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The feed cost of producing milk

Theodore Goodloe Hinton

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I am submitting herewith a thesis written by Theodore Goodloe Hinton entitled "The feed cost of producing milk." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Extension.

C. E. Wylie, Major Professor

We have read this thesis and recommend its acceptance:

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THE UNIVERSITY OF TENNESSEE

THE FEED COST OF PRODUCING MILK

33

by

Theodore Goodloe Hinton

A Thesis
written under the supervision of
The Department of Dairying

Submitted to the Graduate Committee of
the University of Tennessee in partial
fulfillment of the requirements for the
degree of Master of Science in Agriculture.

THE FEED COST OF PRODUCING MILK.

INTRODUCTION.

In ancient times cows were used as beasts of burden to a large extent, the production of milk being a side issue. The animal was expected to work and was kept for this purpose mainly. Any milk that could be produced then was so much gain. The gain was small, however, due to a lack of adequate kinds and an abundance of feed, and also to the fact that cattle were not bred and selected primarily for the purpose of producing milk.

Today in the United States we find things quite different. Few cattle are used as beasts of burden. We find them separated into two specialized groups, viz; beef cattle and dairy cattle. The former group, being kept for beef purposes, produce very little milk, whereas dairy cattle carry little flesh, producing instead more or less large quantities of milk.

So vast has this industry of dairying become that today there are in the United States some 32,000,000 dairy cattle, of which approximately 25,000,000 are dairy cows, leading all other classes of animals in value and

second only to beef cattle in number. (Fig.1)

"The average cow in the United States produces annually about 4,000 pounds of milk, containing about 160 pounds of butterfat, while we have some cows that produce six or seven times this amount. It is the amount of production per cow, perhaps, more than any other one item that determines the economy of production". (7) The value of dairy products far exceeds the value of any of our important crops, in fact being nearly equal in this respect to the combined values of cotton, wheat and potatoes. (Fig.2)

In the earlier days, afore mentioned, the cow made her own living, so to speak. Her ration was "pasture only", a great part of the year, with a very little of rather inferior roughage when weather conditions were extreme. Today the feeding problem has taken on a different aspect. In some specialized dairy sections it is not infrequent that cows go several months, a year, or even all life without so much as being on pasture a single day. She has become a specialized machine. Man gathers and places before her the raw materials and she converts them into the finished product - Milk. She has been changed from a beast of burden into an animal which is very efficient as a human food producer. But she is far from perfect. It is commonly known among dairymen that some cows

Figure 1.

FormE-5

Animals, Number and Value, United States, Jan. 1, 1920. (8)

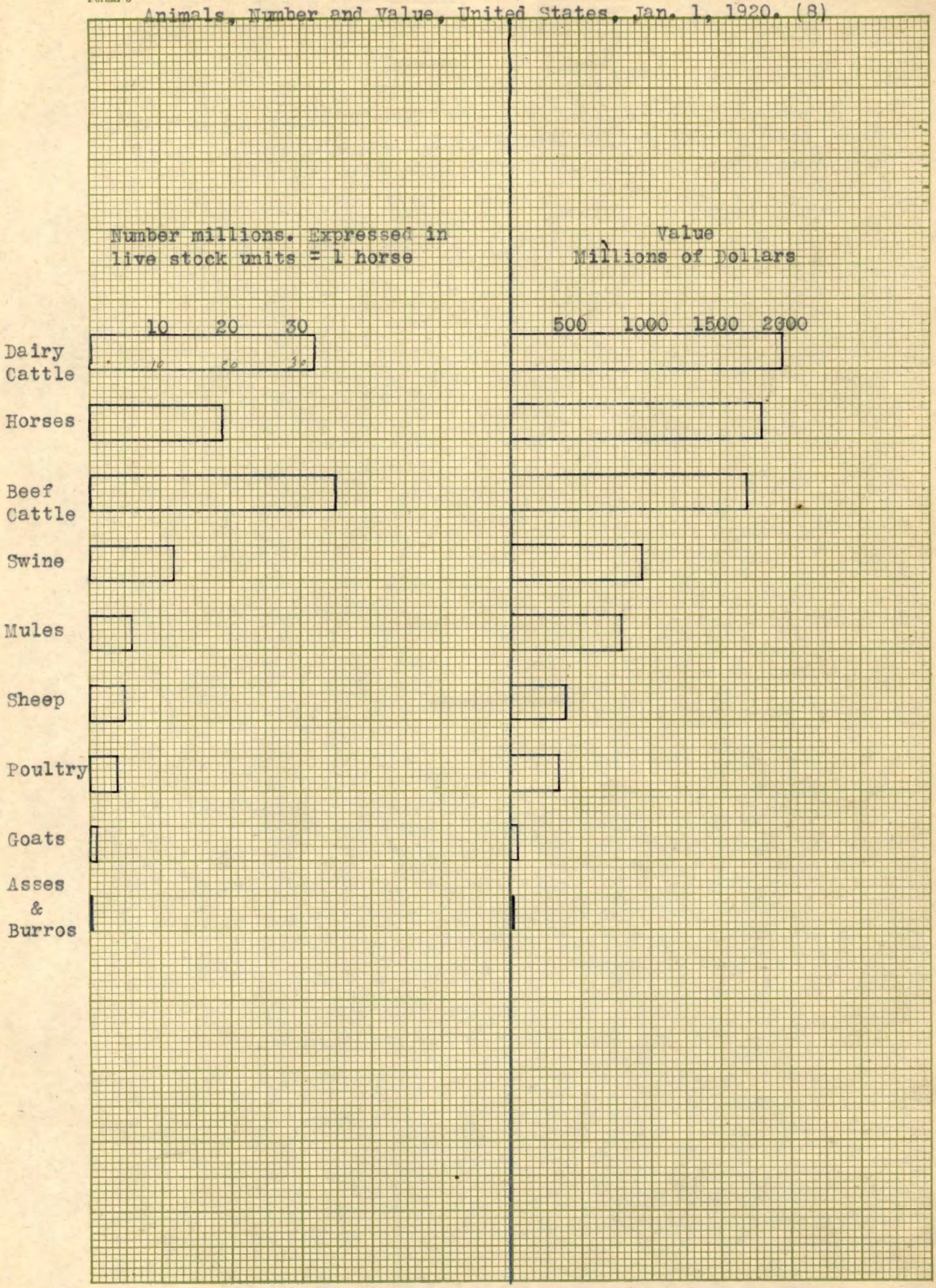

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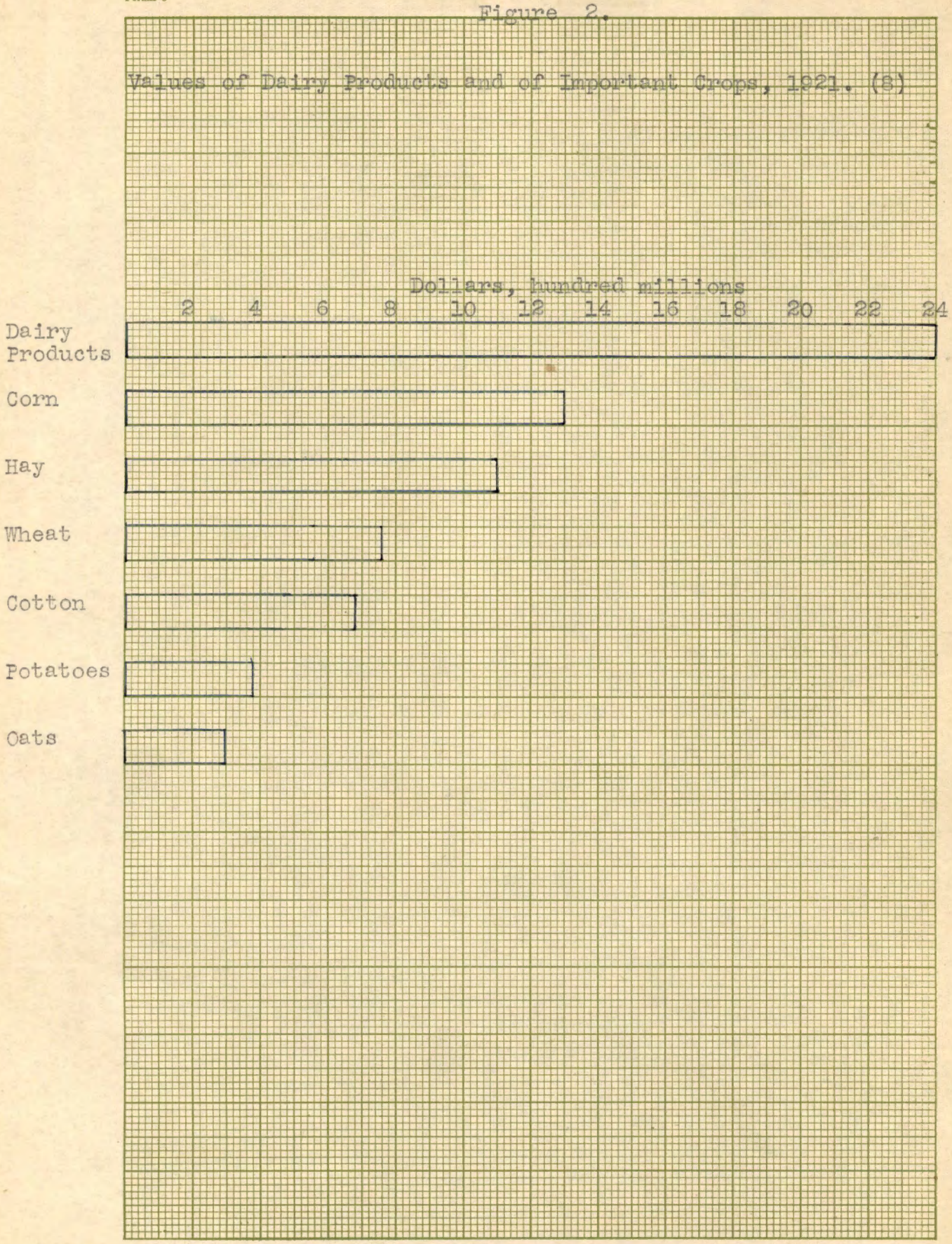
Figure 2.

