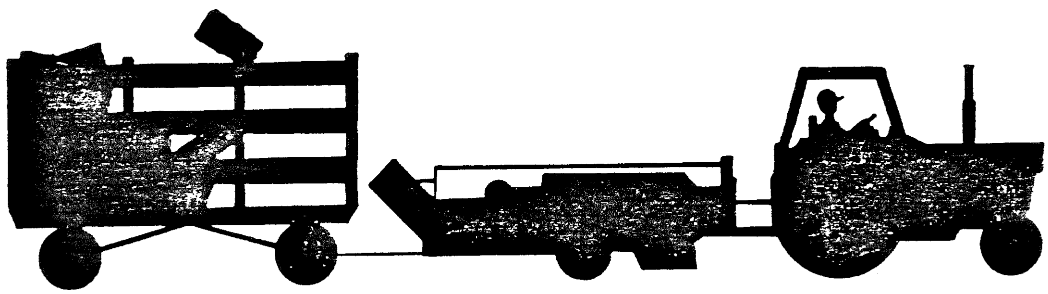
NOVEMBER 1986

A.E. Res. 86-27

# ALTERNATIVE SYSTEMS FOR PRODUCING HAY FOR SALE ON EXITING DAIRY FARMS



by

William F. Lazarus

Department of Agricultural Economics
Cornell University Agricultural Experiment Station
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York 14853

## TABLE OF CONTENTS



## LIST OF TABLES

## ALTERNATIVE SYSTEMS FOR PRODUCING HAY

## FOR SALE ON EXITING DAIRY FARMS

Many Northeast farms are exiting the dairy business by participating in the Milk Production Termination Program (MPTP) or under other circumstances. As of April, 1986, 542 New York dairy farms were scheduled to sell their herds under the MPTP. Sale of the dairy herd frees labor, cropland and capital for other enterprises. Slope, stoniness and poor drainage limit crop alternatives to rotations including a substantial acreage of hay on many of these farms. Unless the dairy herd is replaced by a beef, sheep or other ruminant livestock enterprise, the hay must be sold as a cash crop to produce income needed by the operator to remain on the farm.

The profitability of beef cow-calf and sheep enterprises in the Northeast has been addressed in other studies. Nowak et al. analyzed the profitability and investment potential of a part-time beef cow-calf enterprise. They found that beef is an acceptable long-term investment from the standpoint of a gain in net worth and tax shelter benefits for an investor with a substantial off-farm income, but it faces cash flow problems in the early years. Snyder and Milligan analyzed the profitability of a sheep enterprise. They found that with good production and marketing skills, lamb production with the STAR accelerated lambing system is profitable and provides a positive cash flow.

Selling hay as a cash crop frees the farm operator from the daily chores required by livestock. However, producing high-quality hay bringing the highest prices in the cash market may require investments such as replacing the twine-tie baler with a wire-tie model capable of producing denser bales. Denser bales permit more tonnage to be loaded onto a given sized truck or tractor-trailer rig, reducing the trucking cost per ton at a given cost per mile. Survey results seem to suggest that dealers are willing to pay more for heavier bales because of this lower trucking cost. If realized, this higher price can be a major factor justifying the purchase of a wire-tie baler and associated handling and storage facilities. Also, the farm's full-time hired labor force is likely to have been reduced or eliminated with sale of the dairy herd. Mechanized hay handling implements such as automatic bale wagons may present an attractive alternative to sometimes unreliable part-time help.

Hay is an important cash crop in the Northeast. In New York State, while only 10 to 15 percent is sold, the hay sold is valued at between $35 and $50 million. Hay ranks third in cash sales among New York's field crops, behind corn and potatoes. Kelleher and Lazarus found two fairly distinct marketing patterns for hay. One is direct sale to buyers fairly close to the seller, mainly dairy farms 20 miles away or less. This market may shrink with the reduction in the number of dairy farms and tighter cash flows in the dairy industry. The other marketing pattern is long-distance sales (50 miles or more) through dealers or brokers to racetracks, urban and suburban pleasure horse owners, and commercial horse breeders. This market demands a high-quality product, with dense, well-formed bales to speed loading and unloading and to allow larger loads, a pleasing green color and smell, and high nutritional content. While statistics are limited, it appears that horses and ponies are a growing market for hay producers who can satisfy the quality requirements.

There are many economic comparisons of hay harvesting systems in the literature. Some examples are Schwab, Stevens and Hamm and Schrock. None of these studies consider the problem from the standpoint of a dairy farm making the transition from feeding livestock to producing hay for sale, considering price differences due to long-distance trucking costs to urban horse markets in the Northeast. These issues are addressed in this study.

