Facilities and Curing

Larry Swetnam and Andy Bailey

Conventional Barn Renovation and Remodeling

Curing facilities are a concern for producers wanting to expand their production. With the high cost of new barns, renovation and remodeling of existing barns are an economic option. Curing barns that are generally in good structural condition, with some remodeling, can be improved to make housing easier and/or to aid the curing process.

Good burley curing requires natural air movement. Ventilator doors or equivalent openings equal to one-fourth to one-third of the barn side wall area should exist to permit natural

air to enter and pass through the hanging tobacco. Keep the ventilator doors in good repair so they can be opened and closed as required to regulate ventilation and manage the cure. Whenever possible, remove obstructions such as trees, bushes, and hay stacked in attached sheds that may block prevailing winds.

Where possible, install full-width driveway doors in shed areas to allow wagon access and increase housing efficiency. Several growers still hand tobacco from the driveway across to the sheds and up into the barn, which adds a worker or two and costly labor hours.

Consider fans where natural ventilation is inadequate. Supplemental fan circulation and/or ventilation can help wilt green tobacco, aid curing of tightly housed tobacco in humid weather, help reduce mold growth on curing tobacco in wet curing seasons, and aid air movement in barns with poor ventilation. See publication on the selection, installation, and use of fans in tobacco barns (AEN-69, *Using Fans in Conventional Burley Barns*).

Many producers have found that in older dark tobacco barns, where tiers are only 3 to 3.5 feet apart vertically, better curing results when tobacco is housed on every other tier rail. This method eliminates overlapping and improves air movement. Sticks can usually be placed closer together when the plants do not overlap, thus compensating for barn capacity lost from the omitted tiers. Tier rails should not be overloaded. This could cause the rails to break or reduce air movement through the tobacco.

Structurally sound conventional barns can be modified for two- or three-tier, air-cure housing; cable hoist; or portable frame housing to obtain labor-saving benefits. Specific details of these procedures are contained in other publications.

What Type of Tobacco Barn or Curing Facility Should You Build?

There are several options for new tobacco barn construction as well as field curing structures. Consideration should include the most suitable facility for present and future production methods. With declining labor sources and increasing costs, laborsaving features are a must. Rising material and construction costs continue to increase the initial investment costs. A barn is the largest single investment required in the normal tobacco (burley or dark) production system. Mechanization trends affect whether a facility should be modified, will soon become obsolete, or is needed at all. Partially enclosed barns and plastic-covered field curing structures are alternatives for lower cost tobacco housing and curing. Field curing structures, especially, minimize both initial investment costs and hanging labor requirements, but may require more management for proper curing and are more susceptible to tobacco damage in strong winds.

Producers considering a new facility should certainly not favor the historic tall, labor-intensive barns from the past era of plentiful, low-cost labor and inexpensive homegrown lumber. Likewise, builders should not contend that they can only build barns of that type.

Considerations for Building Barns (fixed-roof structures)

When planning new fixed-roof curing facilities, producers should consider the following options:

- Basic three- or four-tier barn designs, two-tier economy designs, or one-tier field structures in which tobacco housing can be accomplished with a smaller crew and less total labor
- Alternative designs that use portable frames or cable-hoist mechanical handling and housing can save over half of housing labor costs
- Structures that permit other farm uses of the facility during the non-curing season, such as machinery and supply storage
- Future modifications for different tobacco housing and curing methods or other farm enterprises, as these methods could change significantly in the future

Considerations for Outside Field Curing Structures (plastic-covered structures)

Outside curing structures can be constructed at a much lower cost (for the same curing capacity) than barns, so they should be given consideration if curing capacity expansion is needed. They also require considerably less labor for hanging because they are only one tier high, and they have reduced safety concerns because workers do not need to climb to multiple tier heights. However, there are other considerations when using outside field curing structures.

