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HARVESTING

CHAIRMAN: GLENN COPPOCK

CITRUS HARVESTING IN FLORIDA[1]

G. E. COPPOCK
Florida Department of Citrus, Agricultural Research and Education Center, Box 1088, Lake Alfred, FL 33850

S. L. HEDDEN
United States Department of Agriculture, Agricultural Research Service, Agricultural Research and Education Center, Lake Alfred, FL 33850

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Abstract. **Approximately 18,000 Florida citrus growers produced about 10.1 million tonnes of citrus in 1975-76 season on holdings ranging from one hectare to large blocks of thousands of hectares. Hand harvesting of citrus is influenced by fruit type, intended utilization, grove characteristics, harvest labor and costs. Recent developments to aid hand harvesting included, acceptance of 10-box equivalent field containers (.8 m^3), acceptance of the practice of dropping processing fruit on the ground, introduction of topping and hedging to maintain tree size and use of abscission chemical to loosen the fruit. Several mechanical harvesting systems have been demonstrated for harvesting processing fruit but their efficiency has not been sufficient to warrant large scale industry acceptance. At the present time, the harvesting cost-fruit price squeeze is the main area of concern to the citrus industry.**

Florida produced approximately 10.1 million tonnes (11.1 million tons) of citrus fruit in 1975-76 season on about 310 thousand bearing hectares (762.2 thousand acres) consisting largely of oranges and grapefruit (6). A relatively small area of the state produced 25% of the world's oranges and 50% of the world's grapefruit which accounted for about 76% of the U. S. orange and grapefruit production. Florida's citrus production has been increasing on the average of about 5% annually since 1965 and is expected to continue at least through 1980.

There are an estimated 18,000 citrus growers, whose holdings range from one hectare to thousands of hectares. Absentee ownership is common in many areas with large numbers residing either out-of-state or elsewhere in Florida. The development of cooperatives and grove caretaking operations which require minimum owner involvement in management has allowed absentee ownership to exist. Participation plans, which follow cooperative principles where the grower shares in the returns of the final product, are offered by large companies (10).

Organization of the industry has developed over the years into three general sectors: production, harvesting and utilization. In many operations these sectors are under separate management, and ownership of the fruit changes as it moves from one sector to the other. Production and utilization sectors are highly mechanized, and, to some extent, automated. There are machines for cultivating, fertilizing, topping, hedging and spraying. In the utilization sector, there are machines for sizing, packing, extracting juice and containerizing it for the market.

Harvesting is the only sector that still requires large numbers of seasonal hand laborers. This places the entire industry in a precarious position since the seasonal supply and cost of labor varies widely from year to year. Great strides have been made in mechanizing the transport of fruit from the tree to roadside and on to the point of utilization, but the fruit is still largely picked from the trees by hand. Although several mechanical harvesting systems for processed fruit have been developed, their feasibility under existing conditions has not warranted large scale industry acceptance. This paper covers factors affecting both hand and mechanical harvesting, the recent developments to aid hand harvesting and the progress being made in the mechanization of the harvesting operation.

Factors Affecting Harvesting

Examination of the major factors associated with citrus harvesting in Florida reveals some of its many complexities. Generally, harvesting is influenced by fruit type, intended utilization, grove characteristics, harvest labor and cost.

Principal Fruit Type and Utilization

Seven principal types of citrus fruits are grown in Florida. The overall harvest period lasts almost the year around with the fruit being processed from December to July (6, 7) (Fig. 1). Early and mid-season oranges, 'Valencia' oranges and seedless grapefruit constitute the bulk of Florida citrus (Fig. 2). Approximately 92% of all the oranges; 50% of the seedless grapefruit and 98% of seedy grapefruit were processed during the 1975-76 crop year. 'Temples', tangelos and tangerines are grown primarily for the fresh fruit market with only the excess production going to the processors.

Although all fresh-market fruit should be handled with care when harvested, tangerines and tangelos require extra care because of their fragile peel. They are usually clipped from the tree rather than snapped as are the other fruit types.

The 'Valencia' orange is the main fruit type grown in Florida that is harvested after the next year's crop has set. Harvesting this fruit does not require any special consideration if harvesting is done by hand but it is a prime factor to consider in mechanical harvesting to prevent damaging of the next year's crop.

