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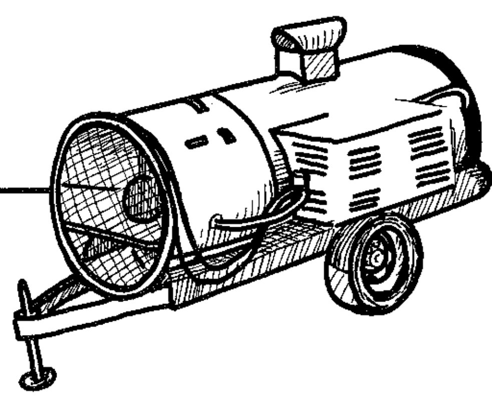
OPERATION OF HEAT DRIERS ON 27 NEW YORK FARMS 1957

G. J. CONNEMAN
C.A. BRATTON



Department of Agricultural Economics
Cornell University Agricultural Experiment Station
New York State College of Agriculture
A Unit of the State University of New York
Cornell University, Ithaca, New York

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INTRODUCTION

A liberal supply of high quality roughage is the cheapest source of nutrients for dairy cows on most New York dairy farms. Experiments conducted at Cornell University indicate that hay cut in early June produced one-fourth more milk per acre than that cut in early July.[1] The problem is one of how to make good quality hay early in June.

Farmers have tried many different machines and methods to eliminate the chance of weather damage, produce high quality roughage, and speed haymaking time. Some farmers have turned to hay conditioners as a tool to aid in making better quality hay. Forced-air mow driers have been used successfully by some farmers. In a rainy season, however, hay dries slowly even though conditioned or placed on a forced-air mow drier. To overcome this difficulty, some farmers have tried heat drying.

A heat drying system requires the investment of several thousand dollars. A farmer is, therefore, faced with the problem of deciding whether a heat drier is a wise investment on his farm.

Purpose of Study

To help answer questions dairymen have been asking about heat drying systems, and to provide information that would be useful to the many farmers who are currently in the process of deciding on whether or not to purchase a heat drier, a study was conducted in the early Fall of 1957 on the cost and operation of heat driers on commercial dairy farms. The number of heat driers in New York State is small but increasing gradually.

Method of Study

In May 1957, a letter was sent to the New York State County Agricultural Agents requesting the names of farmers in their county whom they knew to have a heat drier. All but three agents replied. From these a list of farmers who had heat driers was compiled. It was recognized that this list did not contain the names of all farmers who operated heat driers in the State, so no attempt was made to select a random sample. Furthermore, travel time and the wide scattering of farmers with driers seemed to make the random selection procedure impractical. Instead, the counties with relatively large numbers of driers, and of the several major types distributed throughout the major dairy areas were selected for study. The areas visited and the number of records obtained in each county are indicated in figure 1.

The county agents assisted the enumerators in locating the farmers. During September 1957, information on costs and experiences with heat driers was obtained from 27 New York farmers in 16 counties by the personal interview method. Farmers with the major types of heat drying systems (mow drier with heat, barn batch, platform batch, shed batch, and wagon batch) were visited.

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[1] Trimberger, et al., Effects of Curing Methods and Stage of Maturity Upon Feeding Value of Roughages, Part I, Cornell Bulletin P 910.

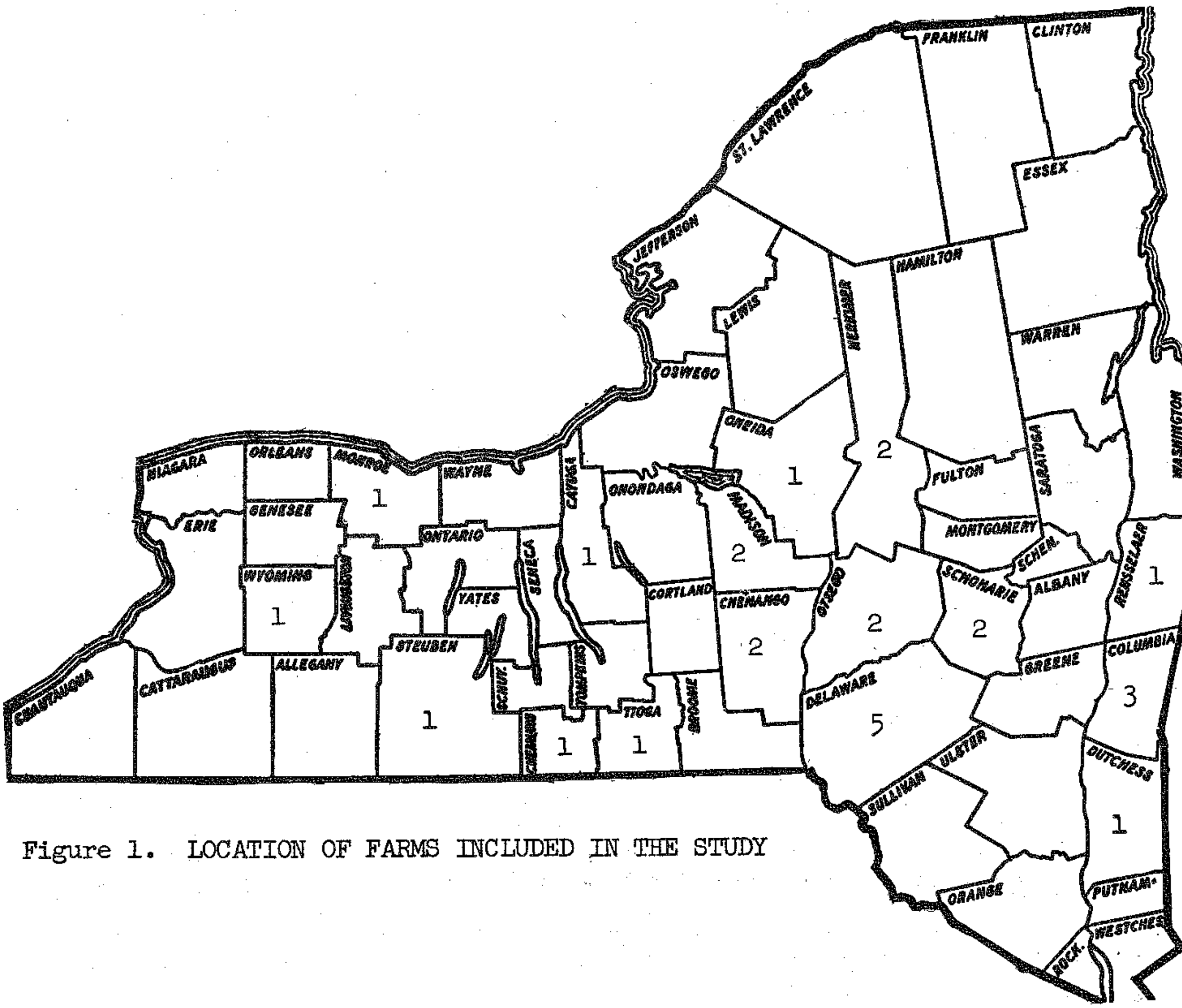


Figure 1. LOCATION OF FARMS INCLUDED IN THE STUDY

The 1957 haying season was dryer than usual. In general throughout the State, drying conditions were excellent. These conditions may have helped speed up haymaking, reduced the length of time required to finish hay on the drier, and caused farmers to use heat driers less than ordinarily might have been the case.

Organization of Farms Studied

The farms included in this study were larger than the average of dairy farms in New York. Number of cows per farm varied from 35 to 220 and averaged 67 cows per farm. This is roughly double the number of cows on typical New York dairy farms,[2] and about three times the average number reported in the 1954 census.

