Practical Paper

Use of Aerial Color Infrared Photography, Dual Color Video, and a Computer System for Property Appraisal of Citrus Groves

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ABSTRACT: Aerial color infrared (ACIR) photographs of all citrus groves in Charlotte County (3181 ha) were taken (at the scale of 1:2400 in June 1983, May 1984, and June 1985. The photographs were analyzed with a two-camera color video system to obtain the total number of healthy trees in each property parcel. Tree counts were made in a 1981 ground survey listing the type of rootstock, variety of scion, estimated and reported yield of grove (boxes/tree), and the total number of hectares in citrus, and these were compared with data from ACIR transparencies. Questionable tree counts from ACIR interpretation were verified by special field surveys. Comparisons were made over a four-year period between ground surveys and ACIR photography to determine the length of time, accuracy, estimated costs, and potential benefits from each method of data collection. Results indicated that the greatest advantages of ACIR were (1) reduction in time of appraisal; (2) ability to compare images from two different years and produce a more accurate property appraisal; (3) reduction of arithmetic errors in recording tree counts; (4) only one appraiser was needed for seven to eight weeks for photointerpretation, releasing a position for other work; (5) visits to groves were minimized, an important factor in the potential spread of citrus canker; and (6) costs of conducting ACIR surveys were considerably less than for ground surveys.

INTRODUCTION

BLACK-AND-WHITE AERIAL PHOTOGRAPHY has been used during the last 20 years by property appraisers in Florida as an aid in property evaluation. The Florida Department of Revenue (DOR) is statutorially charged with developing guidelines to assist county property appraisers in their assessment of property value. One major component of new guidelines that became effective on 30 December 1982 specifically addresses the issue of valuating citrus lands that qualify for agricultural assessment (Clouser and Muraro, 1983).

Anticipating changes in state rules in 1981, the Property Appraiser in Charlotte County conducted a detailed and accurate ground survey of all citrus groves in the county (based on legal descriptions of property boundaries) showing the different varieties, rootstocks, and age of trees. The survey indicated that small citrus groves were predominant, with the larger groves being no more than 590 ha. Therefore, appraisers did not require complicated grove maps and were able to keep mapping procedures to a minimum by developing a set of forms compatible with the property data base stored in a Nixdorf 600 minicomputer (Blazquez, personal communication, 1982).

Citrus grove appraisal values are also of interest to grove owners (Abbitt, 1977a; Abbitt, 1977b; Muraro and Kurras, 1982; Savage, 1961). It has been suggested that owners and managers maintain grove maps to keep track of tree progress (Abbitt, 1977a; Blazquez, 1983; Blazquez *et al.*, 1978; Blazquez and Jackson, 1980) so that comparisons may be made after changes occur, such as the disastrous freeze of 1983 (Muraro and Kurras, 1982). However, tree counts of groves are not easy to obtain, and owners/managers who initiate grove mapping in the first few years of ownership generally do not continue the time consuming practice (Abbitt, 1977a; Abbitt, 1977b; Blazquez, 1983).

The purpose of this report is to describe and evaluate the benefits and disadvantages of a twin-video camera system whereby a photointerpreter may view paired color video monitors with two different ACIR images of a citrus grove, compare them visually with data from ground surveys displayed on a computer terminal, rapidly assign property values, and enter necessary changes in the tax rolls data base.

MATERIALS AND METHODS

Citrus Grove Sites

Commercial citrus groves (3,181 ha) selected from Charlotte County Property Tax Rolls were outlined on U.S. Geological Survey Quadrangle (Quad) Sheets for aerial photography. Property boundaries of each grove (recorded on 1:2400-scale maps) were labeled by Section, Township, and Range for matching with aerial photography. Property records included rootstock and scion, date planted, and estimated or actual production records during the past four years. Total net tree acreage (in hectares) within the property boundary was determined by the formula.

$$\frac{\text{Total number of trees} \times \text{spacing factor (m}^2\text{)}}{\text{m}^2 \text{ per ha}}$$

Ground Inspection Surveys

A list was prepared of all commercial citrus groves and of all private property recorded on tax rolls as having citrus trees. Aerial photographs of grove properties were used as maps to make ground inspections (surveys) in 1981. Ditch irrigation was common in many groves, requiring the use of a four-wheel drive vehicle. Tree counts were made only of productive trees from each property. Large groves with trees of the same variety and age were divided into blocks for convenience in counting.