- Curing quality has generally been found to be equal to or better in outside curing structures than in traditional barns.
- Tobacco on the outside of the structure is subject to increased damage from weather.
- Tobacco can be in case more readily than tobacco in traditional barns.
- There is additional labor and expense related to covering the structures with plastic, negating some of the advantage in labor efficiency over traditional barns.
- There is a risk of damage to the plastic cover and the tobacco from strong winds.
- The space requirements for outside field curing structures are substantial, generally about ¼ acre (including space for maneuvering) for every 1 acre of curing capacity.
- There are maintenance issues to consider (mowing, etc.).
- Portable curing structures can help minimize the distance from the tobacco field to the curing structure, encouraging better rotation practices. But, they have considerably higher costs, require a lot of extra effort to move and set up, have high space requirements for storing during the off season, and it can be more difficult to secure the plastic cover.

Designs and Plans

Numerous designs with plans and publications related to curing facilities are currently available on the UK Department of Biosystems and Agricultural Engineering website: http://www.bae.uky.edu/ext/tobacco. General groupings include the following:

- Three-tier and four-tier air-cure, 32, 40, or 48 feet wide, post-pier or pole-type construction, wood, or metal siding
- Two- or three-tier forced-air, 32 or 40 feet wide, wood or metal siding, pole-type construction
- Three-tier, 32 feet wide, pole rafter type, long tier fire-curing barn

- Open-interior air-cure barn with portable curing frames handled by tractor forklift
- Two-tier, partially enclosed air-cure barn, pole-type construction
- Cable-hoist mechanical housing system for new or modified air-cure barns
- Thirty-foot-wide machine shed with removable tier rails for small air-cure barn, pole-type construction
- One-tier, plastic-covered field curing structures with manual or mechanized housing
- Pallet rack components used as one-tier, plastic-covered field curing structures
- Stripping rooms attached to barns or freestanding, especially layouts for the new big-bale operations

In addition, there are also plans available for 32- to 36-feet wide cross-tier design barns for air- and fire-curing. Cross-tier design barns have become very popular in the dark tobacco production areas of western Kentucky. Most fire-curing barns that have been built in the last fifteen years have been cross-tier design.

Facility Design and Location

A barn should be in an open, well-drained area, on a high point on the farmstead with the broad side facing the direction of the prevailing wind to provide the best cross ventilation. Width is the most important dimension affecting ventilation, since it determines the distance the air must move as it passes through the facility and the tobacco. Traditionally, barns have been 32, 40, or 48 feet wide and as long as needed to hold the desired amount of tobacco. However, very large, high capacity curing barns have been built in recent years for large tobacco operations. For these barns, which may be 80 feet wide, it is especially important that all possible measures be taken to maximize cross ventilation. It is difficult to get sufficient air movement through the tobacco for proper curing in the center of such large barns. It is important that other tobacco barns or farm structures that could block the wind not be located close to these large barns. Regardless of the measures taken to maximize cross ventilation, houseburn may still be a problem in the central sections of such large barns. If that is the case, consider adding fans to supplement natural ventilation. Fans can be used in barns to improve circulation and fresh air exchange through the tobacco to improve curing. Also, not operating fans during drier weather can reduce air exchange and maintain better humidity conditions. For fire-curing barns, the overall barn size determination should consider the size of the labor crew and how quickly they can harvest and house the tobacco to fill the barn. Ideally, a fire-curing barn should be filled within a two-day period to allow yellowing to proceed at approximately the same rate and allow subsequent firing practices to be the same throughout the entire barn. For this reason, many fire-curing barns hold no more than 4 to 6 acres, even on larger operations.

Lumber of sound quality and proper strength should be used for construction as shown in typical plans. For labor savings in housing, the "sheds" of barns should have driveway doors so transport vehicles can pass under the tier rails for efficient handing of tobacco up into the tiers. In air-curing barns, ventilator openings should have doors or panels that open, generally vertical in orientation, and equivalent in area to at least one-fourth to one-third of the sidewall area. Air-curing barns are being built with metal siding that do not have adequate sidewall ventilation. Inadequate ventilation will result in houseburn during humid weather or with tightly spaced tobacco. Air-cured tobacco should not be housed and cured in a fire-curing barn.

