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Regional Analysis of Production Practices and Technology Use in the U.S. Nursery Industry

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Abstract. **The *National Nursery Survey* has been conducted four times at 5-year intervals (1988, 1993, 1998, and 2003) by a multistate research committee on economics and marketing to help fill the void of publicly available information on management characteristics of the nursery industry. For the first time in 2003, the *National Nursery Survey* was conducted using a standard sampling methodology with 15,588 total firms representing 44 states. The objective of this study was to provide a regional analysis of nursery production practices, because production practices and technology use may differ across regions in response to varying economic and environmental conditions. From analysis of the 2485 returned surveys, firms in the northern and interior regions of the country with more seasonal activity made greater use of temporary labor. Containerized growing systems were the predominant system throughout the United States; however, firms in the Southeast, South Central, and Pacific coast regions used this system to a greater degree, whereas firms in other regions also commonly used bare root and balled and burlapped systems. Nurseries in the Southeast region, with a warmer climate, used Integrated Pest Management practices more prevalently. Most regions had a significant share of total production from native American plants, approaching or exceeding 20% of total sales, except the Pacific region. In some regions, forward-contracting accounted for a significantly higher share of total sales, perhaps indicating greater aversion to market risk. The Mountain region stood out for its high level of adoption of computer technologies for production, marketing, and management. Data on water use and irrigation technology did not indicate any clear pattern with respect to regional differences in relation to water scarcity.**

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The *National Nursery Survey* was conducted by the Green Industry Research Consortium (S-1021 Multi-state Research Committee), a group of agricultural economists and horticulturists from 24 land-grant institutions in the United States. The survey was coordinated by John Brooker (Professor Emeritus) at the University of Tennessee.
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The U.S. Green industry, including nursery and greenhouse producers, landscape services firms, and wholesale and retail distributors, has grown dramatically during the past 2 decades, becoming an increasingly important sector of American agriculture. In 2002, the Green industry generated 1.96 million jobs and $147.8 billion in output (sales), and $95.1 billion in value-added (income) in 2004 dollars, including the multiplier effects of supply chain input purchases and employee household spending (Hall et al., 2006). In 2006, sales of U.S. nursery and greenhouse crops reached $16.9 billion (Jerardo, 2007). Despite its growing importance, however, the production and management practices followed in this industry have not been well documented.

The *National Nursery Survey* was conducted four times at 5-year intervals, in 1988, 1993, 1998, and 2003, by the U.S. Department of Agriculture (USDA) multistate committee on economics and marketing of horticultural products. Mail surveys were used to collect information on selected production and marketing practices such as distribution channels, interstate and international shipments, advertising expenditures, selling methods, and other information. The goal of these surveys was to help fill the void of publicly available information on management characteristics of the nursery and greenhouse industry and to provide information useful to growers, allied industry professionals, extension personnel, and researchers. Results of the *National Nursery Surveys* were reported by Brooker and Turner (1990) and Brooker et al. (1995, 2000, 2005). For the first time, in 2003, the *National Nursery Survey* was conducted using a standard sampling methodology with a total of 44 states participating, giving unprecedented coverage for the survey.

The objective of this article is to provide a regional analysis of nursery production practices and technology uses of nursery firms. Our hypothesis was that these would differ substantially across regions of the United States in response to varying economic and environmental conditions. The specific production practices examined in this article include the types of nursery media rooting systems used (containers, balled and burlap, field grown, and so on), sources of irrigation water and application methods, adoption of integrated pest management practices, and the prevalence of native plants in nursery product portfolios. These practices were of particular interest given the recent emphasis on producing plants in an environmentally sustainable manner (Brumfield, 2000). Additionally, with water conservation and quality issues increasingly affecting the ability to produce and market nursery products, it is imperative to document the efforts made in the Green industry to improve the efficiency of water applications in the nursery and/or greenhouse (Mathers et al., 2005).

The other practices examined in this article pertain to adoption of new technologies. First, the tradeoff of automation technology with labor is measured by looking at trends in employment levels for seasonal and permanent employees. In addition, brokered and contractual sales were examined as well as the level of computerization of different managerial functions. The prevalence of industry alliances points to the increased use and sophistication of various communication technologies. Many firms also are counting on positive economies of scope in managing multiple-site production. This article helps to describe these tendencies by measuring the current and projected levels of technology adoption by nursery and greenhouse managers.

Materials and Methods

Questions on the *National Nursery Survey* evolved over time, reflecting changes in the industry. For example, questions about

market channels were revised to capture sales made to mass merchandise or chain stores, home centers, multiple-location garden centers, and rewholesalers. Several new questions were added to the most recent survey to characterize water use and sources of irrigation water, sales of native plants, and use of integrated pest management (IPM) practices.