Table 1. SIZE OF BUSINESS
27 Farms with Heat Driers, New York, 1957

Item	Average	Range
Number of cows	67	35 to 220
Productive man work units	1,140	515 to 3,544
Man equivalent	3.6	1.2 to 8.7
Lbs. of 3.7% milk sold	684,400	290,000 to 2,000,000
Crop acres	189	58 to 436

The man equivalent on the farms studied averaged 3.6 compared with 1.8 on typical New York dairy farms. The number of cows per man was about the same on the farms studied as on the typical dairy farms. Crop acres on these farms averaged 189 compared with 100 acres on the typical farms. Thus, the farms studied had fewer crop acres per cow. Pounds of milk sold per cow on the 27 farms in the study averaged 10,200 compared with 9,400 on the typical farms.

Table 2. DISTRIBUTION OF FARMS BY NUMBER OF COWS
27 Farms with Heat Driers, New York, 1957

Number of cows	Number of farms	Per cent of total
less than 40	5	19
40 - 59	10	37
60 - 79	5	19
80 - 99	1	3
100 - 119	3	11
120 and over	3	11

As might be expected in intensive dairy farm businesses, forage production was of major importance. A large proportion of the cropland was devoted to the production of forage crops. The farms had an average of 100 acres of first cutting hay, 23 acres of corn silage, and 14 acres of grass silage. This means that nearly three-fourths of the cropland on the average was in forage crops.

2/ Bratton, C. A., 1958 Dairy Farm Business Summaries, A.E. Res. 25, July 1959.

Table 3. ACRES OF FORAGE CROPS
27 Farms with Heat Driers, New York, 1957

	Average	Range
Acres of hay (1st cut)	100	36 to 260
Acres of grass silage	14	0 to 85
Acres of corn silage	23	0 to 80
% of cropland in forage crops	72	45 to 100

General Description of Heat Drying Systems

Two general types of heat drying systems were operated by the farmers included in this study, "mow driers with heat" and "batch systems."

The mow drier with heat is similar to the forced air mow-drier with the exception that heated air is used instead of natural air. Hay is placed in barns where it is to be stored for the winter and heated air is blown through the hay to dry it. In the batch systems, a quantity of baled hay (usually 5 to 10 tons) is placed on a special drier platform or wagons, dried with heated air for a period of time (generally 12 to 24 hours) and then the dried hay is moved elsewhere to be stored for the winter. Batch systems are of several kinds including barn batch, platform batch, shed batch, and wagon batch.

Mow Drier with Heat -- Two of the farmers included in this study heat-dried their hay in the mow. Their setups were similar to the forced air mow driers except heated air was used. In both cases the heat drier unit was movable which enabled them to dry hay in several different mows. Both barns were of the "overshot" type frequently found in Southeastern New York. In both cases, field drying was practiced and the heat drier was used to "finish off" hay. The farmers visited indicated that their insurance companies did not consider the practice a fire hazard as long as the drier unit was placed a distance from the barn and a canvas duct was used to connect the heating unit and the duct in the mow.

Batch Heat Drying Systems -- Four different types of batch heat drying systems were included in this study.

Barn Batch -- In this system, a slatted platform and a duct is built in a mow of the barn. A portable heat drier is placed outside the barn. Heated air is carried by a canvas duct from the drier unit to the duct built in the barn and connected with the platform. The heated air is forced up through the hay. After the hay is dried, the bales are moved to the hay mow for storage. The sizes of the platforms varied but generally measured 20 feet by 30 feet with a capacity of 6 to 12 tons.

Platform Batch -- This type of batch drier consists of a platform with a slatted floor and duct arrangement located near the barn. After the bales of hay are in place, the hay on the platform is covered with a canvas. Heated air is fed into the ducts and then distributed through the slatted floor and moves up through the hay from the bottom. Size of the platforms varied from 20 feet by 30 feet to 20 feet by 40 feet depending on whether it was a one or two-sided platform. Those platforms which had two sides were constructed with baffles in the ducts which allowed drying on one side of the platform at a time. Capacity ranged from 7 to 15 tons of baled hay per batch. Construction cost of the platform varied from $150 to $400. From $50 to $200 was invested in the canvas used to cover the platform. Some farmers used a canvas already on the farm, others purchased a new one, and still others pieced old canvas together.

Shed Batch -- The shed batch system is similar in operation and setup to the platform batch except the slatted drying platform is located in a special shed. Total capacity varied from 10 to 30 tons, with half the floor being used at one time. The cost of the shed varied from $500 to $5,000 depending on the elaborateness of the construction. In several cases, the slatted floor was removed after the haying season and the shed was used to store machinery or other things.

Wagon Batch -- Wagon drying employes special wagons and a canvas for drying batches of hay on the wagon. Generally, two or four slatted-floor wagons are used in this system. Each wagon holds 1.5 to 2 tons of hay when bales are stacked four high. The loaded wagons are lined up 6 to 18 inches apart and are covered with a large canvas held in place by special clamps. Gaps between the wagons are closed with flexible canvas spacers. A canvas duct carries the heated air from the drier unit to the wagons. Air is blown down through the hay in some setups and up through in others. By investing in a special perforated grain drying floor, the wagon may be adapted for grain drying.

Four of the five farmers visited with wagon drying outfits had down draft type arrangements. Two used 4 wagons, two used 2 wagons, and one used 3 wagons. All but one used convential type canvas to cover the loads. One farmer had a duct in an old machine shed and backed the wagons into the shed. Two had built their own wagons while the others had purchased commercial rigs.

Further references to the various types of heat drying systems will refer to the systems as described above.

COST OF OWNING AND OPERATING HEAT DRYING SYSTEMS

In deciding on whether or not to purchase a heat drier, a farmer needs to consider not only the original cost of the system but also the cost of operation. The actual experiences of farmers can provide general information on these two items. This information can serve as a guide to other farmers when they are confronted with this management decision.

Total Installation Costs

The total installation cost of the heat drying systems on the 27 farms studied varied from $1,350 to $10,750. The variation was due to type of system and the elaborateness of the installation. A platform batch system had the lowest cost, while the highest was for a shed batch system. The average installation costs of about $5,000 for the shed batch, and wagon batch systems were considerably higher than costs for the other systems (table 4).

Table 4. INSTALLATION COST OF HEAT DRIER SYSTEMS
27 Heat Driers, New York, 1957

Type of system	Number	Installation Cost: Average	Installation Cost: Range
Mow drier with heat	2	$2,088	$1,850 to $2,325
Barn batch	5	2,763	$1,800 to $4,900
Platform batch	4	1,890	$1,350 to $2,550
Shed batch	11	5,449	$2,720 to $10,750
Wagon batch	5	4,747	$4,050 to $6,760

Cost of the Drier Unit

A heat drier unit is essential in all types of systems. In all the cases studied, the drier unit was oil or kerosene fired, generally with a 36-inch fan, driven by a 5 or 7.5 horsepower electric motor. Air heated to about 130 to 140 degrees was blown through the hay. Over 60 per cent of the drier units were purchased in 1956 or 1957. Nozzles burning three to ten gallons of oil per hour were used. In addition to the unit itself, a tank for storage of fuel oil and in some cases wiring for heavier service was part of the installation cost. The drier units ranged in cost from $955 to $6,750 with an average for the 27 of $2,325. Half of the farms had drier unit costs between $2,000 and $2,500.