## Purpose

The purpose of this study is to assess the profit potential of alternative hay harvesting systems, and select hay harvesting systems suitable for producing high-quality hay for the cash market, using labor, land and capital resources typical of exiting dairy farms in the Northeast.

A representative farm with eight alternative harvesting systems is modeled using the economic engineering approach. The representative farm was specified as a former dairy farm with the cattle sold off. The operator still works full-time producing crops during the growing season with the machinery purchased several years ago when the farm was dairying. A limited amount of part-time labor is available to assist with haying, but the logistics of getting the laborers to the farm on days and at times when the hay is ready to bale is a limiting management problem. Standing hay is available on the farm or can be purchased from neighboring farms, so the factors limiting the size of the hay enterprise are labor, capital for machinery and hay storage investments, and the operator's management skills. The farm has a twine-tie baler with a kicker, mower-conditioner and rake, as well as tillage and seeding implements and tractors.

The impact of bale density on trucking costs, and hence on farmgate prices received by the hay producer, is analyzed by estimating the cost of operating a representative tractor-trailer rig hauling hay over a range of distances typical of those from upstate New York to New York City area markets. The difference in trucking costs is assumed to be reflected in the price the producer receives.

## Bale Density, Trucking Costs and Hay Prices

Conventional twine-tie square balers (14" x 18" bale chamber) generally make bales ranging from 8 to 13 pounds per cubic foot, or 40 to 70 pounds for a 36" bale. A 16" x 18" wire-tie baler can make somewhat denser bales up to 14 pounds per cubic foot, for 36" bales up to 85 pounds (Campbell; Halyk; Schwab).

Farmers selling hay in New York State were surveyed by mail in June 1984. The complete survey is described in Kelleher and Lazarus. Amount of hay sold, type of hay, cutting, type of baler, typical bale weight, buyer's destination and price received were among the questions.

Many farmers sold only small amounts of hay or sold to other nearby farms where transportation costs are minimal. Thirty-five farms sold over 25 tons of hay and sold primarily to buyers outside their own county. Twenty-six farms used twine. They reported bale weights averaging 50 pounds, ranging from 40 to 70 pounds. Nine farms using wire reported bale weights averaging 63 pounds, with a range from 50 to 80. While prices varied widely by county and type of hay, there did appear to be a price premium for the wire-tied bales. The twine-tied bales averaged \$80 per ton, while the wire-tied bales averaged \$96. The data was not of sufficient detail to determine how much of the differential was due to bale density and how much was due to other factors.

Several hay dealers were interviewed to determine their offering prices to producers for hay at different distances from buyers. Due to the competitive nature of the business, quality differences and other factors, the information obtained was inconclusive. So, an alternative approach was taken. The operating costs per mile of a typical hay truck were estimated. The tonnage per load was calculated for different bale densities. This information was used to estimate the difference in trucking cost per ton for a range of distances. This difference is then assumed to be reflected in the price paid to the hay producers.

Based on discussions with hay dealers and farmers, it appears that most hay dealers in the Northeast combine the buying and selling of hay and straw with farming, grain merchandising or other enterprises on a part-time basis. The rigs they use tend to be older and operated fewer miles per year than rigs used in general over-the-road trucking. Table 1 shows ownership and operating costs for a typical 7-year old tractor and trailer purchased for \$20,400 and driven for 30,000 miles per year for 10 years. The cost estimates were obtained from a hay dealer in Central New York and a truck dealer. The annual ownership cost is \$3,101, assuming a 20 percent salvage value and 12 percent interest on the average investment. The largest operating cost item is fuel. The driver is assumed to work about half-time hauling hay, driving about 600 hours per year. He is also assumed to spend about the same amount of time loading and unloading. Producers and sellers are assumed to supply the rest of the labor needed for loading/unloading. Loading/unloading time is not included in Table 1, but is included as a cost later in Table 2. Total operating costs are estimated at \$18,970 per year. Operating and ownership costs would then total \$0.74 per mile. This estimate is in line with prices quoted by other hay dealers, which ranged between \$0.50 and \$1.00 per mile.

