Bulletin 1208 December 2014

Current Mechanization Practices Among Greenhouse and Mixed Nursery/Greenhouse Operations *in Selected Gulf South States*

MAFES
Mississippi Agricultural & Forestry Experiment Station • George M. Hopper, Director
Mississippi State University • Mark E. Keenum, President • Gregory A. Bohach, Vice President

Current Mechanization Practices Among Greenhouse and Mixed Nursery/Greenhouse Operations in Selected Southern States

Randal Y. Coker
Research Associate I
Coastal Research and Extension Center
Mississippi State University

Benedict C. Posadas
Associate Extension/Research Professor
Coastal Research and Extension Center
Mississippi State University

Scott A. Langlois
Research Associate III
Coastal Research and Extension Center
Mississippi State University

Patricia R. Knight
Extension/Research Professor and Head
Coastal Research and Extension Center
Mississippi State University

Christine H. Coker
Associate Extension/Research Professor
Coastal Research and Extension Center
Mississippi State University

This research was supported in part by the U.S. Department of Labor, Employment, and Training Administration and the U.S. Department of Agriculture, Cooperative State Research, Education, and Extension Service Hatch project MIS-249110. It was approved for publication as MAFES Bulletin 1208 of the Mississippi Agricultural and Forestry Experiment Station. This bulletin was published by the Office of Agricultural Communications, a unit of the Division of Agriculture, Forestry, and Veterinary Medicine at Mississippi State University.

Current Mechanization Practices Among Greenhouse and Mixed Nursery/Greenhouse Operations in Selected Southern States

Introduction

The nursery and greenhouse industry generates a significant economic impact in selected Southern states. Its estimated annual economic impact in the region amounted to $11.65 billion, with Florida, Georgia, Louisiana, and Tennessee contributing $5.73 billion, $1.47 billion, $1.158 billion, and $1.01 billion, respectively (Hodges et al. 2011). Alabama, North Carolina, South Carolina, and Mississippi contributed $931 million, $829 million, $281 million, and $234 million, respectively (Hodges et al. 2011). In addition, the nursery and greenhouse industry created 134,566 jobs throughout the region (Hodges et al. 2011).

Nursery and greenhouse growers expect to see an increase in production capability and efficiency through adoption of mechanized or automated technologies, as well as improved working conditions and worker safety. Commercial greenhouse systems—which most often have controlled and structured environments, along with a large number of highly repetitive tasks—offer many advantages to automation over other segments of agriculture (Simonton 1992).

We conducted a survey of nurseries and greenhouses in selected Southern states as part of a research project undertaken by the Mississippi Agricultural and Forestry Experiment Station and the U.S. Department of Labor entitled "Enhancing Labor Performance of the Green Industry in the Gulf South." The overall goal of the survey was to develop a socioeconomic profile of nursery and greenhouse workers and to evaluate the impact of automation on their employment, earnings, safety, skill levels, and retention rates (Posadas et al. 2004).

Results from the survey were presented in publications dealing with the socioeconomic characteristics of workers and working conditions (Posadas et al. 2005; Posadas et al. 2009, 2010b), socioeconomic characteristics of managers and operators (Posadas et al. 2010c), socioeconomic impact of automation and mechanization (Posadas et al. 2008a, Posadas 2012), and operational characteristics of nurseries and greenhouses (Posadas et al. 2008b, 2010a). An earlier bulletin summarized the types and levels of automation or mechanization in use among participating nursery-only and mixed operations (Coker et al. 2010).

This bulletin presents an overview of the types and levels of automation or mechanization employed by workers in participating greenhouses and mixed nursery/greenhouse operations when performing major tasks. Mechanization can be defined as "to equip with machinery, especially to replace human or animal labor" and automation as "automatically controlled operation of an apparatus, process, or system by mechanical or electronic devices that take the place of human labor" (Merriam-Webster 2012). Of the nurseries and greenhouses participating in the survey, those that experienced higher levels of sales also demonstrated higher levels of automation or mechanization (Posadas et al. 2008b; Posadas 2012). The employment impact of automation or mechanization was neutral, indicating that any improvement in automation or mechanization did not necessarily lead to a reduction of labor, but rather a more efficient use of labor. Improvements in automation or mechanization resulted in higher total worker earnings reported by participating nurseries and greenhouses.

