Flue-Cured Tobacco Producers Guide to Preparing for and Recovering from Hurricanes in the Southeastern U.S.

This guidance is applicable to the following states:

- Florida
- Georgia
- South Carolina
- North Carolina
- Virginia

This section will focus on:

- Greenhouse Security
- Harvest Management Decisions
- Standby Power Equipment for Curing Barns

I. Pre-Hurricane Planning – Long-term Preparedness

Measures taken to protect managed land from hurricanes expected to come in months or years (i.e., the coming hurricane season and future hurricane seasons)

Initial Site Planning *(include action items that should be implemented when initially planning a site for production)*

- Farm operations must compare the cost of standby power equipment to the potential financial loss and inconvenience resulting from extended power outages. Any standby power capacity must be adequately sized for a given number of curing barns. Farm operations should consult with their electric utility provider and electrician for assistance with selecting standby power units.

- The first factor in determining the generator capacity is the size and nature of the load. The fan motor is the largest electric load in a curing barn. An electric motor is also an inductive load that can require three to five times their rated full load current while starting. The larger starting loads of electric motors *must* be taken into consideration when calculating the total electrical load. The starting and full-load running power requirements for various size single-phase motors are included in Table 1. Fan electric motor sizes are typically, 10, 7.5, or 5 hp. If you are unsure, look at the electric motor nameplate to confirm the size or consult the barn manufacturer.

  The second factor to consider is whether all or only part of the barns will be operated at the same time. The total required generator capacity may be substantially reduced if part of the load may be switched off temporarily. Situations where motors start automatically are particularly problematic because, sooner or later, several motors starting at the same time will place a huge overload on a system. Taking steps to prevent simultaneous starting of motors or load management can reduce the required capacity and prevent overload.

- Generator (Alternator) are rated by their power output, measured either in watts or kilowatts (kW). Most alternators are rated in kilowatts (1 kilowatt = 1,000 watts). Some alternators have substantial overload capacity, although this additional capacity is always limited to short periods of operation. When two ratings are provided on the unit nameplate (for example, 10,000/5,000), the larger number is the short-term overload rating and the smaller number is the continuous-run rating. When selecting an alternator, carefully consider *both* the run capacity and the overload capacity. Some large alternators may be rated in kilovolt-amperes (kVA) or volt-amperes (VA). Their approximate power output in kilowatts may be determined by multiplying the kVA rating by 0.8. It is important that the engine or tractor selected be capable of prolonged operation at high output. The engine should also be capable of maintaining a very constant speed over a wide range of load conditions.

- Almost all electrical power used on farms is either 120- or 240-volt, single-phase, 60 hertz (cycles per second), but many larger size operations now operate on three-phase power. If properly connected, three-phase alternators may be used to power single-phase equipment, but three-phase equipment ***cannot*** be operated with single-phase power without expensive phase conversion equipment. The alternator selected ***must*** be able to produce power at the same voltage and frequency required by the equipment. The voltage should register at least 230 volts for a 120/240-volt service or 115 volts for a 120-volt service. Frequency should never be less than 57 hertz nor greater than 63 hertz. Deviations from these ranges can destroy the alternator and the electric motors.

- Stationary standby power units use an internal combustion engine coupled to a generator and are commonly referred to as a "generating set," or a "genset" for short. Portable engine-driven units may be driven by a small engine fixed to the generator or by the power take-off (PTO) of a tractor. Approximately 2.25 hp per kW of electrical power is required to properly run a generator, regardless of the generator type. For example, a 50 kW generator would require a tractor rated at least 113 hp (50 multiplied by 2.25). Tractor rated performance is typically measured at the PTO. Regardless of the generator type selected, make sure you and all employees that use the system read and understand all the manufacturer's recommendations on its safe operation. Contact your electrical utility provider before installing any generator.

- Here is an example using Table 1 to determine the generator capacity for 10 bulk barns with a 10 hp fan motor. A 10 horsepower motor requires 9 kW to run but 36 kW to start. Each motor is started in sequence, and then the last motor will be started while the previous 9 are already running. Then: 81 kW (9 times 9) + 36 kW = 117 kW required. The tractor PTO power needed is at least 264 hp (117 times 2.25). This demonstrates that multiple generators or a large capacity unit is required to operate all the barns at a large size farm operation.