Table 5. INSTALLATION COST OF DRIER UNIT
27 Heat Driers, New York State

Items of cost	Installation cost: Average	Installation cost: Range
Motor, fan, heat unit	$2,150	$925 to $5,500
Wiring	138	0 to $1,200
Tank	37	0 to $150
TOTAL	$2,325	$955 to $6,750*

*Fourteen farmers had drier unit installation costs between $2,000 and $2,500.

Years of Life

The years of expected life must be determined in order to figure the depreciation costs in operating the drier systems. There are several ways of getting years of life. The farmers' estimate of expected life was used in this study. It does have the limitation that since drying systems are new farmers have not had previous experience on which to base their estimates.

Drier Units -- Farmers' estimates of the life of their drier units varied from 10 to 25 years with about 70 per cent of the farmers' estimating 10 to 15 years. A great majority of the units were purchased in 1956 or 1957 although several were bought in 1952. The average life expectancy of the drier units was 14 years.

Sheds and Platforms -- Nine of the eleven farmers who had special drying sheds estimated the length of life of the shed between 25 and 30 years.

Wagons -- Farmers with wagon drying outfits estimated the life of their wagons at 10 to 20 years. The average estimated length of life for all the wagons was 12 years. Four of the five farmers in the study with wagons estimated the life as 10 or 12 years.

Farmers in general indicated a fairly short life for the canvas used to cover the wagons. Two indicated a life of three years or less, one 10 years, another 15. All indicated that further experience with the drying canvas was needed before they could definitely estimate its useful life.

Tons of Hay Dried Per Season

The annual amount of use farmers made of their driers varied widely. The amount of hay dried varied from 20 to 400 tons. The average was 125 tons per drier. About one-third of the farmers visited dried between 50 and 100 tons. Only 4 farmers dried over 200 tons. Four farmers did not use their driers in 1957.

Table 6. DISTRIBUTION OF TONS OF HAY HEAT DRIED
23 New York Farmers Using Heat Driers in 1957

Tons dried	Number of farms	Per cent of total
less 50	4	17
50 - 99	8	35
100 - 149	4	17
150 - 199	3	14
200 and over	4	17

Proportion of Hay Crop Heat Dried

The proportion of the total hay crop heat dried by farmers using the drier in 1957 varied from 30 to 100 per cent. Five farmers put all their hay over the drier. For all 23 farms, 70 per cent of the hay crop was heat dried.

Costs of Operation for Heat Drying Systems

Information on the cost of operating heat driers was available on 23 of the 27 farms visited. The other farmers did not operate their driers in 1957 or were unable to supply data on operating costs.

Operating costs for the 23 heat drier installations varied widely depending on weather conditions, moisture content of hay when placed on the drier, repairs required, total investment in the drier and total number of tons dried. It cost an average of $809 per year to operate the driers on the 23 farms that provided complete operating cost information. Total operating costs per drier varied from $161 to $2,725.

Fixed costs represented 55 per cent of the total operating cost of the drier (table 7). Variable costs accounted for 45 per cent of the total. Fuel, a variable cost, was the largest single cost item with an average of $262 per farm or about one-third of the total cost.

Table 7. AVERAGE OPERATING COST PER HEAT DRIER
23 Heat Driers, New York, 1957

Item	Average cost per drier		Per cent of total cost	
Fixed Costs:				
Depreciation	$243		30	
Interest	187		23	
Insurance	11		2	
TOTAL FIXED COSTS		$441		55
Variable Costs:				
Fuel	$262		32	
Electricity	49		6	
Labor (extra handling)	54		7	
Repairs	3		--	
TOTAL VARIABLE COSTS		$368		45
TOTAL COST		$809		100

Depreciation -- The largest item of fixed cost on most farms was depreciation. The straight line method was used in figuring depreciation. In cases where the drier equipment had other uses than drying hay, the depreciation charge was prorated. Depreciation ranged from $58 to $534 per drying system varying with initial cost of the equipment, the expected years of life, and other uses of the equipment. Depreciation on the average accounted for 30 per cent of the total cost.

Interest -- A charge was made for the use of capital invested in the drier based on its current depreciated value. Interest was charged at an annual rate of six per cent assuming most farmers would have to pay a similar rate if they had to borrow money for the purchase of a drier system. Interest charges ranged from $29 to $586 per drier. The average interest charge was $187 and was the second largest item of fixed costs.

Insurance -- Fifteen of the twenty-three farmers carried some kind of insurance on their equipment. The average cost of the insurance for all 23 farms was $11.

Fuel -- The largest variable cost item was fuel, which accounted for one-third of the total cost. All the farmers included in the study used either number two fuel oil or kerosene. The fuel cost per drier averaged $262 but ranged from $23 to $1,171.

Electricity -- Total cost of electricity on the 23 driers averaged $49 and ranged from $3 to $326. The variation was due to both the number of hours operated and the size of the motor. The hours of operation ranged from 72 to 1280 and averaged 352.

Repairs -- Only 7 owners of the driers had any repair costs. These repair costs on an annual basis varied from $1 to $25 with an average of $3 per drier repaired. Actual repairs ranged from $3 to $125 and consisted mostly of minor repairs and service calls on the heat unit or remodeling or repairs of the slatted platform. Most of the driers were relatively new which may have accounted for the low repair costs. Repairs may be expected to increase as the driers get older.

Cost to Heat-Dry One Ton of Hay

The cost of heat drying a ton of hay depends on the tons of hay dried, the moisture content of hay going on the drier, and the type of system.

The weighted average cost per ton for heat drying was $6.56; computed by dividing the total costs on all farms by the total tonnage heat dried (table 8). The cost per ton dried on the 23 farms ranged from $3.11 to $19.08. However, the simple average cost per ton dried was $7.86. Since costs on a per ton basis varied from $3.11 to $19.08, the simple average is biased upward. The cost per ton on some farms was high because the driers were not fully used.

Table 8. COST TO HEAT DRY ONE TON OF HAY
23 Heat Driers, New York, 1957

Item	Cost per ton	
Fixed Costs:		
Depreciation	$1.98	
Interest	1.52	
Insurance	.09	
TOTAL FIXED		$3.59
Variable Costs:		
Fuel oil, 14 gallons	$2.12	
Electricity, 20 KW hours	.40	
Labor	.43	
Repairs	.02	
TOTAL VARIABLE		$2.97
TOTAL COST		$6.56

<u>Fixed costs</u> such as interest and depreciation represented over half of the total costs but were relatively small on a per ton basis when spread over a large tonnage of hay. Fixed costs per ton actually ranged from $1.15 to $16.06 and averaged $3.59 per ton. Two-thirds of the farmers had fixed costs between $2.00 and $4.00. With small tonnages of hay the cost per ton was generally high. Farmers who dried less than 50 tons had high fixed costs per ton.

<u>Variable costs</u> per ton ranged from $.83 to $6.20. Sixty per cent had variable costs between $1.50 and $3.00 per ton. Fuel and electricity costs varied with the moisture content of the hay going on the drier, and whether all the drying was done with heated air or if some cool air drying was the practice. Most of the farmers visited generally "finished off" a batch of hay by running the unit from a half-hour to an hour with the heat off.

An average of 14 gallons of fuel oil was used per ton at a cost of a little over $2.00. Twenty kilowatt hours of electricity were used per ton at a cost of 40 cents.

Extra handling of bales is involved in most heat drying operations. On the farms studied, this varied from no extra handling labor to more than an hour per ton depending on the organization of the layout, the use of elevators and the type of system. The average cost per ton for extra labor was 43 cents.