A 40' x 8' wide trailer stacked with 8 layers of 14" x 18" x 36" bales contains 2,986 cubic feet of hay. This is equal to roughly 570 bales, or 500 bales at 16" x 18". The cost per ton at different bale densities from 8 to 14 pounds per cubic foot over distances ranging from 50 to 350 miles (one-way distance) at \$0.74 per mile is shown in Table 2. The distance from a major hay growing area in Central New York to the New York City area is approximately 250 miles. Over this distance, the cost is \$29.77 per ton at 9 pounds per cubic foot (47 pound bales, for a 13 ton load) but drops to \$20.61 at 13 pounds per cubic foot (68 pound bales,

Table 1. Cost of Owning and Operating a Tractor-Trailer Rig for Hauling Hay

| | |
|---|---|
| Investment Required | |
| Truck tractor - Used, 7 years old | $15,000 |
| Flatbed trailer - Used, 7 years old | 5,000 |
| Tarps, chains and binders | 400 |
| Total Investment | $20,400 |
| Annual Ownership Cost | |
| Straight-line Depreciation and 12 percent interest on average investment, owned 10 years, salvage value, 20 percent of purchase price | $ 3,101 |
| Annual Operating Cost (driven 30,000 miles/year) | |
| Diesel fuel 5 miles/gallon, $1.00/gallon | $ 6,000 |
| Repairs | 4,000 |
| Insurance | 3,000 |
| Taxes | |
| Transportation mileage tax, $0.027/mile | 810 |
| Federal highway use tax | 400 |
| Licenses | |
| Truck tractor | 540 |
| Trailer | 20 |
| Wages - driver, $7.00/hour, 600/hours/year | 4,200 |
| Total Annual Operating Cost | $18,970 |
| Total Ownership and Operating Cost | |
| Annual | $22,101 |
| Per Mile, 30,000 miles/year | $0.74 |

19 ton load). If this difference is reflected in the dealer's offering price, then a farmer with a twine baler capable of producing only the 47 pound bales who invests in a wire-tie baler could expect to increase his price by about $9 per ton. This $9 increase compares to the average $16 difference reported in the mail survey discussed above, which again can not be attributed totally to bale weight differences.

## Hay Harvesting and Storage Costs for Alternative Systems

A typical hay harvesting system for a dairy farm consists of a twine-tie baler with a bale kicker and several wagons equipped with racks. Hay would be unloaded by hand for storage in a second-story mow overhead the stable. A pull-type mower-conditioner and rake, tillage and seeding equipment, and several tractors would round out the machinery complement.

Table 2. Trucking Cost Per Ton of Hay at Different Bale Densities and Distances[a]

| Tons/load | Bale density, lbs./cu. ft. | -Distance between producer and buyer, miles- 50 | 150 | 250 | 350 |
|---|---|---|---|---|---|
| 12 | 8 | $9.04 | $21.27 | $33.49 | $45.71 |
| 13 | 9 | 8.04 | 18.90 | 29.77 | 40.63 |
| 15 | 10 | 7.23 | 17.01 | 26.79 | 36.57 |
| 16 | 11 | 6.58 | 15.47 | 24.36 | 33.25 |
| 18 | 12 | 6.03 | 14.18 | 22.33 | 30.48 |
| 19 | 13 | 5.56 | 13.09 | 20.61 | 28.13 |
| 21 | 14 | 5.17 | 12.15 | 19.14 | 26.12 |

[a]40 foot trailer, 8 feet wide, 8 layers (9.3 feet) high, hauling cost of $1.48/mile loaded mile assumed to drive from producer to buyer and return. Loading/unloading cost of $35/load assumed constant for all bale densities and distances.

The minimum investment required to change to heavier bales would be to trade the twine-tie baler for a wire-tie model with a kicker. Bales would continue to be unloaded by hand and stacked in the mow. Some hay producers report that the heavier bales cause increased wear and tear on wagons, not to mention on the backs of the labor force. Two or three people are required for unloading and stacking the hay with either twine-tie or wire-tie bales.

The labor requirement could be reduced by purchasing a pull-type automatic bale wagon. The bale kicker and wagons are then sold. For efficient operation of the automatic bale wagon, the hay must be stacked mechanically. Most dairy barns do not have enough overhead and horizontal clearance for mechanical stacking, so a pole storage structure must be built or the hay must be stacked outside and covered with a tarp. The automatic bale wagon does allow the operator to harvest hay without additional help.

Annual capacities and harvesting and storage costs were analyzed for eight alternative systems differing in investment and labor requirements. The systems are described in Table 3. The annual capacities are based on a 5-week period for harvesting the first cutting with 13 days suitable for baling (Ramsey). Operator and hired labor during this period is assumed to be the only factor limiting hay acreage on the farm, with standing hay available for purchase on neighboring farms to the extent that harvesting capacity is available. The 1984 New York State average yield of 2.4 tons per acre is assumed, with two-thirds of the yield assumed harvested in the first cutting. The annual capacity of each system was calculated based on typical performance rates for the component field operations (Comeau).