Table 1. Starting and Full-Load Running Power Requirements for Various Size Single-Phase, 60 Hz Electric Motors.

Motor Size hp (kW)	Approximate Amps @ 240 Volts	kW Required	
		Starting	Running
1/2 (0.37)	5.0	2.3	0.6
3/4 (0.56)	7.0	3.4	0.9
1 (0.75)	8.0	4.0	1.0
2 (1.50)	12.0	8.0	2.0
3 (2.24)	17.0	12.0	3.0
5 (3.73)	28.0	18.0	4.5
7.5 (5.60)	40.0	28.0	7.5
10 (7.46)	50.0	36.0	9.0

- The National Electrical Code (NEC), the power utilities, and good sense require that any standby generator be connected to the load through a transfer switch. This piece of equipment is essentially a double-throw switch that prevents the accidental connection of the alternator and the power company to the load at the same time. The switch is designed so that either the alternator or the power grid is connected to the equipment but never both. Unless a transfer switch is used, power could be fed back onto the power line from the alternator, endangering those working to repair the lines. In addition, the alternator would be destroyed if the power grid were reenergized while the alternator was connected to the load. The switch must be rated to carry the highest potential current. Common sizes are 100, 200, and 400 amps. The purchase of a genset with automatic transfer equipment is a major investment and it is recommended to get professional assistance in designing and selecting such units.

- The wiring of standby power equipment, even when temporary, should always comply with the NEC (or any local code which may prevail) and be installed by a licensed electrician. Alternators should be well-grounded and positioned as close as practical to the loads to reduce the wire length. Every effort should be made to protect the lines from mechanical damage. Wire should be run over- head if at all possible. Where this is not possible, the lines should be buried.

Site Establishment

- Greenhouse construction sites should be in areas that are not prone to flooding and that are free of vegetation.
- Production fields should be well drained for tobacco production in general, which will aid in water removal following a hurricane.

Seasonal Considerations Outside of Hurricane Season

- Greenhouses should be inspected on a routine basis to ensure that structural integrity has not been compromised.

- Field maintenance is critical for maximized crop production and minimized effects of adverse weather. Field borders should be maintained to allow for sufficient drainage. For example, waterways and ditches should be managed accordingly to ensure that water removal may occur as quickly as possible.

Annual Considerations *(include action items that should be implemented on an annual basis)*

- Proper, timely maintenance is imperative to ensure any standby power unit is in good running order so it will be ready for immediate use when needed. Always be familiar with and follow the maintenance and safety instructions in the manufacturer's manual. To prevent carbon monoxide (CO) poisoning, never operate generators in any type of fully or partially enclosed structure.

- Standby generators should be operated periodically at least 50 percent of the rated load to be sure they are functioning properly.

- Units should be kept clean at all times. Accumulation of dust and dirt may cause a unit to overheat when operating.

- Units should be stored out of the weather, but not covered with a tarp because the covering would allow moisture to condense inside and potentially cause rust.

- All farm employees that might be involved with operating a standby power unit should be completely familiar with its set-up and trained annually on how to safely operate the equipment.

II. Pre-hurricane Planning – Short-term Preparedness

Measures taken to prepare for an existing hurricane that is forecast to make landfall in the next week or less

When a Hurricane Is Forecast to Impact Your Area (1 to 7 days before)

- Properly secure greenhouse infrastructure by closing the curtains and maintaining roof inflation. Roof inflation will help to provide uniform wind resistance across the entire structure.

- If roof integrity is questionable, or if wind speeds will compromise integrity, remove the greenhouse roof entirely.

- Secure all greenhouse doors and ventilation areas to improve wind resistance.

- Cover all greenhouse openings.

- Have a backup plan in case power is lost, as greenhouse inflation fans require electricity for operation. Most inflation fans use fractional horsepower (< 1 hp) electric motors. Electrical power requirements can be found on the motor nameplate.