The most common cost per ton for heat drying hay was $4.00 to $6.00 (table 9). Ten of the 23 farms were in this range. Over half of the farmers had costs between $4.00 and $8.00 per ton. On the other hand, six farms had costs of $10.00 or over per ton. The highest cost per ton was $19.08.

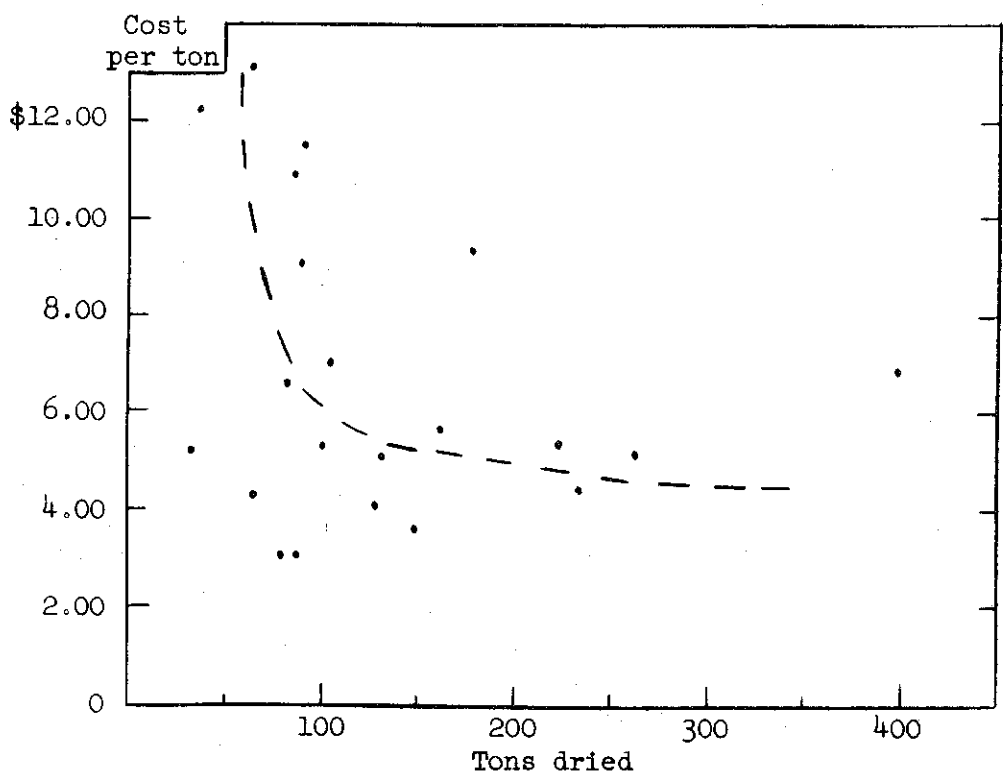
Table 9. DISTRIBUTION OF COST OF HEAT DRYING HAY
23 Heat Drying Systems, New York, 1957

Cost of heat drying per ton	Number of farms
less $4.00	2
$4.00 - $5.99	10
$6.00 - $7.99	3
$8.00 - $9.99	2
$10.00 and over	6

The cost per ton for each farm was plotted to indicate the relationship between the number of tons dried and the cost per ton (figure 2). Although all the heat drying systems were not alike in original cost or operating costs, the chart serves to show how operating costs per ton for individual driers varied in relation to the number of tons dried.

In general, as the number of tons dried increased, the cost per ton decreased. Cost per ton declined rapidly to 125 tons and then decreased more slowly.

All farmers except two, who dried 100 or more tons of hay, had operating costs of less than $6.00 per ton. Those who dried less than 50 tons generally had costs exceeding $10.00 per ton.



(Two observations of $18.34 and $19.08 per ton were too large to be plotted on this graph.)

Figure 2. RELATION BETWEEN OPERATING COST PER TON AND TONS DRIED
23 Heat Driers, New York, 1957

OPERATIONAL CONSIDERATIONS

In the interviews, the farmers were asked specific points about how they operated their heat driers, and their opinions concerning questions which are frequently raised in relation to heat drying hay. It is recognized these are the opinions of the individual farmers based on their experience which in some cases was limited to only one year's operation. The information thus obtained is reported here in the hope that it may be of help to farmers who are considering the purchase of a heat drier.

Size of Batch and Time on Drier

The size of batches dried varied from 5 to 20 tons with most farmers drying between 5 and 10 tons per batch.

The length of time required to dry a batch varied with size of the batch, moisture content of the hay, and whether all heat or some air drying was the practice. Time on the drier ranged from 10 to 36 hours with the majority of farmers leaving hay on the drier 12 to 24 hours. Over half of the farmers visited used some cool forced air to supplement heat drying. This ranged from 1 to 12 hours per batch.

Size of Bale and Method of Piling

Weight of bales going on the drier as reported by the farmers varied from 40 to 100 pounds with the great majority going on between 50 and 75 pounds. Dried bales generally weighed between 30 and 50 pounds. Almost all the farmers indicated that they tried to make as small a bale as possible with their make of baler. Several made "half bales". Apparently, a small bale of uniform density is a must for successful heat drying. Almost without exception, the farmers visited stressed the necessity for proper baling.

About half of the farmers piled the bales with the cut side down and criss-crossed each tier. Another group put strings up and criss-crossed. Although there was no uniform method of piling, farmers agreed that it was necessary to pile the bales carefully, pack them tightly and plug any holes where air leakage might occur. Air control is important for efficient and successful heat drying.

Multiple Use of Drying Systems

About a third of the farmers visited used their heat driers for grain in addition to hay. However, in many cases very little grain was raised on the farms visited, and frequently oats were raised which required little drying. Three farmers made extensive use of their driers particularly for corn. Multiple use is certainly one way to spread the fixed costs over more units.

Several farmers who had heat drying sheds removed the slatted platform at the end of the season and used the shed to store machinery. Most of the drier wagons on the market today may be adapted for grain drying by use of a special perforated grain drying floor.

Harvest Pattern

Although the pattern of hay harvest operation varied from farm to farm, a general procedure was followed. In general, hay was cut in the evening or early in the morning and partially cured in the field to eliminate need for removing excess water with the drier. Weather permitting, hay cut in the morning was raked in the afternoon, baled, and loaded on the drier. The drier was operated overnight, frequently "finished" or "sugared off" with cool air, and then unloaded sometime the next morning. Hay was usually on the drier from 12 to 24 hours.

Moisture Content of Hay Going On the Drier

The farmers interviewed indicated that they attempted to place hay on the drier at a moisture content of about 40 to 45 per cent. To accomplish this, some field curing was usually practiced. In general, when hay was placed on the drier at a moisture content higher than 45 per cent, drying was both prolonged and expensive.

Time of Harvesting Hay

Weatherwise, 1957 was a good hay year with excellent curing conditions in June and July.

Eighty-five per cent of farmers with driers reported that they started haying in 1957 before the middle of June. About one-third started June fifth or before. One-third completed haying on or before July 1st. One-half finished haying after July 10th.

Another rough guide as to how quickly haying was accomplished, is to figure the length of the haying season in days (excluding Sundays) and divide by the acres of first cutting harvested. The haying season averaged 25 days on all farms visited and ranged from 15 to 43 days. As a whole, the group harvested just a little less than 4 acres per day. Over 50 per cent harvested 2 to 5 acres a day.

No information was available as to how quickly farmers without driers were able to harvest their hay. Perhaps in 1957, the difference would not have shown up because of the good curing weather. Nevertheless, the dates of haying and length of time to harvest the crop do indicate that even with the drier many farmers are still harvesting their hay crop past the stage of maximum feeding value.