A listing of over 38,000 U.S. nursery firms in 44 states was obtained from state trade associations and phytosanitary regulatory agencies. The only states not surveyed were Alaska, Alabama, Arizona, Wisconsin, Kansas, and Maryland, which declined to participate for various reasons. Firms on the list were stratified into four size classes based on production area or inventory of plants. A sample of 15,588 firms was selected from the population to receive the survey, including 100% of the large firms (20 or more acres production area), a random selection of 60% of the medium-sized (5 to 19 acres), and small-sized (1 to 4 acres) firms, and 40% of firms of undetermined size (Table 1).

The focus of interest was regional differences in nursery production and technology practices. Analysis of the pooled state data were conducted for eight geographic regions: Appalachia, Great Plains, Midwest, Mountain, Northeast, Pacific, South Central, and Southeast (Fig. 1). These regions were delineated to broadly represent agroclimatic zones, subject to state boundaries, and closely correspond to the USDA "Farm Production Regions." Differences in mean values for survey results across regions were evaluated using Duncan's multiple range test with Statistica software (StatSoft, Tulsa, OK); statistically significant differences ($P < 0.05$) are indicated by different letters for nonhomogeneous regional groups.

Table 1. U.S. nursery firm population, survey sample size, response rate, reported sales, and employment by state and region in 2003.

Region/state	Number of firms			Response rate (percent)	Reported sales ($1000)	Reported employment (jobs)
	Population	Sampled	Responded			
Appalachia	**3,669**	**1,719**	**302**	**17.6**	**314,659**	**5,090**
Kentucky	389	175	31	17.7	20,142	409
North Carolina	1,373	542	96	17.7	142,376	1,951
Tennessee	1,373	690	97	14.1	72,376	1,264
Virginia	377	211	50	23.7	64,050	1,128
West Virginia	158	101	28	27.7	15,717	338
Great Plains	**497**	**278**	**56**	**20.1**	**21,156**	**909**
North Dakota	33	33	12	36.4	3,958	255
Nebraska	362	145	25	17.2	12,723	328
South Dakota	102	100	19	19.0	4,475	326
Midwest	**5,992**	**2,397**	**418**	**17.4**	**380,034**	**7,034**
Iowa	376	148	24	16.2	9,156	333
Illinois	1,122	528	88	16.7	78,375	1,541
Indiana	435	198	34	17.2	32,280	625
Michigan	1,509	576	98	17.0	97,206	1,766
Minnesota	548	218	39	17.9	33,741	917
Missouri	576	143	14	9.8	19,870	99
Ohio	1,427	586	121	20.6	109,406	1,753
Mountain	**868**	**528**	**83**	**15.7**	**67,863**	**1,414**
Colorado	201	99	17	17.2	30,001	426
Idaho	287	115	14	12.2	5,288	180
Montana	49	48	11	22.9	11,203	277
Nevada	78	72	11	15.3	2,141	67
Utah	159	101	19	18.8	18,028	405
Wyoming	94	93	11	11.8	1,202	59
Northeast	**8,070**	**3,660**	**557**	**15.2**	**573,158**	**7,602**
Connecticut	278	108	23	21.3	55,028	557
Delaware	131	131	25	19.1	3,017	41
Massachusetts	180	101	20	19.8	47,105	692
Maine	800	223	44	19.7	8,680	149
New Hampshire	58	56	16	28.6	24,616	393
New Jersey	959	443	64	14.4	113,275	1,106
New York	2,678	1,339	177	13.2	225,331	2,460
Pennsylvania	2,686	1,072	156	14.6	85,918	1,902
Rhode Island	87	86	12	14.0	6,770	168
Vermont	212	101	20	19.8	3,416	134
Pacific	**5,007**	**1,855**	**316**	**17.0**	**472,103**	**7,728**
California	2,504	1,004	128	12.7	201,360	3,212
Hawaii	313	99	14	14.1	34,314	168
Oregon	1,781	599	148	24.7	227,839	4,099
Washington	409	153	26	17.0	8,590	249
South Central	**3,802**	**1,440**	**169**	**11.7**	**180,386**	**4,542**
Arkansas	121	121	28	23.1	5,708	212
Louisiana	881	316	44	13.9	24,773	725
New Mexico	173	100	17	17.0	12,416	224
Oklahoma	468	167	15	9.0	49,343	860
Texas	2,158	736	65	8.8	88,146	2,521
Southeast	**6,946**	**3,711**	**584**	**15.7**	**719,491**	**8,440**
Florida	4,498	2,854	474	16.6	603,828	7,146
Georgia	1,279	421	56	13.3	55,957	902
Mississippi	500	177	22	12.4	34,665	223
South Carolina	669	259	32	12.4	25,041	169
All states/regions	**34,852**	**15,588**	**2,485**	**15.9**	**2,728,850**	**42,759**

Results and Discussion

A total of 2485 usable questionnaires were returned, representing an overall response rate of 15.9% (Table 1). The largest number of respondents were in the Northeast (557), Southeast (584), Midwest (418), Pacific (316), and Appalachian regions (302) followed by the South Central (169), Great Plains (56), and Mountain (83) regions (Table 1).

