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Pallet Rack Structures for Curing Burley Tobacco

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Introduction

Curing facilities for housing tobacco can be expensive. However, using pallet racks for suspending stick tobacco, a recently developed technique for curing burley tobacco, can offer tobacco growers an alternative that substantially reduces long-term investment.

Metal pallet racks, commonly used in warehouses and large retail stores, are sometimes available as surplus. They consist of horizontal rails that snap into vertical uprights to form a rigid structure. Each set of uprights and pair of rails make a section on which sticks of tobacco can be hung. When adjacent sections are connected by horizontal spacers, additional rows of stickered tobacco can be hung between sections (Figure 1). Depending on the height of the sections, multiple tiers of tobacco can be hung per section.

Single-tier configurations are mainly used when the structures are sited in the field, as their lower profile makes them less vulnerable to wind. Configurations that are two or three tiers in height can be used in more protected areas, such as barn driveways or equipment storage sheds (Figure 2).

Using pallet racks has several potential advantages, including the following:

- They can be erected quickly, reducing labor costs and making it easy to expand curing capacity at the last minute.
- They are much easier to disassemble than most other structures, so the space used for tobacco curing can be cleared for other uses during the off-season.
- The disassembled racks take up less space than most other types of racks or structures used for hanging tobacco.

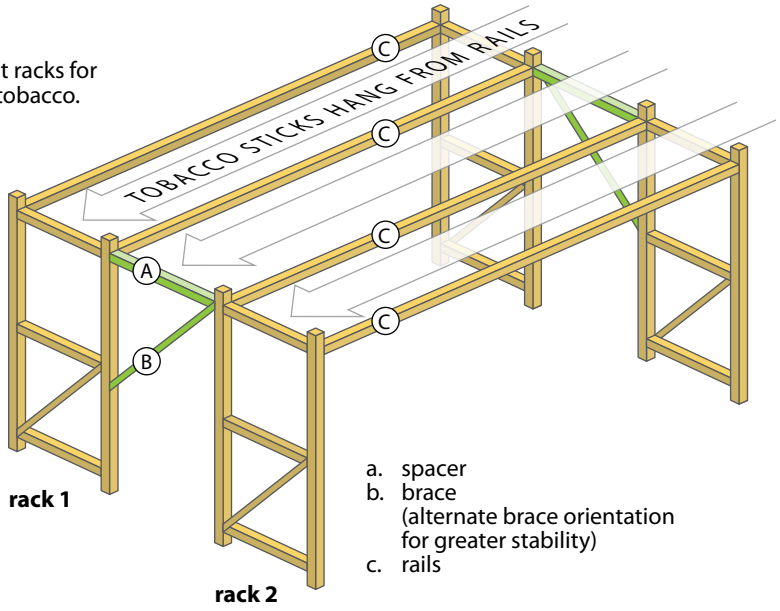


Figure 1. Pallet racks for hanging stick tobacco.

Two pallet racks can be joined with spacers and braces to create a three-stick-wide structure.

- The components are made from industrial steel, so they can be long lasting, especially if they are well-painted or are disassembled and stored out of the weather during the off-season.
- The rack materials will retain a significant portion of their value if a producer does not need them again. At the very least, they can be sold for scrap metal, but they could return more money through the market for used pallet racks or if sold to another tobacco producer.

This last advantage may be the most important one of all, as pallet racks offer an alternative that does not require such a long-term commitment to tobacco.

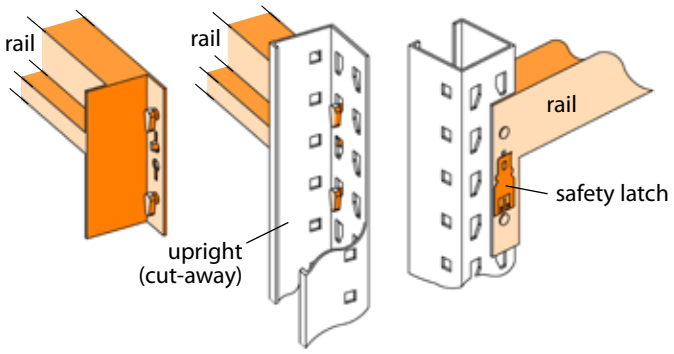
Figure 2. A two-tier pallet rack used in a tobacco barn driveway. (Note: diagonal bracing not visible.)