Values of Dairy Products and of Important Crops, 1921. (8)



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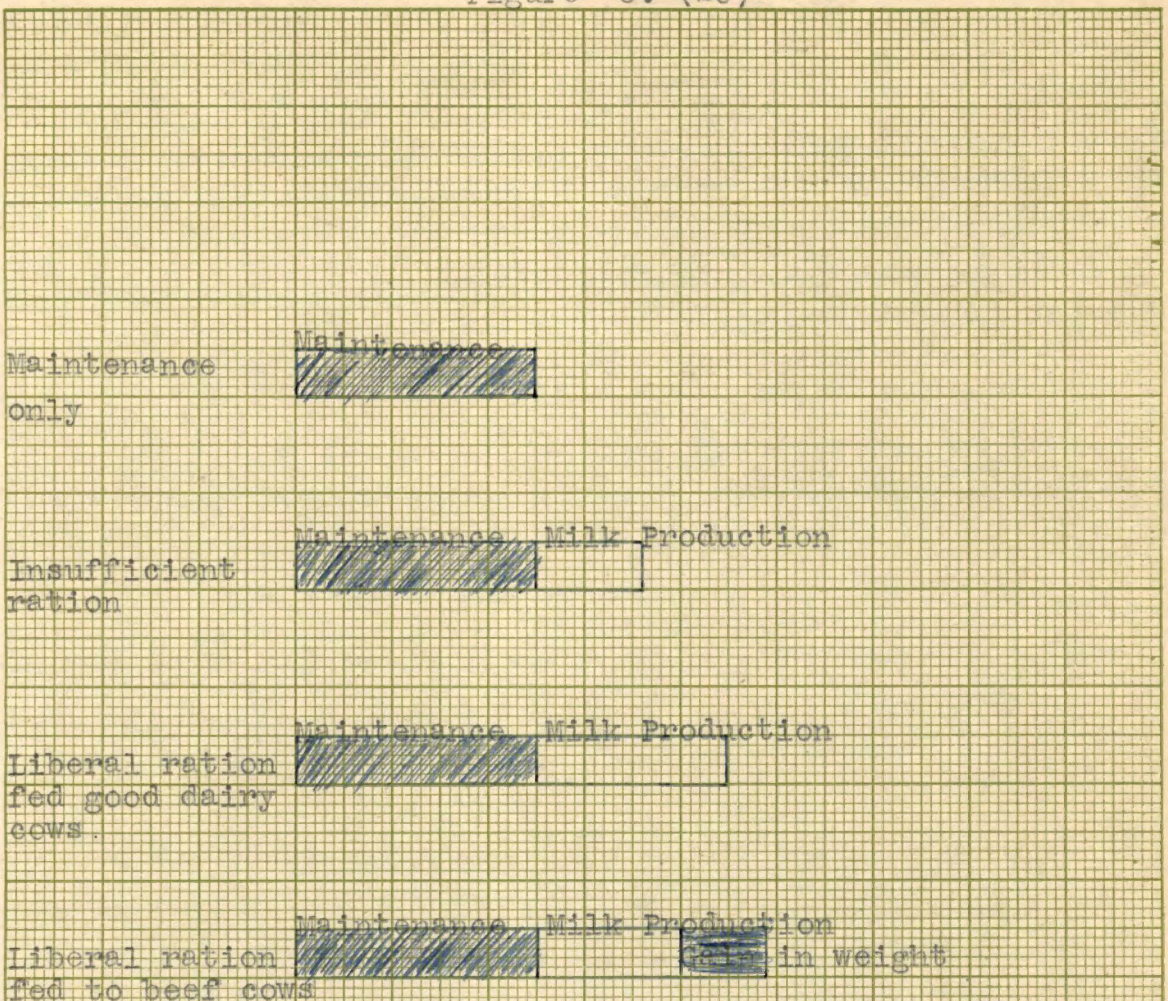
are more valuable than others. They realize that more feed is required by a poor cow to produce 100 pounds of milk or one pound of butterfat, than is required by a good cow. Nor is man perfect. He is lacking in his ability to produce, select and proportion the different feeds she is to receive.

Fig. 3 illustrates the uses of the feed fed a cow. First her body must be maintained, second comes milk production and if the feed is still further increased we have increased production, or in case the cow is of a beefy tendency, a laying on of fat. Quite a few men have spent their entire lives working out feed standards for each of the above. They have endeavored in a gallant way to give to feeders of dairy cattle criteria of feeding that will foster increased and more economic production. The technically trained man understands what is meant by such terms as: digestible crude protein, carbohydrates, or total digestible nutrients. And in a general way he knows how to balance these to meet the several needs of the dairy cow. The ordinary dairyman however, would much rather be told to feed his cows so many pounds of grain, hay and silage and to expect a certain amount of milk in return from cows of different producing powers, than to be given volumes of technical feeding information that to him is practically meaningless. He wants the information in his own language. A certain combination of pounds and kinds of feed should under certain conditions produce so many pounds of milk. If not, why not? The feeder's

Figure 3. (20)



Liberal rations fed to cows of beefy tendencies produce a gain in weight; such fed to good dairy cows produces the largest production of which they are capable.--(Van Norman)

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fault or the cows?

Though this problem of the cost of producing milk has been worked on extensively in a number of s states, very little has been done in the South, particularly in Tennessee. Anyone well acquainted with dairy feeding conditions in this state knows that there is an abundance of room for improvement. The production of the average Tennessee cow is low, and due mainly to poor cows, poor feeding and poor handling.

Realizing these things it was thought worth while to do some work toward determining the feed cost, or more strictly speaking, the pounds of the several different classes of feeds required to produce a given amount of milk or butterfat. Pounds were used rather than dollars and cents, they being more stable.

PLAN OF PROJECT.

A. Review and discussion of Literature.

B. Arrangement of "Feed Cost of Production", Data to Show:

1. Feed Cost Variation According to Section of the Country.
2. Feed Cost Variation According to Season.
3. Feed and Bedding Costs vs all other Costs.
4. Feed Cost Variation According to Production of the Cow.
5. Actual Feed Requirement to Produce a Unit of

Milk or Butterfat.

C. Summary

D. Conclusions.

GENERAL REVIEW AND DISCUSSION OF LITERATURE.

Tables 1, 2, and 3, taken from the works of Larson, (8) Wall (20) and Eckles and Warren (3), are Cost of Production tables which give each cost item of importance separately. In these the amount of feed necessary to produce a unit of product is not set forth directly, most of the items being listed on the dollars and cents basis. They have their importance however, in that they call to ones attention items that must be considered in keeping cost of production records.

Larsen (6) in table 4 gives some interesting information on differences in the value of feed fed cows during a year in different states. Whether or not these figures are for the same year could not be determined. Another thing that would be of interest would be to compare the average yearly production of the same cows with the average feed costs. But this data too was lacking. Certain it is though that the value of the feed fed a cow in one section of the country is no safe index to the value of the feed a cow will consume in some other section.

Table 1.

