

# Hop Harvesting Procedures for Small-Scale Production<sup>1</sup>

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Female flowers of hops (*Humulus lupulus* L.), referred to as cones or strobuli, are used as an essential ingredient of beer to impart bitterness and aroma. In commercial production, hops are grown on a tall trellis, which is typically 18 to 20 ft above the ground. This article explains hop harvesting procedures for small-scale production (generally up to 5 acres). It is part of a series that examines the challenges and opportunities for hop production in Florida based on research at the UF/IFAS Gulf Coast Research and Education Center (GCREC). Corresponding tutorial videos are available at <https://youtube.com/playlist?list=PL4qrj3jZ6i5BwgylgUcb6fMI0z9FKCkQ>. Additional videos on hop production and management are also available at the UF IFAS Horticultural Crop Physiology Lab YouTube channel (<https://www.youtube.com/channel/UCMyYAfFZsib6d4ZI-eaxCTQ>). The intended audience for this article includes growers, certified crop advisors, crop consultants, and county Extension faculty.

## Phenology of Hops Grown in Florida

Hops are known as short-day plants because they flower when daylength becomes shorter than a specific number of hours, referred to as *critical daylength* (Thomas 1969). In general, the critical daylength for hops is 15 to 16 hours (Krebs 2019; Neve 1991), although it varies among cultivars (Thomas 1969). In low-latitude regions (<35° north or south of the equator), inadequate daylength induces hops to flower prematurely, resulting in poor vegetative growth

and cone yields. Florida's latitude is between 24° and 31°N. Therefore, flowering control using supplemental lighting is an important management practice to grow hops successfully in Florida (Agehara 2020).

Florida's subtropical climate, along with flowering control using supplemental lighting, enable double-season production of hops (Agehara et al. 2021). Spring and fall growing seasons for 'Cascade' hops run from February to June and June to November, respectively. Plants go dormant in late December. The video describing spring and fall growth cycles of hops in Florida is available at [https://youtu.be/\\_rAnXr3cQrs](https://youtu.be/_rAnXr3cQrs).

## Determining the Optimum Time to Harvest

Hop cones produce small yellow substances called lupulin glands as they mature (Figure 1). Because bitterness and aroma of beer derive from acids and essential oils contained in lupulin glands, it is critical to harvest cones at the optimum maturity stage. The most accurate method to determine the optimum harvest timing is having cones analyzed in a laboratory. In general, ripe cones should have a moisture content between 75% and 80% (Mabie 2021) and a hop storage index below 0.30 (Nickerson and Likens 1979). In 'Cascade', the normal range of alpha acids is 4.5% to 7% (Hop Growers of America 2017). The ripeness of cones can also be inspected visually in the field. If cones feel soft or damp, they are still immature. Ripe cones should

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look bright green with some browning on tips, and they should feel dry and papery. Lupulin glands inside the cones should be obvious, bright yellow, and aromatic. The tutorial video for determining the optimum harvest timing is available at <https://youtu.be/U6i8rh65jyU>.



Figure 1. Ripe hop cones. Hop cones produce small yellow substances called lupulin glands at the base of bracts.  
Credits: Shinsuke Agehara, UF/IFAS

## Harvesting Procedures

In general, commercial hop harvesting operation involves two steps. The first step is to cut down bines from the trellis. The second step is to separate cones from stems and leaves using picking and sorting machinery. The harvesting procedures used at the UF/IFAS GCREC are described below. We use a mobile hop harvester (Hopster 5P; HopsHarvester LLC, Honeoye Falls, NY) (Figure 2), which is suitable for small-scale production (generally up to 5 acres). The tutorial videos describing the hop harvesting procedures are available at <https://youtube.com/playlist?list=PL4qrj3jZ6i5BwgyIgUcb6fMI0z9FKCkQ>.

