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ECONOMICS OF FORAGE AND GRAIN PRODUCTION
AND UTILIZATION ON DAIRY FARMS

by

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Question:

Is it profitable for dairymen to substitute forage for grain in producing milk?

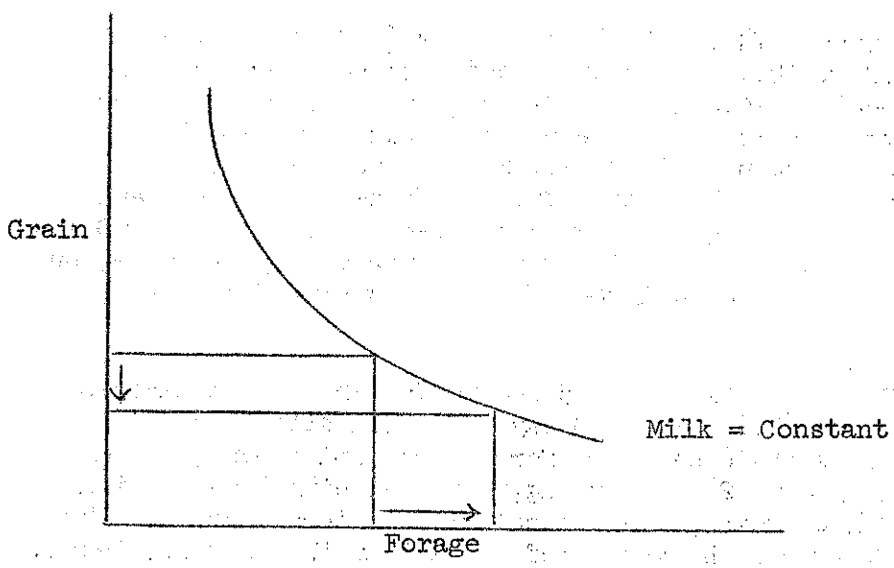

Fig. 1. Substitution of forage for grain in milk production

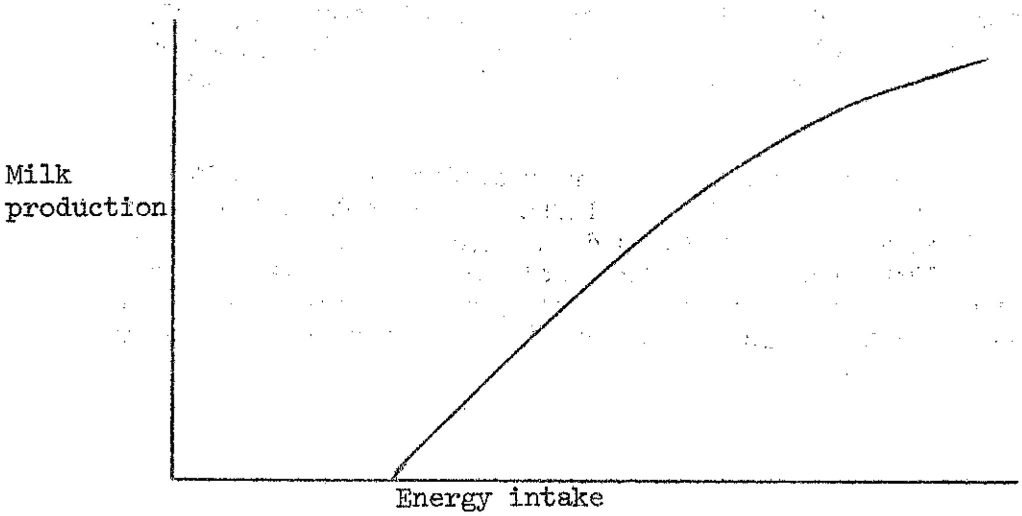

Fig. 2. Generalized relationship of milk production to energy intake

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Economic analysis of forage-grain substitution in feeding dairy cows is limited by the lack of adequate data from research studies on the response of milk production to grain feeding. Data from two rather recent studies (Cornell and Utah) is used here to compare return over feed costs with various levels of grain feeding.