COST OF PRODUCING ONE HUNDRED POUNDS OF MILK IN 1921 (8)

ITEM	VERMONT	DELAWARE	LA.	IND.	NEB.	WASHINGTON.
Average Yearly Milk Production per Cow - Pounds	5.252	5.439	3.106	6.937	5.823	7.833
Butter Fat in Milk - Per Cent	3.9	3.6	4.4	3.8	3.7	3.7
FEED:-						
Grain	$0.40	0.67	1.06	0.45	0.23	0.23
Hauling and Grinding Grain	.01	.01	.07	.02	.01	.01
Hay and Other Dry Roughage	.83	.29	.17	.30	.31	.28
Silage and Other Succulent Roughage	.41	.17	.14	.25	.09	.18
Bedding	.01	.03	.0004	.02	.01	.01
Pasture	.11	.27	.18	.15	.38	.29
LABOR						
Humane	.41	.34	.47	.30	.33	.36
Horse	.06	.05	.07	.02	.01	.01
OVERHEAD AND OTHER COSTS	.48	1.01	.98	.39	.88	.46
Total Cost	$ 2.72	2.84	3.14	1.90	2.25	1.83

Table 2.

Annual Feed Requirements of the Dairy Cow as Found by Nine Stations. (20)

Station	Number of Years	Pasture Days	Feed Eaten: Concentrates Pounds	Feed Eaten: Soiling crops, Roots, or Silage Pounds	Feed Eaten: Hay Pounds	Average Cost of Feed Per Cow	Returns: Milk Pounds	Returns: Fat Pounds	Estimated Feed Units
Conn.	5	152	2029	8694	1830	$53.46	5498	279	5730
New J.	6	168	2624	6753	1825	44.68	6165	277	7836
Mich.	1	139	2774	3638	3986	35.96	7009	260	5964
Wis.	3	180	1914	9448	1200	37.68	7061	299	5769
Minn.	1	131	3435	5306	2029	37.82	6408	301	6439
Missouri	1	191	3027		4380	35.30	5927	248	6327
Utah	1	187	1976	3692	2347	31.61	8783	339	5635
Montana	2	150	1169		6468	32.45	5993	250	5903
Nebraska	5	153	1305		4518	21.43	5601	237	5094
	(total)								
Average	25	161	2250	5281	3076	$36.71	6494	277	6077

Table 3.

COST OF PRODUCING MILK ON NEW YORK FARMS. (3)

	Grade Herds		Purebred Herds	
	1913	1914	1913	1914
QUANTITIES				
Number Herds	17	8	5	4
Number Cows	297.5	189.6	110.5	85.5
Number Cows per Herd	17.5	23.7	22.1	21.4
Number Cattle Units per Herd	23.9	30.9	32.8	36.3
Average Value of Cows	$71.19	70.31	215.90	268.89
Pounds Milk per Cow	6185	5584	7000	7388
Pounds Grain per Cattle Unit	1551	1479	2339	2295
Value of Milk per Cow	$99.46	86.42	107.70	105.10
Pounds Dry Forage per Cattle Unit	3028	2480	3216	3700
Pounds Silage per Cattle Unit	6554	5340	6791	8980
Hours Man Labor per Cattle Unit	116	100	161	183
COSTS PER CATTLE UNIT.				
Grain	$22.71	18.99	34.18	34.24
Dry Forage	17.76	12.90	23.00	16.88
Silage etc	12.90	11.74	14.33	17.47
Pasture	4.96	4.43	4.52	4.15
Bedding	2.22	1.33	2.55	2.70
Man Labor	19.26	16.23	27.86	30.78
Horse Labor	2.64	3.77	3.22	2.31
Equipment Labor	.91	.76	.97	.78
Interest	3.55	2.95	11.21	15.90
Buildings	2.81	2.04	2.34	3.27
Breeding Fees	.003	.36	8.21	1.76
Vet. & Medicine	.20	.09	.55	.59
Miscellaneous	2.13	1.95	6.92	10.16
SUMMARY.				
Feed	$58.33	48.06	76.03	72.74
Man Labor	19.26	16.63	27.86	30.78
All Else	14.46	13.25	35.97	37.48
Total	$ 92.05	77.94	139.86	141.00
RETURNS PER CATTLE UNIT.				
Milk	$ 72.81	66.24	72.61	61.73
Increase & Net Sales	18.02	13.37	87.01	90.47
Manure	10.59	7.87	10.11	10.12
Miscellaneous	.39	.06	1.79	1.95
Total	$ 101.81	87.54	171.52	164.27
PROFIT PER CATTLE UNIT	$ 9.76	9.60	31.66	23.27

Table 4.

The Feed Cost of Keeping a Dairy Cow, per Year, in Different Sections of the United States. (6)

State (Authority)	Ill. (Hepburn)	Minn. (Peck)	Ore. (Howard)	Wash. (Nystrom)	Okla. (Fuller)	Mont. (Martin)	New Hamp. (Rasmussen)	Mass. (Lindsey)	South Dak. (Larsen)
Value of Feed Dollars	76.18	33.03	35.50	65.00	40.00	40.00	73.03	90.04	40.00

The amount, kind and value of feed fed dairy cows in different sections of the country varies a great deal.

Eckles and Warren (3) and Warren (18) in tables 5 and 6 give information supplementary to this statement. There is an outstanding difference in the feed costs of the two sections compared. And just as outstanding is the difference in the pounds of grain fed. Grain in most sections of the country is the highest priced feed, and it is not unlikely that the difference here more than anywhere else accounts for the differences in net returns. In general an abundance of cheap feed makes for cheaper production.

Likely our cheapest dairy feed is pasture. Compare the figures from Misner (11) in table 7 which divides the year into two periods, (Pasture and Winter). The feed in summer came from the same groups or classes of feeds as in winter with the exception of the pasture. During the pasture period it required less than 1/8 as much grain; 1/46 as much silage; about twice as much other succulent roughage; and 1/287 as much dry forage to produce 100 pounds of milk. Pasture made the difference and pasture being comparatively cheap makes cheaper production possible. Larson (8) in table 8 gives more extensive results along the same line.

This fact that pasture does make for cheaper production induces many owners of cows to follow a system of summer dairying. Summer dairying makes for increased production at this time of year, which along with the fact

Table 5.

Cost of Producing Milk (3)

	Delaware County, N.Y. 6422 Cows. Per cattle unit	Rice County Minn. per cow
Quantities:		
Pounds grain fed	1662	864
Hours human labor	130	133
Pounds milk produced per cow	4514	5252
Pounds butter-fat per cow	208	188
Costs:		
Feed	$56.60	$27.50
Bedding	.75	
Buildings	4.41	2.46
Dairy equipment	.41	.58
Interest	2.94	2.35
Human labor	18.26	18.66
Horse labor	.20	
Hauling milk	5.01	
Bull cost		1.98
Depreciation		3.19
Miscellaneous	.91	3.28
Less cattle increase and net sales	.92	
Total cost	$98.57	$60.00

Table 6.

Comparison of Average Costs of Production of Milk on some Minnesota Farms and on a Connecticut Farm. (18)

	Minnesota	Connecticut
Pounds of grain	877	2525
Pounds of hay	5050	2284
pounds of silage		8727
Days of pasture	164	133
Pounds milk produced per cow	4499	6379
Pounds butter (85 % fat)	201	324
Cost of feed	$23	$84
Other costs	29	65
Total cost	52	149
Value of product plus $15 for calf and manure	60	
Value of product, milk 4⁄ qt. calf and manure $15		133
Gain	8	
Loss		16

Table 7.

Feed Used in the Production of Milk and Butterfat (11)

	Pasture Period 159 days			Winter Period 206 days		
	Pounds Used			Pounds Used		
	Per Cow Per Day	Per 100 Pounds 4% Milk Produced	Per Pound Fat Produced	Per Cow Per Day	Per 100 Pounds 4% Milk Produced	Per Pound Fat Produced
Grain	0.856	5.2	1.3	6.007	43.9	11.0
Silage	0.471	2.8	0.7	18.110	129.0	32.2
Other succulents	3.359	20.2	5.0	1.471	10.5	2.6
Dry forage	0.084	0.5	0.1	20.141	143.5	35.8
Days pasture per cow		6.0	1.5			

Figures from records on 2058 cows on 149 N. Y. farms. The amount of feed less pasture varies a great deal with the season.

Table 8.