Lower cost plastic-covered field structures can use untreated wood for a reduced life or preservative-treated wood for a longer life. Various wooden and wire strung designs exist for stick harvested or notched plant hanging and curing. Careless and haphazard construction, including failure to adequately anchor high tensile wire, can result in failure of these field structures when fully loaded with harvested tobacco. Contrary to barns, field structures should be in protected areas, as they tend to have ample air movement through the tobacco but are subject to damage from very strong winds. Locate field structures beside barns or downwind from fencerows or tree lines to help protect them from strong winds.

Costs and Labor Efficiency

Curing facility initial costs can range from $900 to $1,500 per acre of capacity for simple field curing structures with plastic covers to $6,000 to $10,000 or more per acre of capacity for conventional air or fire-curing barns. Field curing structures will also have additional costs each year for the plastic covers, approximately $150 per acre. Useful life of these structures can vary from seven to 10 years for low-cost field structures to 40 or more years for well-built barns. Labor requirements for hanging tobacco in these facilities (not including harvesting and hauling) can vary from approximately 12 worker-hr/A of capacity for the single-tier height field structures up to 30 to 35 worker-hr/A for the tall, traditional barns (hanging labor requirements increase with barn height).

The amortized value of construction cost and labor for these facilities over their useful life is estimated at approximately 8 to 12 cents per pound of cured burley tobacco per year. The annual costs per pound of cured tobacco are even greater to repay short-term construction loans.

Air-Curing Burley Tobacco

One of the most important functions of any tobacco curing facility is to provide an environment for proper tobacco curing and management. The process of air-curing burley and dark tobacco change chemical and physical properties of the leaf from the green and yellowish stages to tan and brown aromatic leaf for processing. Most of the changes occur during the first four weeks of curing (approximately two weeks for yellowing, two weeks for browning) and alter many compounds in the green leaf.

Cured leaf quality of air-cured tobacco is heavily influenced by the weather conditions during the curing season. Quality is influenced by moisture and temperature conditions inside the facility during the curing period. For several decades, the best conditions for curing burley have been cited from Jeffrey (1940) as a daily temperature range from 60 to 90°F and a daily relative humidity average of 65 to 70%. The study was based on airflow of 15 feet per minute (1/6 mph velocity) through tobacco in test chambers. These conditions were for tobacco grown and cured in the 1940s, which was a very thin, buff-colored leaf referred to as "white burley." Changes in varieties, fertility, and

cultural practices in the last couple of decades as well as buyer preferences have resulted in a darker brown to red, thicker leaf now being preferred. Recent barn and chamber studies have indicated that steady or daily average relative humidity in the 72 to 75% range produces the tobacco currently desired by the industry, thus a higher daily average humidity than that of the historic study.

During late August through September, the typical tobacco air-curing season in Kentucky, the outdoor temperature is seldom above 90°F or below 60°F for any extended period of time. Relative humidity can dwell near 100 percent during heavy dew or foggy nights and briefly drop below 40 to 50% during the heat of the day, thus averaging around 70 to 75%. Cooler October temperatures can often be below 60°F for an entire day and/or several consecutive evening periods, with humidity ranging from 25 to 30% in daytime to not over 70 to 80% in evening hours, resulting in daily averages of 45 to 55%. Extensive curing studies by Walton, et al. (1971, 1973) on the effect of several combinations of low and high temperatures and relative humidity on the quality of burley can be summarized as follows:

- Low temperatures result in green leaf, regardless of the relative humidity and airflow. Chemical conversions are too slow at low temperature. The drying rate determines the degree of green cast in the leaf. The higher the drying rate, the greener the cured leaf.
- Low humidity and moderate temperature result in greenish or mottled leaf.
- Low humidity and high temperature (75°F and above) cause "piebald" (yellowish) leaf.
- High humidity and moderate-to-high temperatures for extended periods is "house-burning" weather. Houseburn results in a dark leaf with significant loss in dry weight. The weight loss is primarily caused by microbial activity which causes soft rot.