Pallet Rack Components

The pallet rack rails are typically 10 or 12 feet long and have two or three tabs on the ends. These tabs wedge into tapered holes on the uprights and lock into place to form a rigid connection (see Figure 3). The uprights, which are from 36 to 48 inches in width, have pads attached to the bottom and are connected by both horizontal and diagonal braces to give rigidity (Figure 4). As mentioned previously, spacers can be used to bolt multiple sets of uprights and rails together to create additional rows (Figure 1). Spacer length can range from 36 to 48 inches. The 48-inch length leaves less tobacco stick overhang, but it allows the plants to be spaced farther apart on the stick when they are hung, reducing the chance for rot in the middle sections of the structure during wet curing seasons.

Spacers can be made from many different materials. One of the least expensive ways to make a spacer is to use 1-inch steel electrical conduit with bolt holes drilled through flattened ends (Figure 5). Another option is to use lengths of standard steel strut C-channel (0.5 inches x 1.5 inches), available for use as electrical conduit support. Spacers should also be bolted between pallet rack sections diagonally to provide better stability (see "Structure Stability").

Figure 3. Rail ends attach to uprights and secure with a safety latch.



Pallet Racks for a Field Structure

Size and Labor Requirements

Pallet racks have been most frequently set up in three- or five-stick-wide configurations for a field use, with five-wide structures more efficiently using the pallet rack components. Sticks of tobacco are hung in the racks in essentially the same manner as hanging stick tobacco in any field structure (Figure 6). Table 1 shows labor requirements for hanging stick tobacco in both three- and five-wide structures, based on observations at two farms. The labor requirements were comparable to the 14 worker-hours/acre reported for other field structures (Duncan et al., 2005) and slightly more than half the 26 worker-hours/acre reported for hanging tobacco in traditional multi-tiered barns (Nutt et al., 1990). Workers tended to hang the three-stick-wide structure passing all the sticks from one side. For the five-stick-wide structure, they hung three sections from one side and the remaining two sections from the opposite side. Observations at both farms were made the first time the workers had ever used pallet rack structures. Labor requirements would probably decrease as workers get used to the system and refine their methods.

Table 1. Labor requirements for hanging stick tobacco in pallet rack structures.

Farm	No. of Sticks Wide	Total Time	No. of Sticks	Worker-Hrs/ Acre*
1	3	4.13 hr	300	16.5
	5	6.42 hr	563	13.7
2	3	4.47 hr	360	14.9
	5	5.65 hr	459	14.8

* Based on 1,200 sticks per acre.

Figure 4. Pads attached to the bottom of uprights.

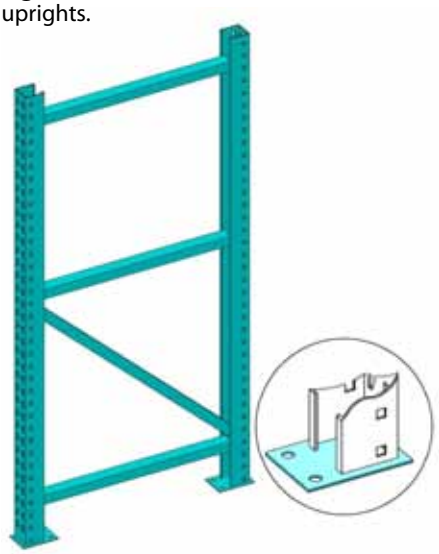


Figure 5. Spacers and braces made out of electrical conduit and standard steel strut C-channel to connect pallet rack sections.

Covering with Plastic

Pallet rack field structures are covered with plastic in the same way as other field structures, so there is the issue of whether to peak the plastic in the middle or leave it unpeaked. Unpeaked plastic will pool water on top, which can help hold it down in the wind. However, the plastic is likely to be torn by the sharp end of stalks, and it has to be removed before the tobacco can be taken down to strip—a process made harder by any standing water. Peaked plastic, on the other hand, promotes water drainage and allows the cured tobacco to be taken down without removing the plastic.

A low-cost way to provide a peak is to stretch high-tensile wire on top of vertical boards attached to the center of the structure. Wooden frames can also be made to fit into the top of the pallet racks for peaking the roof (Figure 7). Additional wood framing can be added to wider structures so that nailing strips can be used to help protect the plastic from wind damage—more likely because of the structure's greater span (Figure 8).