In the Cornell study, group 1 (control) received 3932 lbs. of grain, group 2 (liberal grain) received 6963 lbs. and group 3 (liberal grain, restricted forage) received 8698 lbs. of grain per cow in a 44-week period (Tables 1 and 2). Group 2 cows had greater dry matter intake and produced 1413 lbs. more milk than group 1. Group 3 had less DM intake and produced only 186 lbs. more milk than group 1.

With prices approximating 1974 and 1975 conditions ($50 hay, $17 corn silage, $130 grain and $8.25 milk), return over feed cost was greatest for the control group which received 3932 lbs. of grain (Table 3). Using prices from the late 1960's and very early 1970's, when grain was cheap and interest in heavy grain feeding greater than it is today, return over feed cost was also greater for the control group, but the difference between groups 1 and 2 was rather small (Table 4). This suggests that grain feeding levels of 7000 lbs. per cow (or 2.5 lbs. milk per lb. of grain) may not be the most profitable, but says little about levels between 4000 and 7000 lbs. and nothing about levels below 4000 lbs. per cow.

Using prices relevant to the fall of 1975 and to farmers with homegrown corn worth about $2.25 per bu. ($10 milk, $50 hay, $17 corn silage and $100 grain), return over feed costs would be $1140 for the control group (1) and $1183 for the liberal grain group (2). This suggests that with today's milk prices and with relatively low grain prices in relation to forage prices, the liberal grain feeding program would be more profitable than the 4000 lb. level.

In the Utah study, with four levels of grain feeding and alfalfa hay as the only forage, milk production increased with grain feeding level (Table 5). Using either 1974-75 or late 1960's milk and feed prices, the third level of grain feeding (4942 lbs.) resulted in greater return over feed cost than the two lower levels (Table 6). The highest level of grain feeding (5883 lbs.) was less profitable than the third level. Even with $10 milk and relatively cheap grain in relation to hay prices, the third level returned the greatest income over feed cost, but the difference between the third and fourth levels was only $3 per cow per year.

The Cornell and Utah studies suggest that grain feeding levels in the range of 4000 to 5000 lbs. per cow per 305-day lactation may return the greatest income over feed cost. However, these results do not give clear evidence that New York farmers with excellent forage programs including corn silage and hay or hay crop silage should necessarily be using these grain feeding levels. An example follows in which an attempt is made to consider the results of lowering grain feeding levels.

Table 1. Experimental treatments, liberal grain study, Cornell (44 week trials, 3 year study)

Feed	Group 1, control	Group 2, liberal grain	Group 3, liberal grain, restricted forage
Corn silage	36 lb.	36 lb.	12 lb.
Alfalfa-grass hay	Ad. lib.	Ad. lib.	8 lb.
Grain	20 lb. max., 1:3 above 16 lb. milk	Ad. lib. 1st six weeks	

For details see Trimberger, et. al., New York's Food and Life Sciences Bul. No. 8, Feb. 1972.

Table 2. Feed intake and milk production for three levels of grain fed, 44 week trials, 3 year study (Trimberger, et. al., 1972)

	Intake (lbs.)				Milk	lbs. milk/
Group	Hay	C.S.	Grain	D.M.	4% FCM	lb. grain
1	6508	10,919	3932	12,228	15,932	4.05
2	4532	10,594	6963	13,028	17,345	2.49
3	2409	3,693	8698	10,657	16,188	1.86

Table 3. Feed cost and returns with 1975 prices for intake and production in Table 2

Group	Hay @ $50	C.S. @ $17	Grain @ $130	Return @ $8.25	Return over feed cost
1	$ 163	$ 93	$ 256	$ 1314	$ 802
2	113	90	453	1431	775
3	60	31	565	1336	680

Table 4. Feed cost and returns with early 1970's prices for intake and production in Table 2

Group	Hay @ $25	C.S. @ $8.50	Grain @ $80	Return @ $6.00	Return over feed cost
1	$ 81	$ 46	$ 157	$ 956	$ 672
2	57	45	279	1041	660
3	30	16	348	971	577