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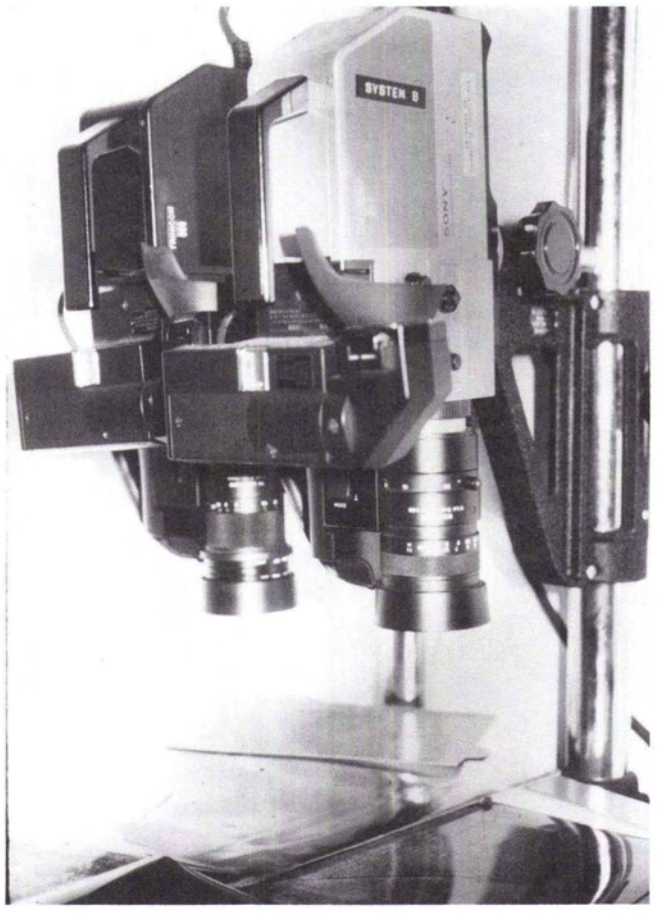

FIG. 1. Two Sony color video cameras with 58-mm close-up lenses mounted on two Testrite CS-5 photographic close-up stands over a fluorescent light table covered with a plastic diffuser.

