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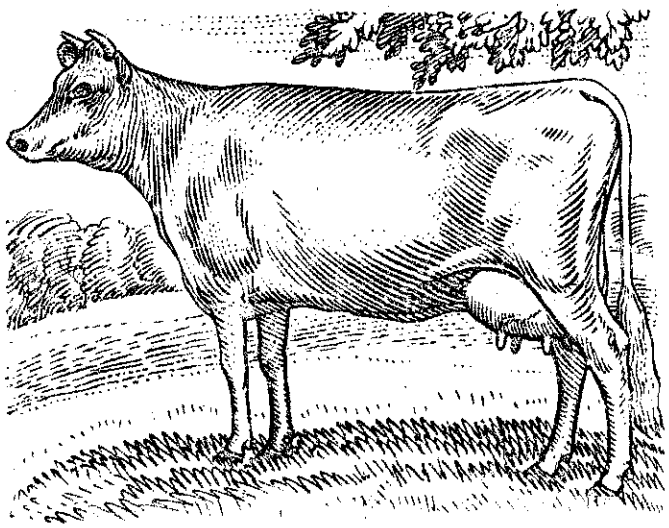
Ed Kearl

INPUT-OUTPUT RELATIONSHIPS IN MILK PRODUCTION FROM NEW YORK COST ACCOUNT FARMS 1940-47



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INPUT-OUTPUT RELATIONSHIPS IN MILK PRODUCTION FROM NEW YORK COST ACCOUNT FARMS 1940-47

INTRODUCTION

Purpose of Study

This study was undertaken to (1) emphasize the importance of feed and labor as factors making up the cost of producing milk, (2) determine the relation of milk production to changes in feeding levels, and (3) determine the most economical level of feeding practices at different levels of cost of feed and price of milk.

Method and Scope of Study

The records for this study were taken from farms on which the operators were keeping complete cost accounts in cooperation with the Department of Agricultural Economics at Cornell University. These farms are located throughout New York State. In general, the operators are more highly educated, operate larger farm businesses and use more modern farm equipment and farming practices than most of the farmers of the State.

For this study, a total of 261 dairy enterprise records were taken from 59 cooperating farms from 1940 through 1947 (table 1). The accounts were kept on an enterprise basis and all farm business costs including interest, taxes, etc., were allocated on a proportionate basis to the appropriate enterprise. Only farms with an average of 10 or more cows were studied.

TABLE 1. YEARS OF RECORDS FOR EACH FARM
261 Accounts, New York Cost Account Farms, 1940-47

Years	Number of farms	Number of accounts
1	10	10
2	6	12
3	8	24
4	8	32
5	5	25
6	7	42
7	4	28
8	11	88
Total	59	261

The milk production was adjusted to a 3.7 per cent butterfat basis and the cost of producing milk was adjusted accordingly; otherwise, all data are the same as those used in Cost Account publications.

DESCRIPTION OF FARMS

Use of Land

The farms studied averaged 245 acres (table 2). Although the size of the farms ranged from 100 to 750 acres, 42 per cent were between 100 and 200 acres, and 32 per cent between 200 and 300 acres.

TABLE 2. Use of Land
59 Cost Account Farms, New York, 1940-47

Use	Acres	Percent of total
Crops	116	47
Pasture	58	24
Woods	51	21
Other	20	8
Total	245	100

Breed of Livestock

Two breeds of dairy cattle were kept on the farms studied - Guernseys and Holsteins. Only four herds of Guernseys were studied. They were excellent herds, and, during the eight-year period studied, were used as 28 accounts or 11 per cent of the total records. Since the butterfat test was converted to a 3.7 basis, the Guernseys were placed on equal basis with the Holsteins.

Size of Enterprise

Measured by the number of cows, the average size of the enterprise was 24 cows (table 3). This number varied from 10 to 80. Nearly one-fourth of the accounts fell in the 15 to 19.9 group. Another 23 per cent was included in the 20 to 24.9 class. Only 10 per cent of the accounts had more than 35 cows but these 26 accounts averaged 52 cows each.