Information on annual sales for each firm was collected as an approximate value or as a range of values with a point estimate at the midpoint or average of the sales range reported (Table 2). Sales for each product type, market channel, and region were estimated from the annual sales together with the percentage share reported by each firm. Nursery sales in 2003 reported by survey respondents totaled $2.73 billion, which represented average sales of $1.15 million per firm. Over half (55%) of firms had sales of less than $250,000, 21% of firms had sales of $250,000 to $999,000, 18% had sales of $1 to $9 million, and 2.3% had sales of $10 million or greater. Approximately 4.5% of firms did not provide sales information. Firms with at least $1 million in sales represented 20% of respondents and accounted for 88% of total sales reported. Missing data on sales were estimated for some respondents who reported employment based on average sales per employee. USDA (Jerardo, 2007) reported 2003 wholesale value of sales for 7742 nursery firms at $3.97 billion.

Permanent and temporary employment. Survey respondents reported a total of 42,759 employees in 2003, of which 53% were full-time and 47% were temporary, part-time, or seasonal employees. Approximately two-thirds (66%) of respondents reported hiring temporary employees. The overall average number of employees per firm was 9.9 permanent and 8.9 temporary. Total sales per employee averaged $58,600. Firms in the Pacific region had the highest mean permanent employment (18.7) followed by the South Central and Southeast (Table 3). Firms in the Great Plains, Midwest, Mountain, and Northeast regions had the lowest permanent employment but the highest employment of temporary, part-time, or seasonal employees, indicating a higher reliance on temporary labor in these regions with reduced business activity during cold winter periods. Over half (57%) of firms indicated that their employment had remained the same over the past 5 years, whereas 29% reported that it had increased and 15% said it had decreased. Firms in the Mountain and Southeast

regions had the highest percentage change in permanent employment (greater than 16%), whereas the Great Plains had the lowest (6%). There were no regional differences in percentage change in temporary employment.

Nursery rooting media systems. Container-grown products were the dominant root packaging category in 35 of the 44 states in the survey with an overall average of 51.8% of respondents, and there were four regions for which more than half the sales were containerized plant materials (Table 4). One would expect the share of containerized plant sales to be highest in the Southeast, South Central, and Pacific regions, which have minimal risk of freeze damage to roots, and indeed this was the case. Sales of balled and burlapped (B&B) plants were a distant second with an overall share of 16.3% and the greatest number being sold in the Midwest region (33.5% of sales). Bare root sales ranged from only 5% of sales in the Northeast to nearly 15% in the South Central region. The means for the "other" category were not separated because it included the combined sales of balled and potted, processed balled, field grow-bags, in-ground containers (pot-in-pot), and other unspecified product forms. Pot-in-pot production systems, although becoming increasingly popular, represented less than 2% of sales in all regions, ranging from 0.4% in the Pacific to 1.8% in the Great Plains region.

Irrigation. Availability of water supplies for irrigation by nursery producers is an increasingly critical issue in many parts of the United States. A section of the survey inquired about sources of irrigation water and changes in water use over the past 5 years. The categories of sources of irrigation water were natural surface, recaptured, city, or wells. Overall, 51.6% of all respondents used irrigation water supplied by wells, although this ranged from 27% in the Appalachian region to nearly 72% in the Southeast (Table 5). Natural surface water was the next most important source and supplied water for 26.5% of respondents overall, but ranged from 14% in the South Central region to 45% in the Appalachian region. Recaptured water was a source for less than 5% percent of respondents, except in the Appalachian region (8.6%). City water was most important in the Mountain, Pacific, and South Central regions with 20.8%, 24.3%, and 29.6% of respondents using this source, respectively.