Grove Characteristics

Seven types of planting systems are used in the Florida citrus industry (2). The rectangle, diamond, triangle, hexagonal, contour and cluster systems are used on plantings

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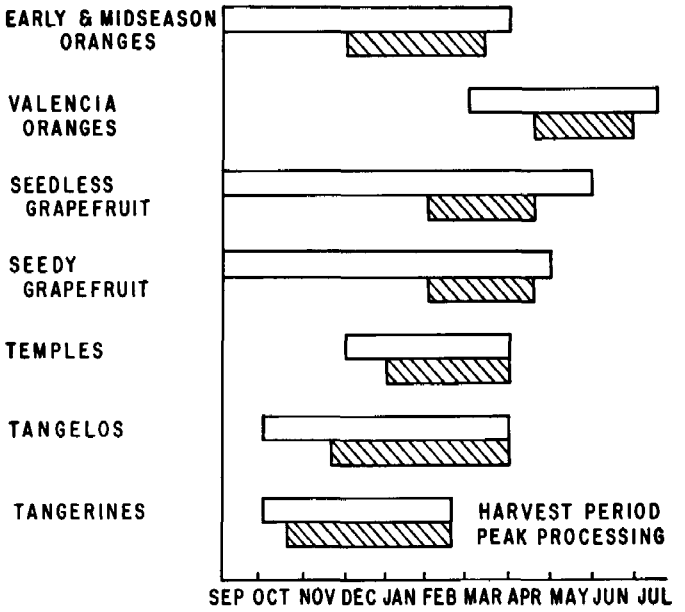

Fig. 1. Principal types of citrus fruit grown in Florida and their annual harvest and peak processing periods.

on the well drained soils and the bedded system is used on plantings on poorly drained soils of the state. The rectangle system is used on 80% and the bedded system is used on 18% of the total plantings. The bedded system may use one of several tree spacing patterns. The number of tree rows per bed vary from one to several depending on local conditions and grower preference. The bedded system and the associated wet and sloping terrain cause some problems in moving the fruit from the grove during harvesting but does not influence handpicking noticeably. However, mechanical harvesting equipment encounters mobility and fruit handling problems under bedded grove conditions.

Tree height in the commercial orange and grapefruit plantings in Florida has been estimated by using the characteristic growth curves and the age of the trees (2). Approximately 28% of the orange trees and 45% of the

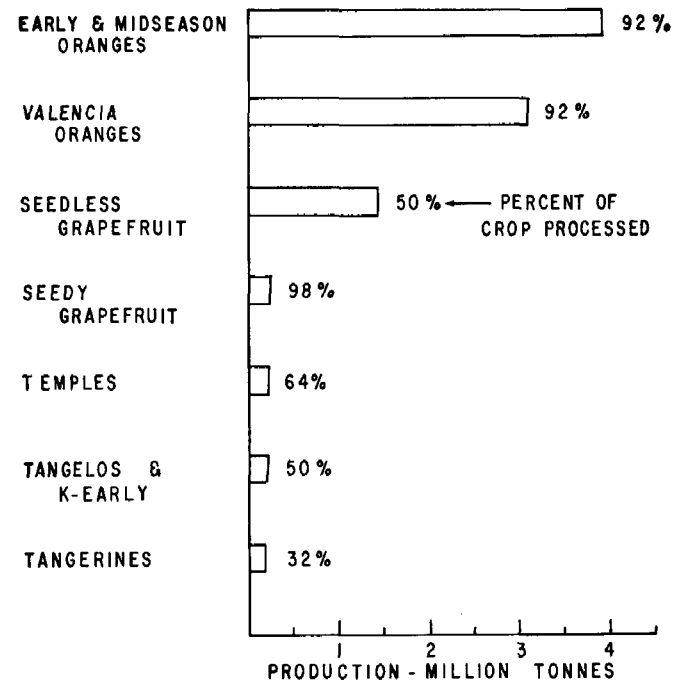

Fig. 2. Production of Florida citrus by principal fruit types and percentage of crop processed for 1975-76 season.

grapefruit trees are over 5.5 m (18 ft) high; 30% of the orange trees and 10% of the grapefruit trees are between 3.6 m (12 ft) and 5.5 m (18 ft) high (Fig. 3). Trees over 5.5 m (18 ft) high are considered hardship picking and usually the pickers demand a premium price for this work