- Remove all loose material from inside the greenhouse. Loose items can damage curtains and plastic coverings, which will reduce greenhouse integrity.

- Remove debris and unsecured items from outside the greenhouse.

One Day Before a Hurricane is Forecast to Impact Your Area

- Perform a final walkthrough of the greenhouse to ensure that previous security efforts remain intact.

- Strategically plan harvesting to minimize the number of barns that will be in the most critical curing phase for damage to occur if standby power equipment capacity is limited or not available. If capacity is available to operate all curing barns during a power loss, then harvesting can proceed until weather conditions limit accessibility. Worker safety must be considered the primary decision.

- The most critical period for damage to occur in the curing process is during late yellowing and early leaf drying (105 to 125°F dry-bulb / 95 to 105°F wet-bulb). Barns in this stage will require a constant power supply. Without the circulation of air to prevent the buildup of heat, the leaf temperature can increase significantly in a short period of time, resulting in widespread leaf damage. The damage might be minimized, especially early in the yellowing stage, if the tobacco can be cooled to near ambient conditions by opening all barn air vents and doors to allow heat to escape. If generator capacity is not available, tobacco that would be in this critical curing stage during an extended power outage might be better left unharvested. During leaf and stem drying phases, biological activity ceases, little or no heat is produced, and the tobacco can tolerate a much longer interruption of power without apparent damage. The damage that is likely to occur will be from the wicking of moisture back into the leaves from the still-moist stems.

- Barns that are at dry-bulb temperatures within 18 to 24 hours of completion (160°F to 165°F) may be able to tolerate several days without power with little apparent damage. If generator capacity is limited, a grower could by-pass barns near the end of stem drying and use the equipment to provide power to barns in the more critical curing stages.

III. Post-hurricane Recovery

Measures taken to assess and repair damage after a hurricane

Immediately After the Hurricane has Passed

- Call your power company or electric utility and report any outage, do not enter areas with downed power lines.

- As soon as it is safe, perform field inspections in order to best identify the areas where harvest can immediately resume, where damage is minimal, and where damage is greatest.

- Contact crop insurance adjustors for assessments.

- Remove standing water from fields to promote plant recovery from partial or complete drowning. Water is a concern due to flooding and/or saturated soil conditions that greatly reduce oxygen in the root system of the plant. The reduction or absence of oxygen produces wilting symptoms in the leaves making them more susceptible to sunscald if temperatures become excessive (>90°F) in the days following a storm.

- Where appropriate, re-initiate harvest as wind blown leaves will begin to senesce quickly when hurricanes arrive later in the growing season (Table 2, Figure 1). Leaf holding-ability is often compromised following extreme, late-season weather events due to the natural presence of the plant growth regulator known as ethylene – which hastens the ripening process. Research is limited that quantifies the impact of hurricanes to cured leaf parameters such as yield and quality; however, the best information available (which was collected following Hurricane Irene in 2011) suggests that the optimum window for harvest is seven to 10 days after the storm clears (Table 2). Cured leaf measurements (yield, quality, price, and value) were greatest when tobacco was harvested two days after Hurricane Irene (Table 2). Following the first harvest timing, remaining plots were subsequently harvested every 10 days, which is the approximate amount of time required to complete a curing cycle (fill, cure, bring into order, and empty). In the second harvest interval (12 days after Irene), cured leaf yield began to decline though not as rapid as the 22 and 32 day harvest intervals (Table 2). However, cured leaf quality, price, and value were significantly reduced relative to the 2 day harvest timing (Table 2). The reductions in quality and economic measurements are largely due to significant reductions in cured leaf quality that resulted from wind damage, which hastens the natural ripening process, as previously referenced. Cured leaf measurements continued to decline as harvest was delayed by 22 days and were lowest in the 32 day interval (Table 2). In addition to the numeric values presented in Table 2, cured leaf color provides a complimentary estimate of leaf quality. Overwhelmingly, leaf color was dominated by ripe to over-ripe grades of tobacco (F and K color descriptions) when harvest occurred two days after Hurricane Irene (Figure 1). When harvest occurred 12 days following Irene, Greenish (V) and Non-descript (N) grades account for 10% of the grade distribution, thus lowering both quality and price (Figure 1, Table 1). Further delay of harvest to 22 days after the storm system cleared increased N grades to 7.5% of the total and variegated, under-ripe grades (KV and KF) to 42.5% (Figure 1). In addition, F and K grades were reduced to 42.5%, which is a decline of 47.5 and 57.5% relative to the two previous harvest intervals. In the final harvest interval, N grades accounted for 92.5% of all grades received, with KV and K grades accounting for 5 and 2.5%, respectively. Ultimately, as harvest was delayed leaf deterioration and respiratory losses became more pronounced, with a large portion of leaves expiring prior to harvest. Figure 2 demonstrates how fast leaf quality can decline when a hurricanes strikes a mature crop.

