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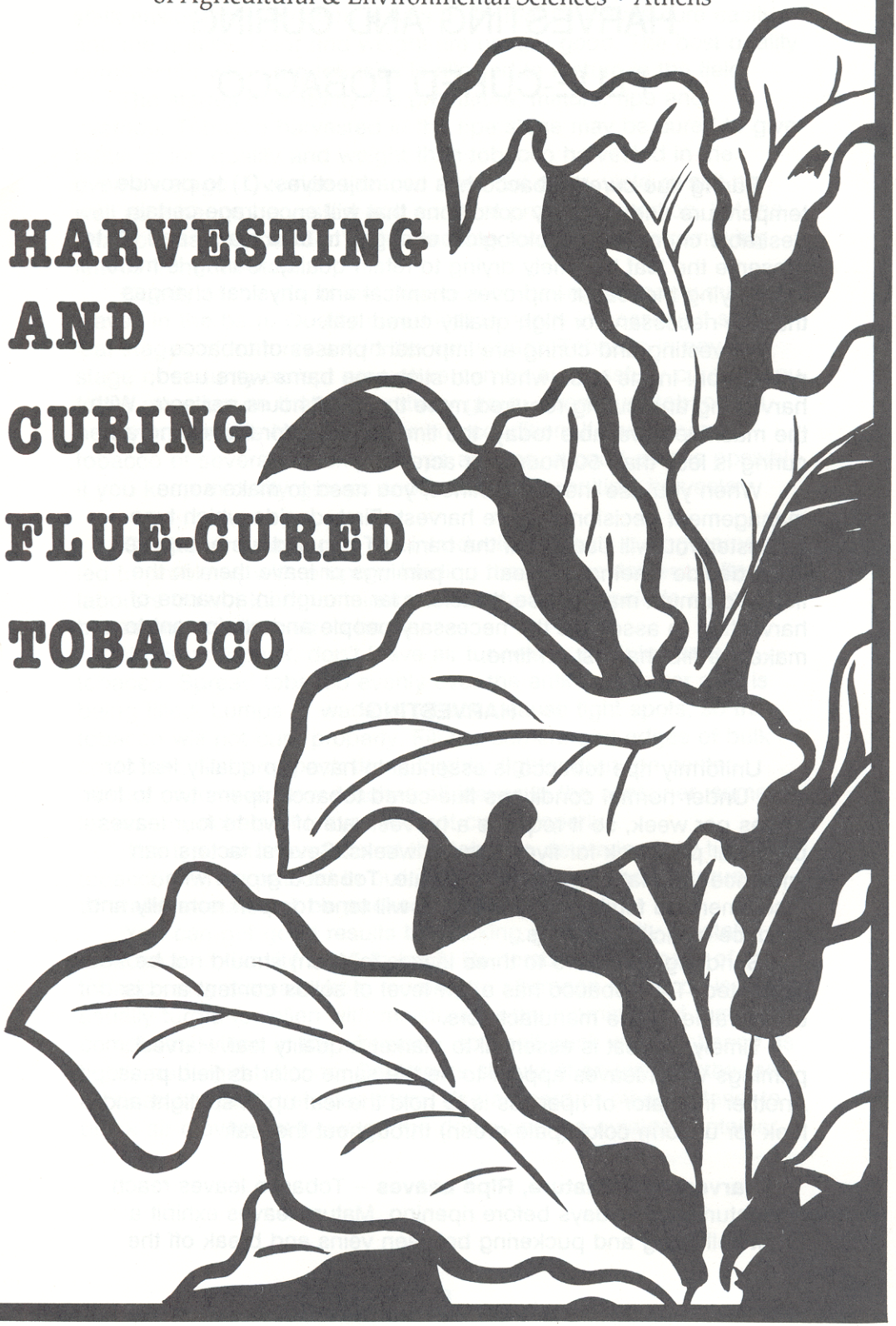
HARVESTING AND CURING FLUE-CURED TOBACCO



HARVESTING AND CURING FLUE-CURED TOBACCO

Curing flue-cured tobacco has two objectives: (1) to provide temperature and humidity conditions that will encourage certain desirable chemical and biological changes to take place, and (2) to preserve the leaf by timely drying to retain quality. Curing is more than drying the leaf. It improves chemical and physical changes that are necessary for high quality cured leaf.