Table 3. Alternative Hay Harvesting Systems

| Code | Description | Annual Capacity (acres) |
|---|---|---|
| TKM1 | Twine-tie baler with kicker, mow storage, operator plus one hired worker, 50 pound bales | 98 |
| TKM2 | Twine-tie baler with kicker, mow storage, operator plus two hired workers, 50 pound bales | 162 |
| WKM1 | Wire-tie baler with kicker, mow storage, operator plus one hired worker, 80 pound bales | 107 |
| WKM2 | Wire-tie baler with kicker, mow storage, operator plus two hired workers, 80 pound bales | 174 |
| WAS0 | Wire-tie baler, automatic bale wagon, pole shed storage, operator labor only, 80 pound bales | 107 |
| WAS1 | Wire-tie baler, automatic bale wagon, pole shed storage, operator plus one hired worker, 80 pound bales | 212 |
| WAO0 | Wire-tie baler, automatic bale wagon, outside storage, operator labor only, 80 pound bales | 107 |
| WAO1 | Wire-tie baler, automatic bale wagon, outside storage, operator plus one hired worker, 80 pound bales | 212 |

The first two systems, TKM1 and TKM2, represent the current twine-tie baler with the operator and one and two additional workers, respectively. Raking, baling, and unloading is done within a 9-hour workday, with mowing done on other days or times not conflicting with the baling and harvesting operations. The next two systems, WKM1 and WKM2, have the twine-tie baler replaced with a wire-tie model with a kicker. Baling and unloading is assumed to take the same time per ton as with the twine system, unloading fewer but heavier bales. The difference in annual capacity is due only to a reduction in transport time to the mow, with the same number of bales but more tonnage per load on the kicker wagons.

The fifth system, WAS0, is a one-man system with the kicker and wagons replaced by an automatic bale wagon, stacking the hay in a newly built pole storage shed.[1] WAS1 includes one hired worker. WAO0 and WAO1 are similar to WAS0 and WAS1 but with outside storage on a 6" stone base,

[1] The prices and performance rates in the analysis were based on a 16" x 18" New Holland Model 426 wire-tire baler and New Holland Model 1003 Automatic Bale Wagon.

covered with a plastic tarp. Comparisons of the annual capacities shows that the automatic wagon increases capacity by a bit more than one worker.

The investment requirements and annual ownership costs of the systems are shown in Table 4. The machines currently owned are assumed to be an

Table 4. Capital Cost Items for Alternative Hay Harvesting Systems

| Item | 1986 Cost | Years Owned | Salvage Value | Annual Ownership Cost by System | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | TKM1 | TKM2 | WKM1 | WKM2 | WAS0 | WAS1 | WAO0 | WAO1 |
| | $ | | % | $ | | | | | | | |
| Items common to all systems all 5 years old | | | | | | | | | | | |
| Tractor (80 hp) | 18,900 | 7 | 40 | 3,116 | 3,116 | 3,116 | 3,116 | 3,116 | 3,116 | 3,116 | 3,116 |
| Tractor (50 hp) | 12,600 | 7 | 40 | 2,077 | 2,077 | 2,007 | 2,077 | 2,077 | 2,077 | 2,077 | 2,077 |
| Plow (5-18") | 5,970 | 7 | 40 | 1,132 | 1,132 | 1,132 | 1,132 | 1,132 | 1,132 | 1,132 | 1,132 |
| Disc harrow (13') | 4,200 | 7 | 40 | 797 | 797 | 797 | 797 | 797 | 797 | 797 | 797 |
| Drag (16') | 1,320 | 7 | 40 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 |
| Cultipacker seeder (10') | 2,160 | 7 | 40 | 410 | 410 | 410 | 410 | 410 | 410 | 410 | 410 |
| Mower-conditioner (9') | 5,700 | 7 | 40 | 1,081 | 1,081 | 1,081 | 1,081 | 1,081 | 1,081 | 1,081 | 1,081 |
| Rake (9') | 4,200 | 7 | 40 | 797 | 797 | 797 | 797 | 797 | 797 | 797 | 797 |
| Total | 52,890 | | | 9,660 | 9,660 | 9,660 | 9,660 | 9,660 | 9,660 | 9,660 | 9,660 |
| Items varying by system | | | | | | | | | | | |
| Baler (14"x18" twine-tie w/kicker, 5 years old) | 5,900 | 7 | 40 | 1,119 | 1,119 | | | | | | |
| Baler (16"x18" wire-tie) | 16,000 | 10 | 20 | | | 2,752 | 2,752 | 2,752 | 2,752 | 2,752 | 2,752 |
| Bale kicker | 2,500 | 10 | 20 | | | 430 | 430 | | | | |
| Wagons w/kicker racks (5@$1380, 5 years old) | 6,900 | 7 | 40 | 1,309 | 1,309 | 1,309 | 1,309 | | | | |
| Automatic bale wagon (63 bale cap.) | 13,000 | 10 | 20 | | | | | 2,236 | 2,236 | 2,236 | 2,236 |
| Hay storage shed | | | | | | | | | | | |
| 100' x 50' x 20' high | 20,000 | 20 | 0 | | | | | 2,200 | | | |
| 200' x 50' x 20' high | 40,000 | 20 | 0 | | | | | | 4,400 | | |
| Stone base for outside stack | | | | | | | | | | | |
| 100' x 50' x 6" thick | 800 | 20 | 0 | | | | | | | 88 | |
| 200' x 50' x 6" thick | 1,600 | 20 | 0 | | | | | | | | 176 |
| Total Annual Ownership Cost | | | | 12,088 | 12,088 | 14,151 | 14,151 | 16,848 | 19,048 | 14,736 | 14,824 |
| Total Investment at 1986 Costs | | | | 65,690 | 65,690 | 78,290 | 78,290 | 101,890 | 121,890 | 82,690 | 83,490 |

