

Exp. Lab. 7a

DESIGN AND PERFORMANCE OF AN EXPERIMENTAL CITRUS WINDROW RAKE

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Several mass removal-type citrus machines detach fruit and drop it on the ground beneath the tree canopy. To complete the mechanical harvest system, handling units are required to gather the fruit and load it into a grove truck. One handling system under

consideration consists of a windrow rake and pickup machine.

The objective of this research was to develop an experimental citrus windrow rake and field-test it in Florida citrus groves.

DESIGN REQUIREMENTS

The following requirements were established as design criteria for a windrow rake in Florida groves:

- (1) Operate in a high percentage of Florida citrus groves in loose sand, firm soil, or sod.
- (2) Rake fruit into a windrow ready for pickup without excessive damage.
- (3) An effective rake width suitable for 20- to 30-foot row middles.

(4) Machine capacity of 20 pounds of fruit per foot of windrow at approximately one-fourth to one-half m.p.h.

(5) Side shift around the tree trunk to allow the transport unit to move in a straight line through the grove.

(6) Pass under low-hanging limbs (20 inches or more) to minimize tree pruning.

(7) Provide flexibility to follow ground contour.

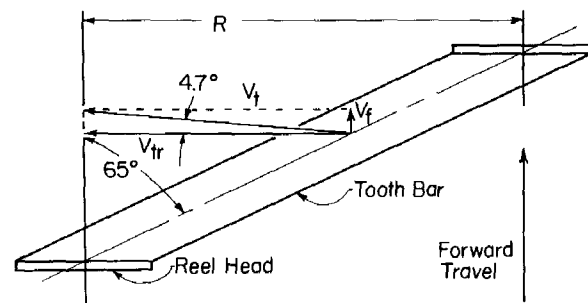
RAKE DESIGN

Raking principles for windrowing were analyzed, and the oblique rake principle had several apparent advantages. Rake tooth travel is almost perpendicular to the forward travel of the rake and minimizes the distance traveled by the fruit. Figure 1 shows the velocity vectors of the oblique citrus rake. The rake frame operates near an angle perpendicular to the direction of forward travel for maximum raking width per length of rake. The rake reel can be side-shifted with little interference in raking.

A commercial side-delivery hay rake was borrowed from a local tractor dealer to check the oblique raking principle. The rake operated satisfactorily, and the oblique principle appeared to be a desirable method for windrowing citrus fruit; however, machine size, speed, and rake tooth design needed to be modified to accommodate citrus.

A rubber-toothed, oblique-type, side-delivery citrus rake was designed and constructed as shown in figures 2 and 3. It was mounted on the front of a

tractor and had an effective rake width of 9½ feet. Four reel bars with 5-inch-long rubber teeth were mounted on 14-inch-diameter hubs. The hubs rotated at 150 r.p.m. to give a tooth velocity of 550 feet per minute with respect to the machine. The rubber teeth were spaced 2¼ inches from center to center. The rake



- R = Raking width.
 V_f = 44 feet per minute - forward velocity.
 V_{tr} = 525 feet per minute - horizontal velocity of tooth.
 V_r = 528 feet per minute - resultant tooth velocity with respect to the ground.

Figure 1.—Velocity vectors of citrus rake

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