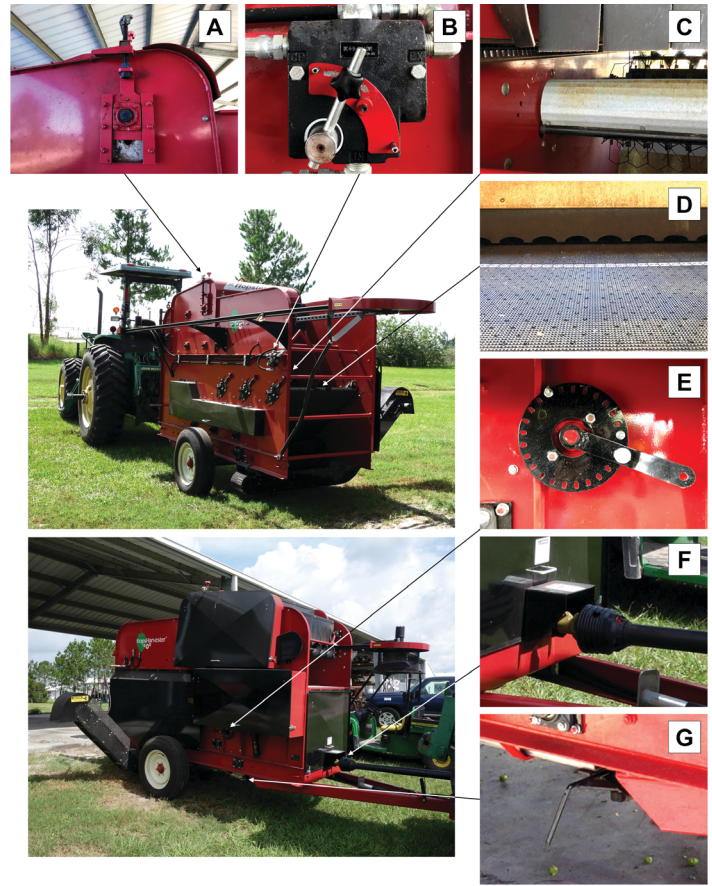
### Step 1: Cutting Down Bines

The first step is to cut down bines from the trellis using a pole hedge trimmer with a 24-inch blade. This step requires a scaffolding system or scissor lift.

1. Cut bines and twines at 3 to 4 ft from the ground (Figure 3A).
2. Cut bines and twines at the top of the trellis (Figure 3B) and pull them down (Figure 3C).
3. Place the harvested bines on a tarp and transfer them to the hop harvester (Figure 3D).

Most hop plants produce very little cones on the bottom 3 to 4 ft of their bines. Therefore, leaving this lower portion of bines in the field does not affect cone yields, but it can make

the handling of harvested bines and the subsequent cone separation process easier and faster.



Harvester setting	Function	Configuration
A. Picking drum gap screws	Controls the space between the picking drums	Widen the gap for thicker bines
B. Carousel control valve	Controls the speed of the chain carousel	0.67–1 rpm (20–30 seconds per hook), reduce the carousel speed for thicker bines
C. Side-arm guide	Guides side arms (lateral branches) up into picking drums	Adjust the angle to prevent side arms from being stripped
D. Leaf shields	Prevent leaves from floating past the dribble belts	Adjust the gap to create large enough space to allow cones to pass through
E. Front leaf shield adjuster	Adjusts the angle of leaf shields	See the configuration for "leaf shields"
F. Power take-off (PTO)	Controls the speed of picking drums, blower, and dribble belts	400–450 rpm, the optimum speed depends on the carousel speed and bine thickness
G. Exhaust-air damper	Controls the amount of air for secondary cleaning before cones drop to the outfeed conveyor	Partially to fully open, adjust the opening to prevent leaves from entering the outfeed conveyor

Figure 2. Function and recommended configuration of main settings for Hopster 5P.

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### Step 2: Separating Cones from Bines

The mechanical hop harvester used at the UF/IFAS GCREC (Hopster 5P) is shown in Figure 4. Its mobility provides flexibility in selecting the location to perform the cone collection process. This harvester requires an external power source: a tractor or truck equipped with both a power take-off (PTO) output and remote hydraulics. The



picking drums, dribble belts, blower, and main conveyor are powered by the PTO, whereas the chain carousel and outfeed conveyor are hydraulically powered. According to the manufacturer, minimum power requirements include a 20-horsepower engine, 540 PTO, and one pair of remote hydraulics at 4 gallons per minute. We use a tractor with a 104-horsepower engine (John Deere 6410, John Deere, Moline, IL) to operate the harvester.