average of 5 years old in 1986. Ownership costs for these machines are based on straight-line depreciation over 7 years with a salvage value equal to 40 percent of the 1986 value, and 12 percent interest on average investment. The wire-tie baler and automatic bale wagon are purchased new in 1986 and will be used 10 years with a 20 percent salvage value. The hay storage shed and stone base are depreciated over 20 years. Prices are based on quotes for new and used machinery by New York dealers. In addition to the items shown in Table 4, the farm is assumed to have a dairy barn with sufficient mow storage to store the hay harvested with the kicker systems. Since the barn is already on the farm and is not readily liquidated, its ownership cost is omitted from the analysis.

The initial investment in the currently owned twine-tie system is $65,690. Purchasing only the new wire-tie baler increases the investment by $12,600. The automatic bale wagon system with the pole storage shed increases the investment by a substantial amount, by $56,200 to a total of $121,890 with the two-man system, WAS1. However, with outside storage, the automatic bale wagon system WAO1 investment is only $5,200 greater than the kicker system WKM2 and $17,800 greater than the twine-tie systems TDM1 and TKM2.

Annual ownership costs with the twine-tie systems (TKM1 and TKM2) are $12,088. They increase by $2,063 for WKM2, the wire-tie baler with kicker and two hired workers. With the automatic bale wagon, outside storage and one hired worker (WAO1), the increase is $2,236.

For calculation of operating costs and hay prices, an average bale weight of 50 pounds was assumed for a 36 inch bale. This is a bale density of between 9 and 10 pounds per square foot. Wire-tie bales were assumed to weigh 80 pounds for a 16" x 18" x 36" bale, which is between 13 and 14 pounds. From table 2, this increase in density should result in an increase of about $9 in price for a shipping distance of 250 miles. A hay price of $75 per ton was used for the twine-tied bales based on early 1986 prices for alfalfa-grass mixtures reported in the Hay Report by the New York Department of Agriculture and Markets. The price is increased by $9 to $84 for the wire-tied hay.

A storage loss of 4 percent is used for the systems with inside storage, from Ramsey. Storage losses are less well established for outside storage. One New York extension agent reported using a 6 mil black plastic tarp to cover the top and sides of a stack, with the ends open for ventilation (Hutt). With that arrangement, losses ranged from no greater than inside storage in most years to 10 percent when the tarp was blown loose in a storm. A loss of 8 percent was used for this analysis. Marketed yield is then 2.30 tons for per acre inside storage and 2.21 when stacked outside.

Assumptions used for calculating daily and seasonal capacities of each system are shown in Table 5. A common practice among New York hay sellers is to delay first cutting harvest until mid-June or later to reduce the chance of rain damage. While it is well known that this delay reduces nutritional value, for the sake of this analysis, the delayed harvest is assumed. Only two cuttings are made, and 1.6 tons or two-thirds of the annual yield is harvested in the first cutting. The first cutting yield is

Table 5. Assumptions Used for Calculating Daily and Seasonal Capacities of Hay Harvesting Systems

| | |
|---|---|
| Harvested Yield Per Acre, Tons | |
| First cutting[a] | 1.6 |
| Total Two Cuttings | 2.4 |
| Travel Distance, Field - Storage, miles[b] | 2.0 |
| Travel Speed, mph | 10 |
| Average bale weight, lbs. | |
| twine-tied bales | 50 |
| wire-tied bales | 80 |
| Bales/load | |
| kicker wagons, twine and wire | 100 |
| automatic bale wagon | 63 |
| Unloading time | |
| kicker wagons, twine and wire, minutes/ton/worker | 48 |
| automatic bale wagon, minutes/load | 5 |

[a]System capacity is limited by first cutting yield, not total.