Harvesting and curing are important phases of tobacco production. In the past, when old stick-type barns were used, harvesting and curing required more than 200 hours per acre. With the machines available today, the time required for harvesting and curing is less than 50 hours per acre.

When you use these machines, you need to make some management decisions before harvest. First, decide which type harvester you will use and if the barns to be used are adequate. Then decide whether to clean up primings or leave them in the field. You must make these decisions far enough in advance of harvesting to assemble the necessary people and equipment to make the first harvest on time.

HARVESTING

Uniformly ripe tobacco is essential to have top quality leaf for sale. Under normal conditions flue-cured tobacco ripens two to four leaves per week, so it requires a harvest rate of two to four leaves per plant per week for five to seven weeks. Several factors can influence the maturity and harvest rate. Tobacco grown with recommended fertilizer requirements will tend to ripen normally and produce sufficient pounds.

Sand lugs (first two to three leaves to ripen) should not be harvested. This tobacco has a low level of solids content and is undesirable by the manufacturers.

Timely harvest is essential to market a quality leaf. Harvest primings when leaves appear to be the same color as field peas. Another indicator of ripeness is to hold the leaf up in sunlight and look for uniform color (pale green) throughout the leaf.

Harvest Only Mature, Ripe Leaves -- Tobacco leaves reach full maturity a few days before ripening. Mature leaves exhibit a slight yellowing and puckering between veins and break off the

stalk easier than immature leaves. Fully mature leaves cure easily, and the quality, color and weight are usually good. The best quality cures occur when the tobacco is allowed to mature in the field.

The stages of maturity are premature, mature, ripe and overripe. Tobacco harvested in the ripe stage may be cured to give better color, quality and weight than tobacco harvested in the overripe stage. Overripe tobacco does not color, yield or sell as well as tobacco harvested and cured at proper maturation. Let the tobacco mature, but don't let it become too ripe before removing leaves from the stalk.

Quality of the cured leaf depends on having uniformly mature leaves in the barn. Quality cured leaf is nearly impossible if several leaf stages of maturity are in the same barn. Tobacco in any one stage of maturity except premature can be successfully cured if you focus attention on that one maturity group. Premature tobacco is nearly impossible to cure under any condition. If you harvest tobacco of several maturity groups at once, a good cure is possible if you keep maturity groups separated using multiple harvests.

Container Loading -- The introduction of bulk curing barns has led to problems with properly loading the bulk containers. Often laborers do not load containers uniformly. These include racks, big boxes and medium-sized boxes.

When you pack, don't leave air tunnels or pack lumps of tobacco. Spread tobacco evenly over the entire container as it is being filled. Lumps or wads of tobacco cause tight spots, so the tobacco will not cure properly. Fill the corners and edges of bulk containers first and pack these slightly tighter than the center. Unless uniform air flow reaches all leaves in the container, some leaves or pockets of leaves will not cure properly.

The type and condition of the tobacco determine how tight the tobacco can be packed in bulk containers. **Lugs (bottom quarter of stalk) should not be packed at all.**

You can get good results by packing good quality, upstalk, dry tobacco to a density of 15 lb./cu.ft. Remember, the density of tobacco may increase from morning to afternoon. Tobacco is usually turgid (swollen with moisture) in the morning, but it may be completely wilted in the afternoon, so don't pack wilted tobacco as tightly as turgid tobacco. Containers should fit snugly together so air does not pass between them. Use a board or other material to block air movement between the doors and the outside container.

CURING

Historically, tobacco curing has been considered an art. Since the use of bulk barns, growers have much more control over the processes. Management skills include understanding the principles of controlling airflow, temperature and humidity in a controlled environment.

Purpose of Curing -- Curing develops and preserves the potential quality, flavor and aroma of tobacco. Once the tobacco is in the curing barn, make a concerted effort to bring the tobacco to a brilliant color (lemon orange). Once you have the desired color, dry the leaf to preserve that color.