Additional Labor Involved in Heat Drying Operations

On the farms visited, the additional labor involved in the heat drying operation varied from none to over one hour per ton. The organization of the layout, the use of elevators to take hay directly from the drier to the haymow, and the type of system accounted for this variation.

In the systems employing a mow drier with heat, no additional labor was involved. With the platform or shed batch systems, the additional labor involved was in placing of bales on and taking them off the drying floor. With the barn batch system, additional labor consisted of placing the bales on the slatted platform. Wagon drying systems employed no additional labor except the time involved in aligning the wagons and fastening the canvas.

That farmers considered this extra handling important is indicated by the fact that over half of the farmers with barn batch, platform, or shed type systems mentioned this additional labor as a disadvantage.

One great disadvantage of batch drying hay using a shed or platform type system is the extra handling of the bales in placing the hay on and removing hay from the drying floor. Although the time required for individual farmers to perform this operation varied considerably, it generally took about two men two hours to place a ten-ton (400 bale) batch on the platform and $1\frac{1}{4}$ hours to remove it.

One way to overcome the extra labor is by use of a wagon drying system. The wagon drying systems involved no extra handling of bales. The only additional labor was that necessary to align the wagons and fasten the canvas. Farmers' experiences on how long it takes to perform this operation varies, but in general it took two men about thirty minutes to cover the wagons and fasten the canvas. Although less labor is involved in handling a given tonnage using a wagon drying system, the wagon drying system does require the investment in a canvas and a generally higher total investment. Farmers' experience varies on the length of life of this canvas, but apparently it is relatively short. Farmers generally seemed to feel that 3 to 5 years was the useful life of the canvas. The question is really one of balancing the total investment in wagon drying and cost of the canvas against the labor involved in the shed batch setup. In addition to just dollar and cent costs, the availability of labor and the investment in the system must be considered.

Several farmers indicated that they felt the extra labor involved in operating a shed batch system amounted to very little. They reasoned that hay was unloaded from the drier at a time when little else could be done; for example, when the dew was still on the ground in the morning, and when the weather was rainy.

Farmers Opinions of Heat Drying Systems

Farmers were asked to indicate the reasons why they were using a heat drying system. Most of the farmers indicated that heat drying gave them better quality hay.

Table 10. REASONS GIVEN BY FARMERS FOR USING HEAT DRYING SYSTEMS
27 Farmers With Heat Driers, New York, 1957

Reason	Number of farmers
Make better quality hay	21
Reduce weather damage	6
Start haying earlier	4
Cows eat more, give more milk	2
Feed less grain	2

Farmers were also asked to indicate any disadvantages they had found with heat driers. The most frequent disadvantages reported were the extra handling involved and the high operating cost and investment.

Table 11. DISADVANTAGES OF HEAT DRYING SYSTEMS AS REPORTED BY FARMERS
27 Farmers With Heat Driers, New York, 1957

Disadvantage	Number of farmers
Involves too much labor, extra handling	14
High cost (operating or installing)	11
Slows haymaking	4

ESTIMATES OF INSTALLATION AND OPERATING COSTS FOR HEAT DRYING SYSTEMS IN 1959

The amount spent by farmers to install and operate their heat drying systems varied considerably. Several different types of systems are currently being used and installed by farmers. In order to illustrate what a farmer might expect to spend when installing a heat drying system on his farm in 1959, estimates based on information obtained in the survey and current prices of equipment and building materials were made for several types of heat drying systems: a wagon drying system using 2 wagons, a wagon drying system with 4 wagons, and a shed batch arrangement.

These estimates can serve as guides as to what a farmer can expect so far as installation and operating costs are concerned. Certain advantages and disadvantages of each system are also indicated.

Individual farmers costs may vary since they operate under a wide variety of circumstances. The "deal" farmers may be able to make in the case of equipment and the use of farm labor and lumber may reduce the "out-of-pocket" costs. Use of the drier unit for grain drying, or additional use of the wagons or shed also affects the costs a farmer can expect.

A Wagon Drying System Using Two Wagons

A wagon drying system consisting of 2 wagons and an oil-fired heat drier unit (36" fan, 5 H.P. motor) has a capacity of 4 to 5 tons per batch.

The average installation cost of this system would be $4,250 if all equipment was purchased new (table 12).

In figuring operating costs, depreciation was calculated on a straight line basis using farmers' estimates of the life of the various items. Interest was charged at 6 per cent on one-half the new value, i.e., on a basis similar to what farmers who borrow money have to pay. The fixed charges of interest and depreciation make up a large proportion of the operating costs. These items vary little regardless of how much the system is used.

Repairs were figured at a higher rate than found in the survey since many of the driers in the study were new and repairs may be expected to increase as the driers become older.

Electricity was charged at a rate of 24 cents per ton and fuel oil at $3.30 per ton. Labor for fastening the canvas in place and removing it was figured at forty minutes per batch (2 men for twenty minutes) and was based on farmers' experience.

As the drier is used for increased amounts of hay, operating costs on a per ton basis decrease quite rapidly. The relationship between the total tons of hay dried and the expected cost per ton is shown in figure 3. More than 100 tons must be handled before operating costs drop below $10.00 per ton. Handling a greater tonnage is limited by the capacity of the two wagon system. Drying 100 tons in a season (80 tons first cutting, 20 tons second cutting) would require operating this system at full capacity for a three or four-week period in June. The tonnage the system can handle does not allow sufficient units over which to spread the large fixed costs.

The estimates assume no other use of the drier or wagons.

Table 12. ESTIMATED INVESTMENT AND OPERATING COST FOR A TWO WAGON DRYING SYSTEM, 1959

EQUIPMENT: 2 wagons; oil-fired drier, 5 H.P, motor, 36" fan; 4-5 tons per batch

INSTALLATION COST:		
Heat drier unit	$2,200	
2 wagons	1,800	
Canvas	250	
Total investment	$4,250	
OPERATING COST:	Estimated Cost for Drying Hay*	
	50 tons	100 tons
Fixed Costs		
Depreciation	$377	$377
Interest	128	128
Insurance	11	11
Total Fixed	$516	$516
Variable Costs		
Oil	$165	$330
Electricity	12	24
Repair	21	32
Labor	10	21
Total Variable	$208	$407
Total -- Fixed plus Variable	$724	$923
COST PER TON DRIED	$14.48	$9.23

*Assuming hay placed on drier at 45 per cent moisture content and dried to 20 per cent; no other use of drier or wagons.

Fixed costs: Depreciation, straight-line, 15 years life on drier unit, 10 years on wagon, 5 years on canvas; interest at 6 per cent on one-half new cost; insurance at $5 per $1000 coverage, one-half coverage.

Variable costs: 22 gal. of oil per ton at 15¢ per gal.; electricity, 12 KW per ton at 2¢ per KW; repairs vary from ½ to 1% of new cost depending on amount of use; labor at $1.25 per hour with 2 men taking 20 minutes per batch to put canvas in place and remove.

A farmer installing a 2 wagon setup and using it to capacity can expect a total cost of $9.00-$10.00 per ton. It is doubtful if the system can be justified unless it is used for at least 2 weeks in a year.

A 2 wagon setup will undoubtedly slow haying on most farms, though it will insure quality forage.

A Wagon Drying System Using Four Wagons

A wagon drying system using four wagons has a capacity of 8 to 10 tons per batch (i.e., 2 to 2.5 tons per wagon or 100 bales stacked 4 high.) The investment in such a system would be about $6,150 if all the equipment is purchased new (table 13).