Materials and Methods

The socioeconomic survey of wholesale nurseries and greenhouses in eight Southern states (Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee) was conducted between December 2003 and November 2009. This length of time was required due to the distance traveled to complete the surveys, as well as the availability of the growers to meet with the survey administrator.

We retrieved official lists of certified nurseries from the Mississippi Department of Agriculture and Commerce (2003), the Alabama Department of Agriculture and Industries (2004), the Louisiana Department of Agriculture and Forestry (2005), the South Carolina Department of Agriculture (2006), the Florida Department of Agriculture (2005), the North Carolina Department of Agriculture (2008), the Georgia Department of Agriculture (2007), and the Tennessee Nursery and Landscape Association Nursery Buyer's Guide (2006). Additional information about the growers came from industry buyer's guides (Alabama Nursery and Landscape Association, 2004; Louisiana Nursery and Landscape Association, 2005) and an earlier draft of a Mississippi State University Extension Service reference guide to nurseries (Johnson and Wells 2007).

Only wholesale growers operating throughout seven of the states, along with north Florida, were included in the selection of survey participants. In Florida, nurseries were randomly selected from the listing using only the nurseries in counties from Alachua County and north. A random sample of 50 growers was generated in each state. These selected growers were contacted via mail and asked to return a postcard indicating their willingness to participate in the survey. Those nurseries indicating a willingness to participate were then contacted by phone, and interviews were scheduled.

Two hundred and fifteen personal interviews were completed with wholesale nurseries (N=88), greenhouses (N=52), and mixed nursery and greenhouse operations (N=75) in Alabama (26), Florida (27), Georgia (24), Louisiana (29), Mississippi (32), North Carolina (30), South Carolina (30), and Tennessee (17). Due to differences in types of automation or mechanization, the greenhouse-only and mixed nursery/greenhouse operations were used for the purposes of this study, for a total of 127 growers.

We performed the statistical comparison using Chi-square tests and frequency distributions within each method of automation or mechanization employed by greenhouse-only operations and mixed nursery/greenhouse operations using SPSS version 16.0 for Windows (SPSS Inc. 2008). We used the Chi-square test to determine the differences within each method of automation or mechanization employed by greenhouse-only and mixed operations. Results of the Chi-square tests indicated there were differences in the methods of mechanization or automation employed by greenhouse-only and mixed operations. We calculated frequency distributions for several greenhouse tasks by method of mechanization of automation and type of operation: media preparation, container filling, cutting and seed collection, cutting and seed preparation, sticking cuttings and planting seed, environmental control, harvesting and grading production, fertilizer application, pesticide application, and irrigation application and management.

Current Mechanization Practices

Media Preparation

Of the growers surveyed, 63.5% of the greenhouse-only operations and 41.3% of the mixed operations purchased the substrate used in their production practices (Table 1). Approximately 13.5% of greenhouse-only operations and 25.3% of the mixed operations did not specify the method they used in preparing media. About 5.8% of the greenhouse-only operations and 17.4% of the mixed operations prepared media manually.

Around 9.6% of greenhouse-only operations and 2.7% of mixed operations reported using pot fillers. Pot fillers were reported to range in cost from $8,000 to $45,000 and required up to nine people to operate them. This equipment generally includes a mixing bin that mixes and prepares the media.

About 3.8% of the greenhouse-only operations and 1.3% of the mixed operations reported using front-end loaders to prepare media. Tractors and scoops were used by 3.7% of greenhouse-only operations and 1.3% of mixed operations.

Approximately 6.7% of the mixed operations reported using mixers for media preparation, while none of the greenhouse-only firms employed this technique. Compost tumblers, shovels and glue plugs were used by 1.3% of mixed operations. No greenhouse-only operations use these items.