Color is important. It indicates that certain chemical changes have taken place, and it is used as an index of leaf quality. Industry representatives estimate that 75 percent of the market value of the leaf is based on the color. The objectives are to maintain life in the leaf until biological processes are completed (yellowing phase). During this phase starch is converted to sugar. Next, stop bio-chemical activities by removing leaf moisture (leaf drying). Finally preserve the leaf by drying the stem.

Closely monitor tobacco throughout the curing process for temperature, humidity and color. Look through observation ports regularly to check the wet-bulb, dry-bulb thermometers and color changes taking place. Open the loading doors carefully because this may release too much moisture and harm the curing process, especially during yellowing. For updraft barns, place the dry-bulb thermometer under the tobacco near an observation port so you won't need to open the door. Place it in between racks or on top of the tobacco for a more accurate indication of wet-bulb temperature Reverse location of thermometers when using down-draft barns.

Temperature Advance Schedule -- There is considerable variance in advancing the temperature depending on the condition of the tobacco. A wet-bulb, dry-bulb temperature schedule (Figure 1) is effective with mature, good quality tobacco.

Humidity -- During the yellowing and leaf-drying phases, humidity control is essential. The relative humidity drops as the curing advances. Control the humidity by adjusting the fresh air exchange rate with the vent system. By controlling the humidity, the coloring time may be extended or shortened to get the most desirable color. If the tobacco is drying too fast (drying before yellowing), close the vents. On the other hand, opening the vents

will speed drying.

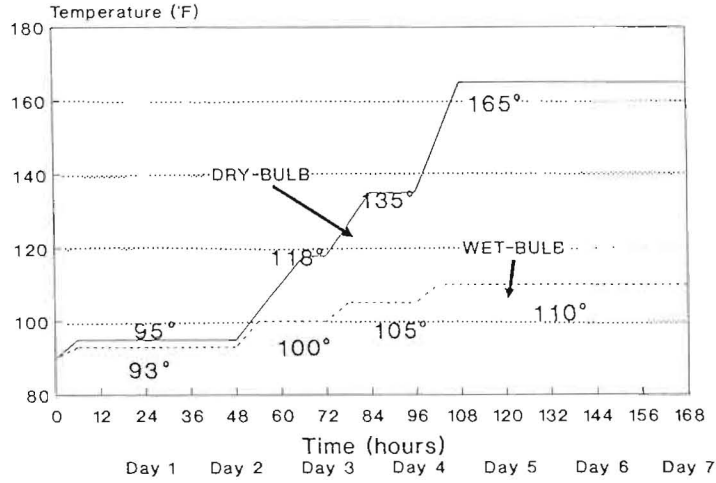


Figure 1. Bulk curing schedule for mature, ripe tobacco.

Remember a couple of points about air and humidity: (1) Air at higher temperature has more drying potential at the same relative humidity. (2) At a constant relative humidity, 105°F air will hold twice as much water as air at a temperature of 85°F.

Using Wet-Bulb, Dry-Bulb Thermometers -- The wet-bulb thermometer measures the temperature of the leaf during the early stages of cure; the dry-bulb thermometer measures air temperature. Most growers use the dry-bulb thermometer, but you also need a wet-bulb thermometer. Since the humidity as well as the dry-bulb temperature must be controlled, a wet-bulb thermometer indicates when adjustments in the vents are necessary. Don't use thermostats as thermometers. They may not be calibrated to sense the same temperatures as thermometers. You can buy wet-bulb thermometers at a local fuel supply dealer, or you can make one at a fraction of the cost. A homemade wet-bulb thermometer designed especially for bulk tobacco barns can be used. Details on construction and a photograph of the homemade wet-bulb thermometer are on page 15.

The relationship between the wet-bulb and the dry-bulb temperatures determines the relative humidity within the barn. The closer the wet-bulb temperature is to the dry-bulb temperature, the higher the relative humidity. The relative humidity within the barn determines the leaf's rate of drying. The lower the humidity, the faster the leaf dries; the higher the humidity, the slower the leaf dries. Maintaining the proper wet-bulb temperature not only results

in the best possible cures but also minimizes the amount of fuel needed to cure the tobacco.