UNIT REQUIREMENT FOR PRODUCING ONE HUNDRED POUNDS OF MILK. (8)

ITEM	VERMONT		DELAWARE		LOUISANA		INDIANA		NEBRASKA		WASHINGTON.	
AVERAGE YEARLY MILK PRO.PER COW-LB:	5,252		5,439		3.198		6,937		5,823		7,833	
BUTTER FAT IN MILK - PERCENT.	3.9		3.6		4.4		3.8		3.7		3.7	
FEED:	W	S	W	S	W	S	W	S	W	S	W	S
Grain -- Pounds	54.1	8.7	53.7	18.5	72.4	62.5	38.6	20.0	41.2	11.0	29.4	5.2
Hays & Other Dry Roughage - Lbs	129.9	18.7	114.2	6.5	38.3	1.0	66.8	27.4	95.3	51.2	92.9	7.5
Silage & Other Succulent R. -Lbs.	191.3	27.8	91.0	10.3	78.4	8.1	141.6	60.1	93.6	29.3	143.3	40.4
Hauling &Grinding Concentrates.	0.02	0.005	0.01	0.002	0.095	0.05	0.03	0.014	0.016	0.004	0.022	0.003
Bedding. Lbs.	11.2		17.9	3.4	0.3		20.3		11.1	0.5	9.0	0.1
Pasture.		0.201	0.006	0.489	0.155	0.197		0.04	0.108	0.653		0.025
Labor.												
Human Hours	2.7	2.0	2.6	2.5	5.8	5.0	2.5	2.2	2.0	1.9	1.9	1.3
Horse .10	.6	.4	.5	.4	.9	.7	.3	.2	.6	.8	.1	.015
Overhead &Other Costs.	0.555	0.425	1.039	0.98	1.22	0.803	0.385	0.393	0.869	0.889	0.578	0.406

that it can be produced more economically then, causes a deflation in the price of milk during the summer months. King (5) brings this fact out very forcibly in table 9, which gives the monthly percentages of the yearly average price paid to farmers for milk for ten years ending Oct. 1, 1916, for New York and Chicago. Fig. 4 is a graphic illustration of the table. Such a table should in a general way enable one to forecast the price of milk. In less stable markets however, the table is less applicable.

The feed and bedding cost is the largest single item of expense connected with milk production. Cooper, Bennett and Church (2) in table 10, show the relation of feed and bedding cost to total cost of keeping a cow. Figures are given from four different states, in each of which this item amounts to around 50 per cent of the total cost. Table 11 from Misner (11) gives figures that ably supplement table 10.

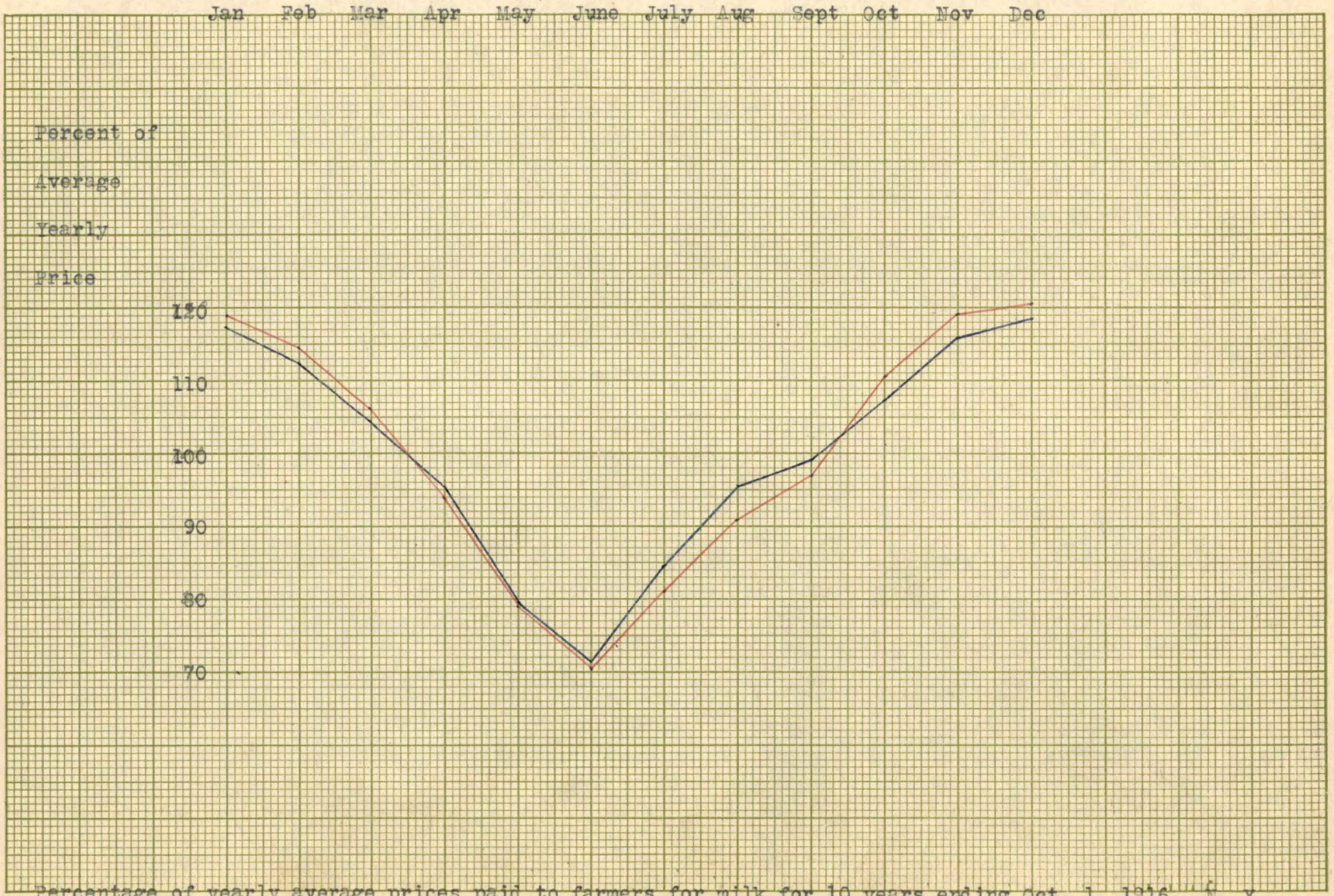
Table 12 from the Fairfax County, Virginia Cow Testing Association Annual Report, 1923 gives the feed necessary to produce a unit of product, in case of an exceptionally high producing cow. Note how little hay, grain and silage it took for her to produce 100 pounds of milk or one pound of butterfat and then compare the figures with those in table 13 for a medium producing cow owned by the University of Tennessee. Larsen (6) in tables 14 and 15 gives further comparisons of good and

Table 9.

Percentage of Yearly average Prices Paid to Farmers for Milk for 10 Years Ending Oct. 1, 1916. New York and Chicago. (5)

Month	Chicago Milk News	New York "26 cent zone" Milk Reporter
January	117.2	119.0
February	112.6	114.7
March	104.6	1o6.1
April	95.4	93.9
May	79.4	79.1
June	71.5	70.6
July	84.8	81.0
August	95.4	90.8
September	98.0	96.9
October	107.2	110.4
November	115.8	119.0
December	118.5	120.2
Average	100.0	100.0

Figure 4.



Percentage of yearly average prices paid to farmers for milk for 10 years ending Oct. 1, 1916. N. Y. and Chicago. (5)

New York—
Chicago —

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Form E-5

Table 10.

Relation of Feed and Bedding Cost to Total Cost of Keeping a Cow (2)

	Wis. Farm	Mich. Farm	Penn. Farm	N.C. Farm
Per cent of Total Cost of Feed and Bedding.	48.5	57.2	52.1	53.2

The feed and bedding cost is approximately one-half the total cost of producing milk.

Table 11.

Average Costs on 2058 Cows for one Year (11)

Item	Per Cow	Per cent of Total
Grain	$20.83	19.7
Succulent Feed	10.94	10.4
Dry Forage	19.79	18.8
Pasture	4.54	4.3
All Other Costs	49.33	46.8
Totals	$105.43	100.0

In this case the feed cost was more than 50 % of the total cost of keeping a cow.

Table 12.

Feed Used in the Production of Milk and Butterfat (1)

	Pounds Used	
	Per 100 lbs. 3.96% Milk Produced	Per Pound Butterfat Produced
Grain (Larro Dairy Ration)	30.6	7.72
Silage and other succulent feed	36.2	9.14
Hay	8.6	2.17

Report on one cow "Sadie", second high producing grade cow in the world, having produced 23,157#of milk, testing 3.96% fat, containing 915.9# fat,in one year. Owned by Mr. Ben Middleton, Herndon, Virginia.

Table 13.

Feed Used in the Production of Milk and Butterfat

	Pounds Used	
	Per 100 lbs. 3.10% Milk Produced	Per Pound Butterfat Produced
Grain	35.72	11.52
Silage	158.00	44.51
Hay	23.83	7.51

Report on one cow, pure bred Holstein No. 19, a medium producing cow owned by the University of Tennessee. Years production: 8684.5 pounds of milk, testing 3.10%, containing 269.31 pounds of butterfat. Compare with preceding table.

