1475 lbs.
Cost per lb. of TDN	2.8¢

[1] Fencing cost based on the 225 acre dairy farm.

REFERENCES

1. Winn F. Finner and Troy Mullins, *Appraisal of Virgin Islands Agricultural Production and Marketing,* ARS 24–1, Agricultural Research Service U.S.D.A., 1954.
2. George A. Stevens, *Farm Data Manual,* Info. Series No. 6, revised, Department of Agricultural and Resource Economics, University of Maryland, 1970.
3. *Agricultural and Food Fair of St. Croix,* 1971, V. I. Department of Agriculture.
4. *National Requirements of Dairy Cattle,* fourth revised edition, 1971 National Academy of Sciences, N.R.C., Washington, D.C.
5. *U.S. Census of Agriculture,* Bureau of the Census, U.S. Department of Commerce.

APPENDIX

Table 1.—Prices received and paid by St. Croix dairy farmers, 1973 [1]

Item	Unit	Price Dollars
Prices received		
Milk	quart	0.23
Cull cows	lb.	0.30
Cull heifers	lb.	0.38
New born calves	head	35.00
Prices paid		
Dairy feed	cwt.	7.50
Semen	Ampule	5.00
Wage [2]	year	6,623.00
Seven foot pole [3]	1	1.89
Wooden post [3]	1	5.40
Barbed wire [3]	480 ft.	11.25
Staples for fence	lb.	0.35

[1] These prices are primarily based on the survey of dairy farmers.

[2] Based on cash wage of $92 per week and the following fringe benefits: Social Security @ 5.85%, unemployment insurance @ 1.5%, workmen compensation @ 2.5%, free house with a rental value of $100 per month, and two quarts of milk per day valued at $168.

[3] Obtained from Mervin Building Centers, St. Croix, and adjusted for 10% discount on bulk purchases.

Table 2.—Cost of erecting four-strand barbed wire fence, per mile

Item	Quantity	Total Cost
Barbed wire	44 rolls; each 480 ft	$ 495.
Steel posts	500; 8 ft apart	1,134.
Wooden posts	60; 88 ft. apart	324.
Staples		27.
Labor		240.
Machinery		80.
Total		$ 2,300.

Table 3.—TDN Requirements Per Dairy Animal

Item	Milk Production [1]	TDN Requirements Maintenance	TDN Requirements Production	Total
1200 lb. dairy cow				
		Pounds per day		
Lactating cow				
Producing 9,200 lb.	25.2	8.7	7.7	16.4
Producing 11,500 lb.	31.5	8.7	9.6	18.3
Producing 13,800 lb.	37.8	8.7	11.5	20.2
Dry cow		11.4		11.4
		Pounds per year		
Lactating cow				
Producing 9,200 lb.	9,200	3176	2810	5986
Producing 11,500 lb.	11,500	3176	3504	6680
Producing 13,800 lb.	13,800	3176	4197	7373
Dry cow		4161		4161
Dairy heifer				
0 thru 6 mo. age (300 lb)	--	--	--	500
0 thru 12 mo. age (500 lb)	--	--	--	2000
0 thru 18 mo. age (500 lb)	--	--	--	3450
0 thru 24 mo. age (1000 lb)	--	--	--	5500

Source: *National Requirements of Dairy Cattle,* Fourth revised edition, 1971, National Academy of Sciences, NRC, Washington, D.C.

[1] Fourteen month breeding cycle and 365 day lactation were assumed.