Table 1. Percentage distribution of greenhouse operations by method of media preparation and type of operations.[1]

Method	Greenhouse only (N=52)	Mixed operations (N=75)	Total (N=127)
Purchased	63.5	41.3	50.4
Manually	5.8	17.4	12.6
Pot Filler	9.6	2.7	5.5
Mixer	0.0	6.7	3.9
Front end loaders	3.8	1.3	2.4
Tractor and scoop	3.7	1.3	2.4
Compost tumbler	0.0	1.3	0.8
Shovel	0.0	1.3	0.8
Glue plugs	0.0	1.3	0.8
Unspecified	13.5	25.3	20.5
Total	100.0	100.0	100.0

[1]Chi-square test indicates results are significant at P≤0.05.

Container Filling

With regard to filling containers, 46.2% of greenhouse-only operations and 28% of mixed operations used pot fillers (Table 2). These machines range in cost from $1,000 to $45,000 and generally required up to nine people to operate, as reported in the survey.

For 42.3% of the greenhouse-only firms and 32% of the mixed operations, container filling was performed manually. Approximately 7.7% of the greenhouse-only firms and 30.7% of mixed operations did not specify their methods of container filling.

Use of shovels and brushes was reported by 1.9% of greenhouse-only firms but no mixed operations. Around 1.9% of greenhouse-only and 2.7% of mixed operations used shovels only.

A type of mixer or loader was used by 2.7% of mixed operations. None of the greenhouse-only firms were found to employ this machinery. Around 1.3% of the mixed operations used bale busters, but none of the greenhouse-only firms reported using this equipment.

Table 2. Percentage distribution of greenhouse operations by method of container filling and type of operations.[1]

Method	Greenhouse only (N=52)	Mixed operations (N=75)	Total (N=127)
Manually	42.3	32.0	36.2
Pot filler	46.2	28.0	35.4
Shovels	1.9	2.7	2.4
Loaders	0.0	2.7	1.6
Mixer	0.0	2.7	1.6
Bale buster	0.0	1.3	0.8
Shovel and brush	1.9	0.0	0.8
Unspecified	7.7	30.7	21.3
Total	100.0	100.0	100.0

[1]Chi-square test indicates results are significant at P≤0.05.

Cutting and Seed Collection

Approximately 51.9% of greenhouse-only operations and 14.7% of mixed operations purchased their cuttings/seeds (Table 3). Approximately 30.8% of greenhouse-only firms and 48% of mixed operations reported

manual collection. Approximately 17.3% of greenhouse-only firms and 36% of mixed operations did not specify a method of collection.

Use of scissors or pruning shears was reported by 1.3% of the mixed operations but none of the greenhouse-only operations. The cost of scissors or pruning shears was reported to range from $10 to $25, and they were used by three to six people at the firms.

Cutting and Seed Preparation

Less than 70% of greenhouse-only firms and 54.7% of mixed operations reported that cuttings and seeds were prepared manually (Table 4). Approximately 17.3 of greenhouse-only operations and 38.7% of mixed operations did not specify the methods of preparing cuttings and seeds. Cuttings and seeds were purchased by 11.5% of greenhouse-only firms and 1.3% of mixed firms.

Use of a seeders was reported by 1.9% of greenhouses and by 5.3% of mixed operations. These seeders were reported to range in cost from $1,000 to $60,000 and required up to six people to operate.

Sticking Cuttings and Planting Seeds

With regard to sticking cuttings or planting seed, 63.5% of greenhouse-only firms and 65.3% of the mixed operations reported performing this task manually (Table 5). No methods of sticking cuttings and planting seeds were specified by 28% of mixed operations and 13.5% of greenhouse-only firms.

Use of seeders was reported by 13.5% of greenhouse-only operations and 5.3% of the mixed operations. Use of pot fillers was reported by 9.6% of greenhouse-only companies but no mixed operations. Soil mixers were used by 1.3% of the mixed operations but no greenhouse-only operations. Pot fillers were reported to range in cost from $8,000 to $30,000 and required from up to nine workers to operate. Seeders were reported to cost between $1,000 and $60,000 and needed up to six people to operate.

Environmental Control

No method of environmental control was specified by 11.5% of the greenhouse-only firms and 33.3% of the mixed operations (Table 6). Approximately 53.5% of the greenhouse-only operations reported employing some combination of heaters, fans, cooling pads, roll-up sides, thermostats, and computers, while 30.8% of the mixed operations use this equipment. This type of equipment was reported to cost from $8,000 to $100,000 and generally required one or two people to control.

