Technology Transfer

Citrus Management Surveys as Tools for Extension Programming

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Summary. Six comprehensive surveys of the Florida citrus industry (345,645 ha), published from 1989 to 1993 as extension bulletins, provide information essential for long-range research and extension program planning and evaluation. These surveys documented changes in production practices, regional priorities for extension programming, marketing trends, and grower ranking of information sources. While formal, comprehensive surveys may be a valuable tool in long-range extension programming for large horticultural industries, more rapid, creative survey methods and educational programs may be needed for more timely programs and for specialized industry groups.

Given the size (345,645 ha) [Florida Agricultural Statistical Service (FASS), 1994] and complexity of the Florida citrus industry, different types of surveys, based on statistical methods, comprehensive interviews, plant and soil sampling, and crop inventories, have been conducted to identify research and extension needs. However, only statewide citrus management surveys using statistical sampling methods and analyses (Ferguson and Taylor, 1993; Israel et al., 1989, 1991; Summerhill et al., 1989; Taylor et al., 1989, 1989a) have provided valid, comprehensive baseline data for long-range citrus extension and research programs. Surveys based on interviews with selected growers and crop sampling from selected groves also have provided information about clearly defined, but

limited, segments of the Florida citrus industry. For example, county agent mailing lists screened to select commercial growers (Jackson et al., 1986), on-site interviews of selected growers (Castle and Ferguson, 1982; Williamson and Castle, 1989; Swisher et al., 1994), or a combination of mailed questionnaires with some follow-up interviews (Spyke et al., 1977) have identified problems in young tree planting and care; described the growth, innovation, and diversification of the citrus nursery industry; characterized commercial organic citrus growers and their production practices, and identified weed control practices and weed populations in southern Florida, respectively. Plant and soil sampling of selected groves also has documented fertilizer inputs, nutritional status, and yields of groves in southern Florida (Tucker et al., 1990), incidence of the citrus nematode *Tylenchulus semipenetrans* Cobb (Ferguson and Dunn, 1984) in central and southern Florida, and *Phytophthora parasitica* Dastur (Zitko et al., 1987) in citrus field and greenhouse nurseries. Biennial commercial citrus inventories conducted since 1966 (FASS, 1994) and estimates of tree mortality derived from them (Muraro, 1988) have provided a basis for projecting tree replacement needs and cash budgets within a production region or entire state.

Before 1988, citrus extension programs were coordinated by the chair of the Fruit Crops Dept. (now Horticultural Sciences), with citrus extension specialists in different disciplines loosely coordinating their extension programs and supporting activities. When extension specialists and county agents developed their first 4-year plan of work for 1988–91, a comprehensive, statewide citrus extension program, Citrus Management in Florida, was formulated. This program consists of four subprogram areas: young tree care, pest management, water management–cold protection, and business management. An extension specialist functioning as team leader coordinated program planning, implementation, and reporting of extension specialists with discipline responsibilities in these different areas. Surveys were conducted in each of these four subprogram areas to obtain baseline data on current production practices, production problems, and information needs to plan statewide extension programs. A similar survey, published in 1993, was conducted for the second 4-year plan of work (1992–1995). The objective of this study was to compare data from the 1993 survey with previous citrus surveys, all based on statistical sampling methods, to document changes in production practices and to identify production problems for the purpose of demonstrating how these surveys were used to develop educational programs to address those problems.

Survey methods

The total design method (Dillman, 1978) of gathering survey information was used in these surveys. Sample populations for all surveys discussed herein were selected at random from the newsletter mailing lists of county agents in major citrus-producing counties and from grower lists of the Florida Dept. of Citrus. An introductory postcard alerted growers in the sample population to the upcoming survey, followed by a cover letter and the survey itself, with a postage-paid, addressed, return envelope. A reminder postcard was sent to nonrespondents, and then a second questionnaire and reminder postcard, if needed. These mailings occurred over a 6-week period. Growers who were surveyed were assured of the confidentiality of their responses. Ques-

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Table 1. Sampling methods of Florida citrus management surveys.