Tree spacing varies widely in commercial orange and grapefruit plantings (2) (Fig. 4). Most between-row spacings are 7.7 m and 8.9 m (25 ft and 30 ft) with 7.7 m (25 ft) the dominant spacing. The trend over the past 15 years has been toward closer in-row tree spacings in order to get more trees per hectare to promote an earlier break-even production level. This is reflected in larger in-row plantings at 4.7 m and 5.9 m spacings than that for between-row plantings at these spacings. These closer spacings cause some problems in hand harvesting because of the difficulty in moving ladders around individual trees. Sometimes cross hedging is employed to facilitate picking in these crowded groves.

Although citrus is grown in 31 counties over peninsular Florida, the bulk of the fruit is grown on the sand hills extending along the center of the state. Most of the bedded groves are planted in the Indian River area located along the East coast and young plantings in the Southern part of the state where the land is level and poorly drained. This wide variation is of prime importance in mechanical harvesting.

Harvest Labor

The citrus picker represents a vital part of the harvest-

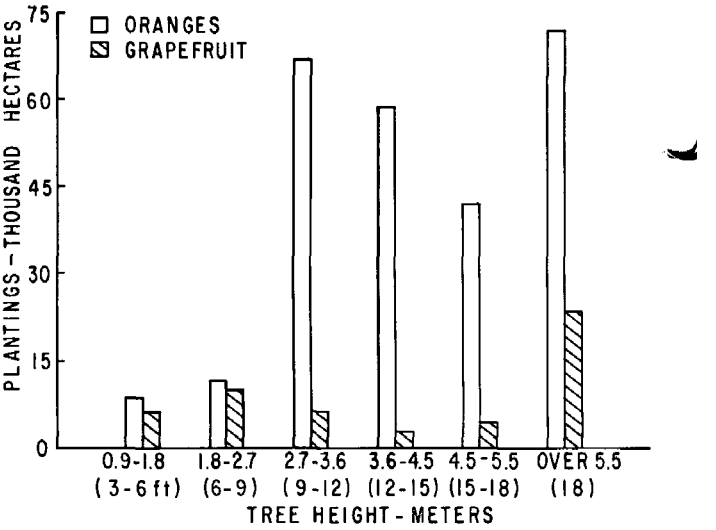

Fig. 3. Commercial plantings of Florida oranges and grapefruit in 1973 by tree height (estimated by using the characteristic growth curves and age of the trees).

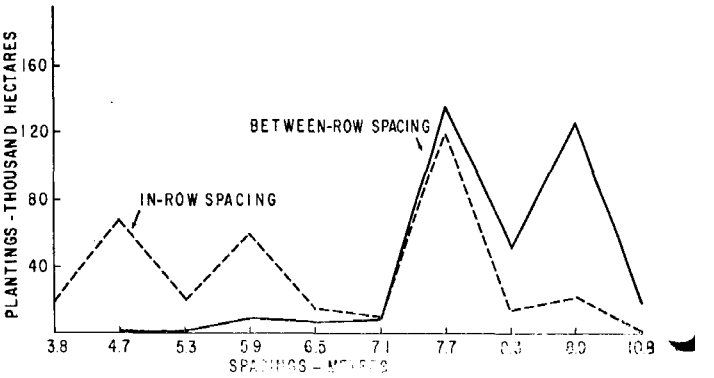

Fig. 4. Commercial plantings of Florida citrus in 1972 by between-row and in-row spacings.

ing sector of the industry. Several studies have been made (4, 8) by public agencies, and various types of citrus labor data and information have been assembled by the Citrus Industrial Council, Lakeland, Florida, which gives some quantitative dimensions of the Florida citrus picker. Still, because of the seasonal nature of the work and the labor supply being influenced somewhat by factors outside the industry, only information of a general nature on trends is valid over a period of time.

Fairchild reported in 1975 on a survey of citrus pickers during the 1972-73 season (4). The survey showed that 70% of the pickers were local residents of the area in which they work, 5% were residents of other areas within Florida and 25% were out-of-state residents or migrants. Another survey conducted during the 1967-68 season by the Florida Industrial Commission in cooperation with others (8) established the average citrus picker productivity for that season by fruit type (Table 1). Picker productivity varied from 10.9 boxes[2] per hour for grapefruit to 2.6 boxes per hour for tangerines.