[b]One-way distance, round-trip distance is 4 miles.

then the limiting factor determining capacity of each system. If the first cutting were harvested earlier so that a third cutting were made, tonnage capacity of all systems might be higher, but that possibility was not considered in this study. The relative profitability ranking of the different systems would likely stay the same.

A travel distance of two miles from field to storage is assumed for all systems, with a travel speed of 10 miles per hour. The increased bale weight of the wire-tie, kicker system increases the tonnage transported per kicker wagon, reducing the number of loads and total travel time per acre. Unloading time per ton and per acre is assumed the same for the wire and twine, kicker systems. While bales are heavier with wire, there are fewer bales per ton, so the two factors are likely to offset each other. For the systems where a third worker is available to help unload, unloading time is reduced by 50 percent compared to unloading with two workers.

The input costs per unit used for calculating operating costs for each system are summarized in Table 6. The operating characteristics of the field machinery are shown in Table 7. The first cutting capacity of the systems are shown in Table 8. The hours per acre are shown in the top panel for each operation. The time required for each operation and the number of workers needed are considered in calculating capacity of each system. See TKM1, the twine-tie, kicker system with two workers, as an example. Travel and unloading are assumed to require both workers, while baling and raking can be done at the same time. The total hours per acre are calculated as the sum of travel and unloading time plus the larger of baling or raking time. The same procedure was used for the other systems.

Table 6. Input Costs Used in System Comparison

| Item | Unit | Cost |
|---|---|---|
| Standing hay | acre | $35.00 |
| Diesel fuel (for off-road use) | gallon | 0.80 |
| Twine (9,000 ft.) | bale | 17.50 |
| Wire (6,500 ft.) | roll | 34.50 |
| Plastic tarp (40′ x 100′, 6 mil., for outside storage) | roll | 70.00 |
| Labor - machine operating | hour | 7.00 |
| Labor - hand stacking | hour | 5.00 |
| Building repairs and insurance, percent of replacement cost | percent | 3 |
| Operating capital | percent | 12 |

Table 7. Field Machinery Operating Characteristics

| Machine | Width | Speed | Field Efficiency | Tractor Size |
|---|---|---|---|---|
| | feet | mph | % | hp |
| Mower-conditioner | 9 | 5 | 70 | 80 |
| Rake | 9 | 4.5 | 80 | 50 |
| Baler (twine or wire) | 9 | 4.5 | 70 | 50 |
| Auto. bale wagon | 9 | 5 | 75 | 80 |

Table 8. Capacity of Hay Harvesting Systems, First Cutting Alfalfa-Grass Hay

| | System | | | | | |
|---|---|---|---|---|---|---|
| Operation | TKM1 | TKM2 | WKM1 | WKM2 | WAS0 & WA00 | WAS1 & WA01 |
| Workers | 2 | 3 | 2 | 3 | 1 | 2 |
| Baler Type | Twine | Twine | Twine | Wire | Wire | Wire |
| Wagon Type | Kicker | Kicker | Kicker | Kicker | Auto. | Auto. |
| | - - - - - - - - - - - - Hours/Acre - - - - - - - - - - - - | | | | | |
| Mow | 0.26[a] | 0.26[a] | 0.26[a] | 0.26[a] | 0.26[a] | 0.26[a] |
| Rake | 0.25[a] | 0.25 | 0.25[a] | 0.25 | 0.25 | 0.25[a] |
| Bale | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29[a] |
| Pickup | | | | | 0.25 | 0.25 |
| Haul to Storage | 0.26 | 0.26 | 0.16 | 0.16 | 0.25 | 0.25 |
| Unload | 0.64 | 0.64 | 0.64 | 0.51 | 0.05 | 0.05 |
| Total | 1.19 | 0.72 | 1.09 | 0.67 | 1.09 | 0.55 |
| | - - - - - - - - - - Acres/Day (9 Hours) - - - - - - - - - - | | | | | |
| Total | 7.56 | 12.50 | 8.26 | 13.43 | 8.26 | 16.36 |
| | - - - - - - - - - Acres/Season (13 Days) - - - - - - - - - | | | | | |
| Total | 98 | 162 | 107 | 174 | 107 | 212 |

[a]Operations that are not assumed to limit capacity. For example, in the twine-tie kicker system TKM1 with two workers, raking is done at the same time as baling, so does not constrain capacity below the level allowed by baling speed. Hauling and unloading requires both workers, so time required does constrain capacity.

Standing hay is readily available to be purchased and harvested in many areas of the Northeast and is likely to become more so as dairy herds disappear. Mostly legume hay is assumed purchased standing in the field for $35 per acre for two cuttings, from Snyder. This is less than the typical cost of recommended establishment and maintenance practices for alfalfa averaged over a four-year stand (Snyder and Lazarus). The hay confers fertility and pest control benefits on following crops which account for part of the difference, and the yield of 2.4 tons used here also reflects a longer stand life and less intensive management.

