AN ECONOMIC COMPARISON OF HAY CROP FORAGE SYSTEMS FOR MILK PRODUCTION IN THE NORTHEAST

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Hay crop forage systems for milk production are compared using the budgeting technique for four feeding plans containing hay (90% dry matter) or hay crop silage (40% dry matter) only and in combination with corn silage as 50% of the forage dry matter. Investments, labor requirements, purchased feed, and cropping program differences are calculated for each hay crop forage system. Hay crop silage-corn silage systems are low cost systems for all herd sizes analyzed. Improved nutrient quality of the hay crop when harvested as hay crop silage is a major factor determining the annual cost ranking.

INTRODUCTION

Hay is grown on more acres of Northeast farmland than any other crop. In 1974, the Census of Agriculture reported over 4.8 million acres were harvested on Northeast farms. This is almost double the combined corn for grain and corn for silage acreage and 35 percent of total cropland. As a large portion of the hay crop is fed to livestock, mainly dairy animals, the economic importance of the production, storing and feeding of this dominant forage is vital to the continued profitability of Northeast dairy farms.

Growing concern over weather variability, an interest in reducing labor requirements on dairy farms and increasing concern over the quality of forages, has heightened interest of dairymen in analyzing alternative methods of harvesting the hay crop. The purpose of this article is to compare the economics of the production, storing and feeding of the hay crop as hay (90% dry matter) and as hay crop silage (40% dry matter).

The data presented herein are for use in planning a complete system, a system toward which a dairy farm manager strives. The sequence of events necessary to move from the present system to a new system are not described. Because of physical and economic differences in farms, no one system or strategy for changing systems will be right for all farms.

STUDY PROCEDURES

The budgeting technique is used to compare investments and annual costs for forage production, storing and feeding systems for 40, 80, and 160 cow herds. Dairy cow rations are generated for each hay crop feeding plan by a computerized model. The rations are least cost combinations of feedstuffs which meet all nutrient requirements of the dairy cow based on body weight, milk production, and milk butterfat content.

Two separate comparisons of hay and hay crop silage are made. Hay and hay crop silage are compared as the only source of forage and when half of the forage dry matter in the ration is from corn silage. Labor and purchased feed requirements are estimated for each system on the basis of crop acreage required and harvest, storage, and feeding technology. Acreage and variable production cost differentials due to ration and harvest, storage and feeding losses are calculated. The two methods of harvesting the hay crop are compared on the basis of annual costs per cow.

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ASSUMPTIONS

The general framework within which the analysis is performed includes assumptions as to management and production levels, definitions of investments and annual costs, and specifications of feed quality, feed storage facilities and purchased feed. These assumptions are constant throughout the analysis.

Management Level: Throughout the analysis, the management of the crop production, storage and feeding systems is assumed to be of good quality, the kind found on well managed commercial dairy farms.

Production Level: Annual milk production per cow is 16,000 pounds. Hay crop production is 4.0 T. per acre of hay crops and corn silage is 16.8 T. per acre prior to incurring harvesting losses.

Investment Costs: Investment costs are based on purchases of new items by Northeast dairymen during 1976.

Annual Costs: Annual costs are defined to include both fixed and variable costs. Depreciation, repairs, interest, insurance, and property taxes on the real property (silos and hay barn), and operating costs of the mechanized equipment, electricity for the silo unloaders and mechanical feeding equipment and diesel fuel and lubricant costs for operating power units to drive silo blowers are estimated for each system.

Forage Quality: For all four feeding plans, the hay on a dry matter basis is 12.6 percent protein and contains 0.44 Mcal of net energy per pound. The hay crop silage, however, is 15.5 percent protein and contains 0.49 Mcal of net energy per pound. These nutrient content differences are attributed to a reduced leaf loss during harvest with the hay crop silage alternative.[1]

Forage Storage: Hay crop silage and corn silage are stored in concrete tower silos. Dry hay is harvested as conventional rectangular bales and stored in a hay barn which is separate from the cow housing.

Purchased Feed: Soybean oil meal and corn grain are purchased from off-farm sources to meet nutrient requirements of the ration.

RESULTS

Analysis of hay crop forage systems entails examination of four major factors. They are: specification of the feeding plans, investment requirements, labor requirements, and harvest, storage and feeding losses as reflected in acreage requirements. These factors are examined separately and then summed for a determination of the total economic differences in hay crop forage systems.