Data furnished by the Citrus Industrial Council (4) for 1974-75 season show that some citrus pickers were employed the year-around. However, the period of highest employment lasted from 7 to 8 months (Fig. 5). Employment peaked with 25,500 pickers the week ending February 15 and again with about 27,000 pickers the week ending May 15.

In 1974 Fairchild reported on the citrus labor requirements in the citrus industry (3). He found that during 7 of the 8 seasons from 1966-67 to 1973-74, the number of domestic citrus pickers employed during the peak week of the season ranged from approximately 23,300 to 26,600 (Fig. 6). Although the peak week employment in 1972-73 fell to 21,352 pickers, it did not represent a trend since the peak week employment returned back to 26,600 in 1973-74 season. Fairchild suggested that Florida would experience a mild labor deficit beginning in the 1975-76 season if: (a) peak week picker employment remained at approximately 26,600, (b) mechanical harvesting did not come into commercial use, and (c) future production estimates were accurate. However, mechanical harvesting did not come into commercial use and the labor deficit did not develop in 1975-76 as predicted which indicated that peak week picker employment increased above the 26,600 level or seasonal picker productivity increased.

Several factors may have contributed to this variation in employment. The slow rate of the national recovery from an economic slow-down which began during the 1972-73 season held labor competition from non-agricultural industries to a minimum. In addition, the industry experienced a large influx of laborers from Texas. Many of these workers have purchased mobile homes in central Florida and may well become a permanent part of the local work force.

The orange production (6), weighted average fruit price at processing plant, (5) and harvesting cost (12) for the past 18 years are plotted in Fig. 7. Harvesting costs have increased steadily over this period while average price at the processing plant has varied widely. These variations in fruit prices are the normal influence of supply and demand on the market. Disregarding the freeze years (1962-63, 1967-68 and 1971-72), orange production has increased rapidly over this 18-year period. The difference between the price and harvesting cost curves represents the portion of the market value of the fruit that can be allowed for production and grower profit. Over the years, as this difference approached the production cost and grower profits dwindled, interest developed in mechanical harvesting. Mechanical harvesting methods were first introduced in the 1966-67 season and experienced a further expansion during the 1970-71 season. In both years grower profits were minimized or did not exist because of rising harvesting costs and lower fruit prices. Grower profits will continue to be minimized by similar conditions.

[2]Florida standard field box holds 38.6 kg (85 lb) of grapefruit; 40.9 kg (90 lb) of oranges and 43.2 kg (95 lb) of tangerines or tangelos.

Table 1. Average citrus picker productivity, 1967-68 season.[z]

Fruit type	Kg per man-hour	Boxes per man-hour
Early and midseason oranges	278.18	6.8
Valencia oranges	298.64	7.3
Grapefruit	421.14	10.9
Tangerines	112.27	2.6
Tangelos	194.32	4.5
Murcotts	190.00	4.4

[z]Florida Citrus Harvest Survey 1967-68 season.

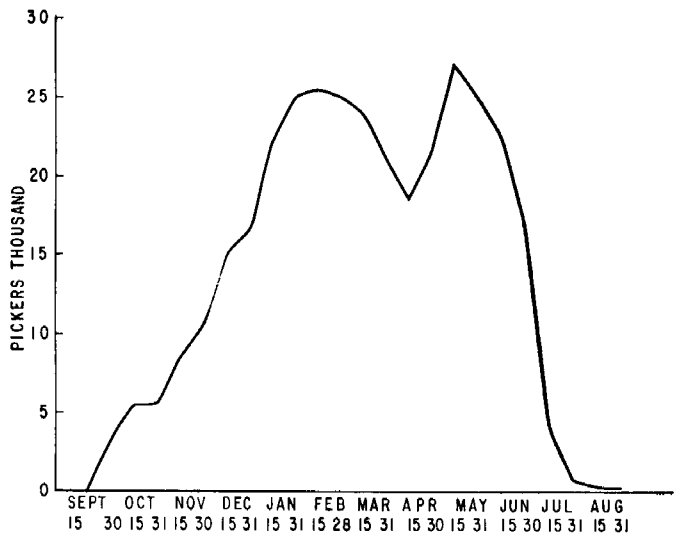

Fig. 5. Florida citrus harvest employment during 1974-75 season, bi-weekly. (Source: Citrus Industrial Council).