Harvesting costs were based on machinery field capacities and cost factors from Snyder and Lazarus. Labor is charged at $7 and $5 per hour for machine operating labor and hand labor for unloading, respectively.

For the machine operating labor, the tractor driver was assumed to spend 1.3 hours for each hour the machines operated in the field to allow for lubrication, adjustments, driving to the field and other incidental tasks. Storage building repairs and insurance were estimated at 3 percent of replacement cost. For outside storage, the plastic tarp is assumed to be replaced annually.

Table 9 compares the return over operating and ownership costs for the eight systems. The most profitable system is the automatic bale wagon

Table 9. Costs and Returns for Alternative Hay Harvesting Systems

| Item | Systems | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | TKM1 | TKM2 | WKM1 | WKM2 | WAS0 | WAS1 | WAO0 | WAO1 |
| Acres Harvested | 98 | 162 | 107 | 174 | 107 | 212 | 107 | 212 |
| Crop Value Per Acre | | | | | | | | |
| Marketed yield, tons[a] | 2.30 | 2.30 | 2.30 | 2.30 | 2.30 | 2.30 | 2.21 | 2.21 |
| Farmgate price per ton | $ 75.00 | $ 75.00 | $ 84.00 | $ 84.00 | $ 84.00 | $ 84.00 | $ 84.00 | $ 84.00 |
| Crop value | $172.50 | $172.50 | $193.20 | $193.20 | $193.20 | $193.20 | $185.64 | $185.64 |
| Operating Costs Per Acre | | | | | | | | |
| Cost to purchase standing hay | $ 35.00 | $ 35.00 | $ 35.00 | $ 35.00 | $ 35.00 | $ 35.00 | $ 35.00 | $ 35.00 |
| Harvesting costs | | | | | | | | |
| fuel, oil, repairs | 11.62 | 12.64 | 11.91 | 12.97 | 18.88 | 21.25 | 18.88 | 21.25 |
| labor | 26.45 | 26.45 | 25.19 | 25.19 | 20.93 | 20.93 | 20.93 | 20.93 |
| twine or wire | 3.11 | 3.11 | 5.52 | 5.52 | 5.52 | 5.52 | 5.52 | 5.52 |
| Storage insurance, repairs and materials | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 2.50 | 2.50 |
| Total operating cost | 82.18 | 83.20 | 83.62 | 84.68 | 86.33 | 88.70 | 82.83 | 85.20 |
| Return Over Operating Cost | | | | | | | | |
| Per Acre | $ 90.32 | $ 89.30 | $109.58 | $108.52 | $106.87 | $104.50 | $102.81 | $100.44 |
| Total | $ 8,852 | $14,467 | $11,725 | $18,833 | $11,435 | $22,154 | $11,001 | $21,293 |
| Total Ownership Cost | $12,088 | $12,088 | $14,151 | $14,151 | $16,848 | $19,048 | $14,736 | $14,824 |
| Return Over Operating and Ownership Cost | $-3,236 | $ 2,379 | $-2,426 | $ 4,732 | $-5,413 | $3,106 | $-3,735 | $ 6,469 |
| Labor Hours Per Acre | | | | | | | | |
| Machine | 2.4 | 2.4 | 2.2 | 2.2 | 3.0 | 3.0 | 3.0 | 3.0 |
| Hand | 1.9 | 1.9 | 1.9 | 1.9 | 0 | 0 | 0 | 0 |
| Total | 4.3 | 4.3 | 4.1 | 4.1 | 3.0 | 3.0 | 3.0 | 3.0 |
| Return/Hour | -1.52 | 9.50 | 0.61 | 12.62 | - 9.92 | 11.90 | -4.68 | 17.21 |

[a]Harvested yield 2.4 tons per acre. Storage loss 4% for mow and shed storage, 8% for outside storage.

with one hired worker and outside storage (WA01), returning $6,469 with 212 acres harvested. If outside storage is considered undesirable and if a second hired worker is available, the next most profitable alternative is the wire-tie, kicker system (WKM2). While the one-man harvesting systems WAS0 and WA00 are technically feasible with the automatic bale wagon, capacity is too low to result in returns high enough to cover ownership costs. The twine-tie system with two hired workers (TKM2) returns only $2,379, due mainly to the $9 lower price. Neither the twine- or wire-tie kicker systems have sufficient capacity with only one hired worker (TKM1 and WKM1) to give a return high enough to cover ownership and operating costs. Hours of machine and hand labor and returns per hour of labor are shown at the bottom of Table 9. The highest returns per hour were achieved with the automatic bale wagon systems with one hired worker.