Fixed costs of depreciation, interest, and insurance are estimated at $777. These fixed charges do not vary regardless of how much the system is used.

Table 13. ESTIMATED INVESTMENT AND OPERATING COST FOR A FOUR WAGON DRYING SYSTEM, 1959

EQUIPMENT: 4 wagons; oil-fired heat drier, 5 H.P. motor, 36" fan; 8-10 tons per batch			
INSTALLATION COST:			
Heat drier unit	$2,200		
4 wagons	3,600		
Canvas	350		
Total investment	$6,150		
OPERATING COST:	Estimated Cost for Drying Hay*		
	50 tons	100 tons	200 tons
Fixed Costs			
Depreciation	$577	$577	$577
Interest	185	185	185
Insurance	15	15	15
Total Fixed	$777	$777	$777
Variable Costs			
Oil	$165	$330	$660
Electricity	12	24	48
Repairs	31	46	77
Labor	10	20	40
Total Variable	$218	$420	$825
Total Fixed plus Variable	$995	$1,197	$1,602
COST PER TON DRIED	$19.90	$11.97	$8.01

*Assuming hay placed on drier at 45 per cent moisture content and dried to 20 per cent; no other use of drier or wagons

Fixed costs: Depreciation, straight-line, 15 years life on drier unit, 10 years on wagons, 5 years on canvas; interest 6 per cent on one-half new cost; insurance, $5 per $1000 coverage, one-half coverage.

Variable costs: 22 gal. oil per ton at 15¢ per gal.; electricity, 12 KW per ton at 2¢ per KW; repairs vary from ½ to 1% of new cost depending on amount of use; labor at $1.25 per hour with 2 men taking 40 minutes per batch to place canvas in place and remove.

Depreciation was calculated on a straight line basis using farmers' estimates of the life of various items. Driers were figured at 15 years life, wagons 10 years, and the canvas at 5 years. Interest was charged at the rate of 6 per cent on one-half the new value. This is a rate similar to what a farmer would have to pay if he borrowed money to buy drying equipment. Insurance was estimated at $5 per $1000 of coverage and assuming that the equipment was insured for one-half coverage.

In budgeting the variable costs of fuel oil, electricity, repairs, and labor certain assumptions and estimates were made based on information obtained in the survey and engineering operating data. It was assumed that hay placed on the drier would have a moisture content of 45 per cent and would be dried to 20 per cent. Under usual conditions this would require about 22 gallons of oil per ton and hay would remain on the drier 16 to 20 hours. A reasonable degree of efficiency in operating the system was assumed. Labor for placing and fastening the canvas and removing it was figured at one hour and twenty minutes per batch (or 2 men for 40 minutes) and was based on farmers' experience. Repairs were budgeted at a rate of $\frac{1}{2}$ to $1\frac{1}{4}$ per cent of the new cost of the system depending on the amount of use.

As the drier is used for increased quantities of hay, the costs per ton decrease quite rapidly. More than 100 tons must be handled per season before costs drop below $10.00 per ton. With less than 100 tons dried per season with a four wagon system, the costs per ton are extremely high. This is due to the high fixed charges. The relationship between the tons dried and the cost per ton are shown in figure 3.

Some argument could be made that estimates for oil, electricity, repairs, and labor charges are too high or too low. However, they seem reasonable based on all available data. If one is too high, it is likely another is too low. A similar argument might be raised as to the estimates for fixed costs. When all three components of depreciation (rust out, wear out, and "fade" out) are considered, along with the available data, the estimates of years of life and depreciation seem reasonable.

The estimates in tables 12, 13, and 14 assume that no other use is made of the drier unit, wagons or drying platform and shed. Of course, one way to lower the per unit cost is to spread the fixed cost over more units or have other multiple use for the equipment. The drier might be used to dry grain, as might the wagons. Wagons could be used for other farm jobs. In the case of a drying shed and platform, the platform might be removed and the shed used for storage of machinery or other farm items.

On those farms where a large amount of grain is raised, the fact that wagons may be used for grain as well as hay may make the purchase of a 4 wagon system feasible. In order to dry grain in wagons, an investment in a special grain floor is required.

Although multiple use of the various pieces of equipment which make up a drying system might lower the cost per ton, the figures in the table are still useful. They indicate the relative costs of drying different quantities of hay. The figures illustrate that a relatively large tonnage of hay is necessary in order to keep heat-drying costs reasonable.

A Batch Heat Drier Using a Pole Shed

A heat drying system consisting of a 26 foot by 52 foot pole type shed with a double drying slatted platform would have a capacity of 10 tons on each side (400 bales piled four high). Materials and labor for the pole shed plus platform and duct would cost about $1.50 per square foot or about $2,025 total (table 14). The cost would increase to approximately $2.00 per square foot if the shed was enclosed on three sides. A farmer using his own lumber and labor would be able to construct such a structure for an out-of-pocket cost of less than the amount indicated above.

Table 14. ESTIMATED INVESTMENT AND OPERATING COST FOR A SHED BATCH DRYING SYSTEM, 1959

EQUIPMENT: 26' x 52' pole shed, 10 tons each side; oil-fired heat drier, 5 H.P. motor, 36" fan

INSTALLATION COST:			
Heat drier unit	$2,200		
Pole shed, slatted floor, duct	2,025		
Total investment	$4,225		
OPERATING COST:	Estimated Cost for Drying Hay*		
	50 tons	100 tons	200 tons
Fixed Costs			
Depreciation	$227	$227	$227
Interest	127	127	127
Insurance	11	11	11
Total Fixed	$365	$365	$365
Variable Costs			
Oil	$165	$330	$660
Electricity	12	24	48
Repairs	21	32	53
Labor	40	81	162
Total Variable	$238	$467	$923
Total Fixed plus Variable	$603	$832	$1,288
COST PER TON DRIED	$12.06	$8.32	$6.44

*Assuming hay placed on drier at 45 per cent moisture content and dried to 20 per cent; no other use of shed or drier

Fixed costs: Depreciation, straight-line; 15 years life on drier unit, 25 on shed; interest, 6 per cent on one-half new cost; insurance, $5 per $1000 coverage, one-half coverage.

Variable costs: Oil, 22 gal. per ton at 15¢ per gal.; electricity, 12 KW per ton, at 2¢ per KW; repairs vary from ½ to 1¼ per cent of new cost depending on amount of use; labor at $1.25 per hour, 2 men for 2 hours to load a 8-10 ton batch; 2 men for 1¼ hours to unload.

Fixed costs of depreciation, interest, and insurance on such a setup are estimated at about $365 per year.

The same assumptions on moisture content of hay and multiple use of the system, and similar procedures for budgeting oil, electricity, and repairs were used as previously indicated. In the shed batch system, labor costs of placing hay on the drier platform and removing it to final storage are a major item. Estimates of the extra time involved in handling hay in this type of batch system were obtained from farmers. Variations in the additional amount of labor involved in handling the bales were related to the general organization of the layout, and the use of elevators to take hay directly from the drier to the haymow.

The estimates used in the budgets are based on farmers experiences. If a reasonably efficient setup is used but no elevators are employed in removing hay from the shed platform, farmers experience indicates that it requires about two men two hours to load hay on the drier and two men about $1\frac{1}{4}$ hours to unload. By locating the shed close enough to the barn to facilitate the use of an elevator from the shed to haymow, the additional labor involved in unloading the platform may be eliminated. This would lower the cost of heat drying approximately 25 cents per ton.

As the system is used for increased amounts of hay, the operating costs per ton decrease rapidly. More than 150 tons of hay must be dried per season in order to reduce costs per ton below $7.00 (figure 3).