TABLE 3. VARIATION IN SIZE OF ENTERPRISE
261 Accounts, New York Cost Account Farms, 1940-47

Cows per account	Number of accounts	Average number of cows	Percent of total
10 to 14.9	44	13	17
15 to 19.9	62	18	24
20 to 24.5	60	22	23
25 to 29.5	41	28	15
30 to 34.5	28	32	11
35 or more	26	52	10
Average or total	261	24	100

Milk Production Per Cow

The average milk production per cow was 86 hundredweight (table 4). This varied from 44 to 124 hundredweight. About thirty per cent of the herds produced between 85 and 94 hundredweight of milk per cow. One-fourth of them produced 75 to 84 hundredweight. More herds produced over 105 than produced less than 65 hundredweight.

TABLE 4. VARIATION IN MILK PRODUCTION PER COW
261 Accounts, New York Cost Account Farms, 1940-47

Cwt. of milk produced per cow	Number of accounts	Average	
		Number of cows	Hundredweight of milk
Less than 65	23	22	57
65 to 74	31	27	68
75 to 84	61	24	78
85 to 94	76	23	88
95 to 104	40	26	98
105 or more	26	26	110
Total or average	261	24	86

IMPORTANCE OF FEED AND LABOR AS COSTS IN PRODUCING MILK

The average cost of producing 100 pounds of milk from 1940 to 1947 was $2.77 (table 5). During this period, the lowest cost was $2.00 in 1940. It increased each year from 1940 to 1947 with the exception of 1945, which was slightly lower than either 1944 or 1946. The highest cost was $3.64 in 1947.

Although the average cost for the period studied is somewhat lower than present day costs, it is expected that farmers will have to reorganize their farm businesses to produce milk at lower costs when the price of milk declines.

TABLE 5. COST OF PRODUCING MILK*
261 Accounts, New York Cost Account Farms, 1940-47

Item	Per 100 pounds of milk produced	Percent of total
Feed	$1.63	59
Labor	0.67	24
All other	0.47	17
Total	2.77	100

* 3.7 butterfat test basis.

The average feed cost per 100 pounds of milk for this study was $1.63. This was 59 per cent of the total cost of producing milk. The feed cost varied from 56 per cent in 1940 to 63 per cent in 1947. The feed cost in terms of dollars increased each year but in terms of per cent of the total cost, varied from year to year. However, it did increase from the first to the last year of the study.

Labor is the second most important cost of producing milk. The average labor cost per hundredweight of milk was $0.67 or 24 per cent of the total cost. The per cent that labor cost was of total cost varied from 23 per cent in 1941 to 26 per cent in 1947.

All costs of producing milk other than feed and labor comprised 17 per cent of the total. "All other" costs include: bedding, horse work, automobile, truck, tractor, equipment, interest, use of buildings, breeding costs, veterinarian, medicine, disinfectants, milk-hauling, cow-testing dues, insurance, registration and transfer fees, light, water, power, strainer cloths and other supplies. All other costs varied from a high of 20 per cent in 1940 to 11 per cent in 1947. In contrast to feed and labor, all other costs decreased proportionately as the total cost of producing milk increased. These represent the more fixed costs.

INPUT-OUTPUT RELATIONSHIP IN MILK PRODUCTION

The most important inputs in milk production are feed and labor. These will be studied separately to show their effect on the principal output from dairy cows - the production of milk.

Relation of Milk Produced Per Cow to Rates of Feeding

Herds with high producing cows were fed at higher rates than the poorer producing herds. A comparison of 23 herds producing less than 6500 pounds of milk per cow with those producing 10500 pounds or more showed that over 2800 pounds more grain, one-half ton more hay and approximately two tons more silage were fed per cow in the latter group (table 6).

TABLE 6. MILK PRODUCED PER COW AND FEEDING PRACTICES
261 Accounts, New York Cost Account Farms, 1940-47

Hundredweight of milk produced per cow	Number of accounts	Average: Pounds of grain per cow	Tons of hay per cow	Tons of silage per cow	Man hours per cow	Feed cost per 100 pounds of milk
Less than 65	23	1700	2.2	3.9	99	$1.95
65 to 74	31	2044	2.1	3.3	107	1.55
75 to 84	65	2413	2.4	4.4	121	1.62
85 to 94	76	2837	2.6	4.5	131	1.58
95 to 104	40	3348	2.5	5.3	129	1.57
105 or more	26	4531	2.7	5.8	146	1.71

Man hours increased directly with increased rate of milk production. A comparison of the first and last groups showed that 47 more hours were spent per cow in the latter group. The additional 50 per cent more labor was used in feeding the extra grain and obtaining and handling the additional milk.