While a $9 difference in price may reflect what a profit-maximizing trucker would be willing to pay for the denser bales when hauling them 250 miles, there are clearly many other circumstances where the differential is higher or lower. Table 10 shows the sensitivity of return over operating and ownership cost for three of the wire-tie systems.

Table 10. Sensitivity of Return Over Operating and Ownership Cost to Wire Price Differential

| Wire Price Differential | System | | | |
|---|---|---|---|---|
| | TKM2 | WKM2 | WAS1 | WA01 |
| $ 0 | $2,379 | $1,130 | $-1,282 | $ 2,253 |
| 4 | 2,379 | 2,731 | 668 | 4,127 |
| 8 | 2,379 | 4,332 | 2,618 | 6,001 |
| 12 | 2,379 | 5,932 | 4,569 | 7,875 |
| 16 | 2,379 | 7,533 | 6,519 | 9,749 |
| 20 | 2,379 | 9,134 | 8,470 | 11,623 |

The automatic bale wagon system with outside storage appears to be superior to the two kicker systems with any wire price differential of $4 per ton or more, because of the higher capacity. With no differential, it returns $126 less than the twine-tie system. With a $20 price differential, the return is $9,244 higher.

## Conclusions and Implications

The main conclusion of this analysis is that producing high-quality, easily transported hay for cash sale to distant markets is a viable enterprise for exiting dairy farms in the Northeast. This is especially true in those situations where soil limitations exist and the operator wants to avoid the responsibility of daily livestock chores. From the perspective of labor and capital constraints, a farm operator with both labor and capital available would maximize profits with one hired worker and the automatic bale wagon. If capital constraints do not allow investment in the bale wagon and storage, a second hired worker is necessary for sufficient annual capacity to be profitable.

The wire-tie baler, automatic bale wagon system with outside storage is clearly superior to the kicker and inside systems based on the assumptions made about storage losses and field capacities. Future research to more accurately specify these parameters would be useful. Another useful area of research would be to better define the size of the market for hay to racetracks, horse breeding farms and pleasure horse owners, and quality determinants. Also, making quality hay without rain damage is always a difficult task in the humid Northeast. It may be time to reconsider hay dryers as a way of producing a quality hay for the cash market, especially if the drying can be mechanized to reduce the necessity of handling bales by hand.

References

Campbell, J. "Where the Power Goes When You Chop Corn," Hoard's Dairyman, Department of Agricultural Engineering, Cornell University, August 25, 1983.

Comeau, G. "An Economic Comparison of Hay Harvesting Systems", M.P.S., Department of Agricultural Economics, Cornell University, 1985.

Halyk, R. The Role of Material Density in the Evolution of Forage Harvesting Systems, Department of Agricultural Engineering, McGuill University, Canada, Paper No. 71-114, June 1971.

Hutt, Guy. Cooperative Extension Agent, Essex County, New York, personal communication, April 1986.

Kelleher, M. and W. Lazarus, Hay Harvesting and Marketing in New York, Department of Agricultural Economics, Cornell University, A.E. Res. 85-8, April 1985.

Nowak, C., R. Milligan, W. Knoblauch and D. Fox. Profitability and Investment Potential of the Part-time Beef Cow-Calf Enterprise, Department of Agricultural Economics, Cornell University, A.E. Res. 83-15, March 1983.

Ramsey, R. "Optimum Forage Production, Harvesting, Allocating and Feeding Systems For Grouped Herds", M.S. Thesis, Department of Agricultural Economics, Cornell University, 1983.

Schrock, M. "Harvesting Suggestions," Wheat Production Handbook, Cooperative Extension Service, Kansas State University, Manhattan, C-529, March 1975.

Schwab, G. Big Package Haymaking: A Description and Investment Analysis, Department of Agricultural Economics, Michigan State University, Report No. 263, June 1974.

Snyder, D. Prices Paid for Standing Hay, Silage and Corn Grain Crops, New York State 1984, Department of Agricultural Economics, Cornell University, A.E. Ext. 85-22, August 1985.

Snyder, D. and W. Lazarus, Field Crop Enterprise Budgets, 1986 Projections, New York State, Department of Agricultural Economics, Cornell University, A.E. Res. 86-7, April, 1986.

Snyder, D. and R. Milligan, 1986. An Economic Analysis of the STAR Accelerated Lambing System. Department of Agricultural Economics, Cornell University, A.E. Res. forthcoming, 1986.

Stevens, D. and D. Hamm, 1973. Hay Harvesting Storing and Feeding Methods In Wyoming--An Economic Analysis. Division of Agricultural Economics, Agricultural Experiment Station, University of Wyoming, B-590, July 1973.