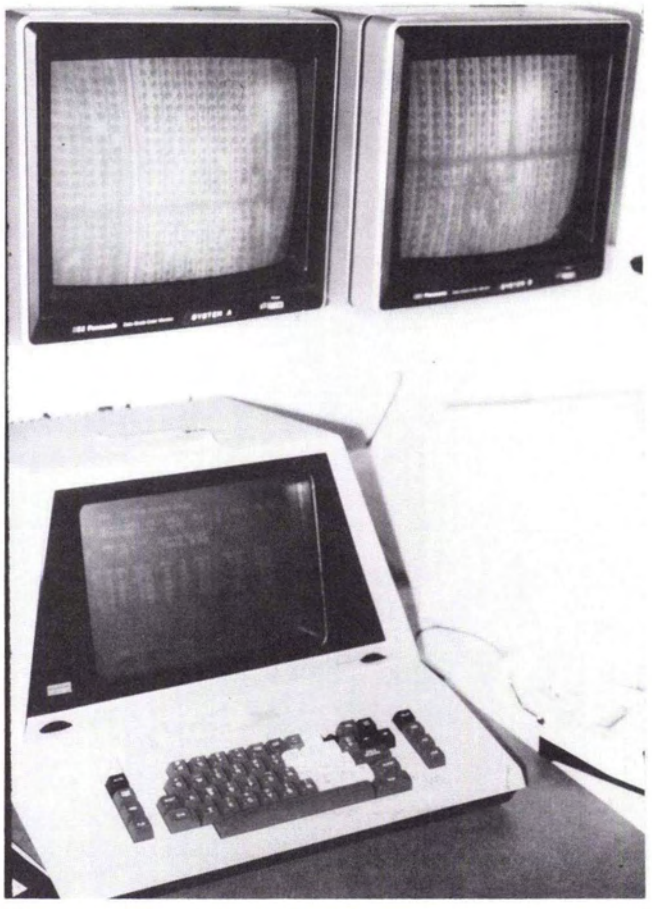

FIG. 2. Two Panasonic CT-1300D Data Grade color monitors mounted at eye level for rapid comparison of transparencies. A Nixdorf SDT-C terminal is located directly below for data input into the County's minicomputer.

Varieties were counted separately within the boundary of each property. Blocks of trees planted at different dates were also counted separately. Tree counts were entered into previously prepared forms and were turned over to a clerk for summarization, arithmetical check, and input into the County's Nixdorf 600 minicomputer.

AERIAL PHOTOGRAPHY

A Zeiss RMK-A 30/23, 23-cm by 23-cm camera with a 30-cm focal length a prochromatic (corrected for three wavelengths) lens mounted in a twin engine Aero Commander aircraft was used to photograph the county groves. The camera was connected to a Zeiss ICC/NS 1 intervalometer powered by the electrical system of the aircraft. Photography was taken with Kodak Aerochrome Infrared 2443 film with a minus blue Zeiss "C" yellow filter (Wratten No. 12 equivalent) from an altitude of 1220 m, resulting in a scale of 1:2400. Photographs were taken using an end lap (forward) of 60 percent (where 60 percent of an area would be included in the next photograph taken) and a side lap of 30 percent (where 30 percent of an area would be included on either side of the flight line). Photographs were taken in June 1983, May 1984, and June 1985. The infrared film was processed into positive transparencies with required chemicals in a standard EKC Model 1811 color processing unit. Aerial photography, processing, and copying were done by the Topographic Section of the Florida Department of Transportation (TOPO, DOT) at Tallahassee, Florida.

COMPUTERS AND DATA ANALYSIS

A computer program called PAGROVE was written in FORTRAN for a Nixdorf 600 minicomputer (Charlotte County main computer) as a data base to store all property data, coordinates, plot numbers, total acreage of grove, rootstock/scion varieties, tree spacing, and all other pertinent data required in grove assessment. A Nixdorf SDT-C terminal was used at the photointerpretation station (equipped with a numerical key pad) to input all photointerpreted data. The computer program automatically updates the data base and calculates the appropriate property assessment.

PHOTOINTERPRETATION

For viewing ACIR transparencies, two Sony HVC-2400 color cameras with 58-mm close-up lenses were mounted on two Testrite CS-5 photographic close-up stands over a fluorescent light table covered with a plastic diffuser. Each video camera (Figure 1) was connected to a Panasonic CT-1300D Data Grade color monitor mounted at eye level (Figure 1). The Nixdorf SDT-C terminal was located next to the color monitors for interpretation data input into the County Central Computer (Figure 2). A computer printout (data base) consisted of the previous year's grove accounts with all pertinent data to each property: (1) tree count, (2) production, (3) acreage, (4) rootstock/scion variety, (5) age (Capitalization Rate), and (6) appraised value. Property boundaries were delineated on transparent mylar sheets to fit the 1:2400 photographic scale. Rolls of ACIR film

TABLE 1. REQUIREMENTS FOR ANNUAL GROUND INSPECTIONS AND AERIAL COLOR INFRARED (ACIR) PHOTOGRAPHY SURVEYS OF CITRUS GROVES, AND OBSERVATIONS ON DATA ACQUISITION AND RECORDING METHODOLOGY