Table 14.

The Relation of Production to Profit (6)

		Cow # 1		Cow # 2
Hay		$13.30		$12.69
Silage		12.50		8.50
Grain		37.50		11.83
Pasture		4.00		4.00
Labor		25.00		25.00
Depreciation on cow		9.40		5.62
Interest on value of cow		8.00		5.60
Interest on barn, per cow		2.66		2.66
Depreciation on barn, per cow		1.60		1.60
Insurance on barn		.42		.42
Insurance or risk on cow		.45		.30
Service fee		2.00		2.00
Gen. Exp., Vet., Medicine etc.		5.00		5.00
Total expenses		$121.83		$85.13
Pounds fat and value	480#	$144.00	148#	$44.40
Pounds skimmilk and value	13000#	32.50	3200#	8.00
Calf		10.00		5.00
Manure		15.00		12.00
Total value		$201.50		$69.40
Total expenses		121.83		85.13
Net profit or loss		$79.67		$15.73

Table 15.

The Relation of Production to Profit (6)

Herd	Cow No.	Milk	Fat	Feed Cost	Profit	Cost of 100 lbs. Milk	Cost of 1 lb. Fat	Returns for $1
A	1	12,275	463.5	$106.80	$119.00	$0.87	$0.23	$2.12
	2	1,540	60.4	44.74	15.38	2.90	.74	.66
B	3	9,773	351.2	96.21	76.88	.98	.27	1.80
	4	3,824	155.3	69.28	5.15	1.81	.45	.92
C	5	8,410	307.3	83.58	65.11	.99	.27	1.78
	6	4,845	277.3	73.83	16.44	1.52	.32	1.22

Cow No. 1 equals seven like No. 6 in profit.
Cow No. 5 equals four like No. 6 in profit.
An excellent example of the value of a good cow over a poor one.

poor cows. Almost invariably the high producer is the more economic producer. And it not only works that way in case of a few individuals but for large numbers as well. Note the figures from Wall (20) given in table 16 and you will find figures just about as outstanding and as convincing. Table 17 (original research data) more nearly brings this fact home in that the figures are taken from records kept on Tennessee cows. Wall (20) and Larson (8) in figures 5 and 6 respectively give illustrations that forcibly bring out this point.

One point further, that of pounds of feed necessary to produce 100 pounds of milk or one pound of butterfat, needs particular stress. The work that has been done along this line would normally come with the review and discussion of literature, but since it is so closely tied in with the original work done, it was thought to be less confusing and more forceful to deal with it in the latter connection.

RESEARCH DATA.

Plan of Research Work.

1. Monthly feed and production tables similar to table 18 were kept on all cows in milk in the University of Tennessee dairy herd.

Table 16.

Returns from Cows of Different Producing Powers (20)

	Lbs. Butter fat	Cost of Feed	Net Returns	Feed Units	Per 100 feed units	
					Lbs. Butter fat	Value of Products
1 Highest producers (134 cows)	529.1	$79.10	$87.72	7161	7.39	2.33
2 Medium producers (133 cows)	420.6	71.08	63.01	6574	6.40	2.04
3 Lowest producers(131 cows)	338.9	65.95	42.17	6084	5.57	1.78
Difference between 1 & 3	190.2	13.15	45.55	1077	1.82	.55
Difference between 1 & 3 in percent	56	20	108	18	32	31

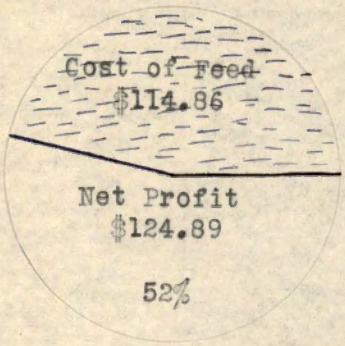
Table 17.

The Relation of Production to Net Returns

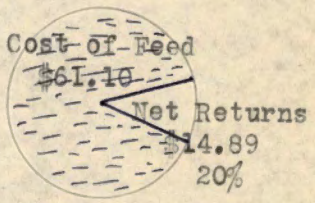
10 high milk producers average	6494.5 lbs. milk
10 low milk producers average	1111.9 " "
10 high butterfat producers average	349.5 lbs. fat
10 low butterfat producers average	67.6 " "
Returns above cost of feed:	
10 high cows average	$111.75
10 low cows average	10.20
Difference	$101.55

Figures from records on 275 cows in Bedford County, Tennessee.

Returns from Cows od Different Producing Powers. (20)



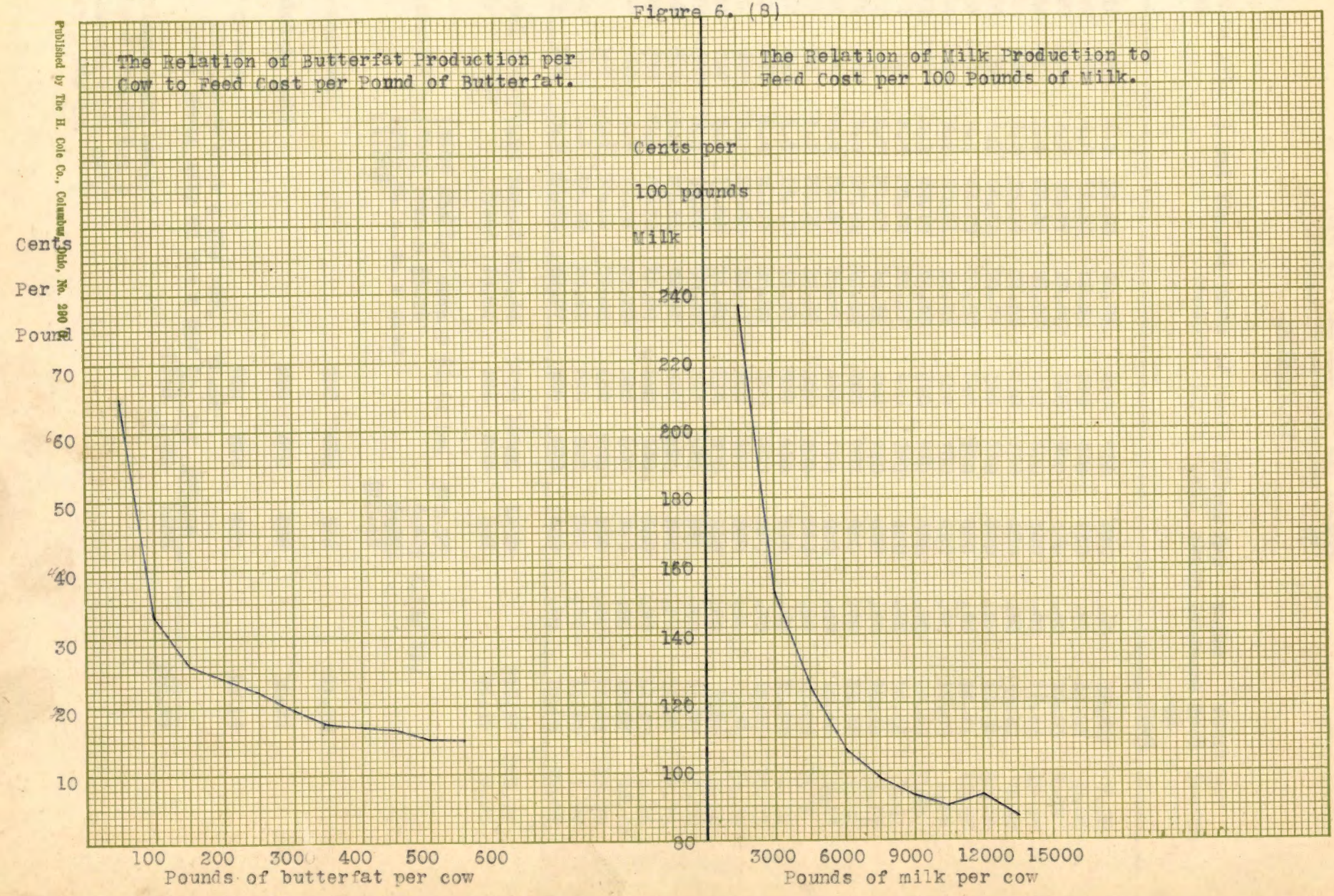
Best 10 Cows



Poorest 10 Cows

The areas of the circles represent the average values of the products from the 10 best or the 10 poorest cows in the Wisconsin Dairy Cow Competition, 1909-1911.

Figure 6. (8)



2. From these, summary tables like tables 19 and 20 were computed for each cow of the herd.

3. From the totals of the individual cow summary tables, tables like 21 and 22 were made which give a summary of the yearly production of each cow, for both Holsteins and Jerseys.