Another survey question asked whether use of irrigation water over the past 5 years (on a per-acre basis) had increased, remained the same, or decreased. If there was a change, respondents were asked to provide a percentage estimate. In general, it appeared that the majority of firms held water use on a per-acre basis constant, whereas most of the remaining share of firms increased rather than decreased water use. Nurseries in the Southeast, Mountain, and Pacific regions maintained relative constant use of water, whereas more of the Great Plains, Northeast, Midwest, Appalachian, and South Central region nurseries indicated a slight increase in the

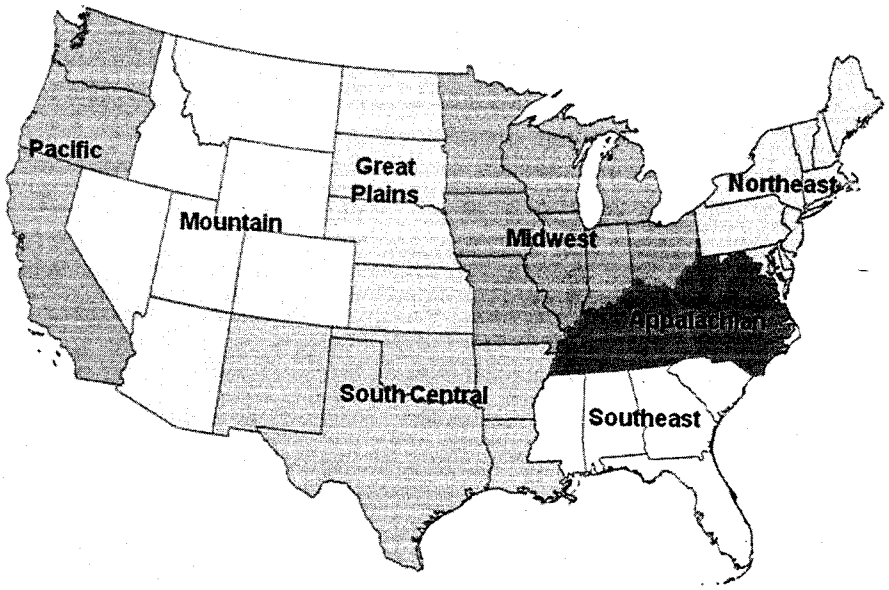

Fig. 1. U.S. regions for analysis of the nursery industry. Note: Pacific region includes Hawaii.

Table 2. Sales for 2003 reported by U.S. nursery firms responding to the *National Nursery Survey*.

Annual sales range	Midpoint or avg value[z] ($1,000)	Respondents		Total sales	
		Number	Percent	$1,000	Percent
<$250,000	40.6	1,367	55.0	55,314	2.0
$250,000 to $499,999	367.4	264	10.6	96,986	3.6
$500,000 to $999,999	703.5	248	10.0	174,466	6.4
$1 to $1.99 million (Mn)	1,447.7	201	8.1	290,991	10.7
$2 to $2.99 Mn	2,388.5	99	4.0	236,459	8.7
$3 to $3.99 Mn	3,440.0	44	1.8	151,360	5.5
$4 to $4.99 Mn	4,250.0	19	0.8	80,750	3.0
$5 to $9.99 Mn	7,425.0	74	3.0	549,450	20.1
$10 to $14.99 Mn	12,500.0	24	1.0	297,000	10.9
$15 to $19.99 Mn	17,500.0	8	0.3	140,000	5.1
≥$20 Mn	20,000.0	26	1.0	656,075	24.0
Not available	NA	111	4.5	NA	NA
Total/all		2485	100	2,728,850	100

[z]Average value for firms reporting actual sales.
NA = not applicable.

Table 3. Mean and percent change in number of permanent and temporary nursery employees in nurseries surveyed in eight U.S. regions in 2003[z].

Region	Permanent employees (mean)	Temporary employees (mean)	Permanent employees changed (percent)	Temporary employees changed (percent)
Appalachia	9.6 bc	8.0 ab	14.4 ab	17.5 a
Great Plains	4.9 c	13.6 a	6.3 b	15.1 a
Midwest	6.2 c	13.2 a	8.6 ab	12.9 a
Mountain	7.5 c	14.3 a	16.2 a	13.1 a
Northeast	6.8 c	9.3 ab	9.8 ab	12.2 a
Pacific	18.7 a	11.2 a	12.7 ab	12.5 a
South Central	17.3 ab	12.6 a	12.5 ab	12.7 a
Southeast	11.6 abc	4.5 b	16.5 a	10.7 a
All regions	9.9	8.9	1.5	12.2

[z]Table entries followed by different letters indicate statistically different values ($P < 0.05$ level).

Table 4. Rooting media systems used in by surveyed nurseries in eight U.S. regions in 2003[z].

Region	Container	Bare root	Balled and burlapped	Other media
	Percent of respondents			
Appalachia	40.5 c	10.6 abc	28.5 cd	16.2
Great Plains	30.5 b	7.9 ab	23.3 bc	38.3
Midwest	30.0 b	9.0 abc	33.5 d	24.6
Mountain	54.5 ad	7.6 ab	23.8 bc	11.8
Northeast	49.3 cd	5.3 a	20.1 b	22.5
Pacific	60.8 a	12.6 bc	6.5 a	15.3
Southeast	72.7 e	6.6 ab	10.5 a	14.2
South Central	60.7 a	14.5 c	6.5 a	8.4
All regions	51.8	8.4	18.6	18.0

[z]Table entries followed by different letters indicate statistically different values ($P < 0.05$). Note that percentages may not sum to 100% within each region as a result of independent values reported.