Advancing Temperatures during Yellowing -- Advancing the dry-bulb temperature and wet-bulb temperature in relation to each other is a critical feature of curing. When starting a barn **close air intake dampers before the heater is turned on.** Turn the heater on and raise the temperature to the yellowing range (Figure 1) gradually. Don't raise the temperature more than 5°F at any one jump. Allow about 30 minutes between temperature rises so curing air can become humid.

Yellowing Considerations -- Curing each barn of tobacco as the season progresses requires adjustments in the curing schedule. For example, tobacco grown under varying climatic and field conditions calls for different yellowing schedules with dry-bulb temperatures varying from 95° to 105°F and wet-bulb of 93° to 97°F.

After you harvest each barn of tobacco, decide the best way to yellow the tobacco. Consider the merits of the tobacco in the barn, such as leaf moisture content, maturity and thickness. Then make a decision at each step about how long to maintain a given temperature and humidity so the tobacco will complete its yellowing process. Failure to do this may result in dry leaf tips with a set green color. Tobacco with a high moisture content requires considerably more moisture removal before color setting than does droughty or low moisture tobacco.

Alter the yellowing schedule throughout the season as the tobacco varies from thin to thick and/or turgid to wilted tobacco with a minimum amount of moisture. For example, if you have immature, wet-weather or drought-grown tobacco, yellow it at the lower yellowing temperatures.

Length of Time Required for Yellowing -- Normal tobacco is yellowed at varying lengths of time, depending on the stalk position. For example, primings and lugs should be completely yellowed in 20 to 30 hours. On the other hand, upstalk tobacco may require 60 or more hours to obtain the desired color. You can improve the quality of certain varieties by extending the yellowing period. Certain varieties may sometimes yellow before starch converts to sugar. When this happens, the result may be pale, slick, immature tobacco.

Other Yellowing Suggestions -- Remove as much moisture as

possible during the yellowing phase of curing. With good tobacco, as much as 20 percent of the moisture can be removed during yellowing. When the yellowing phase is almost completed, the tobacco should show a good yellow color at the leaf tip with slight green-tinged colors running along the main stem and veins to the butt. The leaf tips and edges should begin to tuck and dry to a bright yellow.

When the tobacco throughout the barn reaches the desired color, increase temperature and rate of drying. At the end of yellowing, some wilting should have occurred. Avoid flash temperatures that can dry the leaf before yellowing is completed. This sets an undesirable green color.

Wilting -- Some wilting occurs before the end of yellowing at the 105°F dry-bulb temperature, but most of the wilting should take place as the dry-bulb temperature advances from 110° to 118°F. The rate of temperature advance from 105° to 110°F should be 1° to 1.5°F per hour and wet-bulb of 100°F. During the wilting phase, the tobacco loosens considerably and the air can move through readily.

Do not advance the temperature beyond 118°F dry-bulb temperature until wilting is 100 percent complete.

Leaf Drying -- When the tobacco leaves have reached the desired yellow color and are thoroughly wilted, the leaf must be dried. The drying stage is critical because tobacco is sensitive to temperature change. Impatience to capture a good color often results in advancing the temperature too rapidly and producing a browning or barn scald. If the temperature is advanced too slowly, sponging may occur.

There must be positive control of airflow and temperature during leaf drying to prevent undesirable color in the cured leaf. To prevent sponging, dry the leaf as rapidly as possible, but not so rapidly as to cause scalding.

Wet-Bulb and Dry-Bulb Temperatures -- Maintain the wet-bulb temperature near 100°F during leaf drying. Once the tobacco is dry enough (30-40 percent of the moisture removed) to take dry-bulb readings above 135°F, the wet-bulb temperature is not critical to the quality of the cured leaf. Maintaining a wet-bulb temperature of 110°F or higher, however, tends to conserve fuel.

Stem Drying -- Advance the dry-bulb temperature from 135° to 165°F at a rate of 2° to 3°F per hour. Close dampers gradually

during stem drying. Maintain a damper opening to hold wet-bulb temperature down to 110°F during the first 12 to 18 hours of stem drying. Dampers are usually closed completely about the time the leaf is completely dry and the temperature has reached 165°F. Stems should be killed out at a temperature of 165°F. Sugar caramelization will cause tobacco to turn red when the dry-bulb temperature is more than 165°F.