Ground inspections	ACIR
I. First year's survey	
A. Two appraisers for 7 months (data acquisition in field).	A. One appraiser to photointerpret data and input into computer.
B. One clerk (data processing and computer input). Grove maps locating trees not made. Counts recorded as total/block.	B. Computer program records tree counts and updates property records.
C. Possibility of errors were increased by transferring manually recorded data thrice.	C. Direct data intput into computer minimizes error potential.
D. Long period of data acquisition created problems in scheduling input of data into computer.	D. Rapid input of data into computer reduced last minute scheduling.
E. Must physically inspect trees.	E. Minimal tree checking.
F. Tree counts cannot be re-done.	F. Legal permanent record.
II. Second year's survey	
A. Two appraisers for 7 months (data acquisition in field).	A. One appraiser, photointerpretation will be faster by recording only changes between images from 2 years.
B. One clerk (data processing and computer input). Grove maps locating trees not made.	B. Comparisons between transparencies possible.
C. Tree counts can only be checked, condition of trees not available.	
III. Third year's survey	
A. Two appraisers for 7 months (data acquisition in field).	A. One appraiser, accuracy of interpretation will increase by detection of tree count change between years.
B. One clerk (data processing and computer input). Grove maps locating trees not made.	B. Patterns of tree losses may be readily observed.
C. Tree counts can only be checked, condition of trees not available.	C. Appraisers assigned to other duties, dropping needs for more personnel.
D. Appraisers unavailable for other duties in the office or field calls.	

TABLE 2. PROJECTED EXPENSES AND TIME INVOLVED IN GROUND SURVEYS AND AERIAL COLOR INFRARED (ACIR) PHOTOGRAPHY OF CITRUS GROVES*

Ground survey	ACIR
I. First year's estimated costs	
A. Two appraisers	A. One appraiser
B. One clerk	B. Video system
C. A 4-wheel vehicle	C. Computer program
D. Calculator, expendable materials, graph paper	D. ACIR film (includes cost of flying time and processing)
E. Total cost $21,000	E. Expendable material
	F. Total cost $8,500
II. Second year's estimated costs	
A. Labor and expenses were approximately the same as the first year's.	A. Interpretation and film costs were same as the first year's.
B. A 4-wheel vehicle is needed.	B. Minor maintenance of video equipment.
C. Total cost $21,000	C. Total cost $6,700
III. Third year's estimated costs	
A. Labor and expenses were approximately the same as the first year's.	A. Interpretation and film costs were same as the first year's.
B. A 4-wheel vehicle is needed.	B. Minor maintenance of video equipment.
C. Total cost $21,000	C. Total cost $7,000
*IV. Three-year costs for ground survey**	
Labor, expendable materials, and cost of a 4-wheel vehicle.	Interpretation, film, video system, and expenses.
$63,000	$22,000
V. Two appraisers and a clerk were assigned to ground survey for a total of 24 months.	*V. One appraiser was tied up* with the ACIR survey for 24 weeks.
VI. There were no cost savings.	*VI. Potential savings in* 3 years of $41,000.

*Efforts to assign a dollar value to ground surveys were difficult to establish because many of the variables affecting total costs may be due to in-house shifts and savings of extension of personnel time and equipment and not real cash outflow. The appraisers were hired and the four-wheel vehicle was already owned by the county, so additional considerations must be included in cost analysis of ground surveys.

were cut into individual frames; plastic page protectors were used for each frame which were then labeled with pertinent flight data and property records. Photointerpretation was done by a citrus appraiser viewing two different ACIR images on two different color monitors and comparing them visually with a data base from previous years and detecting any possible changes in tree status or other categories that may have occurred. A system (Blazquez *et al.*, 1978) previously used for identifying tree health, stress, and tree size was adapted to the system used in the tax rolls where only productive trees are inventoried. ACIR transparencies from different years were mounted on the light tables and photointerpreted on the video monitors. Large differences in tree counts from one year to the next were verified by on-site inspection. Tree census data was used to calculate property values and the respective assessment on the Nixdorf minicomputer.