Use of the drier and/or shed for grain drying or for storing machinery would help to spread some of the fixed costs.

The additional labor may be either a smaller or larger disadvantage than the dollar figures indicate. Some farmers' labor situation is such that any additional operation at all is a big disadvantage. Extra labor is simply not available. Under other circumstances, the labor problem is not serious. To some extent the higher labor costs of the shed batch systems are offset by lower fixed costs of the system when compared to a wagon drying setup.

Comparison of Wagon Drying and Shed Batch Drying

A comparison of a two wagon drying outfit, a four wagon setup, and a shed batch system is presented in table 15. The investment, cost, capacity, and major advantage and disadvantage are indicated.

Table 15. COMPARISON OF THREE TYPES OF HEAT DRYING SYSTEMS

Item	2 wagon batch system		4 wagon batch system		26' x 52' shed batch	
Investment		$4,250		$6,150		$4,225
Capacity per batch		4-5 tons		8-10 tons		10 tons
Capacity per season, tons		100		200		200
Operating Costs for:	100 tons	200 tons	100 tons	200 tons	100 tons	200 tons
Fixed cost/ton	$5.16	--	$7.77	$3.89	$3.65	$1.82
Variable cost/ton	4.07	--	4.20	4.12	4.67	4.62
Total cost/ton	$9.23	--	$11.97	$8.01	$8.32	$6.44
Main advantage	Eliminates extra handling of bales		Eliminates extra handling of bales		Low investment and fixed cost/ ton of capacity	
Main disadvantage	Capacity limits economical use		High cost per ton unless used to capacity		Extra labor involved in handling wet bales	

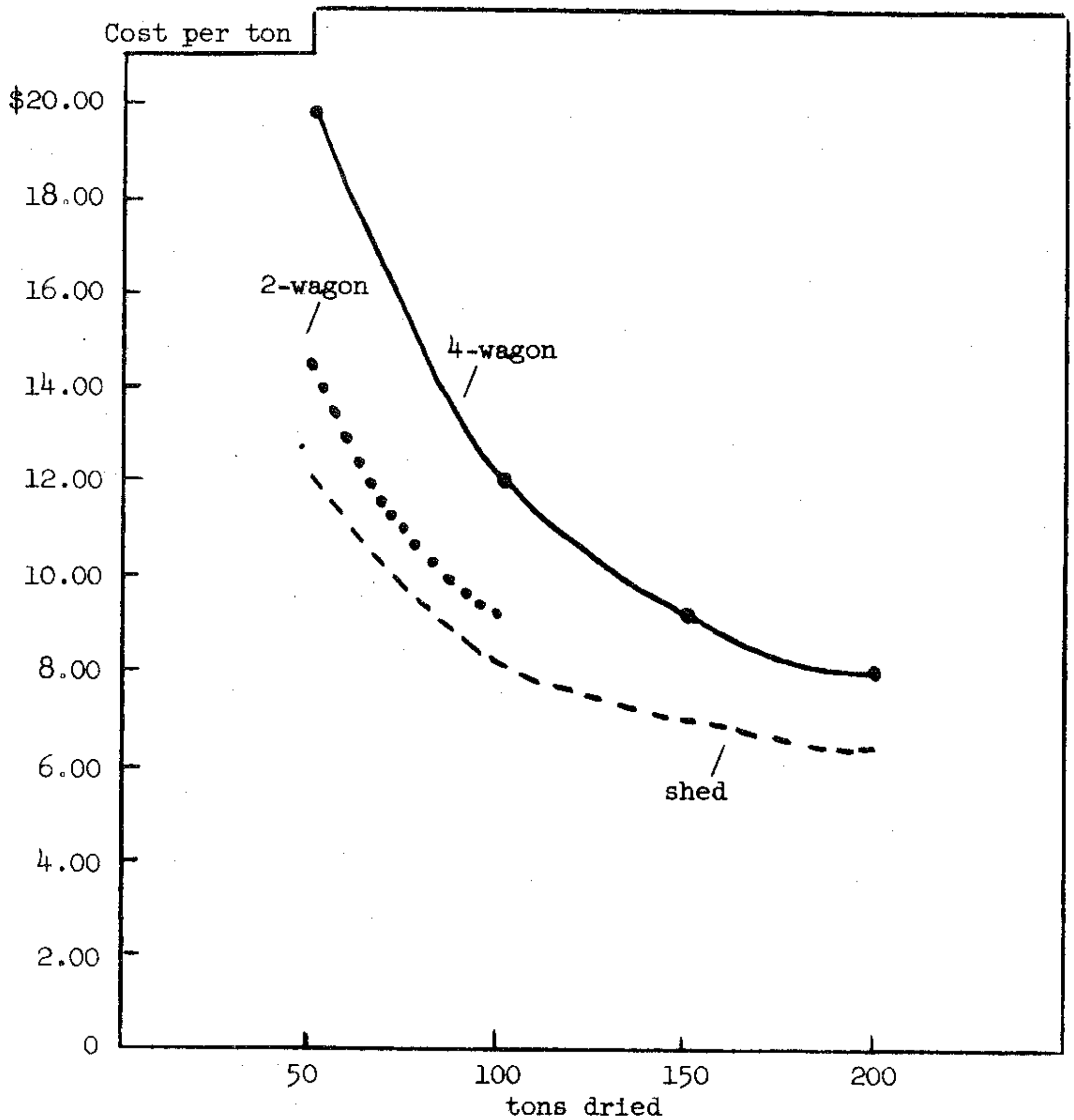


Figure 3. Relationship Between Estimated Operating Cost per Ton and Tons Dried on a System

The two-wagon system is limited in the capacity it can handle per season. Even if 100 tons are dried per season, the cost is still over $8.00 per ton. In other words, the limited capacity of the system makes it difficult to spread the large fixed costs over enough units so as to keep heat drying costs reasonable.

If the four wagon system is used to dry 200 tons per season, cost per ton will average about $7.00. Both wagon drying systems have the advantage of requiring little extra labor in handling bales.

With a pole type shed of a similar capacity to the four-wagon system, fixed costs are generally lower because of a smaller investment. However, extra labor is involved in placing bales on the drying platform, and in moving them to final storage. The main disadvantage of this type of setup is that hay must be handled an extra time before it is stored in the barn.

Investment would be greater if other than pole construction were used.

Capacity of Heat Drier and Tonnage Handled in A Season

One important factor to consider in batch drying is the capacity per day and per season. In order to receive maximum benefit from a batch heat drying system, it is desirable to harvest and dry as much hay as possible during the stage of maximum feeding value. To accomplish this, haying must be completed in a three-week period in June. Hay must be loaded in the afternoon, dried overnight and unloaded the next morning if the 24-hour cycle of drying is to be accomplished. This necessarily puts some limits on the handling of a large quantity of hay using a batch drier. It is probably safe to say that given "normal" weather, the capacity is greater with field cured hay. Ten tons of hay per day is the usual limit of a batch drier whether it is a wagon or shed type. Batch drying is usually accomplished by more frequent haymaking but less at a time. Another way to look at it is to figure that a wagon that can be used 25 days in a season can dry about 50 tons of hay in a year. A two-wagon system would thus have a capacity of 100 tons; a four-wagon system 200 tons. A shed batch system with a double drying floor has a capacity of 200 tons.

Wagon drying eliminates the extra handling of hay which is necessary when using a shed or platform batch and moving hay onto and off a drying floor. The peak labor requirement may, therefore, be minimized.