Because of the difference in the average amount of milk produced per cow, the amount of feed required to produce 100 pounds of milk was less for the high producing herds than for those with low production. Therefore, the feed cost per 100 pounds of milk was less for the former group than for the latter. However, the feed cost fluctuated somewhat with the different rates of production.

Relation of Milk Production Per Cow to Costs and Returns

Not only did the feed cost per 100 pounds of milk decrease with increased rates of production but the total cost decreased likewise. There was a consistent inverse relationship between the production per cow and the total cost of production. The cost of producing 100 pounds of milk with herds producing more than 10500 pounds was $2.56, or $0.98 less than that for farms with herds producing less than 6500 pounds per cow (table 7). However, as the rates of production increased, there was a diminishing rate of decrease in the cost of producing milk.

TABLE 7. MILK PRODUCTION PER COW AND COSTS AND RETURNS
261 Accounts, New York Cost Account Farms, 1940-47

Hundredweight of milk produced per cow	Number of accounts	Average	
		Cost of producing 100 pounds of milk	Returns per cow
Less than 65	23	$3.54	$217
65 to 74	31	2.79	234
75 to 84	65	2.75	279
85 to 94	76	2.71	317
95 to 104	40	2.58	358
105 or more	26	2.56	418

The importance of securing high rates of milk production was also emphasized by the variations in returns per cow from the various production groups. The returns per cow increased consistently with increased rates of production. The highest producing group showed returns of $418 per cow, or over $200 more than the lowest producing group. With an average of 26 cows per herd, this meant more than $5000 additional cash receipts. It could mean the difference between a substantial profit and a heavy loss on the enterprise. The greatest increase in returns per cow was between the two highest producing groups, whereas, the lowest increase was between the two groups with the lowest producing herds.

Relation of Amount of Silage Fed Per Cow to Feeding Practices and Milk Production

There was no consistent relationship between the silage feeding rates and rates of hay feeding. All groups fed approximately 2.4 tons of hay per cow (table 8). However, cows fed increasing amounts of silage were also fed larger portions of grain. The group that fed 3.0 to 3.9 tons of silage per cow fed an average of only 2354 pounds of grain, whereas, the 22 herds that were fed 7.0 or more tons of silage per cow were fed an average of 3650 pounds of grain, or nearly 1300 pounds more than the former. Approximately 70 per cent of the herds were fed from 3.0 to 5.9 tons of silage per cow.

Some of the farms where large amounts of hay or silage were fed per cow may have been supplementing poor pastures.

TABLE 8. SILAGE FED PER COW AND FEEDING PRACTICES AND MILK PRODUCTION
261 Accounts, New York Cost Account Farms, 1940-47

Tons of silage per cow*	Number of accounts	Average per cow			
		Tons of silage	Pounds of grain	Tons of hay	Hundredweight of milk produced
Less than 3.0	37	1.6	2584	2.5	79
3.0 to 3.9	55	3.5	2354	2.6	79
4.0 to 4.9	67	4.5	2683	2.2	86
5.0 to 5.9	55	5.4	2995	2.5	89
6.0 to 6.9	25	6.4	3072	2.4	91
7.0 or more	22	7.8	3650	2.3	99

* Only six herds were fed no silage. They were included in the group which fed less than 3.0 tons of silage per cow.

Rates of milk production showed a tendency for a moderate increase as the amounts of silage fed increased. Herds which were fed less than 3.9 tons of silage per cow had an average production of 79 hundredweight of milk per cow. This increased to 86 hundredweight for cows fed 4.0 to 4.9 tons of silage each. The group which fed 7.0 or more tons of silage had average production rates of 99 hundredweight of milk per cow. The difference in production per cow between the first and last groups was 20 hundredweight.

Relation of Amount of Grain Fed Per Cow to Feeding Practices

As the grain feeding rates increased the rates of hay and silage feeding also increased, but the relationship was not consistent from group to group. The group feeding an average of 2005 pounds of grain per cow fed the lowest amounts of hay and silage, 2.0 and 3.5 tons, respectively (table 9). The group feeding 3900 or more pounds of grain fed 2.7 and 6.1 tons of hay and silage, respectively. This was 0.7 ton more hay and 2.6 tons more silage than the former group.