4. From summary tables 21 and 22 the pounds of grain, hay and silage necessary to produce 100 pounds of milk was determined for both Holsteins and Jerseys.

5. The pounds of grain, hay and silage necessary to produce loo pounds of milk was divided by the fat percent of the milk to determine the pounds of each necessary to produce one pound of butterfat.

6. 275 Bedford County Cow Testing Association records were used to determine the pounds of feed necessary and the costs of producing milk in that county. The average production of the cows was also determined.

7. From figures obtained in 6 (above), the same things as set forth in 4 and 5 (above) were determined for cows in Bedford County, Tennessee.

8. All available tables dealing with the number of pounds of the several classes of feed necessary to produce a unit of product were computed to obtain an average.

Table 19.

Yearly Report

University of Tennessee Dairy Herd on
Jersey Cow # 3

Month	Lbs. Milk	% Fat	lbs. Fat	Value of Product	Lbs. Concentrates	Lbs. Hay	Lbs Silage	Cost of Feed	Net Profit
Feb.	224.9	7.0	17.14	11.11	116	290	870	6.89	4.22
Mar.		(Dry)							
Apr.	633.0	4.5	28.48	18.46	240	240	900	10.55	7.91
May.	483.6	5.7	27.04	16.20	248		930	7.31	8.89
June	684.0	6.0	41.00	24.60	240		900	6.87	12.73
July	582.0	5.5	32.01	19.20	240		900	6.62	12.58
Aug.	564.2	5.7	32.04	23.39	240		450	6.96	16.43
Sept.	588.0	5.8	34.10	24.89	270		900	9.45	5.44 14.89
Oct.	297.6	6.0	17.86	14.82	279	310	930	14.45	.37
Nov.	303.0	7.0	21.21	17.60	180	240	750	10.70	6.90
Dec.	235.6	6.1	14.37	11.93	155	248	930	10.55	1.38
Jan.	192.2	6.7	12.88	10.69	124	186	775	6.89	3.80
Total	4808.1	5.7	8278.13	192.89	2340	1514	9235	97.24	95.65 89.90

Table 20.

Yearly Report

University of Tennessee Dairy Herd on

Holstein Cow # 65.

Month	Lbs. Milk	% Fat	Lbs. Fat	Value of Product	Lbs. Concentrates	Lbs. Hay	Lbs. Silage	Cost of Feed	Net Profit
Feb.	809.1	3.0	24.20	14.27	261	290	1160	9.79	4.48
Mar.	837.0	3.0	25.11	16.31	248	310	1240	10.78	5.53
Apr.	903.0	3.2	28.89	18.72	300	240	1200	12.20	6.52
May	829.0	3.6	32.36	19.38	279		1240	8.54	10.84
June	735.0	3.3	24.20	14.52	270		900	7.36	7.17
July	633.0	3.1	19.62	11.77	270		900	7.10	4.67
Aug.	795.5	3.2	24.30	17.74	310		450	8.01	9.73
Sept.	771.0	3.3	25.44	18.57	300		1050	10.70	87 7.12
Oct.	669.6	3.5	23.41	19.43	279	372	1085	16.00	3.43
Nov.	537.0	4.0	21.48	17.83	180	300	900	12.20	5.63
Dec.	530.1	3.8	20.14	16.72	186	310	930	11.79	4.93
Jan.	210.8	5.2	10.96	9.09	124	217	775	7.20	1.89
Total	8294.1	3.3	280.11	194.35	3007	2039	11830	121.66	72.69 71.94

Table 21.

Annual Report on Holsteins

University of Tennessee Dairy Herd, March, 1925.

Herd Number	Lbs. Milk	Lbs. Fat	Value of Product	Lbs Concentrates	Lbs. Hay	Lbs. Silage	Cost of Feed	Net Profit.
1	6418.4	204.93	135.45	2606	1212	8920	92.06	43.39
3	4639.3	150.27	95.00	2087	840	6780	67.18	27.82
15	10980.5	355.30	258.96	3476	1510	9070	136.64	122.32
19	8684.5	269.31	191.05	3102	2070	11985	125.30	65.75
20	13008.3	430.86	323.88	4738	2410	12115	159.83	164.05
46	7737.0	302.25	217.75	3062	2090	11145	124.24	93.51
47	8874.4	297.44	226.98	3449	2722	11955	142.13	84.85
55	9056.5	315.12	212.44	2899	1780	10670	115.45	96.99
58	1472.5	50.86	33.01	571	600	2090	22.17	10.84
60	1422.9	45.52	29.50	633	600	2400	24.24	5.26
64	1264.8	44.90	29.11	633	600	2400	24.24	4.87
65	8294.1	280.11	194.35	3007	2039	11830	121.66	72.69
68	1908.9	57.37	47.62	1000	562	1615	32.30	15.32
71	2621.5	97.28	80.75	1279	779	2545	42.75	38.00
72	2034.5	73.24	60.79	1000	562	1615	32.30	28.49
74	1714.5	51.12	42.42	916	562	1475	30.20	12.22
Total	90132.6	3025.88	2179.06	34458	20938	108610	1292.69	886.37
Av.	5633.3	189.11	136.19	2153	1318	6788	80.79	55.39

Table 22.

Annual Report on Jerseys

University of Tennessee Dairy Herd, March, 1925.

Herd Number	Lbs. Milk	Lbs. Fat	Value of Product	Lbs. Concentrates	Lbs. Hay	Lbs. Silage	Cost of Feed	Net Profit
5	4808.1	278.13	192.89	2340	1514	9235	97.24	95.65
10	4581.4	249.65	167.57	2763	1698	8180	103.92	63.65
21	5959.2	323.04	225.40	3577	1932	9060	122.56	102.84
53	6483.3	313.07	236.09	3329	2389	9245	127.97	108.12
67	2509.4	123.05	79.27	1600	840	5880	58.98	20.29
83	6306.9	294.66	207.93	3354	2420	11040	132.69	75.24
93	3938.3	263.82	170.99	2071	840	6030	67.69	103.30
119	5537.1	315.55	230.17	3259	1811	8295	111.39	118.78
127	5759.8	346.42	254.05	3035	2020	9520	114.28	139.77
132	471.2	25.95	16.83	180	600	1800	13.14	3.59
144	4844.9	253.22	179.48	2824	2095	7720	110.48	69.00
147	1597.3	80.16	66.53	1122	630	1940	36.54	29.99
149	1788.1	82.27	68.82	1153	661	2095	37.81	31.01
158	1432.3	81.66	67.78	1091	630	1940	36.06	31.72
339	5289.6	295.85	212.99	3197	1952	8580	116.30	96.69
250	1696.6	85.78	71.19	916	503	1320	28.94	42.25
253	4425.8	203.55	146.17	2601	2358	9245	113.31	32.86
255	5042.7	260.31	180.32	2675	1886	9110	106.79	73.53
256	5347.3	305.37	217.01	2685	2170	9670	111.02	105.99
257	4856.4	278.89	187.64	2460	1638	8180	97.05	90.59
258	4822.1	293.66	211.04	3102	1805	8925	107.83	103.91
Total	87497.8	4854.06	3390.16	49281	32392	147010	1852.09	1538.07
Av.	4166.5	231.14	161.43	2346	1542	7000	88.19	73.24

Table 23.

The Feed Cost of Producing Milk

	275 Cows Bedford Co. Tenn. Av. Per Cow.
Feed:	
Concentrates	$15.38
Roughage	14.44
Pasture	7.01
Total cost of Feed	$36.83
Production:	
Milk pounds	3936.5
Average test--per cent	5.02
Butterfat pounds	197.6
Value of Product	$95.06
Value of product above cost of feed	$58.23
Returns for $1 expended for feed	2.58
Feed cost per 100 pounds of milk	.9381
Feed cost per pound of butterfat	.1868

9. By use of the formula M(.4 + 15T) each table covered in 8 (above) was changed to amounts of feed necessary, had the milk tested 4 per cent.

Results of Research Work.

One thing that attention should be called to concerning tables 18-22 is the net profit column. Strictly speaking this is not net profit. Feed is the only cost item considered and credit is given only for milk. It might more correctly be spoken of as returns on milking cows above the cost of their feed. Another thing is the great variation in amounts of feed, production, etc., as given in the annual tables. The extreme lowness of some of these is due to the fact that some of the cows were sold only a few months after the testing work started. Others had been fresh only a month or two at the time final computations were made. The actual time for each cow could have been given but since it had no direct bearing on the amount of feed necessary to produce a unit of product, this was not thought necessary.