RESULTS AND DISCUSSION

All citrus groves and property with citrus trees in Charlotte County were counted in a ground survey conducted in 1981. It took two field appraisers 7-1/2 months to evaluate the county's (then) 3,182 ha of citrus. A clerk transferred all data from the appraiser's survey to computer sheets and entered the data into the County's minicomputer. Manual handling of numerical data three times prior to input into the main computer required considerable double checking to minimize potential errors. Repetitive driving through groves on a daily basis had a negative impact on the performance of the appraisers, requiring additional computational time to insure accuracy of records (Table 1).

Results of the ACIR photographic survey conducted in 1983 indicated that the total citrus acreage had increased to 3,864 ha. Preliminary problems in adapting to ACIR photography interpretation were overcome when a color video system was installed for photointerpretation (C. H. Blazquez, unpublished data, 1985) and the data were entered into the County's minicomputer (Figures 1 and 2). A comparison between ACIR photography and the ground survey showed that the greatest advantage of ACIR photography was the time saved in the duration of the survey and increased accuracy of data.

ACIR photography produced a transparency that was a permanent legal record and did show the productive capability and health of trees in each grove at a point in time. The ACIR transparency could be re-photointerpreted, while the ground survey records were the final results with no image recall capability.

An added advantage of the ACIR surveys was the ability to compare transparencies from different years and determine possible patterns of change or to modify previous photointer-

pretations (Table 1). Comparisons between transparencies from three different years of the same grove increased the accuracy of photointerpretation because it was possible to identify productive trees and follow their growth progress in subsequent transparencies. Interpretation was easier because the total number of trees from the previous year's count was already recorded and displayed on the SDT-C terminal screen. Unless some changes were observed, the previous year's count was accepted and recorded into the computer terminal as the current year's count (Table 1).

Photointerpretation of ACIR imagery required only one appraiser for seven to eight weeks; thus, it was possible to assign the companion appraiser and the recording clerk to other duties. Compared to the ground survey data collection, direct input of tree counts into the Nixdorf SDT-C terminal considerably reduced the error potential and the need to conduct arithmetic double checks to photointerpreted data (Table 1).

In 1984, citrus canker (*Xanthomonas campestris* pv. *citri*) appeared in Florida nurseries which led to restrictions on entrance into groves. ACIR photography allowed the appraisers to count trees in the office, reducing travel into groves to that required for verification of photointerpretation. The County's citrus acreage increased to 4,546 ha, but the appraisal was completed without an increase in work force and with minimal travel.

Comparison of the man-hours and equipment requirements between the two survey methods suggested that there would be considerable cost benefits in counting trees with ACIR photography (Tables 1 and 2). However, actual dollar cost savings were difficult to establish because savings in a personnel and equipment could not be charged to a specific account. The survey vehicle already belonged to the Appraiser's Office, and the citrus appraisers were already on the payroll. In a commercial environment, cost comparisons could have been more easily calculated (Muraro and Kurras, 1982). Even so, with the above limitations, potential cost savings to the county could be estimated (Table 2). The major cost savings of ACIR photography were (1) only one appraiser instead of two was required and (2) survey time was reduced from 24 months to 24 weeks. Total potential cost savings to the county over the three-year survey period was estimated to be $41,000 (Table 2).

SUMMARY

Input of photointerpretation data into a terminal was a faster method of counting trees from aerial photographs and worked well for the small citrus acreage found in Charlotte County. This system would probably require more development in counties with larger citrus acreage. The results obtained for Charlotte County during the past four years suggest that the development of an automatic tree counter and photointerpreter could accelerate data acquisition and input into a computer. Property appraisers, large grove operations, and other interested parties would then be able to more rapidly obtain tree counts and establish property values in a more timely manner.

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