Undesirable colors that prevail in the cured leaf during improper curing are determined by temperature; however, it is relative humidity (if airflow is adequate) that determines the degree of damage incurred. Walton et al. (1973) showed that the greater the departure from the optimum relative humidity range, the greater the damage to the quality of the tobacco.

Control of the curing process is affected by spacing of the tobacco in the curing facility and management of the drying rate. Spacing can vary from 5 to 6 inches between plants or sticks for one- and two-tier facilities to 7 to 10 inches for three- to five-tier barns with tobacco overlapping on close-tier rails. The drying rate is managed primarily by operating the ventilators, plastic covering, or other air control means to regulate the ventilation rates.

The air conditions inside the barn generally follow the conditions outside, depending on the quantity of air movement and buffering action of the tobacco mass. The average temperature inside the barn will be slightly lower than outside because of evaporative cooling during the drying stage. The average relative humidity inside will be higher than outside under most conditions of adequate ventilation because of moisture moving out of the tobacco. A good way to determine the conditions inside the barn and that of the tobacco is to purchase a couple of commercial digital temperature and humidity instruments. Place these in the tobacco mass (but not directly against a moist leaf) to sense and record the environmental conditions. These instruments store maximum and minimum data readings that can be viewed to see past cycle of conditions and reset as desired. The accuracy of relative humidity measurement is generally plus or minus 3%, which is reasonable for the price of these units.

An electronic, interactive tobacco curing advisory tool developed in a collaborative effort by the Department of Biosystems and Agricultural Engineering and the Kentucky Agriculture Weather Center at the University of Kentucky uses real-time data from the Kentucky Mesonet system, now in 69 counties, to produce a summary of average weather conditions (temperature, relative humidity, and wind conditions) for the previous 48 hours, and forecasts conditions for the coming 24 hours. Growers select their county, and the advisory summarizes weather conditions for that specific location and advises opening and closing ventilators, and in extreme conditions, adding supplemental ventilation or moisture. The advisory, which is available during the curing season from mid-July through the end of October, can be accessed at http://weather.uky.edu/burley_curing.html.

One-tier field curing structures with plastic covers normally have plentiful air movement through the tobacco, thus curing as well as the natural weather allows. Such structures should be placed downwind from fencerows or similar wooded areas to give protection from strong winds that can damage the plastic covering and tobacco. Plastic or other covering should be applied over the hanging tobacco before a significant rainfall and maintained throughout the cure for protection from rain and wind damage.

Dark Air-Cured Tobacco

Dark air-cured tobacco is cured essentially the same as burley, but because of the heavier body of dark tobacco, it is more prone to sweat, houseburn, and mold. Barns are used for dark air-cured tobacco, as one-tier field curing structures are not currently recommended due to increased potential for weather and wind damage. Barns used for dark air-cured tobacco are usually somewhat less open than many older barns used for burley, but still have workable ventilators to allow for adequate air flow. Under warm conditions (mean daytime temperatures above 80°F and mean nighttime temperatures above 60°F), barn doors and ventilators should be open during the early stages of curing to promote airflow through the tobacco. If warm, moist weather conditions prevail after housing, it may be beneficial to use some type of heat to aid the curing process. Heat may also be necessary following late harvests if cool (mean daytime temperatures below 65°F), dry conditions persist after housing. Heat sources that can be used include gas burners, coke stoves, or even small wood fires ("open-firing") using dry wood that produces little smoke, such as sycamore. For dark air-cured tobacco, it is extremely important that these heat sources be virtually smoke-free so as not to leave any, or very little, smoke residue on the leaves. Barn temperatures during heating should be kept low (not exceeding 90°F), as too much heat can cause excessive drying (Bailey 2006a). Growers should be aware that the use of heat in dark air-cured tobacco can be of benefit in the situations described above, but heat in dark air

curing is not a necessity. Dark air-cured tobacco harvested by mid-September in western Kentucky is normally exposed to the best curing conditions and should not require the use of heat. Dark air-cured growers should refer to contract specifications and recommendations and comply if there are any restrictions against the use of heat during curing.