Combinations of roll-up sides and auto roofs were reported by 19.2% of the greenhouse-only firms but none of the mixed operations. These types of environmental control devices were reported to cost between

Table 3. Percentage distribution of greenhouse operations by method of cutting and seed collection and type of operations.[1]

Method	Greenhouse only (N=52)	Mixed operations (N=75)	Total (N=127)
Manually	30.8	48.0	40.9
Purchased	51.9	14.7	29.9
Scissors/pruning shears	0.0	1.3	0.8
Unspecified	17.3	36.0	28.3
Total	100.0	100.0	100.0

[1]Chi-square test indicates results are significant at P≤0.05.

Table 4. Percentage distribution of greenhouse operations by method of cutting and seed preparation and type of operations.[1]

Method	Greenhouse only (N=52)	Mixed operations (N=75)	Total (N=127)
Manually	69.2	54.7	60.6
Purchased	11.5	1.3	5.5
Seeder	1.9	5.3	3.9
Unspecified	17.3	38.7	29.9
Total	100.0	100.0	100.0

[1]Chi-square tests indicate results are significant at P≤0.01.

Table 5. Percentage distribution of greenhouse operations by method of sticking cutting and planting seed and type of operations.[1]

Method	Greenhouse only (N=52)	Mixed operations (N=75)	Total (N=127)
Manually	63.5	65.3	64.6
Seeder	13.5	5.3	8.7
Pot filler	9.6	0.0	3.9
Soil mixer	0.0	1.3	0.8
Unspecified	13.5	28.0	22.0
Total	100.0	100.0	100.0

[1]Chi-square tests indicate results are significant at P≤0.01.

$20,000 and $30,000 and could generally be controlled by one person.

Environmental control was reported as manually operated by 9.6% of the greenhouse-only growers and 13.3% of the mixed operations. Boilers and heated floors/heaters were reported by 1.9% of the greenhouse-only firms and 2.7% of the mixed operations.

Computerized greenhouse controls and controllers were reported by 8% of the mixed operations but none of the greenhouse-only firms. Ventilation and heaters were indicated by 3.8% of the greenhouse-only firms and 1.3% of the mixed operations.

Low-voltage relays and water controllers were reported by 4% of the mixed firms. Greenhouse-only growers did not report use of these two techniques. Misters and thermostats only were reported by 1.3% of the mixed firms. The greenhouse-only operations did not report using these devices.

Harvesting and Grading Production

Most harvesting and grading of production was reported as manually performed or unspecified by the growers (Table 7). Approximately 80.8% of the greenhouse-only firms and 62.7% of the mixed operations reported manual harvesting. The remainder of respondents did not specify a method.

Fertilizer Application

Fertilizer application was done by injectors or a combination of injectors and some sort of irrigation by 42.2% of the greenhouse-only operations and 39.2% of the mixed operations (Table 8). Injectors were reported to cost between $500 and $8,000. Generally, one person could operate this equipment.

Approximately 32.7% of greenhouse-only firms and 24% of the mixed operations reported performing this task manually. Use of buckets or cups and spoons were reported by 15.4% of the greenhouse firms and 1.3% of the mixed operations. The buckets/cups and spoons were estimated to cost between $10 and $30 and could be used by one to three people.

Approximately 5.8% of the greenhouse-only firms and 26.7% of the mixed operations did not specify an answer to this survey question. The remaining green-

Table 6. Percentage distribution of greenhouse operations by method of environmental control and type of operations.[1]