Table 5. Effect of increasing concentrate intake on hay consumption and milk production[1/]

Grain to Milk Ratio[2/]	1:4.0		1:2.7		1:2.0		1:1.6
Grain received for:							
20# milk/day	0.0		0.0		0.0		0.0
40# milk/day	5.0		7.5		10.0		12.5
60# milk/day	10.0		15.0		20.0		25.0
80# milk/day	15.0		22.5		30.0		37.5
Cows per group	32		32		32		32
Hay consumed[3/] (lbs)	11,715	(-457)	11,258	(-1359)	9,899	(-960)	8,939
Grain consumed[3/] (lbs)	2,081	(+1252)	3,333	(+1609)	4,942	(+941)	5,883
Feed consumed[3/] (lbs)	13,796		14,591		14,841		14,822
Forage: Concentrate	85:15		77:23		67:33		60:40
DM intake (lbs)	12,269		12,978		13,206		13,192
Milk/305 days (lbs)	13,878	(+783)	14,661	(+1287)	15,948	(+214)	16,162

1/ Data from Lamb et al., J. Dairy Sci. 57:811. 1974

2/ Applied only above 20 lbs./day

3/ Air dry feed consumed during the 305 day lactation

Table 6. Energy intake and return over feed costs (based on data in Table 5)

Group	Energy intake, Mcal	Lbs. milk/ lb. grain		Return over feed cost			
			M H G	$ 8.25 50.00 130.00	$ 6.00 25.00 80.00	$ 8.25 50.00 100.00	$ 10.00 50.00 100.00
1:4.0	8,741	6.7		$ 718	$ 604	$ 749	$ 992
1:2.7	9,499	4.4		712	606	762	1018
1:2.0	10,023	3.2		748	635	822	1101
1:1.6	10,219	2.8		728	623	815	1098

An Example

The economics of high forage feeding of dairy cows may differ among farms for a variety of reasons. One division that might be made is between those farms that grow only forage and those that grow not only forage but at least a major part of grain needs.

A typical year's dairy ration for a cow producing 15,000 lbs. of milk per year might be as listed under I below:

	I	II	III
Grain	5,000	3,000	3,000
Corn silage @ 30% DM	21,055	26,920	21,055
Hay	3,584	3,584	5,584

In ration I, average daily DM intake is 38 lbs. and 2/3 of the forage DM is from corn silage.

In ration II, grain intake is reduced by 2000 lbs. per year and DM consumption held constant by increasing corn silage consumption. (There is some question whether DM intake would in fact be equal to that of ration I).

In ration III, hay is substituted for grain and DM intake held constant.

Let's look at the impact of these two changes on land needed for forage production if corn silage yield is 16 tons and hay yield is 4 tons.

	Acres required per cow		
	I	II	III
Corn silage	0.66	0.84	0.66
Hay (HCS)	0.45	0.45	0.70
Total forage	1.11	1.29	1.36

In each case, acreage to produce the required forage is increased; 16% for ration II and 23% for ration III. This suggests that many dairymen who produce only forage may not want to cut grain feeding levels and substitute forage unless such a substitution is accompanied by increased forage yields and/or quality.

Now let's look at the situation of the dairyman, who in addition to producing forages, also grows grain requirements except for protein supplement.

	Acres required per cow		
	I	II	III
Corn grain	0.80	0.37	.47
Total, forage & grain	1.90	1.66	1.83
Lbs. SOM per cow	1050	1155	690

Estimated corn grain yield is the equivalent of 88 bu. per acre of dry shelled corn. Corn-SOM mixture is adjusted to provide the same total protein in each ration, using corn silage with 8.0% and alfalfa with 18.4% protein in the DM.

In this case, substitution of forage for grain results in decreases in land required to grow the forage and grain requirements.