Survey	Sampling method	Response rate (%)	Expected error ^a (%)	Sample size (n)	Total ha (%)
Ferguson and Taylor, 1993	sps ^b	47.8	±4.7	398	39
Israel et al., 1989	srs ^c	64.0	±5.3	331	65
Israel et al., 1991	srs ^c	52.6	±5.6	281	35
Summa-hill et al., 1989	srs ^c	60.0	±5.4	312	65
Taylor et al., 1989	srs ^c	67.0	±5.1	341	65
Taylor et al., 1989a	srs ^c	58.0	±6.6	293	65

^aError rates calculated for 95% confidence level.^bsps = Stratified proportional sample taken from mailing lists of county agents.^csrs = Systematic random sample of citrus growers taken from mailing lists of county agents and the Florida Dept. of Citrus.

tionnaires were developed by statewide citrus extension specialists, county agents, and faculty members from the Extension Program Planning and Evaluation Unit, who also supervised data analysis. The response rate for all six surveys ranged from 48% to 67%, with an expected error of ±4.7% to ±6.6%, for a 95% confidence interval (Table 1). Data provided by the survey questionnaires were analyzed according to frequency (the number of times an option is chosen) and percent (the number of times an option is chosen divided by the total number of respondents who answered that question). In ranked questions, the response options were weighted and their frequency multiplied by their weight. Responses not included in a particular survey are indicated by a dash in the tables. Citrus is grown in Florida in two different production environments, the deep, well-drained sandy soils of the central Florida ridge, with nonbedded groves, and the shallow, poorly drained flatwoods soils of southern Florida, with bedded groves. Some data in the 1993 survey refer to respondents' groves being nonbedded or bedded. In each of the surveys conducted in 1989 and 1993, there were no significant differences in the ratio of bedded to nonbedded plantings, eliminating geographic location as a factor that might account for changes in production practices between the above dates.

Production practices

From 1986 to 1992, 173,341 ha of new plantings were established (FASS, 1994), making young tree care and maintenance (trees 1 to 3 years old) an important aspect of grove management. In addition, an estimated 3.8% annual tree mortality rate (Muraro, 1988) required planting of additional trees to sustain grove productivity. Major problems and information needs in young tree care, including

cold protection, pest and disease management, irrigation, and fertilization, were identified in surveys published by Jackson et al. (1986), Taylor et al. (1989), and Ferguson and Taylor (1993). Major freezes occurred before the statewide surveys published in 1986 and 1989, and cold protection was ranked the highest in those years. Separate analyses of bedded and nonbedded groves in the 1993 survey reflect continued concern for cold protection in central Florida's nonbedded groves, but less concern in the warmer, poorly drained, bedded groves of southern Florida, where fire ants, weed control, and phytophthora root rot, a soil-borne disease of citrus crown roots, rootstock, and scion, were ranked as first, second, and third concerns, respectively (Table 2). Fire ants were not mentioned as a separate category in 1986 and 1989, but were listed in 1993 and were ranked as first and second concerns by growers in bedded and nonbedded groves, respectively, indicating the increasing statewide importance of this pest. The use of microsprinkler irrigation for young trees increased from 23% in 1986 to 68% in 1989, to 87% in 1993.

Percent respondents using chemical weed control for young trees increased from 77% in the 1986 Jackson et al. (1986) survey to 95% in Taylor et al. (1989), and 98% in Ferguson and Taylor (1993). Overuse of herbicides leading to phytotoxicity, and soil erosion on newly planted, bedded groves is a common problem. Extension programs have emphasized frequent herbicide applications at low rates to reduce phytotoxicity and potential herbicide leaching, especially in areas where contamination of groundwater may be a problem. Interactive software programs also have been developed to rank the potential of organic chemicals to contaminate groundwater on agricultural soil types, and

Table 2. Major problems in young citrus tree care and maintenance.

Problem	Ranked order of importance ^a			
	1986	1989	1993 Nonbedded ^b	1993 Bedded ^c
Cold protection	1	1	1	4
Weed control	2	2	3	2
Fire ants		---	2	1
Insect pests	3	3	6	5
Foot rot	5	4	5	3
Irrigation	6	5	11	12
Fertilization	8	6	14	14
No. of items in survey question	10	10	16	16

^aSome items not included in all surveys.^bNonbedded = deep, well-drained, sandy soils of central Florida ridge.^cBedded = shallow, poorly drained flatwoods groves of southern Florida.

Table 3. Major problems in management of mature groves^a.

Problem	Ranked order of importance		
	1989	1993	
		Nonbedded ^b	Bedded ^c
Pest management	2	1	1
Cost-effective chemicals	5	2	2
Marketing	10	8	3
Government regulations	3	7	4
Water management	6	5	5
Rootstock/scion selection	9	6	6
Environmental concerns	8	9	7
Fertilization and liming	13	4	8
Cold protection	1	3	9
Mites	---	10	10
Equipment costs	7	11	11
Labor	4	13	12
Harvesting	12	---	---
Labor and harvesting	---	13	12
Urban encroachment	11	---	---
Biological control	---	12	13
Sustainable agriculture	---	16	14
Organic farming and marketing	---	15	15
Use of manure	---	17	16
Other	---	14	17
No. of items in survey questions	---	13	17

^aSome items not included in all surveys.

^bNonbedded = deep, well-drained, sandy soils of central Florida ridge.