Method	Greenhouse only (N=52)	Mixed operations (N=75)	Total (N=127)
Manually	9.6	13.3	11.8
Heaters, fans, and thermostats	13.5	9.3	11.0
Heaters and fans	5.7	2.7	3.9
Heaters and thermostats	5.7	2.7	3.9
Roll-up sides	9.6	0.0	3.9
2 top roofs and roll-up walls	7.7	0.0	3.1
Computerized greenhouse controls	0.0	5.3	3.1
Fans, heaters, and roll-up sides	3.8	2.7	3.1
Heaters, thermostats, fans, and roll-up sides	7.7	0.0	3.1
Low-voltage relay	0.0	4.0	2.4
Ventilation and heaters	3.8	1.3	2.4
Water controllers	0.0	4.0	2.4
Boilers and heated floors	0.0	2.7	1.6
Controllers	0.0	2.7	1.6
Fans	0.0	2.7	1.6
Heaters	1.9	1.3	1.6
Heaters and misters with timers	0.0	2.7	1.6
Heaters and roll-up sides	3.8	0.0	1.6
Heaters and vents	3.8	0.0	1.6
Heaters, fans, and cooling pads	0.0	2.7	1.6
Heaters, vents, and timers	0.0	2.7	1.6
Auto sides and roofs	1.9	0.0	0.8
Boilers and heater	1.9	0.0	0.8
Gas heater and fans	1.9	0.0	0.8
Heaters and cooling pads	1.9	0.0	0.8
Heaters, cooling pads, and auto roof and sides	1.9	0.0	0.8
Heaters, fans and roll-up sides	1.9	0.0	0.8
Heaters, fans, auto vents, and computer	0.0	1.3	0.8
Misters	0.0	1.3	0.8
Thermostats	0.0	1.3	0.8
Unspecified	11.5	33.3	24.4
Total	100.0	100.0	100.0

[1]Chi-square tests indicate results are significant at P≤0.0001.

Table 7. Percentage distribution of greenhouse operations by method of harvesting and grading production and type of operations.[1]

Method	Greenhouse only (N=52)	Mixed operations (N=75)	Total (N=127)
Manually	80.8	62.7	70.1
Unspecified	19.2	37.3	29.0
Total	100.0	100.0	100.0

[1]Chi-square tests indicate results are significant at P≤0.05.

house-only growers used hand sprayers (1.9%) and incorporated fertilizer at planting (1.9%). The remaining mixed operations used CLF batch feed (2.7%), hand sprayers (1.3%), incorporation at planting (1.3%), mixers (1.3%), or a combination of spreaders and spoons (1.3%).

Pesticide Application

Pesticide application was reported as being performed manually by 28.8% of the greenhouse-only operations and 20% of the mixed operations (Table 9). Hand sprayers were used by 21.2% of greenhouse-only growers and 13.3% of the mixed operations. Hand sprayers were reported as ranging in cost between $20 and $500 and required one or two workers to operate.

Approximately 17.3% of the greenhouse operations reported using backpack sprayers for pesticide application, while only 2.7% of the mixed operations reported using them. Backpack sprayers ranged in cost from $50 to $1,000 and required one or two people to operate.

Approximately 5.8% of greenhouse-only operations and 25.3% of mixed operations did not specify methods of pesticide application. Approximately 5.8% of the greenhouse-only growers and 2.7% of the mixed operations used foggers. Foggers/fog systems range from $3,000 to $20,000 and usually required only one person to operate. Some greenhouse growers reported using buckets and scoops (3.8%) and hydraulic sprayers (5.8%). Use of these techniques was reported by 1.3% of the mixed operations.

Other forms of automation/mechanizations employed by the greenhouse-only firms included air blowers, backpack sprayers and fog, cups and spoons, sprayers and foggers, and tractors and sprayers (each used by 1.9%). Mixed operations reported using sprayers (6.7%), air blowers (5.3%), electric sprayers (4%), tractors and sprayers (4%), 400-psi pumps (2.7%), injectors (2.7%), electric sprayers and chemigation (1.3%), hand sprayers and motorized sprayers (1.3%), hoses and siphon (1.3%), and pump sprayers (1.3%).