Table 23 gives the feed costs, production and some other related figures on 275 cows owned in Bedford County, Tennessee. The pounds of the several classes of feeds necessary in producing a unit of product are given in table 32.

Table 24-37 are what might be called a series of tables. Though some include additional data the main purpose of including them here is to set forth the amount of feed necessary to produce a unit of product, as determined by various investigators. Quite a few of these tables have been changed from their original form, in most cases giving only such information as was considered of specific interest. Most generally the original tables did not give the feed requirements to produce a pound of butterfat. This however, could easily be obtained in each case where the per cent of fat of the milk produced was given. Only two tables lacked this information.

Tables 38 and 39 are summary tables, (one for milk and the other for butterfat) giving the same information as included in tables 24-37. The numbers 1-14 in tables 38 and 39 correspond to tables 24-37 respectively.

A glance at table 38 shows that there are some outstanding differences in the amounts of the different classes of feeds necessary to produce a unit of product, e.g. in case No. 4 only 19.90 pounds of concentrates were used per 100 pounds of milk produced, as compared with 56.32 pounds in case No. 8. The hay requirement though in the same two cases was 87.00 and 37.02 pounds respectively, thereby somewhat counterbalancing the former difference. In other cases the difference in fat per cent of the milk produced

Table 24.

Feed Used in the Production of Milk and Butterfat (8)

	Pounds Used	
	Per 100 lbs. 3.79% Milk Produced	Per Pound Butterfat Produced
Grain	38.6	10.18
Silage	147.6	31.02
Hay	66.8	17.62

66

The number of records on which the above figures are based was not given. However the fact that they are U. S. Dept. of Ag. figures and are based on records from 6 states assures one that quite a number were used.

Table 25.

Feed Used in the Production of Milk and Butterfat (18)

	Pounds Used	
	Per 100 lbs. 3.47% Milk Produced	Per Pound Butterfat Produced
Grain	32.4	9.33
Silage	154.0	44.38
Hay	36.4	10.49
Other forage	25.9	8.50

Figures from records on 407 cows in Ill.

Table 26.

Feed Used in the Production of Milk and Butterfat (13)

	Pounds Used	
	Per 100 lbs. 3.56% Milk Produced	Per Pound Butterfat Produced
Grain	35.0	9.83
Silage	140.0	39.32
Hay	36.0	10.11
Other roughage	29.0	8.14

Figures from records on 19,802 cows owned on 680 farms in Ill.

Table 27.

Feed Used in the Production of Milk and Butterfat (15)

	Pounds Used	
	Per 100 lbs. 3.89% Milk Produced	Per Pound Butterfat Produced
Grain	19.9	5.11
Silage	44.5	11.43
Dry roughage	87.0	22.36
Pasture	3.1 days	.79 days

Figures from records on 1304 cows owned in 3 counties in Minn.

Table 28.

Feed Used in the Production of Milk and Butterfat (16)

	Pounds Used	
	Per 100 lbs. 3.83% Milk Produced	Per Pound Butterfat Produced
Concentrates	20.0	5.22
Succulents	17.6	4.59
Hay	98.1	25.61
Pasture	3 days	.77 days

Figures from records on 2208 cows in Spokane and Stephens counties, Washington.

Table 29.

Feed Used in the Production Of Milk and Butterfat (10)

	Pounds Used	
	Per 100 lbs. 3.87% Milk Produced	Per Pound Butterfat Produced
Concentrates	21.9	5.79
Succulent roughage	118.5	31.34
Dry roughage	40.3	10.66
Pasture	2.4 days	.63 days

Figures from records on 384 cows owned in 24 herds in Waukesha County, Wisconsin.

Table 30.

Feed Used in the Production of Milk and Butterfat

	Pounds Used	
	Per 100 lbs. 3.35% Milk Produced	Per Pound Butterfat Produced
Grain	38.23	11.38
Silage	120.50	35.89
Hay	23.22	6.92

Figures from records on 16 Holstein cows owned by the University of Tennessee, Knoxville, Tennessee.

Table 31.

Feed Used in the Production of Milk and Butterfat

	Pounds Used	
	Per 100 lbs. 5.54% Milk Produced	Per Pound Butterfat Produced
Grain	56.32	10.16
Silage	168.01	30.28
Hay	37.02	6.67

Figures from records on 21 Jersey cows owned by the University of Tennessee, Knoxville, Tennessee.

Table 32.

Feed Used in the Production of Milk and Butterfat

	Pounds Used	
	Per 100 lbs. 5.02% Milk Produced	Per Pound Butterfat Produced
Grain	22.92	4.57
Silage and othersucculent feed	82.79	16.49
Dry roughage	12.76	2.54
Pasture	5.76 days	1.15 days

6

Figures from records on 275 cows in Bedford county, Tennessee.

Table 33.

Feed used in the Production of Milk and Butterfat (11)

	POUNDS USED		
	Per Cow Per Year	Per 100 lbs. of 4.3% Milk Produced	Per lb. of Butterfat Produced
Concentrates	2,290	34.9	8.1
Silage	3,672	55.9	13.1
Other Succulent Feeds	1,648	25.7	6.0
Hay	3,151	48.0	11.2
Other Dry Forage	173	2.6	0.6
Pasture			

Figures from; 1,214 records of cows in Experiment Station Herds in the following states: Conn., Mass., Mich., Minn., Mo., Mont., Neb., N.J., Utah, and Wis.

Table 34.

Feed used in the Production of Milk and Butterfat (11)

Item	Total	Pounds Used		
		Per Cow Per Year	Per 100 Pounds of 4% Milk Produced	Per Pound of Butterfat Produced
Grain	2,895,814 lbs.	1,407	25.4	6.3
Silage	3,915.9 tons	3,806	68.8	17.1
Other Succulent Feed	861.43 tons	837	15.1	3.8
Hay	3,553,45 tons	3,453	62.4	15.5
Other dry Forage	729.60 tons	709	12.8	3.2

Figures from records on 2058 cows kept on 149 N. Y. farms.

Table 35.

Feed Used in the Production of Milk (15)

	Pounds Used Per 100 lbs. Milk Produced
Grain	33.5
Silage	93.2
Other succulent feed	9.4
Hay	45.3
Other dry roughage	11.5

Figures from records on 976 cows on 490 farms in Minn., Mich., Mass., Conn., N. Y. and N. J. The work of a committe appointed by Mr. H. C. Hoover to investigate the cost of producing milk during the war. Fat % figures not given.

Table 36.

Feed Used in the Production of Milk (17)

	Pounds Used	
	Per Cow Per Year	Per 100 Pounds Milk Produced
Grain	1,240	23.27
Silage	5,440	102.10
Other Succulent Feed	400	7.50
Hay	3,500	67.56
Value Pasture	$6.95	$0.13

Figures from records on 4650 cows kept on 212 Vermont farms, located in 12 counties. Average production: 5328 lbs. milk per cow. Fat % not given.

Table 37.

Feed Used in the Production of Milk and Butterfat (12)

	Amount	Total Value	Lbs. Used Per 100 Lbs. 3.7% Milk Produced	Value Per 100 Lbs. Milk	Lbs. Used Per Lb. Butterfat Produced	Per Cent of Total Value of Feed
Grain	1,606,308	$27,809	39.1	$.676	10.56	32.6
Silage & other succulents	4,807,500	17,636	117.1	.430	31.64	20.7
Hay & other roughage	3,944,500	22,366	96.0	.544	25.94	26.2
Pasture	1727 A.	16,715		.406		19.6
Corn stalks pastured	433 A.	414		.010		.5
Salt	29,823	304	.7	.007	.19	.4
Total		$85,244		2.073		100.0

Figures from records on 900 cows in Iowa.

Table 38.

Feed Used in the Production of 100 pounds of Milk.

Case No.	1	2	3	4	5	6	7	8	9
Fat % of Milk	3.79	3.47	3.56	3.89	3.83	3.87	3.35	5.54	5.02
Concentrates	38.6	32.4	35.0	19.9	20.0	21.9	38.23	56.32	22.92
Silage	147.6	154.0	140.0	44.5	17.6	118.5	120.50	168.01	82.79
Other Succulent Feed	66.8	36.4	38.0	87.0	98.1	40.3	23.22	37.02	12.76
Hay									
Other Dry Forage		25.9	29.0						
Pasture, days				3.1	3.0	2.4			5.76

Table 38 Continued

Case No.	10	11	12	13	14	Totals	Average
Fat % of Milk	4.30	4.00			3.70		
Concentrates	34.9	25.4	33.5	23.27	39.1	441.44	31.53
Silage	55.9	68.8	93.2	102.10	117.1	1430.60	102.18
Other Succulent Feed	25.7	15.1	9.4	7.50		57.70	4.12
Hay	48.0	62.4	45.3	67.56	96.0	758.86	54.20
Other dry Forage	2.6	12.8	11.5			81.80	5.84
Pasture, days						14.26	1.2

may have a direct bearing on the feed requirement. Still another thing to which attention might well be called is the very outstanding differences in the amount of pasture. In only four casesa are pasture figures given at all. Possibly in some of the cases the cows really did not receive any pasture. It is more likely though that most did receive some pasture, but as is often the case in specialized dairy sections, a large number of cows on a small acreage makes this item of so negligible importance as to seem unnecessary to include. Case No.b9 shows the highest figures in this respect, the cows receiving on an average 5.76 days of pasture for each 100 pounds of milk produced. This great amount of pasture cuts down on the other feeds necessary, and since pasture is a cheap feed, incidentally cuts down the cost of production.

