



## BARN HAY DRYING

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### INTRODUCTION

Barn hay drying systems are commonly installed today as a basic component in the production of quality forage. A properly managed hay drying system reduces field curing time and thus lessens the risk of losses due to rain, minimizes leaf loss, and eliminates the danger of fire due to spontaneous combustion.



Figure 1 Hay Dryers Assist in Producing a Quality Forage

A barn hay dryer makes use of a suitable fan and air duct distribution system to force outside air through partially dried hay, placed in storage. This movement of air through the hay removes heat and excess moisture and will eventually complete the drying process which started in the field.

The following factors must be considered when investigating the installation of a hay drying system for your farm.

### 1. MOW FLOOR

1. Hay to be dried will weigh 10 to 30% more than field dried hay. All floor supports should be checked and strengthened or replaced if necessary.
2. The mow floor must be air tight so that air is forced through the hay and not through the floor. The floor can be sealed with a 6 mil (0.15 mm) polyethylene plastic or covered with 5/16" (8 mm) thick plywood.

### 2. AIRFLOW RATES

Hay dryers should be designed to complete the curing of tough or damp hay and not be expected to dry wet hay. The amount of airflow required depends on the initial hay moisture content and the grass-legume mixture of the forage. The following airflow rates (Figure 2) can be used as a guideline.

| HAY MOISTURE<br>CONTENT<br>% | AIRFLOW RATES |             |
|------------------------------|---------------|-------------|
|                              | cfm/ton       | (L/s/tonne) |
| < 25                         | 150           | (80)        |
| 25-30                        | 300           | (160)       |
| 30-35                        | 500           | (260)       |

Figure 2 Airflow Rates for Varying Hay Moisture Content

The most desirable average hay moisture content for barn drying is 25% or less. An average moisture content exceeding 30% can become very risky for artificial drying.

For calculation purposes one ton (0.9 tonne) of dry baled hay occupies approximately 250 cubic feet (7.0m<sup>3</sup>) of space or consists of approximately 50 standard bales weighing 40 pounds (18 kg) each.

### 3. THE DRYING FAN

The fan is selected to deliver the desired amount of air at a static pressure of 1" (0.25 kPa). There are two types of fans used; the axial flow (propeller) fan or the centrifugal fan. A centrifugal fan operates much quieter than an axial fan but is also more expensive.

Generally, 5 horsepower (3.7 kW) or 7.5 horsepower (5.6kW) axial or centrifugal fans are readily available. More than one fan, if necessary, may be installed on a hay storage to meet the airflow requirements.

If centrifugal fans are used to dry the hay, a constant check must be kept on the drive belt tension. Any loss in revolutions per minute due to excessive belt slippage will reduce the fan output considerably.

Electrical requirements for the fan motor can be substantial and should be considered in the original planning process. The fan should be located where it can be easily reached for maintenance and repair, and should also be protected from the weather. Remember when selecting the fan location that it will be running continuously for a period of time and making considerable noise.

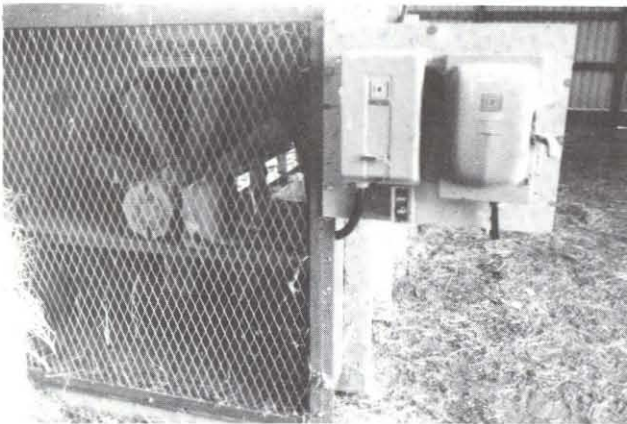


Figure 3 An Axial Hay Drying Fan with Electric Controls.