Table 5. Water sources used for irrigation by surveyed nurseries in eight U.S. regions in 2003[z].

Region	Wells	Natural surface	Recaptured	City (municipal)
	Percent of respondents using			
Appalachia	27.2 c	45.1 c	8.6 b	15.4 c
Great Plains	62.2 b	18.6 ab	2.5 a	12.5 ab
Midwest	44.8 a	39.8 c	3.5 a	6.3 a
Mountain	51.9 a	22.9 ab	4.4 a	20.8 c
Northeast	49.6 a	27.8 b	3.5 a	14.6 bc
Pacific	49.9 a	19.9 ab	3.8 a	24.3 c
Southeast	71.6 b	16.1 a	3.7 a	6.6 a
South Central	49.8 a	13.5 a	4.7 a	29.6 c
All regions	51.1	26.5	4.3	14.3

[z]Table entries followed by different letters indicate statistically different values ($P < 0.05$). Note that percentages may not sum to 100% within each region as a result of independent values reported.

Table 6. Irrigation methods used by surveyed nurseries in eight U.S. regions in 2003[z].

Region	Overhead irrigation	Drip irrigation	Subirrigation	Other methods
	Percent of respondents using			
Appalachia	64.4 a	38.0 a	1.6 a	8.0 c
Great Plains	41.7 b	37.5 a	10.4 c	20.8 b
Midwest	55.4 a	33.5 a	3.1 ab	13.5 abc
Mountain	65.9 a	46.6 ab	22.7 d	13.6 abc
Northeast	58.5 a	39.1 a	5.2 abc	14.4 abc
Pacific	63.8 a	44.7 ab	6.4 abc	18.7 ab
Southeast	77.6 c	52.4 b	4.6 abc	10.1 ac
South Central	61.6 a	39.1 a	7.5 bc	18.8 ab
All regions	62.7	40.6	5.3	13.4

[z]Table entries followed by different letters indicate statistically different values ($P < 0.05$). Note that percentages may not sum to 100% within each region as a result of independent values reported.

Table 7. Native plant sales as a percentage of total sales by surveyed nurseries in eight U.S. regions in 2003[z].

Region	Percent of sales
Appalachia	27.1 a
Great Plains	25.9 a
Midwest	23.2 a
Mountain	23.9 a
Northeast	19.7 ab
Pacific	13.2 b
South Central	23.9 a
Southeast	22.5 a
All regions	21.9

[z]Table entries followed by different letters indicate statistically different values ($P < 0.05$).

amount of water used on a per-acre basis. The change in irrigation water used ranged from a 6.9% increase in the Mountain region to a 12.1%, 12.8%, and 15.5% increase in the Appalachian, Northeast, and South Central regions, respectively.

Overhead irrigation systems were used by the majority of nursery firms responding, ranging from 42% usage in the Great Plains to 78% in the Southeast (Table 6). Other major irrigation systems used included drip irrigation, particularly in the Pacific (44.7%), Mountain (46.6%), and Southeast (52.4%) regions. Subirrigation methods were seldom used except in the Great Plains (10.4%) and Mountain (22.7%) regions. Almost 21% of the Great Plains nurseries used irrigation systems other than those specified. Note that respondents were allowed to choose more than one type of water source or irrigation system, so percentages may not sum to 100%.

Native plants. Native plants have become increasingly important in the U.S. nursery industry as a result of growing consumer awareness about invasive exotics and mandates by local governments that specify a minimum percentage of natives in new landscapes (Zimmerman and Ankersen, 2005). Native plants were defined in the survey questionnaire as those present in a state before European settlement. This question simply asked for the percent of total sales of native plants. Annual sales values provided by the respondents were used to weight the sales percentages reported for this question. For the total sample, 21.9% of total sales were accounted for by native plants in 2003. Table 7 presents the breakdown of sales of native plants by region.

Integrated pest management. Integrated pest management has become an established approach to pest management in the nursery and greenhouse industry in the face of increased chemical and application costs, chemical resistance of pests, and worker safety and environmental issues. Use of IPM practices was assessed for the first time in the most recent *National Nursery Survey*. The most commonly used practices (Table 8), reported by at least half of respondents, were removing infested plants or plant parts (88%), cultivation and hand weeding (77%), spot treatment with pesticides instead of broadcast spraying (73%), inspecting incoming stock for insects/diseases (72%), alternating pesticides to avoid pesticide resistance (63%), and elevating plants for air circulation (60%). Other common practices used by one-third to one-half of respondents were ventilating greenhouses (45%), adjusting fertilization

Table 8. Integrated pest management (IPM) practices used by surveyed nurseries in eight U.S. regions in 2003[z].