Table 8. Percentage distribution of greenhouse operations by method of fertilizer application and type of operations.[1]

Method	Greenhouse only (N=52)	Mixed operations (N=75)	Total (N=127)
Injector	38.4	36.5	37.0
Manually	32.7	24.0	27.6
Bucket and scoop	13.5	1.3	6.3
CLF batch feed	0.0	2.7	1.6
Hand sprayer	1.9	1.3	1.6
Incorporated at planting	1.9	1.3	1.6
Injector and timers	0.0	2.7	1.6
Cup and spoon	1.9	0.0	0.8
Injector and controller	1.9	0.0	0.8
Injector and drip	1.9	0.0	0.8
Injectors, sprinklers, and drip	0.0	1.3	0.8
Mixer	0.0	1.3	0.8
Spreader and spoon	0.0	1.3	0.8
Unspecified	5.8	26.7	18.1
Total	100.0	100.0	100.0

[1]Chi-square tests indicate results are significant at P≤0.05.

Table 9. Percentage distribution of greenhouse operations by method of pesticide application and type of operations.[1]

Method	Greenhouse only (N=52)	Mixed operations (N=75)	Total (N=127)
Manually	28.8	20.0	23.6
Hand sprayer	21.2	13.3	16.5
Backpack sprayer	17.3	2.7	8.7
Sprayer	1.9	6.7	4.7
Air blower	1.9	5.3	3.9
Fogger	5.8	2.7	3.9
Hydraulic sprayers	5.8	1.3	3.1
Tractor and sprayer	1.9	4.0	3.1
Bucket and scoop	3.8	1.3	2.4
Electric sprayer	0.0	4.0	2.4
Sprayer and fogger	1.9	2.7	2.4
400 PSI pump	0.0	2.7	1.6
Injector	0.0	2.7	1.6
Backpack sprayer and fog	1.9	0.0	0.8
Cup and spoon	1.9	0.0	0.8
Electric sprayer and chemigation	0.0	1.3	0.8
Hand sprayer and motorized sprayer	0.0	1.3	0.8
Hose and siphon	0.0	1.3	0.8
Pump sprayer	0.0	1.3	0.8
Unspecified	5.8	25.3	17.3
Total	100.0	100.0	100.0

[1]Chi-square tests indicate results are significant at P≤0.05.

Irrigation Application and Management

Approximately 15.3% of the greenhouse-only and 12% of mixed operations reported that irrigation was done manually at their operations (Table 10). Approximately 1.9% of the greenhouse-only firms and 1.3% of the mixed operations reported using electric valves, golf course controllers, and timers. Twenty-four-volt (24V) controllers were reported by 4% of the mixed operations but none of the greenhouse-only firms. Use of auto booms was reported by 3.9% of the greenhouse-only operations but none of the mixed operations.

Some combinations of drip with timers, computers, misters, emitters, and hoses were reported by 30.6% of the greenhouse-only firms and 24% of the mixed operations. These systems were reported to range from $1,500 and $100,000 and usually required one or two people to control. The wide cost range is attributed to varying amounts of acreage/square footage being irrigated. Approximately 13.3% of the greenhouse-only growers reported using hoses and some sort of nozzles or emitters. None of the mixed operations reported these devices.

Approximately 26.7% of the greenhouse-only firms and 9.2% of the mixed operations reported employing some combination of irrigation using misters, timers, overhead, emitters, and various control devices. These systems range from $200 to $55,500 and usually require one or two people to operate. Again, the large price range is due to differences in acreage/square footage being irrigated.

Approximately 34.7% of the mixed operations and 5.8% of the greenhouse-only firms did not specify a method of irrigation. Approximately 5.3% of the mixed operations indicated using some configuration of sprinkler system, while the greenhouse-only firms reported no use of this equipment. The remaining 9.5% of the mixed operations reported some other form of irrigation management.

Table 10. Percentage distribution of greenhouse operations by method of irrigation and type of operations.[1]