#### EXAMPLE SYSTEM - FAN SELECTION

**Example:** Calculate the required fan capacity to dry a mow of hay with dimensions 30' (9.1 m) x 70' (21.3 m) x 12' (3.65 m) deep when the hay has an initial moisture content of 25%.

#### SOLUTION

- Volume of Storage = length x width x depth  
 $= 30' (9.1 \text{ m}) \times 70' (21.3 \text{ m}) \times 12' (3.65 \text{ m})$   
 $= 25200 \text{ cu. ft. (707 cu. m.)}$
- 1 ton (0.9 tonne) of dry baled hay occupies 250 ft<sup>3</sup> (7.0 m<sup>3</sup>); thus the mow hay volume is  

$$\frac{25200 \text{ ft}^3 (707 \text{ m}^3)}{250 \text{ ft}^3 (7.0 \text{ m}^3)} \sim 100 \text{ ton (90 tonne)}$$
- From Figure 2 for 25% moisture content hay, the airflow rate is 150 cfm/ton (80 L/s/tonne).  
 Thus, select a fan that will deliver  
 $100 \text{ ton (90 tonne)} \times 150 \text{ cfm/ton (80 L/s/tonne)} = 15000 \text{ cfm}$   
 or 7200 L/s of air at 1" (0.25 kPa) static pressure.
- Check with your supplier for an appropriate fan. Manufacturer's data may suggest a 36" (914 mm) diameter axial fan with a 5hp(3.7kW) electric motor.

#### 4. AIR DISTRIBUTION SYSTEMS

The air distribution system comprises a main air duct with or without a slatted floor section, depending on the mow dimensions (Figure 4). Air is forced into the duct system by the fan which delivers air throughout the hay mow.

The main air plenum is a rectangular plywood-lined air tight duct that is smooth on the interior to allow unrestricted airflow. Air control doors are located along the base of the duct walls and on top of the duct to direct air into the hay. The doors also control the airflow to different mow sections.

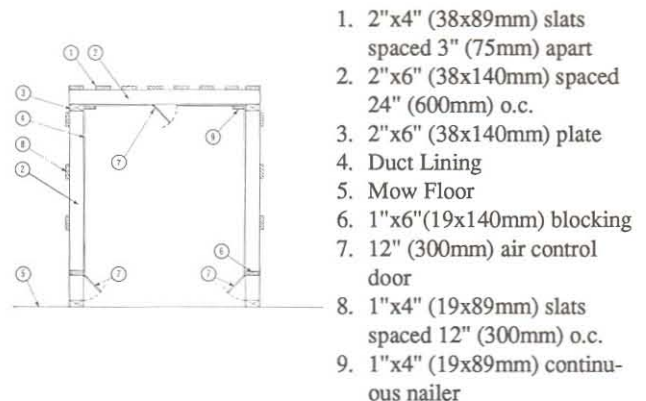


Figure 4 Lined Rectangular Duct Without Slatted Floor  
 Courtesy Atlantic Provinces Pub. No. 8

The main air plenum is located either through the centre section of the hay storage or along one side. Side-wall main ducts are used with narrower mows – less than 24' (7.3m). The advantage of side-wall ducts is the ease of working around them in the mow. However, it is more difficult to make side-wall duct systems airtight.

A triangular duct may be constructed as the main air plenum in place of the rectangular or square duct. The height of this duct often becomes too great for moving bales over the top from one side of the mow to the other. Also, it is difficult to stack a mow tightly around a triangular plenum. The triangular duct is used most successfully when bales, shorter than 30" (0.76 m.) in length are randomly dropped into the mow without being stacked in a conventional manner.

Ducts may also be constructed without an interior lining provided that the distance the air has to travel to the perimeter of the mow is equal over the entire mow. The flexibility of drying sections of the mow separately is lost with an unlined duct. A hay duct, constructed of hay sides and a plank top can also be used as a main duct with the same limitations as the unlined duct.