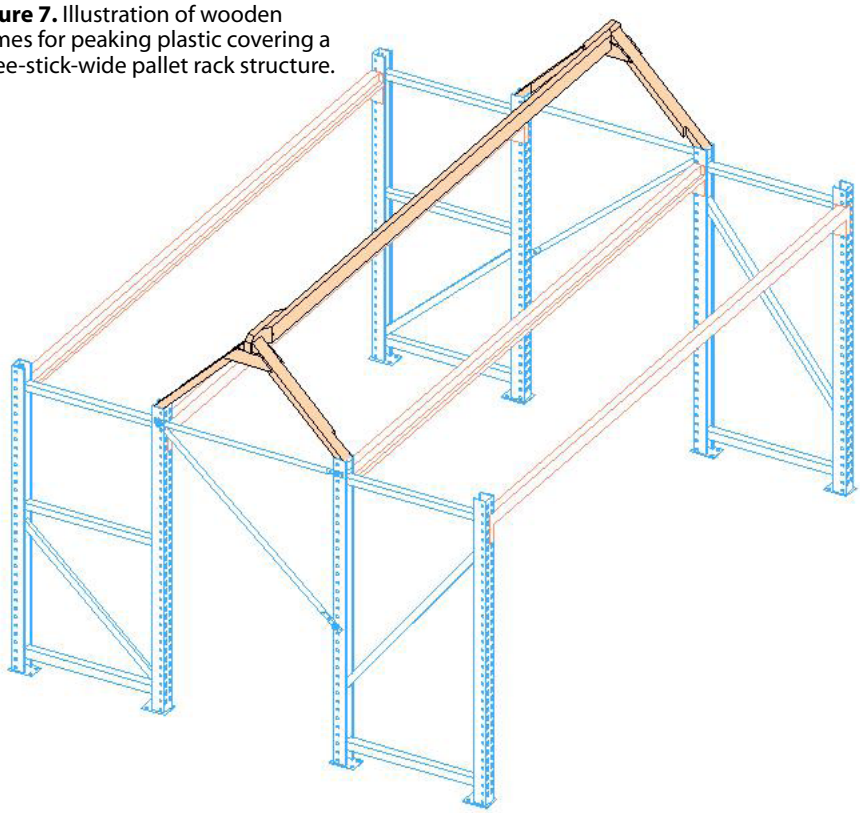
A three-stick-wide structure with a peaked roof covered with plastic is shown in Figure 9. A five-stick-wide structure with peaked roof covered with plastic is shown in Figure 10. Secure plastic using the same supplies you would use with a wooden curing structure. Additional twine may be needed to tie down the plastic because nailing strips can't be used on metal racks.

As with plastic covering on any field curing structure, it can be hard to keep the plastic from tearing and pulling off in strong winds. Securely tie down the plastic, using multiple lines of crisscrossed twine to help hold it down. Materials added to blunt or cover sharp corners can help reduce tearing of the plastic (see Figure 6).

Growers have reported some cases of tobacco rotting in the center of five-stick-wide pallet rack structures. Resist the temptation to pack the tobacco too tightly in these structures, just as when curing in barns or other field structures. Spacing tobacco sticks approximately 6 inches apart (or 25 sticks per 12-foot rail) generally has given good results. Five-stick-wide structures are probably more likely than three-stick-wide ones to experience rot because it's hard to get enough air movement in the middle section. Plastic along the sides should be kept in a raised position as much as possible when it's humid to encourage increased air movement and reduce the chance for rotting.

Figure 6. Hanging stick tobacco in a pallet rack structure.

Figure 7. Illustration of wooden frames for peaking plastic covering a three-stick-wide pallet rack structure.