^cBedded = shallow, poorly drained flatwoods groves of southern Florida.

these have been demonstrated in extension programs (Nofziger et al., 1988).

While young tree care is an important part of citrus production, requiring cultural practices different from those of mature groves, young tree care is not a discipline in itself and involves the integration of different disciplines, including horticulture, entomology, hematology, plant pathology, and soil science. Extension programs in young tree care initially were conducted by extension specialists with a broad, general knowledge of the above areas. However, as young tree care became more important, county agents later organized regional short courses in young tree care, drawing on the expertise of extension and research faculty members in these different areas.

Although cold protection, weed control, and pest management remained important problems statewide from 1986 through 1993, their relative importance in different production regions established priorities for extension programs in those different regions, especially in terms of research and demonstration projects involving new cold-

protection methods such as tree wraps, continuous and intermittent microsprinkler irrigation in combination with tree wraps, heated irrigation systems, and tree covers,

Major problems in mature groves are similar to those in new plantings, with cold protection and pest management ranked highly in 1989 and 1993 (Table 3). However, growers with bedded groves in southern Florida again ranked cold protection as a lower priority than growers with nonbedded groves in central Florida. Cold protection research and demonstration projects focusing on placement of elevated microsprinklers within the canopy and weather forecasting programs are located primarily in cold-sensitive areas. Marketing was ranked higher by southern Florida growers than central Florida growers, possibly reflecting the concentration of fresh-fruit packing houses in southern Florida and the Indian River Production areas, in particular, where postharvest extension programs are focused.

Environmental concerns, biological control, sustainable agriculture, and organic farming were ranked relatively low in 1989 and 1993, even though 91% of growers thought

Table 4. Factors affecting the decision to irrigate.

Factor	Banked order of importance ^a		
	1989	1993	
		Nonbedded ^b	Bedded ^c
No. of days since last rain	1	1	2
Soil looks dry	2	2	1
Trees show wilt during day	3	3	3
Accounting method	4	5	4
Use of soil moisture measuring device	5	6	6

^aSome items not included in all surveys.

^bNonbedded = deep, well-drained, sandy soils of central Florida ridge.

^cBedded = shallow, poorly drained flatwoods groves of southern Florida.

pesticide use restrictions would increase and 74% thought pesticide use restrictions would have a negative impact on grove operations in the next 10 years (Ferguson and Taylor, 1993). Growers see change coming, but do not rank alternatives to conventional agriculture highly, presenting a challenge to extension leadership in these areas, in terms of defining and recommending sustainable practices. Although agricultural water management is an important issue in Florida, days since the last rain, dry soil, and tree wilt were the three most important factors affecting the decision to irrigate mature trees in 1989 (Taylor et al., 1989a) and 1993 (Ferguson and Taylor, 1993); accounting methods and soil moisture monitoring devices were placed at the bottom of the list (Table 4). Although water management has received much attention in Florida, these data indicate the need for additional educational programs in this area.

Market specialization

Some citrus cultivars are associated with a greater degree of market specialization than others. For example, when sweet oranges were grown for the processed market, about 60% of surveyed growers devoted at least 75% of their acreage to that market (Israel et al., 1991). In an earlier survey (Israel et al., 1989) 68% of respondents on 74% of the surveyed acreage also said they grew oranges primarily for the processed market. Growers of fresh-market oranges, grapefruit, or mandarins were much less specialized, hence more diversified, but lime growers were the most specialized, with 93.3% devoting at least 75% of their acreage to that crop (Israel et al., 1991).

Because production programs for processed oranges require lower inputs and costs than for fresh oranges, the most cost-efficient management strategy would be to plan and carry out different production programs for crops intended for different markets. Furthermore, when different pricing-packout scenarios for fresh and processed fruit were considered, the decision to send fruit grown under a processed fruit program to the processing plant was more profitable in every situation than sending fruit grown for the fresh market to the processing plant (Muraro et al., 1991). However, growers divert 41% of fresh fruit to the processed market and 38% of processed fruit to the fresh market (Ferguson and Taylor, 1993). Another indication of grower ambivalence about marketing decisions comes from a 1987 survey in which growers ranked rust mites and melanose, a fungal disease, as major pest problems, even though these rind blemishes do not affect processed fruit substantially,

which comprised 74% of the surveyed acreage (Summerhill et al., 1989). The fresh-fruit market may become saturated quickly, forcing these market allocation decisions, but better planning could reduce this likelihood, especially in the current oversupplied market with depressed prices. A series of workshops on economical production strategies for growers producing fruit for the processed market, including discussions of low, medium, and high production cost-profit scenarios, emphasized the advantages of long-range planning in this area.