The layout of the air duct and slatted floor should provide for equal travel distance for the air to move to the outside perimeter of the mow. (Figure 5).

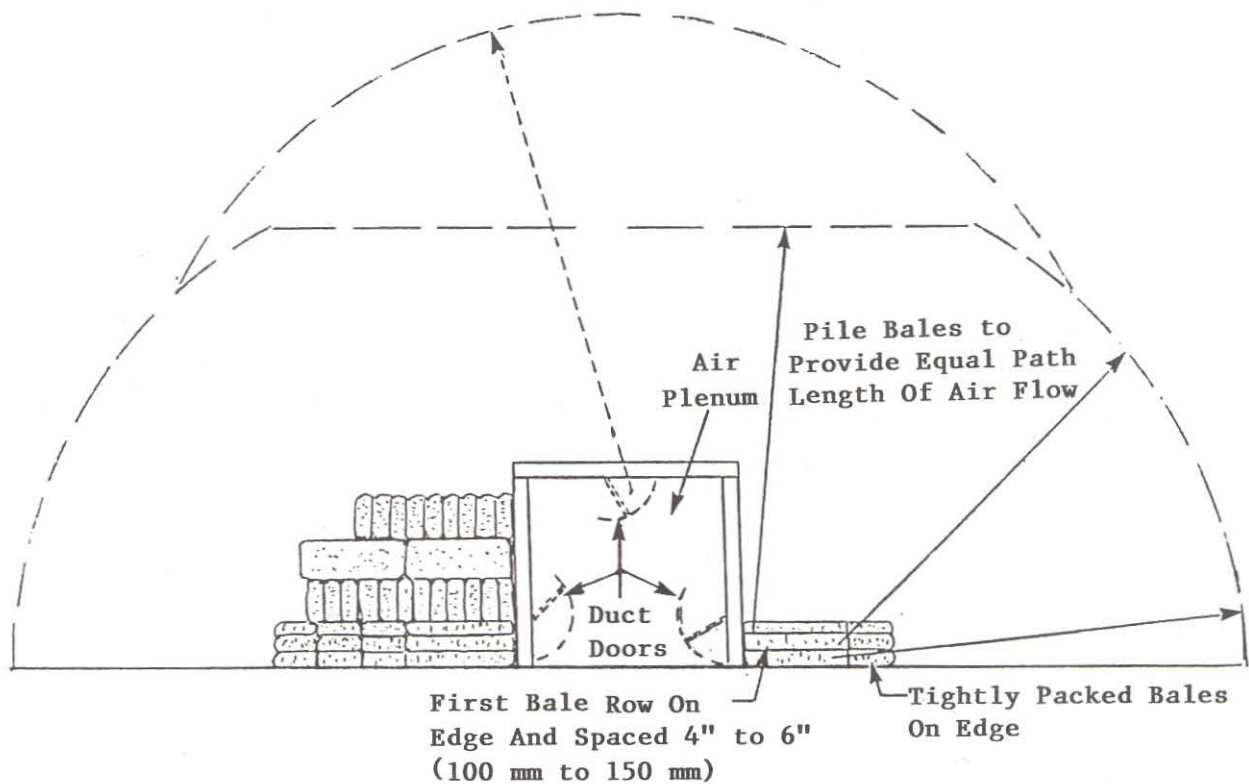


Figure 5 Equidistant Air Travel Path Through a Mow of Hay

Therefore, if the distance from the main duct air slot to the outside walls and to the mow top are equal, a slatted floor is not necessary. A single row of bales placed on edge at right angles to duct, with 4"-6" (100-150mm) spaces between them should be provided as a minimum. These air channels will lessen the pressure around the duct. Beyond the first bale row spacing, more bale row openings may be provided to achieve the equal air travel distance through the solid packed bales to the mow perimeter (Figure 6).