Recently Developed Aids for Hand Harvesting

Over the past decade, several beneficial developments and changes have taken place in the industry which have facilitated hand harvesting.

The standard 0.08 m³ (4800 in.³) field box has been

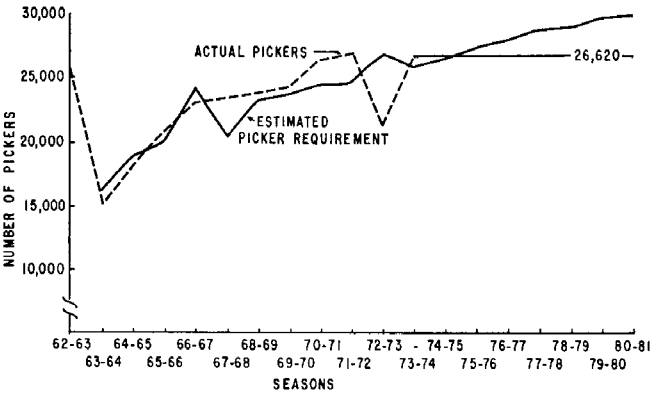

Fig. 6. Actual pickers employed and estimated picker requirements (based on actual crop sizes through 1972-73 and estimated crop sizes from 1973-74 through 1980-81) during peak period without mechanical harvesting systems. (Copied from Florida Department of Citrus Report (3).

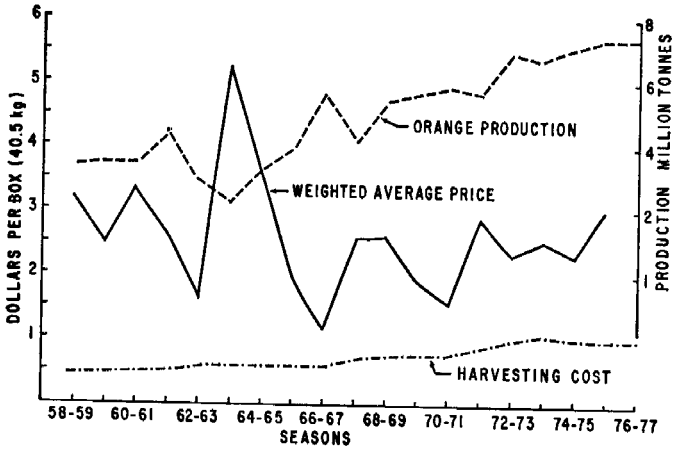

Fig. 7. Orange production, weighted average price of oranges received at processing plant for concentrated orange juice and harvesting costs from 1958-59 to 1975-76 season.

replaced with 10-box equivalent containers (.8 m^3). Square shaped containers (pallet bins or pallet boxes), usually constructed of steel or wood, are used for handling fresh market fruit. Conical shaped plastic or steel tubs are used to handle processing fruit. Both types of containers are handled in the field with a loader mounted on the grove truck that transports the fruit to the roadside. Loaders are available that can adapt to either container. Fresh-market fruit is hauled to the packinghouse in the square containers but processing fruit is usually dumped into a bulk bodied truck or trailer and hauled to the processing plant, leaving the empty containers in the grove.

In an effort to reduce the hard work involved in carrying a bag of fruit down the ladder, pickers began the practice of dropping the fruit on the ground and picking it up later. Although it is not encouraged by growers, it has become an accepted practice for handling processing fruit. There is little evidence that the pick and drop procedure increases the production of a good picker; however, it does make the work easier and tends to speed up the rate for an inexperienced picker.

The introduction of a topping and hedging program by many growers to maintain a smaller, more uniform tree size has been a very significant aid to harvesting. The demand by fruit pickers for premium prices to pick groves with tall and crowded trees along with the need to move large equipment through the grove were strong factors encouraging this practice.

Most of the abscission chemicals (14) which loosen the fruit were developed to assist mechanical harvesting, and have been used on an experimental basis to aid in handpicking of processing fruit (scarring of the peel prevents use of such chemical for fresh-market fruit). Although increased picking rates of about 38% have been reported, pickers have not been willing to reduce their wage rates enough to offset the cost of the chemical. Limited use has been made of the abscission chemical, Ethrel, on tangelos and tangerines to allow them to be snap-picked for the fresh-fruit market since it does not scar the fruit. A serious problem developed in attempts to introduce the use of Ethrel in a standard packinghouse operation because the 5-7 day delay between application of Ethrel and harvesting was not compatible with present marketing procedures.