Sources of information

Florida citrus growers seek information from a variety of sources. A significantly higher percentage of growers (55%) ranked fertilizer and pesticide representatives as their first source of information in 1989, followed by other growers/managers (48%), with university personnel (45%) and publications (42%) ranked third and fourth, respectively (Israel et al., 1989). In a 1993 survey (Table 5), there was no significant difference in use of these four sources (Ferguson and Taylor, 1993).

The importance of different sources of information used by growers also varies by the size of the citrus operation. While only 33% of growers with 4 to 24 ha cited university personnel as a primary source of information, this percentage increased to 46% for growers with 25 to 242 ha, and to 88% for growers with more than 243 ha. Similar trends occurred with university publications, industry meetings, and seminars conducted by extension specialists. Use of consultants decreased with the decreasing size of the operation in this survey (Israel et al., 1989).

Discussion

Developing, analyzing, and publishing comprehensive surveys based on mailed questionnaires requires considerable time, experience, and labor and their relevance decreases if publication is postponed. The cited surveys published in 1989, 1991, and 1993 were conducted in 1987, 1990, and 1992. However, final drafts of tables and figures containing analyzed data were discussed in extension program planning and evaluation sessions considerably before publication dates, thereby expediting utilization of survey results. The time lag between sampling and publication might be shortened by using the rapid, sophisticated telephone polling methods commonly used by political consulting and marketing firms to identify differences in clientele problems, needs, and information sources. Although many production problems were recognized before surveys were conducted, the regional importance and changes in production practices, such as increased use of herbicides and microirrigation, could be documented only by statistically valid surveys. Subsequent formal publication of comprehensive surveys as extension bulletins provides valuable information that also can complement field research data frequently requested by regulatory agencies and other groups.

When the same large population (e.g., Florida citrus growers) is sampled over time in different surveys, the profiles of the respondents should be similar. Otherwise, difference in the profiles of respondents might account for changes in production practices rather than adoption of recommended production practices by the same population of growers sampled in different surveys. In the surveys cited here, there was no significant difference in the ratio of

Table 5. Sources of information for production and marketing decisions.

Sources of information	Growers valuing information sources (%)
Fertilizer/pesticide representatives	57
Univ. of Florida personnel	54
Univ. of Florida Publications	54
Other growers and managers	54
Industry meetings	50
Trade magazines	49
Consultants	28
Futures market	9

Expected error rate of $\pm 4.7\%$ at 5% level (Ferguson and Taylor, 1993).

production managers with nonbedded and bedded groves.

Management responsibilities of the respondents also should be determined. Only the 1993 survey categorized respondents in this way: 24% were owners not involved in daily management decisions; 57% owned and managed their groves and also managed for others; 19% were managers only. Owners not involved in daily management decisions may include investors whose groves are under the supervision of caretakers and cooperatives, limited partnerships, and investment groups. Educational programs and delivery methods, different than those for on-site production managers, could be developed, perhaps on the Internet, for such nonmanaging owners who are frequently out-of-state residents.

Grower adoption of recommended production practices and new technologies can be attributed to extension educational programs, frequent, continual contacts with agrichemical representatives, interaction with other growers, and information published in trade magazines. Agrichemical representatives derive much of their production information from land-grant research and extension programs, thus functioning more as information transfer allies than competitors. However, because many growers rank agrichemical representatives as greater than or equal to extension programs and publications as primary information sources, some extension programs should be designed specifically for those representatives who may need different or more-detailed information on a narrower range of topics than grower audiences. Furthermore, when prior educational programs, production region, grove size, information source, and computer usage affect the nature of information growers receive (Israel et al., 1989), these factors also should be considered in program planning and evaluation.

Comprehensive, statewide extension programs require close cooperation among the design team leader, team members who are extension specialists in different areas or disciplines, county agents, and supporting extension administrators. Reduced state funding, increased reliance on extramural grants and contracts, and blurring of the distinction between applied research, extension program administration, and extension activities can reduce the motivation of extension specialists to participate fully in long-range extension programs. Strong administrative support and feedback as well as effective communication among unit administrators and team members in different departments and locations is essential for the success of comprehensive extension programs in large horticultural industries.

While traditional extension program-planning models measure improvement in targeted audiences with numerical indicators, the above interactions suggest that changes occur through a more-complex learning process. For broad, multidisciplinary extension programs addressing problems that may be unsolvable or unmeasurable in any valid way, new planning paradigms have been suggested, advocating conceptual tools and techniques such as mind-mapping, action research, soft-systems methods, and wicked problems (Patterson, 1993). Nevertheless, federal and state agencies require documentation of program impacts. These new program-planning models should be considered in planning and developing realistic evaluation procedures for extension programs addressing the problems of large commodity groups such as the Florida citrus industry.

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