Hay Crop Feeding Plans

Large differences exist between hay and hay crop silage feeding plans and between hay-corn silage and hay crop-corn silage feeding plans (Table 1). Converting hay crop silage to hay equivalent, the hay crop silage plan uses over 400 pounds more hay equivalent than the hay feeding plan.[2] Correspondingly, the hay crop silage plan requires 11.6 bu. less shelled corn and 1.5 tons less soybean meal.

Comparing hay-corn silage and hay crop silage-corn silage feeding plans shows 450 fewer pounds of hay equivalent, 0.5 ton of corn silage and 0.6 ton of soybean meal are needed for a balanced ration. Approximately equal amounts of shelled corn are required.

These differences in ration composition are attributable to the higher nutrient content of hay crop silage as previously indicated.

Table 1. Annual Least Cost Balanced Rations Per Cow For Each Hay Crop Feeding Plan

Feedstuff	Feeding Plan			
	Hay	Hay Crop Silage	Hay-Corn Silage	Hay Crop Silage-Corn Silage
	Quantity[a]			
Hay Corn (T.)	4.9	11.5	2.9	6.0
Corn Silage (T.)	—	—	8.6	8.1
Shelled Corn (bu.)	107.9	96.3	48.7	48.9
Soybean Meal (cwt.)	4.7	3.2	12.1	11.5

Source: Derived from Smith and LaDue

[a]Amount to be consumed, not including storage or feeding losses. Production of 16,000 pounds of 3.5 percent butterfat milk per cow with a 10 month lactation and 2 month dry period. Average body weight 1,300 pounds.

Investments

Investments in feed storage facilities are lowest for hay feeding and highest for hay crop silage-corn silage feeding systems for all three herd sizes (Table 2). Hay crop silage and hay-corn silage systems are approximately equal in total investment.

No feed handling equipment is required for hay feeding, but investments increase with herd size and when a silage is part of the feeding plan. Forage machinery investments are largest for hay-corn silage systems and lowest for hay systems. Little difference exists between hay crop silage and hay crop silage-corn silage systems. The differences in forage machinery costs result from investing in two technologies for harvesting forages with the hay-corn silage system and the larger investments required with hay crop silage or corn silage systems.

Total feed storage, feed handling and forage machinery investments show hay-corn silage and hay crop silage-corn silage systems to have similar but the highest investments. Hay crop silage systems show a reduction in investments of about 15 percent and hay systems of approximately 60 percent.

Labor

Labor required for the hay alternative, unlike the investments, is greater than for the hay crop silage system (Table 3). For example, the total labor required for the growing and harvesting of hay is 620 hours for the 40 cow herd or 200 hours more than the hay crop silage system. The 30-45 percent reduction in labor requirements with a hay crop silage system is an attractive feature for those dairymen desiring to work fewer hours or who are unable to obtain additional labor.

The hours required for growing, harvesting, and feeding of hay-corn silage systems range from 30 to 40 percent longer than for the hay crop silage-corn silage system.

These differences are almost totally attributable to the lower labor requirements in the harvesting of hay crop silage as well as the fewer acres required. Feeding operations while requiring less labor with hay crop silage-corn silage do not result in significant cost savings.

Cost savings for labor when the labor force consists of an operator or an operator and full time employee may not be fully realized. However, labor savings may be realized in less laborious work or more pleasurable work.

Table 2. Feed Storage, Feed Handling and Forage Machinery Investments

Herd Size and Forage System	Feed Storage Facilities[a]	Feed Handling Equipment	Forage Machinery	Total Investment	Per Cow
	Dollars				
40 Cows					
Hay	8,100	—	13,350	21,450[d]	536
Hay Crop Silage	17,960	5,200[b]	18,350	41,510[e]	1,038
Hay-Corn Silage	20,575	5,200[b]	26,950	51,225[f]	1,280
Hay-Crop Silage-Corn Silage	25,160	5,200[b]	20,550	49,410[g]	1,235
80 Cows					
Hay	16,200	—	14,350	30,550[d]	380
Hay Crop Silage	31,515	9,850[c]	24,600	65,965[e]	825
Hay-Corn Silage	33,370	9,850[c]	33,200	74,920[f]	937
Hay Crop Silage-Corn Silage	42,240	9,850[c]	26,800	77,390[g]	967
160 Cows					
Hay Crop Silage	59,215	12,150[c]	30,800	102,165[e]	639
Hay-Corn Silage	64,865	12,150[c]	39,400	92,380[f]	577
Hay Crop Silage-Corn Silage	76,580	12,150[c]	33,000	97,695[g]	611

Source: Derived from Adams; Campbell; and Hoglund, 1976.