Dark Fire-Cured Tobacco

The fire-curing process for dark tobacco can be broken down into four phases: yellowing, color setting, drying, and finishing.

Although fire curing is still more art than science, with many slight variations in practices, the following are some basic, general guidelines for these phases:

Yellowing. The degree of yellowing that occurs in the tobacco before fires are started will affect the color of the cured leaf. Tobacco should be allowed to yellow as much as possible without heat, managing ventilators carefully to prevent houseburn and sweating. Firing should begin when yellowing is nearly complete (yellow spots appear or most of the leaf lamina has reached a solid yellow color). This usually occurs five to eight days after housing. Initial fires should be around 100°F. Fires that are too hot too soon will cause "bluing" of the tobacco, which results in a crude, green color that will remain after curing is completed. Top ventilators are usually left open during this phase of curing, and fires are mostly smoke with low heat.

Color Setting. When yellowing is complete and the entire leaf lamina is a solid yellow color with little or no brown color, temperatures are increased with additional fires to set leaf color. Ventilators are usually closed, and temperatures should be kept between 100°F and 115°F. These conditions should be maintained until the leaf shows a solid brown color. Depending on tightness of the barn and weather conditions, color setting may be done with one firing or may take two successive firings over a seven- to 14-day period. Ventilators should be opened completely between firings to allow the tobacco to obtain some order before refiring. When the tobacco has a clear, solid brown face and the stems are dried and browned one-half to two-thirds up the leaf, it is time to complete drying.

Drying. Tobacco is brought in order, ventilators opened, and heat increased until the midribs are completely dried down and darkened. Heat during the drying phase should not exceed 130°F. When drying is complete, very little or no green pigment should be left in the stalks; tobacco should shatter when touched, and no puffiness or "fat stems" should be present in the leaf midrib near the stalk. Puffy stems that remain after the drying phase will not easily be dried down during the finishing phase.

Finishing. After the midribs and stalks are dried and darkened, temperatures are reduced to no more than 120°F, and smoke volume is maximized to add "finish" to the leaf surface. The finishing phase usually requires one to two slow firings over a 10- to 14-day period but may vary depending on the amount of finish desired by the buyer. Tobacco takes finish much better when in order, so ventilators should be opened for several nights prior to finishing to allow moisture to enter the barn. Finishing fires should contain minimal slabs and heavy sawdust to maximize smoke with little or no ventilation. The sawdust, barn floor, and walls may be dampened to produce a moist smoke that will help keep the tobacco in order longer to increase finish.

Firing Materials and Methods

Hardwood slabs and sawdust are the traditional firing materials used for dark fire-cured tobacco. Seasoned hardwood materials are preferable, since they tend to burn more slowly and evenly than softer types of wood. Evergreen wood species should be avoided, as they contain resins that can impart off-flavor and aroma to the cured tobacco. Materials, such as sulfur or salt, should not be used in the yellowing or drying phases, and other materials, such as molasses or brown sugar, should not be used during the finishing phase to increase finish in the cured leaf. Where these materials are used, the result may be tobacco that is excessively sticky and difficult to handle or not usable by the industry because of off-flavor.

With traditional fire-curing, initial fires during yellowing and color-setting usually consist of slabs being placed in narrow rows on the floor of the barn and covered completely with sawdust, except for a small opening exposing slabs on alternating ends of each row where fires are started. Slabs should be overlapped so that fires will burn continuously to the end of each row. Later firings during the drying phase require increased heat, and slabs may be stacked higher and in wider rows or beds or placed solid throughout the floor of the barn with sawdust covering the slabs.

Fires may be started on one or both ends of rows. Fires started on one end of a row will burn slower, whereas fires started on both ends will burn faster and hotter. Finishing fires usually have minimal slabs placed either in rows or solid with increased amounts of sawdust to produce maximum smoke volume. Hardwood chips may also be used in combination with sawdust during later firings to help fires burn more slowly with increased smoke volume (Bailey 2006b).