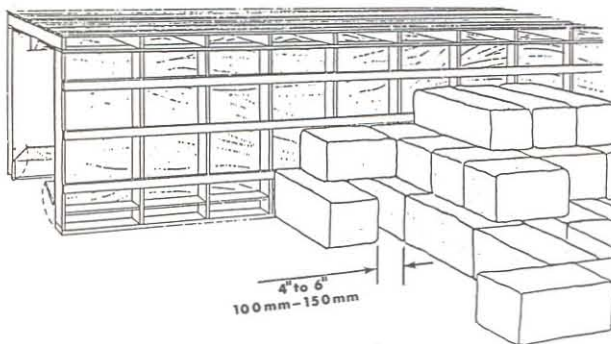


Figure 6 Perspective of Hay Dryer with Bottom Layer of Bales Spaced to form Air Channels  
Courtesy Atlantic Provinces Publication No. 8

Slatted floors should never be used where the distance from the main duct to the outside of the mow is less than to the top of the mow, as the air will short-circuit through the sides of the mow.

## 5. DESIGNING THE SYSTEM

The following points must be kept in mind when designing the system:

1. The main air duct should be sized to provide a minimum of 1 square foot (.09 sq.m.) of cross sectional area for every 1000 cfm (470 L/s) of fan capacity.
2. Air control doors should be sized to create a maximum air velocity through the opening of 500 fpm (2.5 m/s) or provide 2 square feet (0.18 sq.m.) of opening area for every 1000 cfm (470 L/s) of fan capacity.
3. Air control doors should not be installed closer than 8 feet (2.4 m) to the ends of the main duct. The first 8 feet (2.4 m) of duct next to the fan should always be tightly sheathed.
4. Provide 2 square feet (0.18 sq.m.) of opening from the mow to the outside for every 1000 cfm (470 L/s) of fan capacity for exhaust air discharge.

## 6. HARVESTING AND FILLING

The hay dryer is designed to dry tough or damp hay and not wet hay. Field dry the hay to an average moisture content of 25% before baling. Hay with a high grass content may be baled with a slightly higher moisture level. Bale the hay at normal baler tension and make slight adjustments, if necessary, for high moisture contents. Remember that the bales will shrink slightly during the drying process.

Hay should be placed uniformly over the entire mow section being dried. Pack the mow tightly with the bottom layer of bales on edge. The upper remaining layers of bales may be placed flat with alternate layers at right angles to each other.

The fan should be started once the loading of the mow commences. Enough hay must be placed on the dryer the first day to adequately cover the floor and duct section. This ensures that effective drying can begin.

## 7. OPERATION OF DRYER

1. Once the fan is started, run it continuously until the hay is dry.
2. When the hay at the top of the mow appears fully dry (minimum of 7 days after last hay put in mow), turn the fan off overnight. Start it again the next morning with someone in the mow to check for warm air or steam escaping.

3. If heating is evident run the fan for a day or two and re-check.
4. If no heating is evident after three checks, the hay may be considered dry.

## 8. COST

The capital cost of the hay drying system will vary depending on the type and size of system, the available materials and labour. As of 1986, the minimum cost of a hay drying system including an axial fan, the main air plenum (no slats) but with no labor cost for building the duct would be \$2500. This cost could easily be doubled if a centrifugal fan was installed and hired labor was used to construct the ductwork.

Operating costs will depend on hay moisture content and weather conditions during the drying period. An average energy usage of 50-75 kWh/ton (55-83 kWh/tonne) can be expected. Using a 1986 electrical charge of \$0.045/kWh this would translate to \$2.25-\$3.38/ton (\$2.48-\$3.73/tonne) of dry hay.

## 9. FURTHER ASSISTANCE

Further assistance may be obtained from Agricultural Engineers located in the Ministry of Agriculture and Food County Offices.