[a]Haybarn or concrete silos and unloaders.

[b]Silo blower and electric feed cart.

[c]Mechanical conveying equipment.

[d]Mower-conditioner-windrower, side delivery rake, baler with thrower and bale wagons.

[e]Mower-conditioner-windrower, side delivery rake, forage harvester and pick-up head and forage wagons.

[f]Same as [d] plus forage harvester, pick-up head and corn head.

[g]Same as [e] plus corn head.

Harvest, Storage, and Feeding Losses

An important consideration in comparing hay and hay crop silage systems is the losses which occur during harvesting, storing and feeding. A review of research data suggests that hay in conventional bales stored in a barn incurs dry matter losses of 25 percent during harvest, 4 percent during storage and 8 percent during feeding, a total of 37 percent of the yield (Hoglund). With hay crop silage stored in concrete upright silos these losses are reduced to a total of 24 percent; 5 percent during harvest, 12 percent in storage and 7 percent in feeding.

While the harvest loss incurred with the hay crop is five times as great as that for hay crop silage, storage loss rates for hay crop silage stored in concrete stave silos are three times those of hay stored in barns in rectangular bales. There is no significant difference between the two forages in terms of feeding losses. An additional analysis of harvesting losses of the hay crop is contained in the Sensitive Factor section.

Table 3. Labor Requirements and Value of Labor

Herd Size and Forage System	Labor Required				Value of Labor Required[a]	
	Growing & Harvesting					
	Hay Crop	Corn Silage	Feeding	Total	Total	Per Cow
	----- Hours Per Year -----				-- Dollars --	
40 Cows						
Hay	620	—	440	1,060	3,710	93
Hay Crop Silage	420	—	280	700	2,450	61
Hay-Corn Silage	395	245	360	1,000	3,500	88
Hay Crop Silage-Corn Silage	245	235	280	760	2,660	67
80 Cows						
Hay	1,203	—	720	1,925	6,740	84
Hay Crop Silage	790	—	400	1,190	4,165	52
Hay-Corn Silage	740	425	560	1,725	6,040	76
Hay Crop Silage-Corn Silage	440	410	400	1,250	4,375	55
160 Cows						
Hay Crop Silage	1,530	—	560	2,090	7,315	46
Hay-Corn Silage	1,425	800	830	3,055	10,690	67
Hay Crop Silage-Corn Silage	830	770	560	2,160	7,560	47

Source: Revised from Hoglund, 1976; and Knoblauch et al.

[a]All labor valued at $3.50 per hour.

Table 4. Annual Costs Per Cow for Hay Crop Forage Systems

Herd Size and Forage System	Feed Storage and Feed Handling	Forage Machinery	Labor[a]	Purchased Feeds		Additional Charges		Annual Comparative Costs
				Soybean Meal	Corn Grain[c]	Land Usage[d]	Variable Costs[e]	
	-- Annual Cost Per Cow --							
40 Cows								
Hay	25	58	93	47	320	38	15	$596
Hay Crop Silage	95	87	61	32	285	12	0	$572
Hay-Corn Silage	101	120	88	121	144	25	38	$637
Hay Crop Silage-Corn Silage	124	98	67	115	144	0	24	$572
80 Cows								
Hay	25	33	84	47	320	38	15	$563
Hay Crop Silage	83	60	52	32	285	12	0	$524
Hay-Corn Silage	84	79	76	121	144	25	38	$567
Hay Crop Silage-Corn Silage	104	67	55	115	144	0	24	$509
160 Cows								
Hay Crop Silage	70	38	46	32	285	12	0	$483
Hay-Corn Silage	72	52	67	121	144	25	38	$519
Hay Crop Silage-Corn Silage	85	46	47	115	144	0	24	$461

[a]Labor is, however, not a cash cost for many farms in the lower herd size category. The labor is mainly operator or operator and family supplied.

[b]Derived from Table 1 Soybean Meal priced at $200 per ton.

[c]Derived from Table 1 Corn Grain priced at $2.75 per bushel.