Irrespective of the outstanding difference in the number of cows in each case, they were given equal value in computing the average. This could be done it was thought, since each group contains a sufficient number of cows to make the coefficient of error negligible, and als o because of the fact that any one of the groups could be considered as representative of a far larger number of cows of that particular section.

Table 39 is similar to table 38 except that it gives the feed necessary to produce one pound of butterfat. In this case the figures are more uniform, due if for no other reason to the fact that butterfat is standard and milk varies

Table 39

Feed Used in the Production of one Pound of Butterfat

Case No.	1	2	3	4	5	6	7	8	9
Fat % of Milk	3.79	3.47	3.56	3.89	3.83	3.87	3.35	5.54	5.02
Concentrates	10.18	9.33	9.83	5.11	5.22	5.79	11.38	10.16	4.57
Silage	31.02	44.38	39.32	11.83	4.59	31.34	35.89	30.28	16.49
Other Succulent Feed									
Hay	17.62	10.49	10.11	22.36	25.61	10.66	6.92	6.67	2.54
Other Dry Forage		8.50	8.14						
Pasture, days				.79	.77	.63			1.15

Table 39 Continued

Case No.	10	11	14	Total	Average
Fat % of Milk	4.30	4.00	3.7		
Concentrates	8.10	6.30	10.56	96.53	8.04
Silage	13.10	17.10	31.64	314.63	26.22
Other Succulent Feed	6.00	3.80		9.80	.81
Hay	11.20	15.50	25.94	165.64	13.80
Other Dry Forage	.60	3.20		20.44	1.70
Pasture, days				3.34	.28

in proportion to the amount of fat it contains.

Two still more stable tables though are numbers 40 and 41, in which tables 38 and 39 have merely been reduced to give the feed requirement to produce 4 per cent milk, or fat in 4 per cent milk. In reducing these to standard or 4 per cent milk the formula M(.4 + 15T) was used where "M", the milk yield in pounds and "T" the fat percentage were given. A precisely equivalent formula is .4 M 15 F. Here "M" is the milk yield in pounds and "F" the fat yield in pounds. Gaines and Davidson (4) give a full explanation of the basis underlying this method of correction or standardization.

The figures then in these two tables are far more comparable than is the case with the two preceding ones, since they are on the basis of a uniformily standard product.

In tables 39, 40 and 41 Cases No. 12 and 13 have been omitted due to a lack of fat per cent figures.

It ~~would be~~ 15 interesting to compare the feed requirements of Holsteins and Jerseys for both milk and fat production. This can be done in only one case however. In table 38, Cases 7 and 8, we have respectively the Holstein and Jersey feed requirements for producing 100 pounds of milk. The same cases in table 39 give the requirements to produce one pound of butterfat. These cows having been

Table 40.

Feed Used in the Production of 100 pounds of Milk

Case No.	1	2	3	4	5	6	7	8
Fat % of Milk	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Concentrates	39.85	35.19	37.43	20.23	20.52	22.33	42.35	45.75
Silage	152.51	167.30	149.89	45.24	18.06	120.85	133.51	126.48
Other Succulent Feed								
Hay	68.97	39.54	40.68	88.46	100.66	41.10	25.72	30.07
Other Dry Forage		28.13	31.05					
Pasture, days				3.15	3.07	2.44		

Table 40 Continued

Case No.	9	10	11	14	Total	Average
Fat % of Milk	4.0	4.0	4.0	4.0		
Concentrates	19.87	33.39	25.40	40.94	383.25	31.93
Silage	71.80	53.49	68.80	122.61	1240.54	103.38
Other Succulent Feed		24.59	15.10		39.69	3.31
Hay	11.06	45.93	62.40	100.52	655.11	54.59
Other Dry Forage		2.48	12.80		74.46	6.20
Pasture, days	4.99				13.65	1.13

Table 41.

Feed Used in the Production of one pound of Butterfat

Case No.	1	2	3	4	5	6	7	8
Fat % of Milk	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Concentrates	9.99	8.79	9.35	5.05	5.13	5.58	10.59	11.44
Silage	38.13	41.82	37.47	11.31	4.51	30.21	33.38	34.12
Other Succulent Feed								
Hay	17.24	9.88	10.17	22.11	25.16	10.27	6.43	7.52
Other Dry Forage		7.03	7.86					
Pasture, days				.79	.77	.61		

Table 41 Continued

Case No.	9	10	11	14	Total	Average
Fat % of Milk	4.0	4.0	4.0	4.0		
Concentrates	4.97	8.35	6.35	10.23	95.82	7.98
Silage	17.95	13.37	17.20	30.65	310.12	25.84
Other Succulent Feed		6.15	3.77		9.92	.82
Hay	2.76	11.48	15.60	25.13	163.75	13.64
Other Dry Forage		.62	3.20		18.61	1.55
Pasture, days	1.25				3.42	.28

kept in the same herd, treated the same way and their records covering the same period of time, makes the comparisons very fair. These figures show that Holsteins produce milk more cheaply than do Jerseys, whereas the opposite is true in fat production. In case however, the milk is standardized to 4 per cent the feed requirement was found to be less for the Holsteins in both milk and fat production.

Then referring to table 40 get the actual amounts of the different classes of feed necessary to produce 100 pounds of 4 per cent milk. If the feeds are grouped into classes we get the following:

Concentrates	31.93	Lbs.
Hay and other dry forage	60.79	"
Silage and other succulent feed	107.09	"
Pasture	1.13	days

These may be compared with 100 pounds of milk to get the ratio of each to a unit of production. They may also be compared with each other to get the proportionate amounts of each feed used. No doubt the feed requirement is somewhat greater than this in winter when cows are not on pasture, but of course in correspondingly less in summer.

The The same things hold true in regard to the production of butterfat since it takes exactly 1/4 as much feed to produce one pound of fat in 4 per cent milk as is required to produce 100 pounds of milk.

Summary of Research Work.

1. The above data shows that a high producer requires less feed to produce a unit of product than does a low producer.

2. The cost of keeping a cow a year was found to vary somewhat with the section of the country.

3. University of Tennessee Holsteins require less feed than do University of Tennessee Jerseys to produce 100 pounds of milk.

4. University of Tennessee Holsteins require more feed than do University of Tennessee Jerseys to produce one pound of butterfat.

5. Pasture was found to materially reduce the amounts of other feeds necessary to produce a unit of product.

6. Milk or butterfat was found to be produced more cheaply during the summer or pasture months.

7. The feed and bedding cost was found to be approximately 50 per cent of the entire cost of producing a unit of product.

8. To produce 100 pounds of 4 per cent milk it was found to require 31.95 pounds of concentrates; 60.79 pounds of hay and other dry forage; 107.09 pounds of silage and other succulent roughage; and 1.13 days of pasture. One fourth of these amounts was required to produce one pound of butterfat.

Conclusions.

1. In general the greater the production of milk and butterfat per cow, the more economical the production.

2. In general the more pasture there is available, the more economical is the milk and butterfat production.

3. Milk or butterfat can be produced more economically in summer than in winter, due at least partly to the difference in pasture available.

4. There is a greater difference in the amounts of feeds necessary to produce 100 pounds of milk than there is in the amounts necessary to produce one pound of butterfat--the former containing varying amounts of fat and,other solids.

5. The cost of producing a unit of product varies with the breed.

6. Taking the feed required to produce one pound of butterfat as given in table 41, with the present feed prices the cost of producing a pound of fat is 30-35 cents, and the cost of producing 100 pounds of 4 per cent milk four times this amount.

Many factors such as those above mentioned and dealt with have a profound influence on the economic production of milk or butterfat. If dairymen will realize and study these factors; keep better cows; provide larger amounts of cheap feed, particularly pasture; properly proportion his classes of feeds, one to another; and to the production of the cow; they will be a long way on the road to more economic production, which in turn means greater profits and a general advancement of the dairy industry as a whole.

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