Within a Week Following Hurricane Impacts

- Depending upon the severity of the hurricane, it is possible that harvest should conclude within seven to 10 days of the end of the hurricane. Discussion points for this recommendation are listed in the previous sub-section.

Within a Month Following Hurricane Impacts

- Reconstruct production areas to fill in washouts so that commercial crop production may normally resume the following season. Repair damage to greenhouse structure(s) to ensure integrity is maintained throughout the off-season.

Table 2. Upper-stalk position yield, quality, price, and value as influenced by harvest delay following Hurricane Irene in 2011[a,b].

Harvest Timing	Yield	Quality[c]	Price	Value
Days After Hurricane	**lbs./acre**		**$/lb.**	**$/acre**
2	1,658 a	90 a	1.83 a	3,033 a
12	1,583 ab	79 b	1.57 b	2,549 b
22	1,421 b	54 c	1.08 c	1,626 c
32	1,028 c	22 d	0.56 d	575 d

[a] Treatment means followed by the same letter within the same column are not significantly different at the $\alpha=0.05$ level.
[b] Results are pooled across the varieties PVH 2110, NC 196, GL 395, K 326, GF 318, CC 65, NC 299, NC 297, PVH 1452, and CC 35.
[c] Cured leaf quality is assessed on a scale of 1-100, with 100 being of the highest quality.

This guidance was developed by Dr. Matthew Vann (Extension Agronomist, Department of Crop and Soil Sciences) and Dr. Grant Ellington (Extension Agricultural Engineer, Department of Biological and Agricultural Engineering) in coordination with the North Carolina Cooperative Extension Service. The information contained in this publication is based on information from the 2019 Flue-Cured Tobacco Production Guide. Content review was provided by Dr. J. Michael Moore, University of Georgia Extension Tobacco Agronomist. Additional information can be found on the NCSU Tobacco Portal: http://tobacco.ces.ncsu.edu