[d]The land usage charge equates the differing land bases required with each feeding plan. A hay crop silage-corn silage plan requires 58 acres with a 40 cow herd. The hay, hay crop silage and hay-corn silage plans require 74, 63, and 68 acres respectively. The additional acres required with these plans have alternative uses if a hay crop silage-corn silage plan is followed. In order to account for this difference, an opportunity cost of $95 per acre for each acre above 58 is used. The $95 opportunity cost is calculated from gross returns minus variable costs for hay production. [3T/A. x $50/T. = $150/A. minus $55 variable costs is $95.] A $95 per acre opportunity cost is multiplied by the acreage differential and divided by the number of cows. [$95/A. x 16 A. ÷ 40 = $38/Cow.] A $38 per cow additional charge results for the hay plan.

[e]The variable costs of production for different acreages of the same crop and different crops need to be equated. Variable costs of production per cow are $15 higher for hay than hay crop silage plan (Knoblauch and Milligan). The acreage differential is multiplied by variable costs of production per acre and divided by the number of cows. [11 acres x $44/A. ÷ 40 = $15/Cow.]

Annual Costs Comparison

Total annual comparative costs per cow are highest for the hay-corn silage system, followed by hay, hay crop silage and hay crop silage-corn silage systems (Table 4). At the 40 cow herd size, hay crop silage and hay crop silage-corn silage systems are equal in annual comparative cost ($572 per cow), but at the 80 and 160 cow herds the hay crop silage-corn silage is the lowest cost system, approximately $20 per cow below the hay crop silage system cost.

These rankings, which show systems containing hay crop silage to be of lower cost, occur primarily from the higher protein and energy content of hay crop silage resulting in lower purchased feed requirements and lower land usage charges.

Hay-corn silage is the high cost system as a result of high forage machinery investments and large variable cost charges due to greater acreages of crops required.

Sensitive Factors

Four factors in the analysis, sensitive to change, could result in a change in ranking plans. The factors are (1) soybean meal prices (2) corn grain prices (3) relative yields of hay crops and corn silage and (4) harvesting losses of hay versus hay crop silage.

As the price of soybean meal increases from the level in the analysis, systems containing corn silage are economically harmed more than hay crop only systems. An increase in soybean meal price above the $200 per ton specified in the analysis would cause the hay crop silage system for a 40 cow herd to be the most economical. A soybean meal price greater than $236 for the 80 cow herd and $253 for the 160 cow herd would cause the same change in system rankings, moving the hay crop silage system into the lowest cost position.

The opposite is true for corn grain prices, as they increase, hay crop only systems are harmed more than those containing corn silage. Regardless of corn grain price movements, however, the ranking of the forage systems will remain the same.

As relative yields of corn silage to hay crop change, the ranking of systems for a particular farm may change. As hay and corn silage yields move closer together, the more favorable the hay crop alternatives, as they move farther apart the more favorable are alternatives containing corn silage.

The difference in harvesting losses between hay and hay crop silage used in the analysis is 20 percentage points (25 percent loss for hay minus 5 percent for hay crop silage). This value is variable from farm to farm dependent upon management of the operator. As the difference narrows, hay systems become more economically feasible. Because harvesting losses have an impact on forage quality, acreage requirements, labor for forage production, and purchased feed costs all will change with harvesting losses.

A difference of 15.6 percentage points and 12.8 points for 40 and 80 cow herds, respectively, with all hay crop plans are break-even points (other factors remaining constant). At the above differences in losses, both hay and hay crop silage systems have equal annual costs per cow.

Equal harvesting losses for hay and hay crop silage are required to equate annual costs per cow when corn silage is half of the forage dry matter in the feeding plan.

SUMMARY

The four hay crop forage systems studied showed wide variations in investments and annual costs for the system components, but much less variation in the total of those annual costs.

Systems containing hay crop silage rather than hay were the low cost systems. Hay crop silage in combination with corn silage was a low cost system for all herd sizes.

The highest cost system for all herd sizes was hay-corn silage. This is attributable to the two different technologies for harvesting, storing and feeding. This was most prevalent at the 40 cow herd size where very large investments per acre and per cow occurred.

FOOTNOTES

[1]The calculation to estimate the increased protein and energy content of hay crop silage is made with a 20 percent reduction in harvesting losses. The leaves of the alfalfa plant were the portion saved due to harvesting at higher moisture content. Leaf protein content is three times that of the stems and energy content 60 percent greater (Liu and Fick).

[2]Convert hay crop silage to hay equivalent by dividing by 2.25.

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