Mechanical Harvesting

Over 20 years of formal research and development have gone into efforts to mechanize the harvesting of citrus fruit. Several systems have demonstrated good potential for the economical harvesting of processing fruit under specific grove conditions (9). In the more promising of these systems the tree is shaken to remove the fruit. To aid the removal of the fruit, abscission chemicals have been developed which reduce the fruit attachment force. A large field of technology has developed around the use and control of these chemicals in conjunction with the fruit removal equipment (9, 13, 14). The fruit is either caught on a catching surface or allowed to fall to the ground where it is picked up later (11).

It appears at the present stage of development that no one harvest system will perform acceptably under the wide range of existing harvest conditions. Thus, each system will have to be tailored for a specific range of conditions and the groves modified to enlarge its adaptability.

Through the Florida Department of Citrus, the industry has taxed itself to fund programs for the purpose of accelerating the use of improved harvesting methods. One program is designed to encourage equipment developers by making loans available for specific development work judged to have merit. Another program is designed to encourage growers and custom harvesters to become involved in the use of mechanical harvesting equipment by offsetting some of the risk involved through an incentive payment on the fruit harvested. A third program funds expanded research on mechanical harvesting by public agencies.

Several pilot systems are being used commercially and reports indicate that under certain conditions in groves with high fruit yields, costs for these systems compare quite favorably with costs of hand harvesting. Industry acceptance has been very limited and mostly in conditions where handpicking is difficult. Some of the factors responsible for the lack of industry acceptance at this time are: high initial cost of equipment, poor machine reliability, low increase in workers' productivity, inefficient fruit recovery compared to hand harvesting, fear of permanent damage to trees and an adequate supply of handpickers. The influence of these factors adds up to the fact that the economic returns of mechanical harvesting are inadequate to warrant making a major change in the industry when adequate hand harvesting labor is available at an affordable price.

Discussion of Harvesting Trends

Trends in several areas related to harvesting interplay to produce a problem of major concern to the Florida citrus industry. Citrus production has been increasing rapidly over the past decade and is expected to continue increasing until at least 1980. The average harvesting cost has more than doubled over the past 2 decades while the price received at the processing plant has fluctuated widely; at times these factors have reduced the allowable return to pay production costs and to offer the grower a profit. The relationship between the supply and demand for citrus harvesting labor has varied considerably over the past decade. The outlook for the next few years suggests that supply and demand will generally be in balance with the possibility that demand may slightly exceed supply.

At the present time, the harvesting cost - fruit price squeeze is probably the main area of concern to the industry and especially to the grower. Better management of the available labor supply, improved working conditions and the introduction of mechanical aids to make the work more attractive might assist in stabilizing the labor supply-demand relationship in some operations. However, the justifiable expenditure in this area would be small. Most mechanical picking aids have not justified their use economically (1).

Mechanization, although not presently developed to the stage of general acceptance, has not only the potential of

capping the rising harvesting cost trend, but also of eliminating the need for a larger hand labor force to harvest the anticipated crops. However, other problems may be generated because a new type of labor force would be needed—that of machine operators. This would entail training those in the hand labor force that are trainable or competing with other industries on the labor market for skilled labor. Skilled workers would be difficult to attract because of the seasonal nature of the work. Also, large investments would be needed for expensive machines, making it imperative that good operators be maintained.

Another approach to relieving some of the industry concerns about harvesting would be to phase in mechanical harvesting. This would be done by using the handpickers to perform those operations that can not be efficiently mechanized in a specific grove condition. This might involve removing fruit mechanically and employing hand labor to pick it up or vice versa. This approach would be especially applicable at the present stage of mechanical harvesting development. The main drawback would be in finding picking labor that would be willing to work in this manner.

There does not appear to be a clear cut solution on the horizon for all Florida's citrus harvesting problems. However, remarkable progress has been made in the development of mechanical harvesting systems tailored to specific grove conditions. It is anticipated that these systems gradually would become acceptable if they are made more efficient and if hand harvesting cost continues to increase.

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