Practice	Appalachian	Great Plains	Midwest	Mountain	Northeast	Pacific	South Central	Southeast
	Percent of respondents practicing							
Remove infested plants or plant parts	87.6 a	93.8 a	90.2 a	86.4 a	91.0 a	86.4 a	85.7 a	88.5 a
Alternate pesticides to avoid pesticide resistance	65.6 ab	54.2 b	57.5 b	55.7 b	59.7 b	63.4 ab	57.1 b	73.9 a
Elevate or space plants for air circulation	57.2 bc	52.1 c	51.4 c	51.1 c	63.3 abc	68.5 ab	60.2 abc	69.7 a
Use cultivation, hand weeding	74.0 b	87.5 a	73.5 b	80.7 ab	73.9 b	86.0 a	79.7 ab	82.1 ab
Disinfect benches/groundcover	32.4 b	31.3 bc	20.3 c	38.6 ab	40.5 ab	44.7 a	28.6 bc	44.9 a
Use sanitized water foot baths	1.6 a	0.0 a	2.2 a	1.1 a	3.1 a	2.1 a	1.5 a	3.1 a
Soil solarization or sterilization	8.4 a	10.4 a	6.2 a	12.5 a	9.5 a	12.3 a	12.0 a	9.7 a
Monitor pest populations with tarp or sticky boards	23.2 b	25.0 b	19.4 b	36.4 a	35.3 a	39.6 a	20.3 b	15.5 b
Adjust pesticide application to protect beneficials	39.6 a	29.2 a	37.5 a	36.4 a	37.2 a	35.7 a	34.6 a	38.3 a
Use mulches to suppress weeds	31.2 de	58.3 a	44.3 bc	51.1 ab	45.3 bc	40.4 bcd	33.8 cde	24.6 d
Beneficial insect identification	32.4 a	27.1 a	36.0 a	33.0 a	32.0 a	31.9 a	32.3 a	29.2 a
Inspect incoming stock	75.2 a	70.8 ab	68.9 ab	78.4 a	74.6 a	76.2 a	63.2 b	75.9 a
Manage irrigation to reduce pests	34.8 bc	27.1 c	31.7 bc	42.0 ab	32.2 bc	51.5 a	38.3 bc	52.4 a
Spot treatment with pesticides	76.4 abc	81.3 a	75.4 abc	77.3 ab	70.1 abc	67.7 bc	65.4 c	77.0 ab
Ventilate greenhouses	42.8 bc	41.7 c	27.7 d	54.5 ab	49.1 abc	60.4 a	53.4 abc	48.0 abc
Use of beneficial insects	12.8 c	12.5 c	12.0 c	22.7 ab	15.9 bc	26.8 a	24.1 ab	15.0 bc
Keep pest activity records	28.8 b	20.8 bc	24.3 bc	39.8 a	28.7 b	24.7 bc	15.8 c	26.5 bc
Adjust fertilization rates	53.6 ab	29.2 e	35.4 de	39.8 cde	41.2 bcde	51.5 abc	45.1 abcd	56.0 a
Use screening or barriers to exclude pests	7.2 b	8.3 b	7.4 b	14.8 ab	12.1ab	17.4 a	13.5 ab	15.7 ab
Use biopesticides or lower toxicity pesticides	15.2 bcd	8.3 d	13.2 cd	25.0 ab	19.2 abc	27.2 a	20.3 abc	20.6 abc
Treat retention pond water	8.8 a	0.0 c	2.8 bc	4.5 abc	3.1 bc	6.0 ab	2.3 bc	6.2 ab
Use pest resistant varieties	40.0 abc	33.3 c	46.2 ab	50.0 a	41.7 abc	31.9 c	29.3 c	35.6 bc

[z]Table entries followed by different letters indicate statistically different values ($P < 0.05$).

rates to control weed/pest growth (45%), managing irrigation to reduce pests (39%), using pest-resistant varieties (38%), using mulches to suppress weeds (37%), adjusting pesticide application to protect beneficials (37%), and disinfecting benches or groundcovers (36%).

Significant regional differences were seen in many of the IPM practices. In the Southeast region, where pest pressures are generally very high, there were high rates of practices to alternate pesticides to avoid chemical resistance (74%), elevate or space plants for air circulation (70%), adjust fertilization rates (56%), manage irrigation to reduce pests (52%), and disinfest benches or groundcover (45%). The Pacific region had similarly high levels of some of these same practices and, in addition, cultivation/hand weeding (86%), ventilate greenhouses (60%), use of biopesticides or reduced toxicity pesticides (27%), and use of beneficial insects (27%). The Great Plains and Mountain regions had high use of mulches to suppress weeds, cultivation/hand weeding, and spot treatment with pesticides. The use of beneficial insects was also high in the Mountain (23%) and South Central (24%) regions. Practices that did not significantly vary regionally included removing infested plants or plant parts, using sanitized water foot baths, soil solarization, beneficial insect identification, adjusting pesticide application to protect beneficials, and inspecting incoming stock.