There was little increase in hay feeding until the grain feeding rate reached 2500 pounds per cow. Below this point, the cows were fed an average of 2.1 tons of hay; above it, an average of 2.6 tons.

With increased grain feeding, silage feeding rates fluctuated more widely than hay feeding rates. Cows fed less than 2500 pounds of grain were fed an average of 4.2 tons of silage, whereas those fed 2900 or more pounds of grain were fed 5.2 tons of silage.

TABLE 9. GRAIN FED PER COW AND FEEDING PRACTICES
261 Accounts, New York Cost Account Farms, 1940-47

Pounds of grain per cow	Number of accounts	Average per cow		
		Pounds of grain	Tons of hay	Tons of silage
Less than 1900	33	1465	2.1	4.5
1900 to 2099	25	2005	2.0	3.5
2100 to 2299	23	2210	2.2	4.4
2300 to 2499	34	2405	2.2	4.6
2500 to 2699	24	2591	2.6	4.1
2700 to 2899	28	2797	2.7	3.9
2900 to 3099	20	2971	2.6	5.1
3100 to 3499	26	3279	2.5	4.6
3500 to 3899	22	3690	2.7	4.8
3900 or more	26	4970	2.7	6.1

Cows fed increasing amounts of grain were fed greater quantities of roughage but not in direct proportion. Cows fed less than 1900 pounds of grain were fed at a roughage-grain ratio of 9.1, whereas, those fed 3900 or more pounds of grain were fed at a ratio of only 4.1

Relation of Amount of Grain Fed Per Cow to Man Labor and Milk Production

There was a tendency for the number of man hours required per cow to increase as the pounds of grain fed per cow was increased. However, this increase was not consistent with every group. Herds fed less than 1900 pounds of grain per cow required 103 hours of labor per cow, whereas those fed 3900 or more pounds required 136 hours per cow (table 10). Labor per cow increased consistently with increases in grain feeding up to 2700 pounds of grain per cow. Beyond this point the trend was still upward but fluctuated somewhat.

The higher labor requirements per cow were the direct results of increased feeding of grain as more time was required to move larger quantities of feed. They were also the indirect result of increased feeding as more labor was required to handle the additional milk and manure produced with the increased consumption of grain.

TABLE 10. GRAIN FED PER COW AND MAN LABOR AND MILK PRODUCTION
261 Accounts, New York Cost Account Farms, 1940-47

Pounds of grain per cow	Number of accounts	Average		
		Number of cows	Man hours per cow	Hundredweight of milk per cow
Less than 1900	33	22	103	68
1900 to 2099	25	25	114	75
2100 to 2299	23	24	120	80
2300 to 2499	34	20	120	84
2500 to 2699	24	26	128	84
2700 to 2899	28	24	126	85
2900 to 3099	20	30	139	90
3100 to 3499	26	28	126	93
3500 to 3899	22	24	138	96
3900 or more	26	24	136	109

Milk production per cow was directly related to pounds of grain fed per cow. Cows fed less than 1900 pounds of grain produced an average of 68 hundredweight of milk. The production of milk increased as consumption of grain increased; cows consuming 3900 or more pounds of grain produced 109 hundredweight of milk, or over 4000 pounds more milk than cows fed less than 1900 pounds of grain. There was no consistent relation between the rate of grain feeding and the size of herd.

Relation of Amount of Grain Fed Per Cow to Costs and Returns

There was a tendency for the feed cost of producing 100 pounds of milk to increase with increased feeding of grain. The feed cost varied from a low of $1.33 for cows fed 1900 to 2099 pounds of grain to a high of $1.84 for those fed 3900 or more pounds, a difference of $0.51 per hundredweight of milk (table 11). The feed cost per 100 pounds of milk produced from cows fed less than 1900 pounds of grain was greater than that from cows fed from 1900 to 2500 pounds of grain. However, when the amount of grain increased from this point, the increased production of milk was not sufficient to offset the additional cost of the feed, resulting in a higher feed cost per 100 pounds of milk.

