Curing Hay in the Barn

E. L. Barger
Iowa State College

C. K. Shedd
Iowa State College

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Workmen at the right are assembling the main air duct of a system for drying hay in the mow. These men are drawing together and are fastening the prefabricated pieces.

MAKING HAY in the barn isn't exactly new. But only a few farmers have equipment for doing it. This method of making hay—curing it in the mow—was tried more than 10 years ago by the Tennessee Valley Authority.

The TVA was trying: (1) To find a way of producing higher quality hay by avoiding trouble with weather; (2) to demonstrate another practical use for electricity on the farm.

The method worked pretty well. Then began many more experiments by state agricultural experiment stations, farmers and others. Most experiment stations have now tried the method to find whether it would work under their own weather conditions. The Iowa Station started work on the method after much had been done in other states.

The Iowa trials have been largely intended to find simpler methods of putting the plan to work on the farm. We've been trying to get the equipment problems solved.

Curing hay in the mow consists, in general, of putting a system of air ducts or tunnels on the floor of the mow, storing partly dried hay on these and then blowing air through these ducts and up through the hay until it is dried out. Openings are provided in the air duct system for the air to pass out through the hay. The air forced through these ducts may be natural or it may be heated. Using heated air has these objections: It is not so simple as using natural air, and the equipment costs more. There is some danger of fire if the furnace is not properly installed. The accompanying illustrations show the systems which we are testing at the Iowa Station.

Barn-Dried Hay Better

Hay dried in the barn has been higher in quality than that cured in the field. Ninety samples graded by the U.S.D.A. from Tennessee and Virginia gave 88 percent of U.S. No. 1 and No. 2, and 12 percent No. 3 and sample grade when barn-dried. Field-dried gave only 35 percent of U.S. No. 1 and 2, and 65 percent of No. 3 and sample grade.

The accompanying table showing data reported by the Tennessee Valley Authority from Maryland, Tennessee and the U.S.D.A. gives some interesting facts. Note that hay cured in the barns had more leaves, higher percentage of green color, more carotene (which means a higher vitamin A content—or the makings of vitamin A) and 3 percent higher protein content.

<table>
<thead>
<tr>
<th></th>
<th>leaves</th>
<th>green</th>
<th>PPM</th>
<th>protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barn cured</td>
<td>43.6</td>
<td>63.8</td>
<td>40.0</td>
<td>18.1</td>
</tr>
<tr>
<td>Field cured</td>
<td>34.7</td>
<td>46.2</td>
<td>20.9</td>
<td>15.1</td>
</tr>
</tbody>
</table>

Cure Partly in Field

Experience has shown that it is best to let the hay about half cure in the field before it goes into the mow. Half-curing the hay makes it easier than green hay to handle and speeds up the drying. It costs money to force air through the hay. Having the hay partly cured before drying in the mow reduces the cost of finishing off in the barn.

To half-dry the hay in the field means getting it down to about 35 to 40 percent moisture instead of 20 to 25 percent moisture which field-cured hay usually contains when it goes into the mow. Now there isn't any simple and easy method of determining on the farm how much moisture hay contains. Most farmers will have to use their own judgment and by experience find out how much to
The man at the right is attaching the lateral duct to the main duct. The pictures in center and at the bottom show two differently designed systems installed. The one in center is tapered both in the main and lateral air ducts. These two are being compared in experiments.

cure the hay so that it can be stored to dry by this method.

Hay stored in a mow will finally get down to the moisture content in the air, which usually means 10 or 15 percent. The problem of mow-drying is to bring the hay down to a safe level. Air blowing should be continued until the hay is all below 20 percent moisture. A good test is to shut the blower off overnight, then start the blower up in the morning. If the air comes off cool and dry at all points over the surface of the hay, curing is finished and there will be no danger of heating or spontaneous combustion.

The Iowa Experiments

Last year (1945) we conducted hay-drying tests at Ames with equipment in two college barns. Each barn was filled with first cutting hay and then again with second cutting, making four tests in 1945. All of this hay was made during poor haying weather. But the hay dried out well, had good color, was free from dust except in scattered pockets, held the leaves and was of higher quality than that cured in the field.