Good quality sawdust is the most important material used in fire curing. The sawdust over the slabs acts as a damper to allow for a smoldering fire with little or no open flame. Excessive open flames are more of a fire hazard to the barn, and result in excessive temperatures and increased levels of NO_x gases, which may contribute to increased TSNA formation (see TSNAs in Burley and Dark Tobacco on page 64).

The dark-fired tobacco industry is dependent on the sawmill industry to provide an adequate supply of slabs and sawdust for fire-curing. This dependence has resulted in increased prices for these firing materials in years when the sawmill industry is slow, causing shortages of these materials, particularly sawdust. The coarse sawdust from circular sawmilling is much preferred for use in fire-curing. Although there have been times when fine sawdust from band saw mills seemed more plentiful, the coarser circular sawdust is always preferred. Band sawdust is much finer and may also have much less uniform particle size than the coarser circular sawdust. The finer band sawdust also has somewhat different burning qualities than the coarser circular sawdust. It has been observed that the finer band sawdust may tend to cake more, allowing the fire to tunnel under the sawdust, preventing some of the dampening effect of the sawdust on the slabs and increasing temperature and open flame in fire-curing barns. It has also been observed that the finer band sawdust may also tend to allow burning on top of the sawdust. The finer band sawdust can also be more difficult to wet prior to use in fire-curing barns, and when wetted over the top of rows in the barn, only contributes to more caking and more tunneling of the fire underneath the sawdust.

Wetting piles of band sawdust for 1 to 2 days prior to loading in the barn is recommended if dry band sawdust must be used. Growers using the finer band sawdust should use extra caution when firing and those supplying sawdust to growers should be aware that circular sawdust is much preferred.

In the past few years, several buyers of dark-fired tobacco have asked growers not to fire the tobacco as many times as they had been in the past. This preference for less firing is likely an effort to reduce the amount of benzo[a]pyrene (BaP) present in the cured leaf. BaP is a carcinogen that is particularly high in dark fire-cured tobacco due to the curing process. Research has shown that, in general, more firing results in increased BaP. To limit BaP formation, tobacco should be fired only until midribs are sufficiently dry. Contrary to traditional firing methods, growers should now avoid additional firings just to add more finish to the leaf.

Double-Crop Curing Dark-Fired Tobacco

Double-crop curing refers to curing two crops of dark-fired tobacco in the same barn and season. Double-crop curing requires additional planning and management for both the field and curing barn compared to conventional single crop curing. It generally takes six to seven weeks to fire-cure a crop of dark tobacco by conventional means. This time frame can still be applied to the later second cures in double-crop curing, but the first cure needs to be fired more aggressively, so that it can be taken down in no more than four to five weeks to allow timely harvest of the second cure. The two cures need to be harvested about five weeks apart, so they should also be transplanted about five weeks apart. First cures should be transplanted as soon as possible, ideally May 1-15. Second cures should be transplanted June 5-20. If this time frame is followed, first cures will be ready for harvest in mid- to late August, and second cures can be harvested in late September to early October.

The most critical part of double-crop curing is the aggressive firing of the first cure. Whereas the first fires for single crop cures are not usually started until around seven days after housing, first cures for double cropping usually need to be fired sooner to stay on schedule. Fires for single-crop curing can be allowed to go out for a few days between later fires after color is set in the lamina, possibly allowing the tobacco to come in order a bit so it will take finish better. Double-crop first cures, however, need to be fired almost continuously, with little or no delay between firing to stay on the four- to five-week schedule. Artificial moisture will almost certainly have to be used to takedown first cures in a timely manner. This moisture can be added with overhead misting systems built into the top of the barn so water can be applied over the top of the tobacco or by applying steam up into the tobacco from the barn floor. Sidewall misting systems can also be installed to help in wetting the floor of the barn for ordering tobacco, and can also be used to cool fires that become too hot during curing. Most dark-fired crops will need two applications of misting or steaming to stabilize moisture in the leaf to allow takedown. Caution should be used with any artificial moisture source to prevent tobacco from getting too high in order. Steam or mist only enough to allow the tobacco to be taken down. Additional steaming or misting to allow stripping can be done later on the wagon if needed (Bailey, 2007).