TABLE 11. GRAIN FED PER COW AND COST AND RETURNS
261 Accounts, New York Cost Account Farms, 1940-47

Pounds of grain fed per cow	Number of accounts	Average				
		Cost of producing 100 pounds of milk			Returns per 100 pounds of milk	Return per hour of labor
		Feed	Labor	Total		
Less than 1900	33	$1.56	$0.68	$2.88	$3.23	$1.04
1900 to 2099	25	1.33	0.63	2.40	2.79	0.77
2100 to 2299	23	1.48	0.65	2.63	3.31	0.82
2300 to 2499	34	1.54	0.69	2.66	3.22	0.97
2500 to 2699	24	1.80	0.75	3.12	3.60	0.95
2700 to 2899	28	1.66	0.69	2.86	3.22	0.78
2900 to 3099	20	1.80	0.81	3.02	3.61	1.00
3100 to 3499	26	1.72	0.66	2.81	3.34	0.95
3500 to 3899	22	1.64	0.61	2.70	3.11	0.77
3900 or more	26	1.84	0.54	2.64	3.34	1.00

There appeared to be no consistent relation between the grain feeding rate and the labor cost per 100 pounds of milk. Also, there was no consistent relation between the grain feeding rate and the total cost of producing 100 pounds of milk.

There was no consistent relation between increased feeding of grain and either returns per 100 pounds of milk or returns per hour of labor. In general, the farmer received as much for his time when feeding at low levels as when feeding at high levels of grain. However, the farmers feeding more grain received more milk, spent more hours of labor per cow, and, thus, received higher total labor returns.

In general, the cost to keep a cow for a year increased as the rate of grain feeding was increased. The total cost increased from a low of $199 for cows fed 1900 to 2099 pounds of grain to $336 for those fed 3900 or more pounds (table 12). However, the returns per cow also increased with higher levels of grain feeding. In each group, the returns per cow were greater than the total cost of keeping the cow, indicating that the farmers did not feed beyond the point where no profit was left. However, some groups made more profit than others.

TABLE 12. GRAIN FED PER COW AND COSTS AND RETURNS
261 Accounts, New York Cost Account Farms, 1940-47

Pounds of grain per cow	Number of accounts	Average		
		Cost to keep a cow	Returns per cow	Profit per cow
Less than 1900	33	$207	$235	$28
1900 to 2099	25	199	232	33
2100 to 2299	23	227	269	42
2300 to 2499	34	244	294	50
2500 to 2699	24	288	331	43
2700 to 2899	28	261	295	34
2900 to 3099	20	299	352	53
3100 to 3499	26	285	335	50
3500 to 3899	22	286	326	40
3900 or more	26	336	414	78

The profit per cow increased consistently with each group up to 2500 pounds of grain per cow. With groups feeding more than 2500 pounds of grain, the profit per cow was inconsistent but the trend was slightly upward. Cows fed less than 1900 pounds of grain returned a profit of $28 each. Profits increased to $50 per cow for those fed 2300 to 2499 pounds of grain and $78 for those fed 3900 or more pounds. The difference between the lowest and highest profits was $50 per cow, making it worthwhile to feed the additional grain.

Relation of Man Hours Per Cow to Milk Production

The cost of man labor is the second most important cost in producing milk. During the period studied it accounted for approximately one-fourth of the total cost of all inputs. The variation in the hours of labor spent per cow was analyzed to determine its relation to milk production.

Since man labor per cow and grain per cow were interrelated, records were first sorted by grain per cow, and then sub-sorted by man hours per cow. The results are shown in Table 13.

TABLE 13. MAN HOURS PER COW AND MILK PRODUCTION
261 Accounts, New York Cost Account Farms, 1940-47

Man hours per cow	Number of accounts	Average Man hours per cow	Average Pounds of grain per cow	Average Hundredweight of milk per cow
	Farms feeding less than 2614 pounds of grain per cow (low-grain)			
Less than 85	22	71	1757	72
85 to 99	26	92	2170	75
100 to 114	27	106	2141	79
115 to 129	22	120	2120	78
130 or more	35	165	2206	82
	Farms feeding 2614 pounds or more of grain per cow (high-grain)			
Less than 110	25	96	3125	89
110 to 124	32	117	3342	92
125 to 139	22	132	3974	96
140 to 154	21	145	3941	102
155 or more	25	185	3372	104

On the farms feeding relatively low amounts of grain, there was some increase in milk production as more labor was used per cow. However, the amount of increase was relatively small.