Table 9. Brokerage practices by surveyed nurseries in eight U.S. regions in 2003[z].

Region	Firms brokering plants (percent)	Sales brokered (percent)
Appalachia	44.8 b	11.2 b
Great Plains	52.1 ab	18.9 a
Midwest	55.4 ab	15.6 ab
Mountain	60.2 a	17.9 ab
Northeast	51.9 ab	15.1 ab
Pacific	44.6 b	13.0 ab
South Central	50.4 ab	17.3 ab
Southeast	50.6 ab	15.3 ab
All regions	49.4	15.0

[z]Table entries followed by different letters indicate statistically different values ($P < 0.05$).

Brokerage. The U.S. nursery industry has a high level of trade among producing firms with sales to other growers now accounting for the largest share of sales to any single market channel. Historically, many nursery growers have engaged in brokerage for other producers to make up large orders or as a service by companies with well-developed marketing programs. Overall, ≈49% of firms reported having some brokerage activity in 2003. This ranged from a high of 60% in the Mountain region to a low of 45% in the Appalachian and Pacific regions (Table 9). Among firms engaged in brokerage, brokered sales accounted for 32% of total sales, whereas for all firms, brokerage represented 15% of sales. Brokered sales represented the highest share of total sales in the Great Plains region (18.9%) and the lowest share in the Appalachians (11.2%).

Production contracting. Forward production contracting is an important strategy to reduce market risk for nursery products by establishing a price and quantity to be sold in advance. Approximately 30% of survey respondents reportedly engaged in this practice in 2003. Although contracted sales accounted for only ≈11% of total sales nationwide, it accounted for 37% of sales for the firms that engaged in this activity. The share of contract sales was highest in the Pacific region (16%) and lowest in the Great Plains (9%) (Table 10). Commonly, production was contracted with retail garden centers and other producers, each representing 11% to 20% of survey respondents regionally, although these percentages did not differ statistically. Miscellaneous other buyers also were an important market for contract sales, with the highest share of firms in the Mountain (24%) and South Central (23%) regions and lowest in the Great Plains (10%). Mass merchandisers were a significant market for production contracting by a relatively small percentage of all firms (5.2%), most commonly in the South Central region (11%); however, this outlet represented ≈9.3% of total sales in the industry.

Table 10. Product contracting by surveyed nurseries in eight U.S. regions in 2003[z].

Region	Share of production contracted (Percent)	Other producers	Retail garden centers	Mass merchandisers	Cooperatives	Other buyers
		Percent of respondents contracting by market channel				
Appalachia	12.2 ab	17.2 a	13.6 a	8.4 ab	3.2 a	11.6 bc
Great Plains	8.7 b	14.6 a	18.8 a	0.0 c	2.0 a	10.4 c
Midwest	11.5 ab	12.6 a	12.9 a	2.5 bc	1.5 a	12.0 bc
Mountain	12.1 ab	13.6 a	14.8 a	7.9 ab	1.1 a	23.9 a
Northeast	6.7 b	11.4 a	16.8 a	4.0 bc	1.7 a	12.6 bc
Pacific	16.0 a	20.4 a	14.5 a	5.5 abc	1.3 a	20.4 ab
South Central	10.5 ab	15.0 a	12.0 a	11.3 a	0.0 a	23.3 a
Southeast	11.9 ab	18.8 a	12.4 a	6.4 ab	1.3 a	18.1 abc
All regions	10.9	15.4	13.8	5.2	1.6	15.8

[z]Table entries followed by different letters indicate statistically different values ($P < 0.05$).

Computerization. Respondents were asked to indicate whether they currently use, or planned to use, 12 different functions that involved a computer in their nursery operations within the next 5 years. If the appropriate spaces beside a function were left unchecked, the blank was interpreted to mean the function was not currently used and that the respondent did not plan to begin using a computer for that function during the next 5 years.

Word processing was the leading function for which nursery professionals use a computer. Overall, 65.8% of the respondents reported word processing as a current computer activity (Fig. 2). This was closely followed by e-mail communications (59.9%) and accounting functions (59.0%) within the nursery. Inventory control was the next most important business function computerized at 40.5% with 11.6% of the respondents indicating they were planning to implement computerized inventory control over the next 5 years.