CURING PROBLEMS

Most curing problems are caused either by improper packing of containers and/or by wet tobacco. Problems occur with all makes of containers packed with wet (from rain or dew) primings or lugs. The problem with wet tobacco has been especially bad with low-stalk tobacco.

Soft Rot -- Low-stalk tobacco (primings and lugs) is especially susceptible to soft rot damage during wet harvest conditions. These leaves are close to the ground in the field and are contaminated by barn rot organisms that stem from bacteria found in many fields.

Once the tobacco is in the barn, moisture and warm temperatures provide an ideal environment for barn rot bacterial growth to damage the tobacco. When dried, affected areas develop a black color and follow irregular patterns on the leaf. Prevent soft rot by harvesting completely dry tobacco.

Lessen barn rot on wet tobacco by operating the fan with dampers wide open and heat off until the surface moisture is removed from the leaf. This may require as long as 48 hours. If heat is added to remove surface moisture (100 percent relative humidity outside), set thermostat no more than 5°F above the outside air temperature and provide maximum ventilation without setting green color in the leaf. The object is to keep the leaf as dry and cool as possible to prevent the growth of the barn rot bacteria.

Sweating -- Tobacco sweating is caused by overcrowding and insufficient and ineffective ventilation of tobacco during the yellowing and wilting phases. Too much moisture remains in the leaf when the temperature is raised causing super-saturated stagnant air.

To prevent sweating, speed the drying rate as fast as possible once the color is set. Remove as much moisture as possible during yellowing phase. As the temperature goes up, increase ventilation. If water is condensing on the top tiers, close vents until tobacco is warm, then flush.

Brown Spot -- Tobacco damaged by brown spot should be yellowed at a high yellowing temperature. Early, rapid leaf drying will usually stop the spread of brown spot.

Immature and Slick -- Immature, slick tobaccos are described by the trade as lacking in grain and other elements of quality. The surface of the leaf is smooth -- it does not have the desirable crepe-like texture, and the leaf is papery, with little or no elasticity or oiliness. Such tobaccos lack richness of color and aroma, and have a flat, undesirable taste. They're like fruits that have been harvested green and allowed to ripen in storage -- the field-ripened flavor isn't there.

This condition is associated with such factors as (1) improper fertilization; (2) close spacing or topping too high, causing shading and greater competition for plant food, water and sunlight; and (3) excess rainfall or over-irrigation, which leaches out the fertilizer and upsets normal growth processes. These conditions often cause yellowing before ripening, and harvesting of immature leaf. Varieties differ in their tendency to produce tobacco of this type.

Green -- Green color in the cured leaf results from a failure to break down all the chlorophyll during the curing process. Several conditions cause green tobacco:

(1) Harvesting the leaves before they are ripe, as when too many leaves are pulled at once. Tobacco leaves sometimes acquire a faded-out yellow color, suggesting ripeness, which is not true ripeness.

(2) Severe drought conditions, which prevent ripening. Leaves that are harvested under such conditions will generally cure with a greenish cast.

(3) Excessive nitrogen supply, which prevents proper ripening. Tobacco grown with too much available nitrogen will cure out green or brown.

(4) Insufficient yellowing of the leaves before drying. Other deficiencies are associated with the green color, causing a harsh, bitter taste. Lighter shades of green will improve on aging, but pronounced green grades are undesirable.

Sponged -- The term "sponged" is used to designate those well-grained, porous, overripe tobaccos that are dull, grayish-brown.

This type of cured leaf results when good quality tobacco overripens in the field, or when holding low temperatures too long in the early part of the curing process. It occurs at high humidity and low temperature (105° - 125°F).

If the moisture in the leaves is not removed fast enough, sponging is likely to take place, resulting in grayish and brownish blotches on the leaf surface. In normal curing, the color breakdown goes from green to yellow. By drying, the color may be fixed at either of these stages. In the case of sponging, the color breakdown has gone beyond the yellow stage to the gray or brown stage.