As stated previously, traditional fire-curing methods involve laying (3- to 4-foot wide) rows of hardwood slabs covered with sawdust perpendicular to the length of the barn. One end of each row is lit for a slower, lower-heat fire during early stages of curing, while both ends of rows are lit for higher heat for drying. This process is repeated two times or more, with each firing event lasting between 5 and 10 days.

Recently, larger growers have begun to use higher volumes of wood and sawdust during curing to allow the process to be completed in only two firings. Slabs covered with sawdust are laid in beds 5- to 6-foot wide or more that run parallel with the length of the barn. Heavier volumes of sawdust are placed over the slabs than in traditional curing methods so that fires last longer. Several fires are lit in each bed and may burn for up to 14 days. Research has shown a 39% savings in wood curing materials used with this high-volume firing method compared to traditional fire-curing in a first cure (early crop) (Table 1). Second (late-season) curing typically requires more wood consumption in order to maintain desired barn temperatures as outside temperatures are colder during late-season curing. However, savings in wood consumed was still 16% with high-volume fire curing compared to traditional fire curing of a second (late) crop.

Using Fans in Conventional Air-Curing Barns

High-volume ventilation fans can be used in conventional barns to aid air circulation and improve curing. When using fans to aid curing, make the air pass through the tobacco rather than just circulate around the driveway or gable space. You also need to move enough air to justify your effort in using the fans. Most fans in the gable end of conventional barns are too small to do much more than short-circuit air through nearby wall and eave cracks. Fans at ground level in driveways or doorways need to have means (boards, etc.) to direct and/or deflect air up through the tobacco for more effective results.

The most efficient and effective method of using fans in conventional air-curing barns with numerous openings around the

Table 1. Comparison of wood consumption in traditional and high-volume fire-curing methods, Univer-sity of Tennessee Highland Rim Research & Education Center, Springfield TN, 2015.

	Fire-curing Method	
	Traditional Fire-curing (rows)	**High-volume Fire-curing (beds)**
First (Early) Cure:		
Number of firings	3	2
Total Weight of slabs used per cure	4495 lbs	3226 lbs
Total weight of sawdust used per cure	5226 lbs	2686 lbs
Total cured weight of tobacco	1500 lbs	1500 lbs
Cured tobacco:Wood ratio	1:6.5	1:4
Wood savings		39%
Second (Late) Cure:		
Number of firings	6	2
Total Weight of slabs used per cure	7613 lbs	7000 lbs
Total weight of sawdust used per cure	8058 lbs	6162 lbs
Total cured weight of tobacco	1500 lbs	1500 lbs
Cured tobacco:Wood ratio	1:10.4	1:8.8
Wood savings		16%

eave, walls, and doors is to place good quality, belt-driven ventilation fans horizontally in the center, bottom rail of every other bent. This placement pulls any humid, stagnant air through the mass of tobacco from above and around the fan and blows it directly toward the ground. Thus, air is moved through the central core of the tobacco where moisture problems generally first occur. To prevent damage by the fan, sticks of tobacco are omitted directly above the fan and plants are moved sufficiently away from the sides. Leave the side ventilators or other doors open to allow the ground-level, moist air to migrate out of the barn and fresh, drier air to come in around the eave, through the sidewall vents, and through the tobacco.

For beneficial curing results, fan capacity should be 12,000 to 18,000 cubic feet/minute of 0.1-inch static pressure-rated airflow for every two bents of 32- to 40-feet-wide barn. This means good quality fans of 42 or 48-inch diameter; one-half, or three-fourths hp should be suitable for the above circulation method in conventional barns, depending on barn size, amount of tobacco, and the effectiveness of air movement you desire. Details on fan selection and location are given in a separate publication (Duncan, 1992).

Operate the fans 24 hours a day during rainy or humid weather and/or daily during the first two or three weeks of curing when the tobacco is still green or yellow and contains turgid stalks and stems. After about three weeks, the fans may be operated only during the day to dry the tobacco as needed and turned off at night to avoid bringing in moist air. Time clocks can be installed to automatically power the fans on and off each day.