The Mountain region is by far the most computerized among all regions (Table 11), ranking among the top three regions in each category of business function computerized

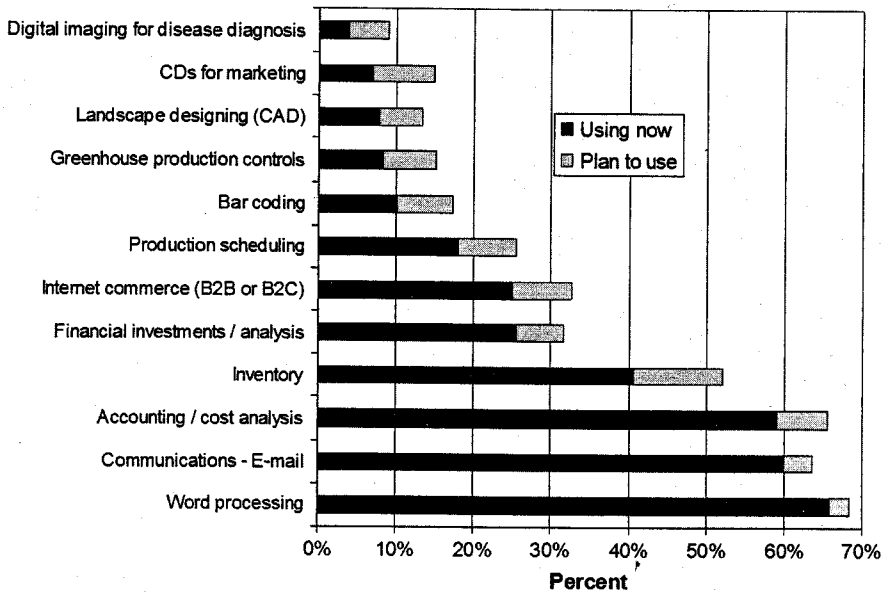

Fig. 2. Percent of surveyed U.S. nursery firms currently using (in 2003) or planning to use computers in the next 5 years by function.

Table 11. Rank order of computerization for selected business functions in U.S. nurseries surveyed in eight regions in 2003.

Business function	Appalachian	Great Plains	Midwest	Mountain	Northeast	Pacific	South Central	Southeast
	Ordinal ranking among regions[z]							
Word processing	4	7	5	1	8	3	2	6
Communications, e-mail	4	5	7	1	8	2	3	6
Accounting, cost analysis	4	8	6	1	7	2	3	5
Inventory	4	8	3	1	7	2	5	6
Financial analysis, investments	4	8	2	1	7	3	5	6
Internet commerce	7	8	5	1	6	2	3	4
Production scheduling	3	8	4	1	6	2	7	5
Bar coding	3	8	7	1	6	2	4	5
Greenhouse control	4	8	6	2	5	1	7	3
Landscape design (CAD)	6	1	2	3	4	8	5	7
CDs for marketing	6	8	5	1	7	4	3	2
Digital imaging for disease diagnosis	4	8	6	7	3	5	1	2
Mean ranking	4.4	7.1	4.8	1.8	6.2	3.0	4.0	4.8

[z]Ranking score of 1 = highest, 8 = lowest.

with the exception of digital imaging for disease diagnosis (where the region ranked seventh). In fact, the Mountain region was first in nine of 12 categories. The Pacific and South Central regions also were heavily computerized, closely followed by the Appalachian, Midwest, and Southeast regions. The Northeast and Great Plains regions were well below their regional counterparts with respect to their computer use with the exception of landscape design functions in the Great Plains and digital imaging functions in the Northeast where they ranked first and third, respectively.

Conclusions

This analysis of national survey data for the nursery and greenhouse industry in the United States showed that there are distinct regional differences in production practices and technology use. In general, firms in the northern and interior regions of the country with more seasonal activity made greater use of temporary labor. Containerized growing systems are the predominant system throughout the United States; however, firms in the Southeast, South Central, and Pacific coast regions, which experience warmer winter weather and lower risk of freeze damage, use this system to a greater degree, whereas firms in other regions also commonly used bare root and B&B systems. Regions with higher overall pest pressures as a result of warm and humid conditions, particularly the southeast United States, were found to practice IPM more prevalently. Most regions had a significant share of total production from native American plants, approaching or exceeding 20% of total sales, except in the Pacific region (13%). In some regions, forward-contracting accounted for a significantly higher share of total sales, perhaps indicating greater aversion to market risk. The Mountain region stands out for its high level of adoption of computer technologies for production, marketing, and management. Data on water use and irrigation technology did not indicate any clear pattern with respect to regional differences in relation to water scarcity.

Given the reduction over time in the number of states included in USDA nursery reports, this study provides useful insight into a broader perspective of the nursery industry with regional comparisons. The next *National Nursery Survey* will be conducted in Jan. 2009.

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