Color alone doesn't designate tobaccos as sponged -- some brown tobaccos may be slick, dead, "toady" or otherwise undesirable. Slight sponging may not seriously hurt quality.

Toady -- Toady tobacco has a slick, dense, sometimes thick and leathery leaf that is nondescript smutty, grayish-brown. Toady leaves have no grain and are compact. They are abnormally high in sugar content. They are usually soggy, but may be dry-natured and starchy.

Researchers aren't sure what causes toadiness. However, certain varieties tend to produce higher proportions of this type of leaf than others. In seasons of high rainfall or following over-irrigation, some toady tobacco may be found in all varieties. Rapid drying discourages the development of this condition.

Moisture Run Back -- Dark or reddish areas along the upper portions of the leaf midrib and larger lateral veins is known as "moisture run back" or "circle stem." It is caused by lowering the temperature after the blade of the leaf is dry, but before all moisture has been removed from the midrib. The moisture in the midrib seeps back into the leaf, causing a dark area.

Refiring and drying the midrib will not remove the discoloration, but it will put the tobacco in safe keeping condition. Run back will not occur if you fire the curing unit continuously until the entire leaf is fully dry.

Barn Scald -- Dark, chocolate-colored areas on cured leaves, or brown scald, may result from excessive humidity in the curing barn, over-crowding in the barn and inadequate ventilation. Barn scald may occur at any dry-bulb temperature above 110°F. The leaves are cooked, rather than dried, when the temperature is raised.

Brown scald will also occur in properly loaded barns if killing

heat is applied before drying is complete. A set green color, or green scald, may develop in the leaf tips if flash heat occurs before the tobacco is yellowed.

Swelled Stems -- After colors have been set and the leaf partially dried (130° to 145°F), the remaining moisture is removed at "killing out" temperatures of approximately 165°F. Failure to remove all moisture from the midrib leaves it soft, pliable and larger than when dry. Temperature may be too low or held too briefly.

Incompletely-dried midribs are called "swelled stems." Swelled stems usually mold in storage and may cause considerable loss by damaging the surrounding tobacco. Reduce swelled stems by holding temperatures high (165°F) until the stem is dried. Some curing barns have areas of ineffective ventilation causing swelled stems. Pack containers evenly to ensure uniform distribution of curing air.

Scorched -- This condition is associated with high temperatures, especially during the stem drying phase. Scorched tobacco has an abnormal aroma and an off-taste when smoked. To keep scorched tobacco to a minimum, keep dry-bulb temperatures below 165°F.

ORDERING

When curing is over and the stems have been killed, the moisture content of the leaves is near zero. At this stage, the leaves and stems are too brittle to handle, so add enough moisture to the leaf to bring the moisture content up to about 15 percent. The leaves are then pliable and easily handled.

The rate to add the moisture to the leaf depends mainly on the method to add moisture to the barn and on the condition of the tobacco itself. A barn of 3,000 pounds cured tobacco requires about 50 gallons of water to bring the leaf into order. Running the fan with the dampers wide open usually brings the tobacco in order overnight.

There are many spray-injection systems that can bring a barn of tobacco in order in a few hours. If there is a floor in the curing barn, pour water onto it. No matter which method is selected, do not apply the water directly to the leaf. The ordering method depends on the equipment available and how quickly you need to get the tobacco in order.

The best way to add moisture back into tobacco is when the temperature of the leaf is high (165°F). Turn off the furnace and

insert a hollow cone spray nozzle operating at 100 psi into the air stream around the furnace. A cured barn of tobacco can be easy to handle in one to two hours. Table 1 lists types of hollow cone nozzles and hours of operation to add moisture to cured tobacco.

Table 1. Number of hollow cone nozzles required to order a bulk barn of tobacco.