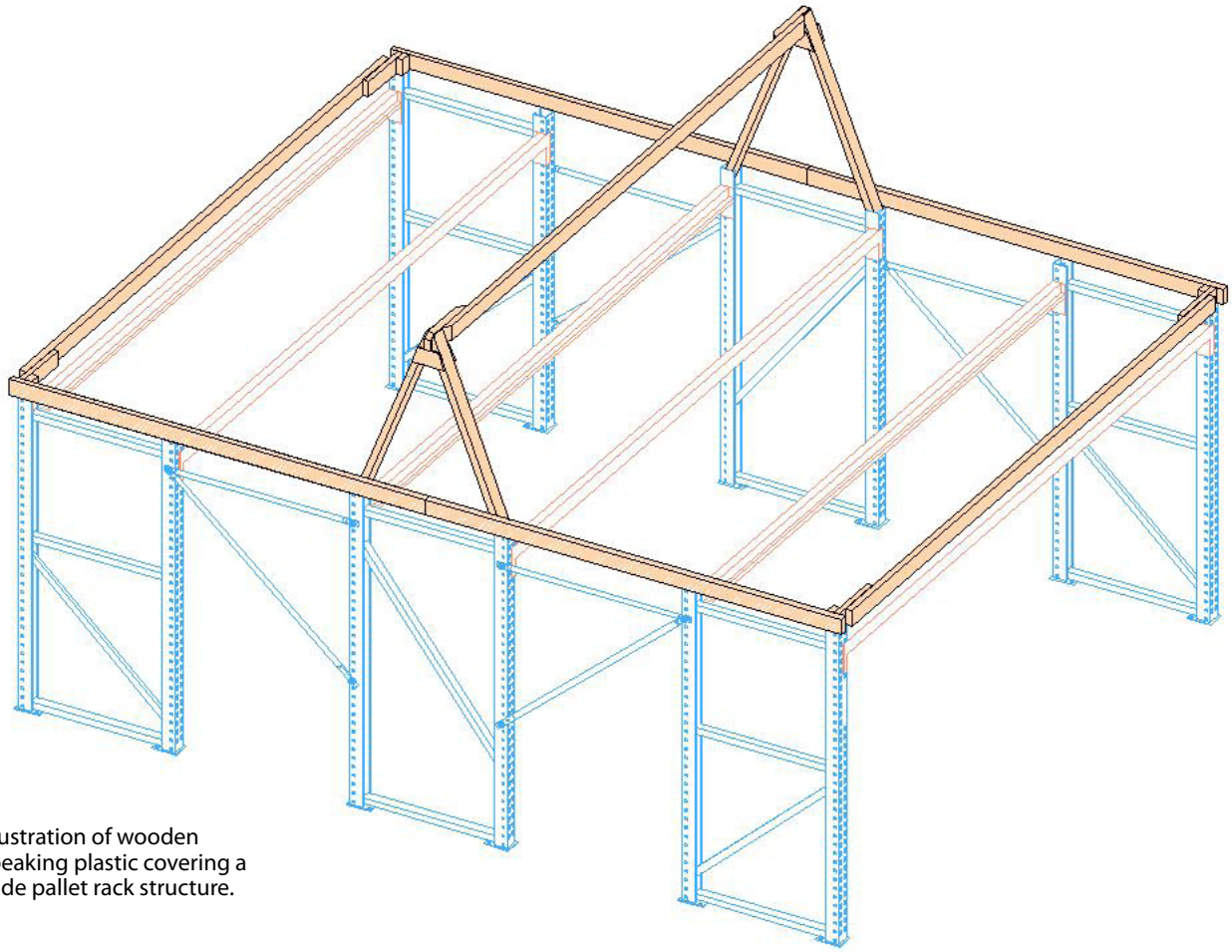


Figure 8. Illustration of wooden frames for peaking plastic covering a five-stick-wide pallet rack structure.

Figure 9. A three-stick-wide structure with peaked roof covered with plastic. The structure is 10 feet wide; the plastic covering is 16 feet wide.

Figure 10. A five-stick-wide structure with peaked roof covered with plastic. The structure is 17 feet wide; plastic is 28 feet wide, although 24 feet probably would have been enough.

Costs

The costs for three- and five-stick-wide pallet rack field structures for curing approximately 1 acre of burley tobacco (excluding the cost of a plastic cover and assembly labor) are shown in Tables 2 and 3. These costs were estimated based on assumed prices of $30 per 6-foot upright and $25 per 12-foot rail, a curing capacity of 25 sticks per section, and 1,200 sticks of tobacco per acre. For three-stick-wide field curing with pallet racks, two separate structures eight sections long were assumed for 1 acre of curing capacity, so the structures were not too long (see "Structure Stability"). For five-stick-wide field curing with pallet racks, a single structure 10 sections long was assumed. This size actually has a capacity of 1.04 acres, so the total cost was adjusted to a 1-acre basis.

The estimated cost of the five-stick-wide structure, $2,754/acre, was only slightly lower than that of the three-stick-wide structure at $2,970/acre. Given the likely increased risk of rot in the center of the wider structure as well as the more substantial wooden framing required to peak and secure the plastic with the wider span, the five-tier-wide structure may not be justified.