Clearly, in the case of substituting corn silage for corn grain, more energy is produced per acre. In substituting alfalfa or alfalfa-grass mixtures for corn grain, whether more or less energy is produced depends, in addition to relative yields, on the energy level of the hay crop. The corn grain, at 88 bu. per acre, would produce 4638 Mcal NE (Lact). A 4 ton hay crop would need to contain 0.66 Mcal NE per lb. to produce as much NE per acre. Very early cut hay or hay crop silage might have an energy level this high.

The amount of land required for corn grain depends on the protein content of the hay crop. Lower protein in the hay would result in less land needed for grain, and more purchased protein.

The land not required for forage and grain production could be used to produce crops for sale or to increase herd size.

Energy intake and milk production

	I	II	III
Estimated energy intake, Mcal, NE (Lact)*	11,062	10,657	10,305

*Based on the following energy levels:

	NE (Lact) per lb. DM
Grain	1.0
Corn silage	0.77
Hay	0.57

If DM intake did remain constant for rations I, II, and III, it is difficult to see how energy intake could remain constant because neither corn silage nor hay contains as much energy as the grain mixture.

If milk production is to be maintained while decreasing grain feeding levels one or more of several conditions would need to exist:

a) Dry matter intake increases as grain feeding level is reduced

b) Energy in the ration is used more efficiently as forage level is increased

c) Cows were receiving more energy than necessary before grain feeding level was reduced.

The bottom line?

In the case where the dairyman is growing both roughage and grain perhaps the simplest case to consider is balancing the opportunity to sell some grain (because of the reduced land required) against the possible reduction in milk output.

Ignoring such ramifications as higher costs for corn silage and lower costs for hay crop silage production compared to corn grain, one might look at the amount of milk that could be sacrificed in order to sell grain corn.

For ration II, 0.24 acres of land could be saved per cow. At 88 bu. per acre and $2.50 per bu., income of $53 could be gained from sale of corn. An additional 105 lbs. of SOM is needed. At a price of $150 per ton, this would cost about $8. The net added income would be $45. At $9 per cwt. of milk about 500 lbs. of milk could be sacrificed and still break even.

The Cornell and Utah studies suggest that over the range of 5000 to 3000 lbs. of grain more than 500 lbs. of milk would be sacrificed.

For ration III, 0.07 acres of land could be saved and 360 lbs. less SOM would be required per cow. Additional corn income ($6) and savings on purchased SOM ($27) would total $33. At $9 per cwt., less than 400 lbs. of milk could be sacrificed and still break even. Again, the Cornell and Utah research data suggest that production would decrease more than 400 lbs. per cow.

If DM intake decreased as forage was substituted for grain, the savings in land required per cow would be greater than shown above. Therefore increased income from corn sales and savings on purchased feed would be greater than shown above. However, the general conclusions would not be altered.

High Quality Forage

The preceding research data and example have not answered the question of the economics of high forage feeding as practiced by Dick Popp and Harry Pankow.

In the Utah study, only hay was fed. The energy level of this hay, although higher than that in most New York hay or hay crop silage, was not as high as the energy level in good corn silage (on a DM basis).

In the Cornell study, although the hay was of relatively high quality, it was not as high in energy (and protein) as some of the very early cut hay and hay crop silage harvested by New York farmers.

The key to maintaining high production on high forage rations appears to be extremely high quality forage. In the case of hay or hay crop silage high quality is needed to attain the palatability required to get high intake of dry matter which in turn must contain a high level of energy to maintain energy intake on high forage diets.

Extremely high quality forage requires extremely early cutting which raises the question "What does it cost to produce early cut, high quality forage?" This in turn raises many other questions. Since the yield from the first cutting will be smaller, maintaining or increasing the total yield per acre from all cuttings probably means moving from a three-cut to a four-cut system and the added costs of an additional harvest. Are the second and later cuttings as high in energy as the first cutting? Also important is the competition for labor and equipment between corn planting and the first cutting of hay.

Early harvest and high forage rations are undoubtedly profitable on some farms, but perhaps not on all farms.

More research is needed on production response to high forage diets including extremely high quality forage. This needs to be combined with data on yields and forage quality for various cutting systems and economic evaluations need to be made of the total system of crop production and feeding.