		Nozzle Operation Time		
Nozzle	Pressure	2 hrs	4 hrs	6 hrs
Type	(PSI)	No. Nozzles Required Per Barn		
TX-3	40	8	4	3
TX-4	40	7	3	2
TX-6	40	4	2	1
D1-13	40	7	3	2
D3-13	40	4	2	1
D1-23	40	6	3	2
D2-23	40	4	2	1
TX-3	100	6	3	2
TX-4	100	4	2	1
TX-6	100	3	1	1
D1-13	100	4	2	1
D2-13	100	3	2	1
D1-23	100	4	2	1

EQUIPMENT AND BARN MAINTENANCE

Harvesters -- Before harvesting and curing begin, check and service the equipment used. Harvesters must be in good condition for trouble-free, efficient harvesting. Check all systems and parts for proper operation and remaining service life. Check the engine, power train, hydraulic system, tires, etc. Check the condition and tension of drive belts and chains and replace them if necessary. Grease and oil bearings and replace if needed. All adjustment mechanisms should operate freely, so you can make adjustments rapidly and easily in the field.

The mechanical harvester operator needs to get ready for the harvest season. The operator probably last used the machine nine to ten months ago, and he or she may have forgotten some operation details. Review the operator's manual and perform all inspections and services recommended just before the harvest season. These actions refresh the memory on important operating procedures, required service and necessary adjustments. Practice

operating the machine around the machinery storage area. This will help the operator become familiar again with the location of control levers and the kind of reaction to expect.

Curing Barn -- Successful bulk curing depends on satisfactorily working equipment. Faulty equipment can cause a bad cure and considerable financial loss. Initiate a preventative maintenance program for your tobacco-curing equipment before it is put into heavy use. Clean the fan, thermostat and electrical controls. Check the capillary tube on thermostats for kinks and/or breaks. Replace the wicks on wet bulb thermostats and check water reservoirs. Check and repair belts, bearings and shafts if needed. Inspect, clean and replace burner components if necessary.

Loading Doors -- Hang loading doors so they will seal the entire opening. Gaskets around the door should be in good condition. Replace torn or frayed gaskets. A good substitute material is thick piled carpet. This material can be easily obtained and installed to seal the loading doors. Water hoses will not withstand the high air temperatures and should not be used.

Foundation -- Seal the foundation of bulk curing barns with an asphalt sealant. This material will expand and contract as the barn heats up and cools during the curing season. A small crack between foundation and pad area can waste more money in energy loss than the small cost of sealing.

Curing Chamber and Furnace Room Areas -- Examine the curing chamber and furnace room closely. Look for small and large cracks. Seal them with a butyl caulk or a caulking material that can withstand 180°F air temperatures and remain flexible. One way of detecting air leaks is to go into the barn, close the door and look for daylight. These will be the areas to caulk.

Barn Insulation -- If the bulk barn is only a few years old, it probably has adequate insulation, but you can reduce fuel costs for older barns by insulating them. It's money well-spent.

You can reduce fuel consumption by 15 to 20 percent by adding insulation with an R-value of 3.5 to the structure. The payback for insulating varies from operation to operation, but when insulation was installed in old bulk barns, the payback for investment was one to two years.

Consider several kinds of insulation for tobacco barns. Use a

material that has a high R-value per inch (greater than 6) and does not absorb moisture. Styrofoam bead board and polyurethane type are the insulations of choice. Normally these types of insulations have foil protection on one side or both. This protects the insulation from damage or being destroyed.

Existing Uninsulated Barns -- When insulating an existing bulk barn, the choice of insulation material is a board type. When using the board-type insulation, be sure you get a tight fit. If the board insulation does not fit tightly, heat (energy) will be lost at these points.

Here is a method to insulate an existing uninsulated bulk barn. Cut insulation ($^1/_2$ inch material) to fit between the tier rails and nail it to the interior wall. Insulate doors and furnace end on the interior. Insulate the ceiling by attaching the board-type insulation to the bottom of the rafters. After all insulation has been installed, caulk with a flexible heat resistant material.

For Powell barns before 1974, place the insulation between the rafters over the furnace. Don't reduce the return air volume over the furnace.

Pad Installation -- Concrete and soil are poor insulators, with an R-value of 0.08-0.10 per inch. If you install a concrete foundation, insulate under it. Place at least one inch of board-type insulation under the concrete foundation (Figure 2). Cover the insulation with a layer of polyethylene to eliminate the problem of the insulation floating up in the slab. Place two inches of sand under the insulation to provide adequate drainage.