The common practice in this new haying method has been to build the air ducts on the mow floor with boards. We have felt that some farmers would prefer to purchase the ducts all ready to install. We have been searching for a system that could be quickly and easily installed. We have therefore been testing two designs of prefabricated duct systems.

The designs used were worked out in cooperation with the Louden Machinery Company of Fairfield, Iowa. The duct systems were built in the Louden factory. An accompanying picture shows one of the prefabricated (metal) duct systems ready to be installed. It consists of lateral or branch ducts, flat sheets that are bent over and...
fastened to the hoops to form the main ducts, and a blower or fan. This fan was run by an electric motor (not shown). The Westinghouse Electric and Manufacturing Company cooperated with the Iowa Station by furnishing the motor, fan and motor controls for the test.

We compared two systems designed differently. In the second system the air was supplied by a gasoline engine-driven blower, built experimentally and furnished by Allis-Chalmers Manufacturing Company. (It is shown in another illustration.) Air was carried from the fan unit to the ducts on the mow floor through a section of Ventube, a duPont product designed to carry air into mine shafts.

Dry Bales Successfully

In one of our tests at Ames in 1945 we dried bales successfully. They were stored loosely over the floor ducts with about a 2-inch space between the bales. The bales were set on edge. Each layer of bales was placed in the opposite direction—at right angles to the layer below. The hay ran as high as 28 percent moisture. At the time of baling we considered it too wet to keep without artificial drying.

While we were filling the barn the weather turned bad and a light rain fell during part of the time. Baling started at 8 in the morning where normally it would not be possible to start before 11. We were thus able to lengthen the haying day, and the hay was moist enough that baling did not shatter the leaves. We ventilated this barn of baled hay for 72 hours when we found that it had been brought down to safe moisture content.

Question of Safety

Many have asked about the safety of storing hay in a barn with high moisture content. You can be assured that the hay will not heat as long as air is being well circulated through it. To insure good circulation the air ducts must be properly constructed and installed, the hay well spread in the mow, and the blower supplying the air must be able to provide enough air, at least 10 cubic feet per minute per square foot of mow floor.

Tests to date indicate that loose hay should not be stored more than 8 feet deep for drying at one time. Later fillings may be stored on top, and depths up to 12 feet may be handled. The reason for limiting the depths is twofold: (1) To limit the load on the blower and (2) to assure early drying of the top of the pile.

While information is limited on depths to which chopped or baled hay may be stored safely, the depth of chopped hay probably should not be more than half that of loose hay. But this means actually more than half the amount of loose hay, for chopped hay takes less space. If bales are properly placed with spaces for air circulation between them, they can be stored to about the same depth as loose hay. The baled hay, however, should be cured in the field down to about 30 percent before it is baled.

The temperature of hay in the mow we found was about 8 to 10 degrees cooler than outside air temperatures when the fan was operating during the hottest part of the day. This is to be expected since evaporation of moisture from the hay tends to reduce its temperature. Another important advantage of "making hay in the barn" is that you can continue the drying by operating your fan until the hay is dry enough so there is no longer any danger of heating or spontaneous combustion.

Loose Hay or Chopped?

Though the success of making hay by this system was originally shown with loose hay, a real objection to it is the hard work. Pitching or loading half-cured hay is tiring. And when it is inside the mow, getting it evenly spread over the duct system is mighty hard work. It is necessary to get the hay evenly spread to insure that it will dry properly.

Because of these objections, chopping the hay holds a lot of promise. The Indiana, Ohio and Wisconsin Stations have shown that it is practical to dry chopped hay in the mow. The general precautions which they suggest are: (1) It should not be chopped finer than necessary for successful handling with the blower; (2) it should not be tramped or packed in the mow; and (3) the depth of chopped hay stored should be limited to not over 4 or 5 feet at one drying.

To mow chopped hay properly requires that someone direct the blower pipe so that it spreads the hay evenly over the floor and duct system.