Structure Stability

Some failures have occurred with these structures, so stability is critical. The potential failures include collapse due to wind loads, sinking legs, and buckling of uprights from heavy tobacco loads. To stiffen the racks to prevent them from toppling, use diagonal cross-bracing and horizontal spacers to connect the rack sets (Figure 1). The horizontal spacers should be attached at rail level at every upright, and diagonal spacers should be bolted to at least every other set of uprights. To provide stiffening in both directions, the orientation of the diagonal braces should alternate, as shown in Figure 1.

Figure 11. Wooden pads, approximately 6 inches x 6 inches, placed under pallet rack uprights that lack attached metal pads.

All the uprights must have diagonal bracing welded in place to eliminate the chance of buckling. The uprights also should have metal pads attached to the bottom so they will not sink into soft ground, which can make the structures less stable. Both diagonal bracing and metal pads are illustrated in Figure 4. Although upright sections are manufactured with diagonal bracing and pads already attached to the bottom, if you have uprights lacking these features (if uprights were cut down from taller units), you should contact the original supplier about modifications, especially the addition of the diagonal bracing. The lack of pads can be overcome by placing small wooden pads (approximately 6 inches x 6 inches) under the uprights (see Figure 11).

One final precaution—To minimize the chance of failure of a pallet rack structure used for tobacco curing, don't make it either too large or too small. Individual structures should be limited to no more than eight to 10 sections, as the collapse of a single section can cause attached sections to go down as well. Making the structure too small may allow strong winds pulling on the plastic cover to lift the entire structure. Structures that are less than four to six sections may be too light to resist strong winds and should be anchored with twine tied to stakes driven into the ground. This technique has been tested with moveable curing frames (Duncan et al., 2005). Also, orient structures so they are not broadside to the prevailing wind and are sheltered from it by fencerows or other obstructions.

Other Applications

Taller pallet rack sections have been used for inside tobacco curing—in hoop barns or equipment storage sheds, for example. Two-tier pallet racks used in a tobacco barn driveway are shown in Figure 2. Because of the higher center of gravity, taller pallet rack sections should have diagonal bracing to improve their stability. (Note: diagonal bracing is not visible in Figure 2.)

Table 2. Estimated costs for three-stick-wide pallet rack structures.

Structure Components	Unit Price	# Units	Total Cost
Uprights (6 ft high)	$30	36	$1,080
Rails (12 ft long)	$25	64	$1,600
Spacers	$3	27	$81
Lumber			$176
Hardware/fasteners			$33
Total cost for 1 acre			$2,970

* Excluding cost for plastic cover and assembly labor. Assumes a 25-stick capacity per rail and 1,200 sticks of tobacco per acre.
Note: Two structures, eight sections each.

Table 3. Estimated costs for five-stick-wide pallet rack structures.

Structure Components	Unit Price	# Units	Total Cost
Uprights (6 ft high)	$30	33	$990
Rails (12 ft long)	$25	60	$1,500
Spacers	$3	28	$84
Lumber			$250
Hardware/fasteners			$40
Total cost for 1.04 acre			$2,864
Total cost for 1 acre			$2,754

* Excluding cost for plastic cover and assembly labor. Assumes a 25-stick capacity per rail and 1,200 sticks of tobacco per acre.
Note: One structure, 10 sections.

Another possible application is to outfit pallet racks with wire mesh panels for hanging notched tobacco plants that has been harvested mechanically (Figure 12). Preliminary trials conducted by the UK Department of Biosystems and Agricultural Engineering indicated that these panels work satisfactorily provided that they are well-secured to the rails. However, pallet racks outfitted with these panels will be much harder to dismantle and therefore considerably less portable.

Summary

With care, pallet racks can be used effectively for hanging stick tobacco, whether in field structures or inside buildings. They also can be useful for hanging mechanically harvested, notched tobacco. Pallet racks are not a particularly low-cost option for burley tobacco curing. However, they could be an appropriate choice because of their ease of assembly/disassembly and especially because of their resale value—a plus for growers who, with uncertainties in the tobacco industry, want to expand curing capacity but are reluctant to make a large capital investment with a long payback period.

Figure 12. Pallet racks outfitted with wire mesh panels for hanging notched tobacco plants that have been mechanically harvested.

References

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