Photographs

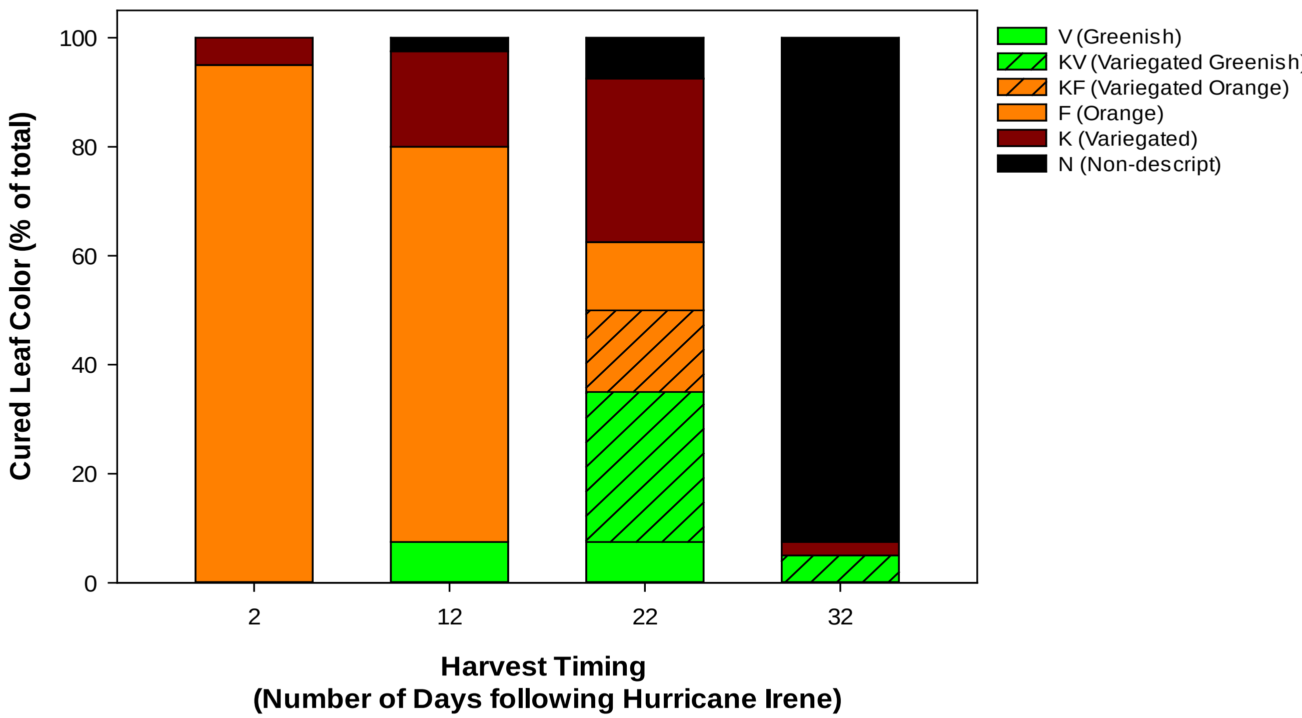

Figure 1. Upper-stalk cured leaf color as influenced by harvest delay following Hurricane Irene in 2011. Data are pooled across 10 varieties and reflect test averages of USDA color standards.

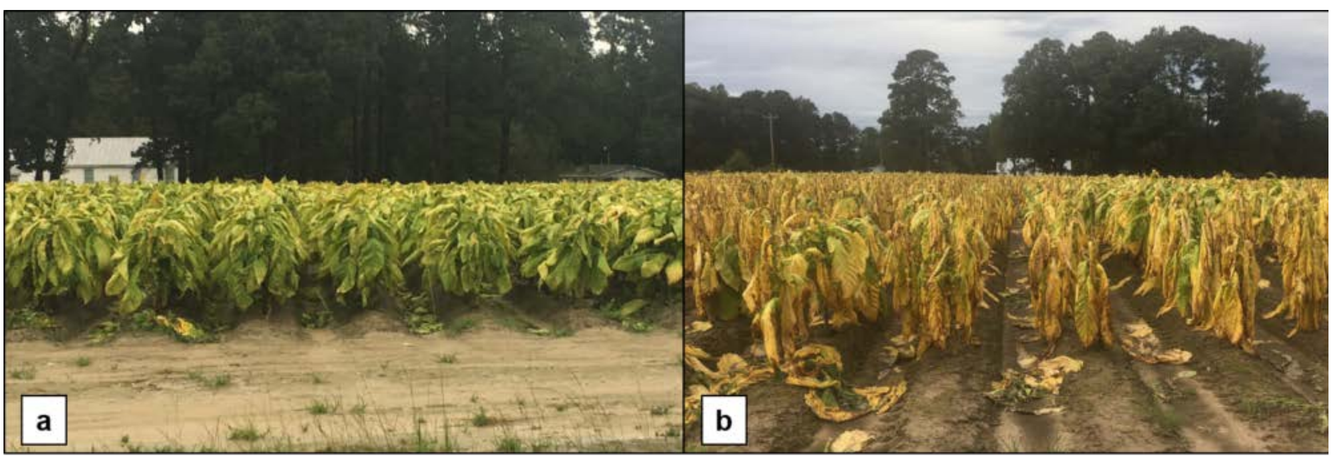

Figure 2. Leaf response to Hurricane Florence over a 72 hour period in 2018 - a.) Saturday (Sept. 15th) and b.) Tuesday (Sept. 18th).