Method	Greenhouse only (N=52)	Mixed operations (N=75)	Total (N=127)
Manually	15.3	12.0	11.8
Drip	5.8	4.0	4.7
Drip, misters, and timers	3.8	5.3	4.7
Drip, misters, sprinklers, and manual controllers	1.9	6.7	4.7
Drip, misters, and manual controllers	9.6	0.0	3.9
Misters and timers	5.8	1.3	3.1
24V controllers	0.0	4.0	2.4
Hose, wand, and misters	5.7	0.0	2.4
Misters, sprinklers, and timers	1.9	2.7	2.4
Sprinklers	0.0	4.0	2.4
Electric valves, golf course controllers, and timer	1.9	1.3	1.6
Auto boom	3.9	0.0	1.6
Drip, hose, and irrigation control	0.0	2.7	1.6
Drip, overhead sprinkler, and irrigation controllers	0.0	2.7	1.6
Hose and nozzle	3.9	0.0	1.6
Misters and sprinklers	3.9	0.0	1.6
Misters and time clock	0.0	2.6	1.6
Misters, overhead, and timers	1.9	1.3	1.6
Phytotonic Saturn 6 controller and overhead	0.0	2.7	1.6
Pumps and timers	0.0	2.7	1.6
Risers, overhead, timers, and misters	1.9	1.3	1.6
Timers	0.0	2.7	1.6
Drip and injectors	1.9	0.0	0.8
Drip and misters	1.9	0.0	0.8
Drip, misters, and computer	0.0	1.3	0.8
Drip, misters, and hand watering	1.9	0.0	0.8
Drip, misters, and hose	1.9	0.0	0.8
Drip, misters, and sprinklers	0.0	1.3	0.8
Drip, misters, and emitter	1.9	0.0	0.8
Hose and sprayer	1.9	0.0	0.8
Hose and watering wand	1.9	0.0	0.8
Mist system	1.9	0.0	0.8
Misters, emitters, and hose	1.9	0.0	0.8
Misters, overhead, and controllers	1.9	0.0	0.8
Misters, risers, and sprinklers	1.9	0.0	0.8
Misters and solenoid	1.9	0.0	0.8
Misters, temp. sensors, and timers	1.9	0.0	0.8
Misters, timers, and hose	1.9	0.0	0.8
Misters, timers, and computer controller	0.0	1.3	0.8
Sprinklers and timers	0.0	1.3	0.8
Unspecified	5.8	34.7	22.8
Total	100.0	100.0	100.0

[1]Chi-square tests indicate results are significant at P≤0.01.

Summary and Implications

From 2003 through 2009, the socioeconomic survey of nursery automation was conducted in Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee. We surveyed 215 growers, and 127 were used for the purpose of this study (75 mixed operations and 53 greenhouse-only operations). All participating growers were asked a series of questions to determine the types of automation or mechanization employed in the performance of 10 major greenhouse tasks: media preparation, container filling, cutting and seed collection, cutting and seed preparation, sticking cuttings and planting seed, environmental control, harvesting and grading production, fertilizer application, pesticide application, and irrigation application and management.

While there is automation or mechanization available to greenhouse growers, this study indicates that a majority of the growers surveyed were still relying on manual labor for many tasks. There are opportunities for mechanization or automation implementation among the participating greenhouse and mixed operations, particularly in the areas of harvesting and grading of production, cutting and seed collection, cutting and seed preparation, and sticking cuttings and planting seed.

Results also showed that significant mechanization is currently in use to support processes such as irrigation and greenhouse environmental control. Some of the most common forms of mechanization employed were pot fillers to support the container-filling process; injectors to support fertilizer application; drip, timers, computers, overhead, emitters, timers, and hoses to support irrigation management and application; and hand sprayers and backpack sprayers to support pesticide application.

With the development or modification of equipment and technology, growers may be able to lower production costs and increase worker efficiency. Integration of mechanization could also offer a positive impact to worker safety and morale through a safer work environment and increased comfort and productivity.

Literature Cited

Alabama Department of Agriculture and Industries. 2004. Certified nurseries. Bureau of Plant Industry. Montgomery, Alabama.

Alabama Nursery and Landscape Association. 2004. Buyers' guide. Auburn, Alabama.

Coker, R.Y., B.C. Posadas, S.A. Langlois, P.R. Knight, and C.H. Coker. 2010. Current Mechanization Systems Among Nurseries and Mixed Operations in Selected Gulf South States. Mississippi Agricultural and Forestry Experiment Station Bulletin 1189. Mississippi State, Mississippi.

Florida Department of Agriculture. 2005. Bureau of Plant Industry. Tallahassee, Florida. www.freshfromflorida.com (Last verified September 15, 2012).

Georgia Department of Agriculture. 2007. Bureau of Plant Industry. Atlanta, Georgia.