Lower Plenum -- The side walls of the lower plenum (Figure 2) of most bulk barns are difficult to insulate. The drying floor is difficult to remove, and exterior metal sheeting will cover most of it on the outside. The side walls need to be insulated because of their construction, which usually is only an 1/8-inch piece of metal.

If this area cannot be insulated, you can reduce heat loss at this point by piling a foot or two of soil outside the barn to cover the area where the side wall or sheet metal meets the lower plenum (Figure 2). This reduces heat loss through side wall delivery plenum and seals air leaks between the concrete pad and the barn.

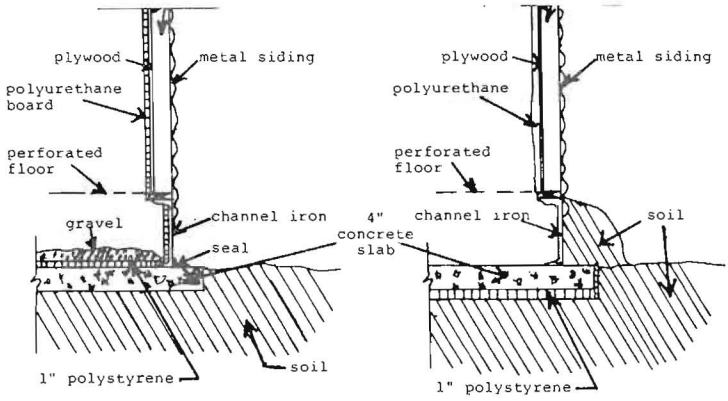


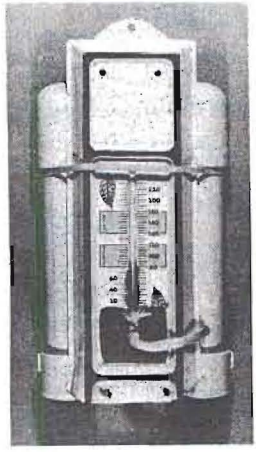
Figure 2. Diagram of Floor and Wall Insulation

How to Make a Wet-Bulb Thermometer

Properly managing the curing process and maintaining the barn can reduce fuel use drastically. No matter what type of bulk barn is used, fuel consumption can be reduced by tightening up the barn and using a wet-bulb thermometer to gauge ventilation. Caulking compound for structural cracks and new weather stripping for doors cost only a small amount compared to the heat they save.

You can make a wet-bulb thermometer for $3-5. The home-made wet-bulb thermometer shown has been used successfully as an indicator of wet-bulb temperature in bulk barns.

Materials



2 - pieces 1" PVC pipe, 7" long (one piece with $^1/_4$" hole drilled $1^1/_2$" from one end)
1 - piece 1" PVC pipe, 2" long
2 - 90° 1" PVC elbows
2 - end caps, 1" PVC
1 - piece athletic shoestring, 7" long (wick)
1 - Tobacco curing thermometer with bulb guards cut out
1 - wide rubber band
1 - piece of thread (not shown) 4" long to tie wick to thermometer bulb

Instructions for Construction, Filling and Using

1. Glue all PVC pipe together as shown in figure.
2. Carefully remove glass thermometer bulb from holder and cut out in a 1 to 1 1/2" square around bulb.

3. Replace glass thermometer bulb and calibrate according to another thermometer.
4. Secure thermometer to PVC pipe with rubber band or light gauge wire.
5. Fill with water. Use a large syringe or a small snout "squeeze-it" type plastic detergent bottle.
6. Insert wick into water. A small nail, large toothpick, or kitchen matchstick may be helpful.
7. Place in curing barn where air flow is strong. In updraft barns (e.g. Roanoke, Long, Powell) lay wet-bulb device flat on its back on the perforated floor near the loading doors. In down-draft barns (e.g. bulk tobacco), lay wet-bulb device flat on its back near the loading doors where air flow will strike the wet bulb of the thermometer.
8. Open fresh air vents only enough to maintain a wet-bulb temperature of 100° to 105°F during leaf drying and 105° to 110°F during stem drying.

Prepared by Paul Sumner, Extension Engineer and J. Michael Moore, Extension Agronomist

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