Another possibility to increase the capacity is to grow different hay mixtures in order to spread out the maturity dates.

FEEDING VALUE OF HEAT DRIED HAY

The 64 dollar question many farmers ask is: "Will the additional feeding value and milk production from heat dried hay more than pay the additional costs?"

No attempt was made in this study to obtain information on feeding value of hay. However, without exception, farmers felt that their heat dried hay was of higher quality.

Research does indicate that early harvest is essential for top quality hay. An acre cut early in June will produce one-fourth more milk per acre than an acre cut in early July. A heat drier is one tool which may allow a farmer to harvest early cut good quality hay without weather damage.

The problem, therefore, boils down to how much extra value there is in heat dried hay. The answer actually is -- "It depends." Research results are conflicting on this matter but some work done by the U.S.D.A. at Beltsville indicates the general principle. Potential milk production per acre was the standard used for comparison.

Heat dried hay had approximately 34 per cent more milk per acre when compared to rain damaged field cured hay (table 16). However, heat dried hay was only 7 per cent better than good field cured hay.

The best guide for comparison is one which reflects the conditions farmers usually encounter. Some hay is field cured without rain damage. Some hay is rain damaged. Compared to the average of all hay harvested (some with rain damage, some without) the potential milk production per acre is approximately 17 per cent higher with heat dried hay.

Table 16. DAIRY COWS--POTENTIAL MILK PRODUCTION PER ACRE FROM VARIOUS FORAGES[1]

Forages compared	Relative milk production from other forages when compared with: Field-cured-hay (all hay harvested)	Field-cured hay (little or no rain)	Field-cured hay (rain damaged)
	%	%	%
Field-cured hay (all)	100	92	114
Field-cured hay (no rain)	109	100	125
Field-cured hay (rained on)	88	80	100
Barn-dried hay (no heat)	112	103	128
Barn-dried hay (heat)	117	107	134
Wilted silage	115	105	131
Dehydrated hay	125	111	142

[1] Based on consumption of equal amounts of dry matter and nutrients (per 100 pounds of milk) from the forages and rations fed.
Source: U.S.D.A. Technical Bulletin 1079.

Another comparison that is helpful in evaluating the increased feeding value of heat dried hay is one between mow dried hay without heat and heat dried hay.

Comparing field cured hay (some rain damaged and some no rain damage) with barn dried without heat and barn dried with heat, the heat dried hay has 17 per cent higher potential milk production per acre compared to 12 per cent for the barn dried hay without heat.

The answer to the question on how much extra feeding value there is in heat dried hay depends, therefore, on what it is being compared with. If a farmer is accustomed to having a large proportion of his hay rained on, then he can expect a great increase in value of hay by heat drying. On the other hand, if a farmer usually manages to harvest his hay early with little or no rain damage, he may receive little increased value from heat drying.

The following budget form may serve as a guide to a farmer in estimating the extra value and costs he can expect from heat drying hay.

Estimate of Returns and Cost for Heat Dried Hay

1. Returns from heat drying hay:

   Added value of heat dried hay compared with:

Good field-cured hay	10%
Field-cured hay, part rained on	15%
Field-cured hay, rained on	30%

$__________ x ______% = $__________

Value ton ordinary hay — See above — Return from drying

2. Cost of heat drying hay:

	Tons dried per season			
	50	100	150	200
Pole-shed batch drier	$12.00	$ 8.25	$7.00	$6.50
Four-wagon batch system	20.00	12.00	9.25	8.00

Estimated cost per ton for your farm $__________

3. Considerations other than cost:

   a.

   b.

   c.

SOME CONSIDERATIONS IN DECIDING ON THE PURCHASE OF A HEAT DRIER

A farmer contemplating the purchase of a heat drier is faced with the problem of deciding whether this piece of equipment is the right one for his farm. Based on this study and the principles of good farm management a farmer needs to consider the following questions before investing in a heat drier:

1. Do I have enough tonnage to keep the cost per ton reasonable?

With the high installation costs the drier must be used a great deal to keep the drying cost per ton at a reasonable level. Farmers in this study who dried less than 50 tons of hay had costs exceeding $10 per ton. Only a few farmers put their entire crop on the drier. When the weather was favorable, most farmers practiced some field curing. The evidence seems to indicate that a farmer needs to dry about 200 tons of hay to economically justify a heat drier. This means at least a 50-cow dairy.

2. Could the money required for a heat drying system be more wisely invested elsewhere in the farm business?

The installation of a heat drying system requires an additional investment of between $4,000 and $6,000. A farmer must weigh the benefits of owning the drier against the benefits from investing his money in other machinery, more cows, or in other areas of his farm business.

The question that needs to be answered, therefore, is whether it would be more satisfactory to install a forced-air mow drier without heated air or would a hay conditioner do the job?

3. Will the improved quality and extra feed value of heat dried hay offset the costs of heat drying?

In deciding on whether to invest in a heat drier the costs must be compared with the increased value of hay.

Research indicates that early harvest is essential for top quality hay. Cornell studies showed that hay cut early in June produced one-fourth more milk than an acre cut in early July. A heat drier is one tool which may allow a farmer to harvest early cut, good quality hay without weather damage. Considering all costs, a farmer can expect a cost of $5 to $10 per ton to heat dry hay. The extra value he receives from heat drying depends on the quality of hay he is presently making. If the use of the heat drier allows a farmer to harvest early cut, good quality hay where he otherwise would be unable to do so, the additional benefits may be greater than the additional cost of $5.00 to $10.00 for heat drying.

4. On my farm, how much of a disadvantage is the additional labor that is required to operate a batch system?

The additional labor required to operate a barn, platform, or shed batch system was the most frequently listed disadvantage of a heat drying system. Whether this is a disadvantage depends on the labor situation on an individual farm.

5. <u>If I invest in a heat drier, will I also have to invest in companion pieces of equipment?</u>

Several farmers in this study indicated that a hay conditioner was necessary in order to accelerate drying and make the 24-hour heat drying cycle possible.

6. <u>Can a heat drier be justified on the basis of insurance alone?</u>

A heat drier might be justified on the basis of insurance against complete or major crop losses caused by unseasonable storms or weather.

Is a Heat Drying System the Answer to the Haying Problem on My Farm?

The consideration of the above question really brings a farmer to ask the following question: Is a heat drying system the answer to my problem of how to complete haying on my farm in a short time?? A heat drying system requires additional investment in equipment. Heat drying does have the advantage of allowing haymaking to progress in all kinds of weather. In other words, it is a more "positive" system. However, if heat drying costs are to be kept reasonable about 200 tons of hay must be dried each season. How much extra feeding value there is in a ton of heat dried hay depends on the quality of hay a farmer is presently harvesting. If at present most of the crop could be rated as good field cured hay, it is doubtful if the increase in value of heat dried hay will pay the additional cost. The following factors need to be balanced: tonnage dried, investment, operating cost, positive system, extra feeding value.

If a farmer is presently putting up 150 to 200 tons of hay and experiences difficulty in harvesting good quality hay, consideration should be given to the use of a wagon drying system.

If less than 150 to 200 tons of hay is likely to be heat dried in a season, it is difficult to keep heat drying costs reasonable unless multiple use can be made of the equipment for drying grain.

For the small farmer, use of a hay conditioner[1/] and/or mow drier[2/] may be the answer to the haying problem.

1/See A.E. Res. 2, <u>Operation of Hay Conditioners on 91 New York Farms, 1957.</u>

2/See A.E. 1040, <u>Operation of Forced-Air Mow Driers on New York Farms, 1956-57.</u>