The advantages of curing chopped hay in the mow are that you can do the whole job with machin-
ery. You get away from that hard work of pitching and mowing loose hay or wrestling with bales. If you chop hay when it is half dry, you save the leaves and the quality is better.

Operating Fan or Blower

Two systems of operating the fan or blower have been used. In one the fan is operated continuously day and night. In the other system the fan is operated continuously during the day when drying conditions are good and then is operated intermittently at night. That is, the fan at night may run for a half hour, then be off for 2 hours, then run again for another half hour and so on during the night. This intermittent operating requires use of an electrical time switch that automatically turns on and shuts off the power.

In our tests at Ames we have been able to get very little drying done during the day. At that time the air carries more moisture, and hay doesn’t dry much. But the fan or blower needs to run a part of the day to keep the hay from heating. Most experiments, show that continuous operation gets the drying done in a shorter period. The continuous operation requires a less complicated system, too. We cannot say yet which method is to be preferred.

Both electric and gasoline-driven units are used. The electric-driven outfit is in more common use. Motors from 3 to 7.5 horsepower are used. Rural electric power lines usually will handle these all right. Electricity has the advantage of more safety, it is easier to install and has the advantage of automatic control.

On the other hand, the advantages of the gasoline engine are that the air may be drawn from the engine and use practically all of the heat it forms, including that from the exhaust. In this way the temperature of the air is raised about 5 degrees, which means faster drying. Also the engine can be used if electricity is not available. The gasoline engine unit can be transported easily, too. The unit which we used is not yet being produced commercially.

How Much Air Needed?

From work done the country over, it appears that at least 10 cubic feet of air per minute for each square foot of mow floor are needed. So if you have a barn that is 36 x 50 feet, then your blower or fan should be sending at least 18,000 cubic feet of air each minute through the hay.

In our tests at Ames we ran 15 cubic feet of air per minute for each square foot of mow floor. Experience indicates that barn curing should be completed within a week after the half cured hay is placed in the barn, otherwise there may be some moldy or dusty spots. Putting more air through the hay per minute naturally will dry it faster.

The pressure needed to force air through hay has been studied. Most blowers for hay drying are designed to operate on a pressure of about 0.75 inch of water. This is the pressure required to support a column of water 0.75 inch high. The blower will usually work all right on a pressure up to 1 inch, but when you get more than this it may reduce the efficiency and output and require excessive power.

At the left is shown the portable gas engine blower connected to the duct system on the mow floor. All of the heat of the engine is used in raising the temperature of the forced air.

Cost of Barn-Drying

How much more does it cost to cure hay in the barn than in the field? The main difference is in the power to supply the air and the overhead cost of the system itself. Our tests at Ames varied in power costs from 70 cents to $2.37 per ton. An average cost would probably be about $1.50 per ton for power.

The cost of installing a system, including ducts, blowers, power units and power connections, has been found by the TVA to be between 25 and 35 cents per square foot of mow floor. For a barn 36 x 50 feet, the cost would be between $450 and $630. Assuming it had a 25-year life and figuring interest at 5 percent, the overhead cost would be between $25 and $35 a year. This would be about 50 cents a ton of stored and cured hay. So the total cost of curing in the barn including equipment, overhead and power costs would probably be about $1.50 a ton.

To sum it up, the advantages of mow curing are: (1) It makes good quality hay more certain; (2) if the job is properly done, danger of heating and spontaneous combustion can be eliminated.

There is every reason to believe that curing hay in the mow will work as well in Iowa as in other areas where it has been used more.

A study of Iowa weather data shows air temperature and humidity during the haying season are as favorable or more so than in areas which are now using mow-drying successfully.

When an attempt was made to substitute soybean oil and other oils for butterfat in milk for young calves, the calves lost the hair on the inside of their thighs unless the oil was emulsified.

This was found in work at the Iowa Station. When the oil from these other sources was emulsified, there was no trouble with the hair falling out. Though emulsifying the oil prevented the hair from falling out, it did not stimulate growth of the calves.

Work is under way at the Iowa Station to develop better varieties of apples, plums, pears and other fruits for Iowa.