On the farms feeding high amounts of grain, increased labor per cow resulted in significant increases in milk production.

Relation of Increased Feeding to Feed and Other Costs, Returns, and Profits Per Cow

The feed cost per cow increased rapidly with intensity of grain feeding up to about 2700 pounds of grain per cow (figure 1). From this point, it increased more slowly, reaching a peak at about the 3000 pound level. With further increases the feed cost per cow decreased. This seems impossible but actually occurred. When the price of grain was high in relation to milk, farmers fed less grain. Therefore, an average of the high feeding rates was an average of low feed prices, whereas, an average of the low feeding rates was an average of both high and low feed prices, resulting in lower feed costs per cow for the higher grain feeding group.

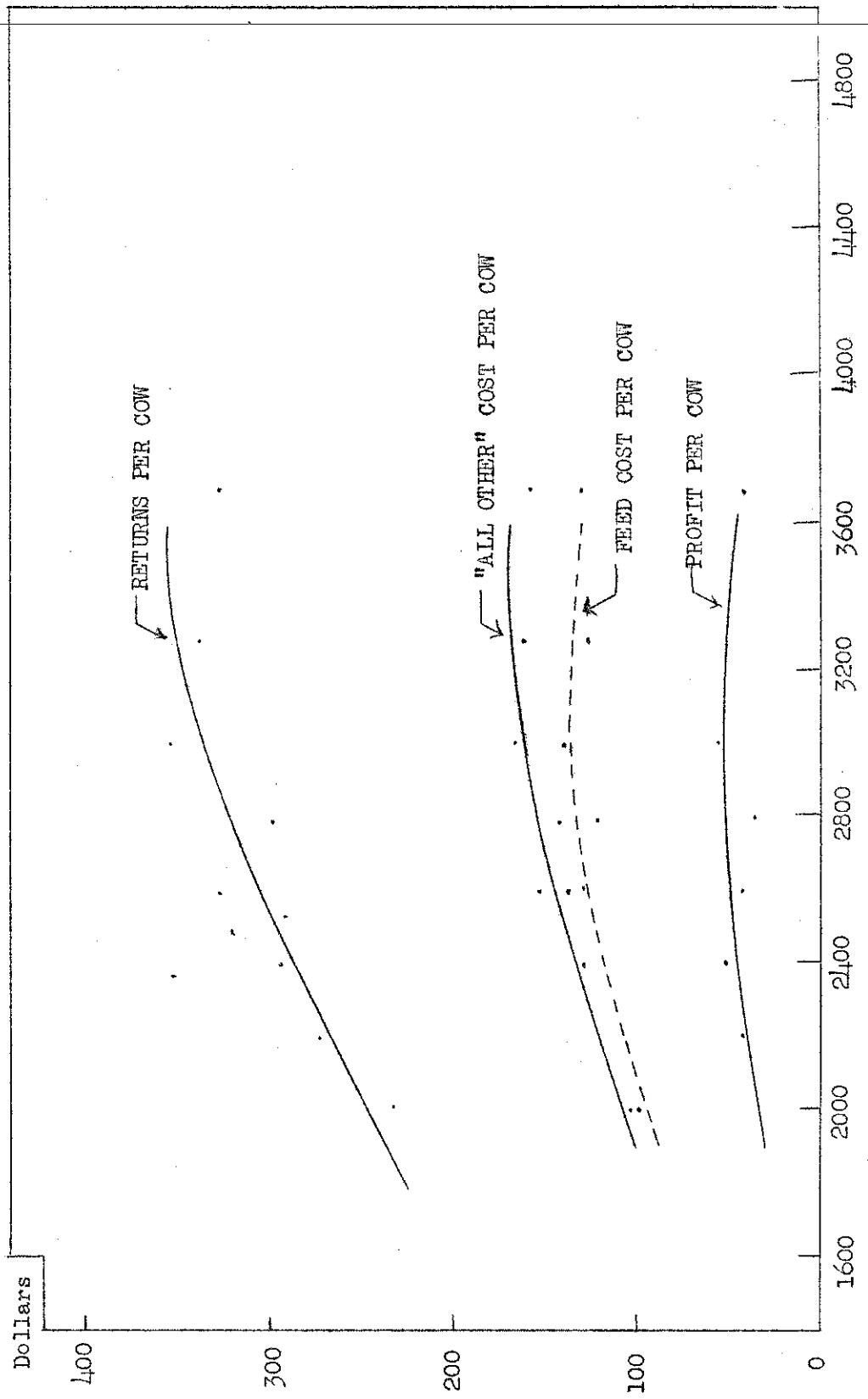

FIGURE 1. RELATION OF LEVEL OF GRAIN FEEDING TO COSTS AND RETURNS
261 Accounts, New York Cost Account Farms, 1940-47

All costs other than feed tended to increase as grain feeding rates increased. However, the higher the feeding rate, the less rapidly the increase. At approximately 3400 pounds of grain per cow, "all other costs" per cow reached a peak and remained fairly constant thereafter.

With increased grain feeding, up to 3000 pounds, the returns per cow increased more rapidly than either grain or all other cost per cow. The latter two combined gave the total cost of keeping the cow for one year. The difference between the total cost of keeping a cow and the returns per cow is the profit. As grain feeding increased to 3000 pounds, profits per cow increased. Any greater intensity of feeding gave less profits. On the basis of this analysis the most profitable level of feeding during the period studied was 3000 pounds of grain per cow. Farmers who fed at this rate received approximately $50 profits per cow.

Response in Milk Production to Increased Grain Feeding

For the analysis, all 261 records were plotted separately according to grain consumption and milk production per cow. Two curves were fitted to the data (figure 2). The upper curve showed to what degree total milk production was increased by heavier feeding. The lower curve showed the increase in milk production obtained for each additional unit of grain at the different levels of feeding.

The total output curve describes how the principle of diminishing increase applies to milk production. As more units of grain are added to a fixed set of other factors of production, the additional outputs of milk decrease and a point is eventually reached after which the total output of milk stops increasing. It can be seen from this curve that it is possible to increase milk yields by supplying increased quantities of feed, but the increased production is not the same for each added quantity of feed.

The additional output curve shows the amount of milk produced with each added quantity of feed. There is almost a straight line relationship between feed inputs and milk outputs up to approximately 4000 pounds of grain per cow. Actually, the point of diminishing increase was reached before the 1000 pound grain feeding level. Thus, the added output of milk decreased with each additional input of grain. However, the rate of decrease was not large until the 4000 pound level was reached. Beyond the 6000 pound level there was no additional output of milk when additional grain was fed. At this feeding level, the total output appeared to have reached its maximum point.