Figure 3. The procedure to cut down bines in the field.  
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1. Connect the harvester to a tractor.
2. Start the tractor, engage PTO, and turn on hydraulics.
3. Adjust the engine speed to run PTO at 400 to 450 rpm (Figure 2).
  - Our 104-horsepower tractor uses 1200 to 1700 rpm for the engine speed to run PTO at 400 to 450 rpm.
4. Adjust the carousel speed to 1 rpm using the chain carousel control valve (3 hooks on the carousel chain).
5. Adjust the exhaust-air damper, leaf shields, and picking drum spacing based on the conditions of harvested bines (Table 1).
6. Attach the bottom end of the twine to the hook (Figure 4A).
  - When working with thin bines, it may be possible to attach more than two twines on the same hook.
  - Keep bines to the right of the triangle to increase the contact of bines with the picking drums (Figure 4B). The chain carousel will feed bines into the picking

drums to strip cones and leaves from stems (Figure 4C).

- Leaves will be sorted from cones through a series of inclined dribble belts that allow cones to roll down (Figure 4D). Leaves will then be ejected from the rear of the harvester (Figure 4E).
- Cones will be transferred to the outfeed conveyor (Figure F) and ejected from the harvester (Figure 4G).

7. Remove stripped bines from the chain carousel once they have completely exited the front of the harvester (Figure 4H).

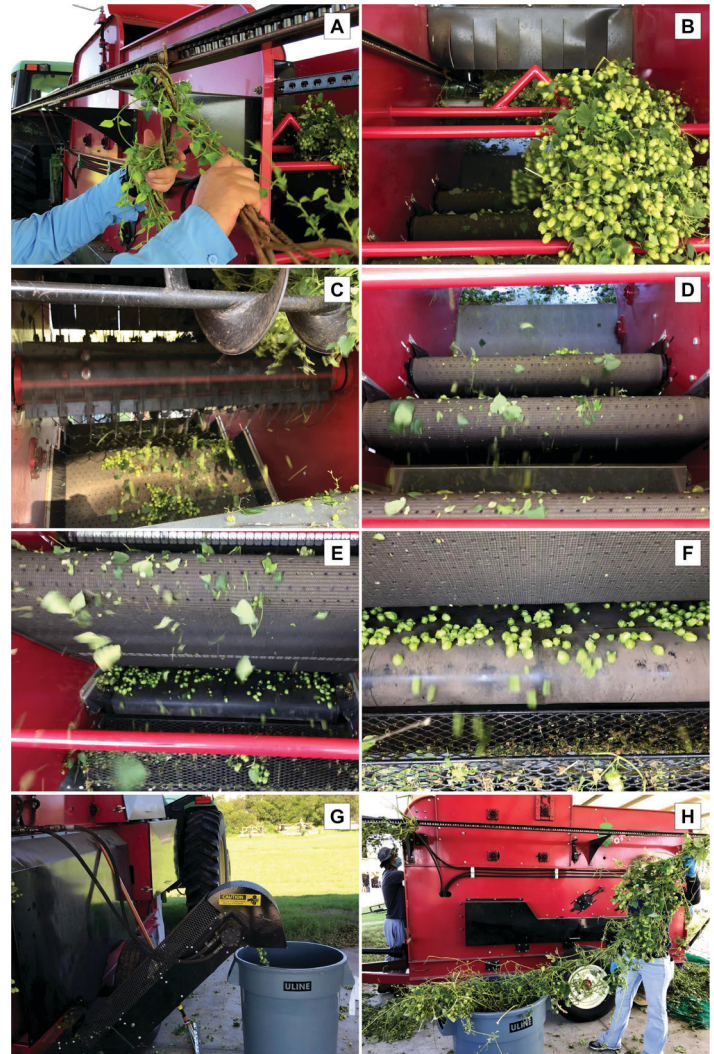


Figure 4. The procedure to separate cones from bines using a mechanical harvester (Hopster 5P).  
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The efficiency of cone separation is affected not only by these harvester settings, but also by wind and the angle of dribble belts. Under outdoor conditions, place the rear of the harvester on the downwind side to minimize the impact of wind. If cones cannot be sorted properly by adjusting

the harvester settings, lower the front of the harvester by lowering the height of the tractor drawbar. This will make the slope angle of dribble belts steeper, allowing cones to roll down more easily. After changing the belt angle, readjusting of the harvester settings may be necessary to achieve the best results.

## Remarks

Harvesting is generally the most labor-intensive activity of hop production, accounting for 42% to 51% (134 to 162 hours per acre) of the total labor input in our operation at the UF/IFAS GCREC (Agehara et al. 2021). The harvesting procedures described in this article are only suitable for a small operation (typically less than 5 acres). When the production scale is expanded, harvesting labor could be reduced significantly by implementing large-scale harvesting machinery.

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