Don't operate the fans during cool, dry weather (below 50 to 60°F and below 60 to 65% relative humidity) when the tobacco still has green or yellow color in the leaves, as over-drying and off-colors can result.

When planning to use the electrically powered fans in conventional barns, carefully check the existing electric wiring and service entrance components. Many barns have been wired for only driveway or stripping-room lights and do not have enough capacity to operate fan motors. Damaged and burned-out wiring or motors can quickly result from insufficient electrical service capacity. Have a local electrician or utility company representative help you check your electrical circuits.

Tobacco Stripping Rooms

A good stripping room is very helpful for the stripping and market preparation tasks for most producers. Some producers strip early in the fall in the barn driveways, using wagons for the stripping work area. Others can get by with temporarily enclosing a portion of the barn with plastic, tarps, etc., using an improvised or fold-up workbench and portable vented heater or stove, or they can haul the unstripped tobacco to a more suitable location. The advent of the big baler for burley baling requires greater space for the baler, a supply of unstripped tobacco, and the accumulation of stripped tobacco. As a baler is being filled with 550 to 750 pounds of one tobacco grade, the additional leaf grades stripped from the plants must be stored somewhere. Such storage can be avoided only by operating multiple balers at a greater cost.

Heated workshops or garages can serve as temporary stripping areas. Likewise, any permanent stripping room can also serve as a workshop or storage area the rest of the year, if suitably arranged and conveniently located. Features to be considered for a stripping facility include:

- Workbench of proper width and height (see website below) or appropriate mechanical stripping aid
- Overhead lighting with shatterproof shields
- Adequate space for workers bringing in stalk tobacco, baling equipment, and removing the bare stalks
- Doorways large enough to accommodate the tobacco handling equipment and personnel
- Heating equipment (with proper exhaust venting) for warmth in cold weather
- Electricity for the lights and power equipment needs

Blueprints available from the BAE website show typical construction of traditional stripping rooms https://www.uky.edu/bae/content/tobacco-plans#room. Some possible layouts of larger stripping rooms for the big baler operation are also shown on the site https://www.uky.edu/bae/sites/www.uky.edu.bae/files/StrRmLys.pdf). Benches should be 32 to 36 inches high and 48 to 60 inches wide for one side stripping or double width for workers on both sides. The top surface of the benches should be slatted wood or heavy wire mesh with half-inch crack openings that allow fine particles of trash and debris to fall through. Dual-chain stick conveyors (stripping chains) that move sticks past workers for hands-free stripping with no bench have become very popular among dark tobacco growers. However, these stick conveyors require additional space that needs to be considered in stripping room design.

Overhead lights should be multiple-tube fluorescent fixtures with a reflector shield, protective mesh grid, and equal numbers of cool white and daylight type tubes per fixture. These tubes provide a good, economical light source to see the tobacco color and grade qualities while stripping. Each tube should also have a shatter-guard cover to protect the tobacco from glass contamination should a tube shatter. Special lights with a more balanced daylight spectrum and quality of light are other options.

Another consideration for stripping room design is efficient removal of tobacco stalks from the stripping room after tobacco leaves are removed. Moving bulky tobacco stalks out of the stripping room to a wagon or spreader, and then spreading the stalks on a field takes additional labor and time. Some large tobacco operations are beginning to experiment with stalk choppers set up just outside the stripping room where stalks can be placed in the chopper through an opening in the wall. A demonstration of this can be found at: https://www.youtube.com/watch?v=FOLj9JEBiUs

Tobacco stripping rooms should be kept free of trash and other foreign matter that could contaminate the tobacco. Tobacco buyers have no tolerance for non-tobacco-related material (NTRM). NTRM contamination of tobacco is most likely to occur during stripping, so cleanliness of stripping rooms is very important. Any NTRM should be removed from the stripping room before stripping begins, and workers should take breaks and deposit trash in an area separate from the stripping room. Care should be taken to avoid contamination from petroleum products, or chemicals stored in shop areas that double as stripping rooms and market preparation areas.

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