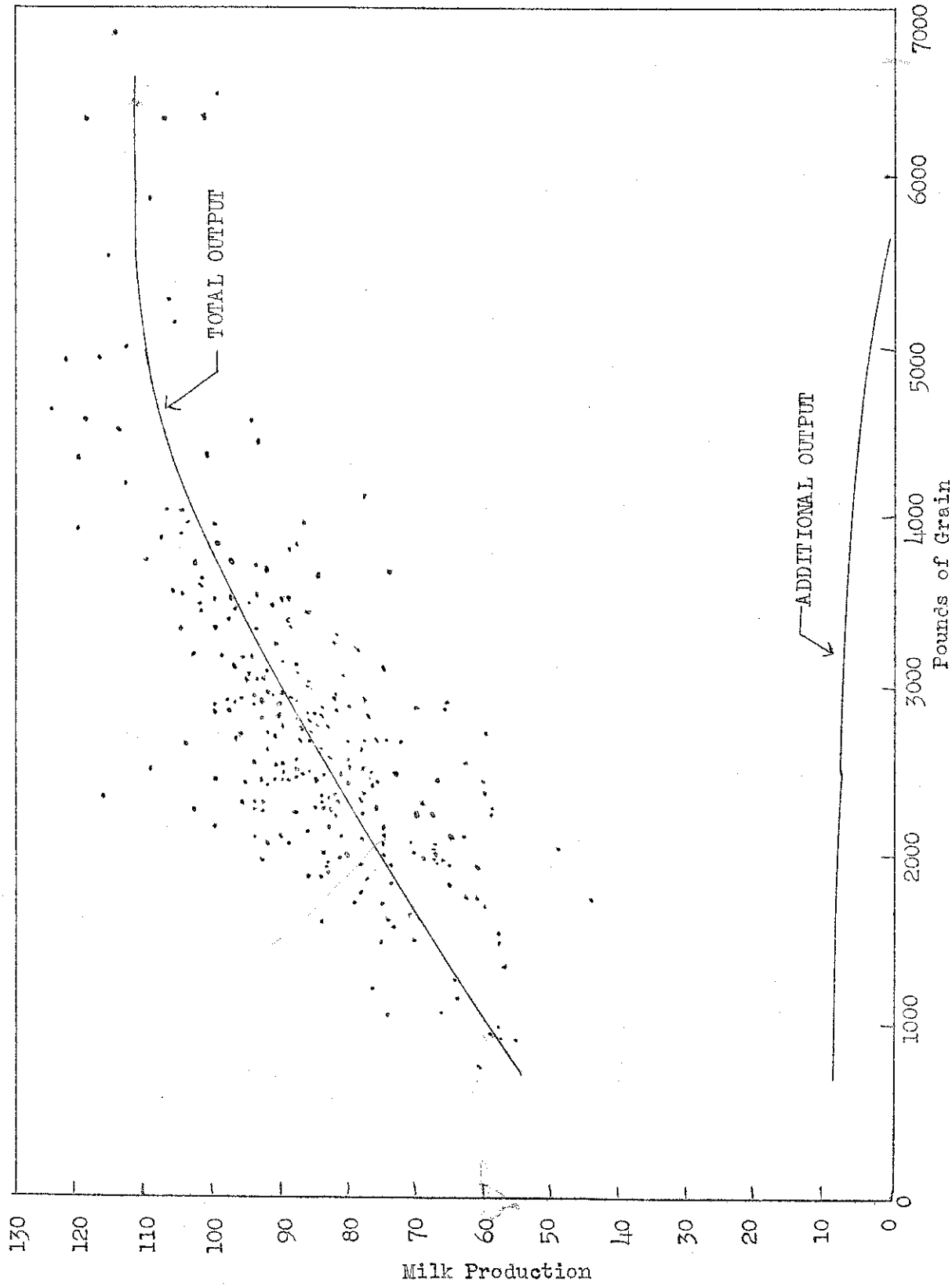

FIGURE 2. RESPONSE IN MILK PRODUCTION TO INCREASED FEEDING
261 Accounts, New York Cost Account Farms, 1940-47

SUMMARY

A total of 261 dairy enterprise accounts for the period 1940-47 were summarized from New York Cost Account Farms. Only accounts with an average of 10 or more cows were studied.

The milk production was adjusted to a 3.7 per cent butterfat basis and the cost of producing milk was adjusted accordingly.

Two breeds of dairy cattle were kept on the farms studied - Guernseys and Holsteins.

The size of the enterprise varied from 10 to 80 cows but averaged 24. The average milk production per cow was 86 hundredweight.

The average cost of producing 100 pounds of milk for the period studied was $2.77. Feed and labor were the most important costs, averaging 59 and 24 per cent, respectively, of the total cost.

With increased silage feeding rates, the amount of hay fed per cow did not increase. However, pounds of grain fed, hundredweight of milk produced, and feed cost per 100 pounds of milk increased, but the total cost decreased.

There was a direct relationship between the grain feeding rate and the amount of hay and silage fed per cow. As the amount of grain fed per cow increased, the feed cost per 100 pounds of milk increased but the labor cost and total cost per 100 pounds of milk increased little, if any, mostly fluctuating about a constant level. The returns per cow were more than enough to offset the additional cost per cow.

It was found that the principle of diminishing increase applies to grain feeding and milk production. However, there was no substantial decrease in the additional outputs of milk until the 4000 pound feeding level was reached. Beyond the 6000 pound level there was no additional output of milk when additional grain was fed.

On the basis of returns above costs per cow, the 3000 pound grain feeding level was most profitable for Cost Account farmers for the period studied.

The most profitable level of feeding is not fixed. It varies according to the relation between price of milk and cost of grain, referred to as the grain-milk price ratio.