Hodges, A.W., C.R. Hall, and M.A. Palma. 2011. Economic Contributions of the Green Industry in the United States, 2007. http://www.fred.ifas.ufl.edu/economic-impact-analysis/pdf/US-green-industry-in-2007.pdf (Last verified: September 20, 2012).

Johnson, K., and W. Wells. 2007. A quick reference guide to wholesale nurseries and commercial sod producers. Publication 2348. Mississippi State University Extension Service, Mississippi State, Mississippi.

Louisiana Nursery and Landscape Association. 2005. Louisiana wholesale nursery buyer's guide. Baton Rouge, Louisiana.

Louisiana Department of Agriculture and Forestry. 2005. Nursery certificate listing. Horticulture and Quarantine Programs, Baton Rouge, Louisiana.

Merriam-Webster.com. www.merriam-webster.com/dictionary (Last verified September 15, 2012).

Mississippi Department of Agriculture and Commerce. 2003. Directory of Mississippi certified nurseries and nursery dealers. Bureau of Plant Industry, Mississippi State, Mississippi.

North Carolina Department of Agriculture and Consumer Services. 2008. Plant Industry Division. Directory of Certified Nurseries and Plant Collectors. Raleigh, North Carolina.

Posadas, B.C., G.B. Fain, C.H. Coker, P.R. Knight, C.D. Veal, and R.Y. Coker. 2004. Socioeconomic survey of nursery automation. Proceedings of the 55th Annual Southern Nursery Association Research Conference. 49:306-309.

Posadas, B.C., P.R. Knight, C.H. Coker, R.Y. Coker, S.A. Langlois, and C.D. Veal. 2005. Socioeconomic characteristics of horticulture firms in the Gulf South. Proceedings of the 55th Annual Southern Nursery Association Research Conference. 50:348-350.

Posadas, B.C., P.R. Knight, C.H. Coker, R.Y. Coker, and S.A. Langlois. 2008a. Socioeconomic Impact of Automation on Horticulture Production Firms in the Northern Gulf of Mexico. HortTechnology, 18(4): 697-704.

Posadas, B.C., P.R. Knight, C.H. Coker, R.Y. Coker, and S.A. Langlois. 2008b. Operational Characteristics of Nurseries and Greenhouses in the Northern Gulf of Mexico. Proceedings of the 55th Annual Southern Nursery Association Research Conference. 53:290-296.

Posadas, B.C., P.R. Knight, R.Y. Coker, C.H. Coker, and S.A. Langlois. 2009. Socioeconomic Characteristics of Workers and Working Conditions in Nurseries and Greenhouses in the Northern Gulf of Mexico States. Mississippi Agricultural and Forestry Experiment Station Bulletin 1182. Mississippi State, Mississippi.

Posadas, B.C., R.Y. Coker, S.A. Langlois, P.R. Knight, and C.H. Coker. 2010a. Operational Characteristics of Nurseries and Greenhouses in the Northern Gulf of Mexico States. Mississippi Agricultural and Forestry Experiment Station Bulletin 1184. Mississippi State, Mississippi.

Posadas, B.C., R.Y. Coker, S.A. Langlois, P.R. Knight, and C.H. Coker. 2010b. Socioeconomic Characteristics of Workers and Working Conditions in Nurseries and Greenhouses in the Northern Gulf of Mexico States. Mississippi Agricultural and Forestry Experiment Station Bulletin 1182. Mississippi State, Mississippi.

Posadas, B.C., R.Y. Coker, S.A. Langlois, P.R. Knight, and C.H. Coker. 2010c. Socioeconomic Characteristics of Nursery and Greenhouse Managers and Operators. Proceedings of the 55th Annual Southern Nursery Association Research Conference. 55:174-176.

Posadas, B.C. 2012. Economic Impacts of Mechanization or Automation on Horticulture Production Firms Sales, Employment, and Workers' Earnings, Safety, and Retention. HortTechnology, 22(3): 388-401.

Simonton, W. 1992. Automation in the Greenhouse: Challenges, Opportunities, and a Robotics Case Study. HortTechnology, 2: 231-235.

South Carolina Department of Agriculture. 2006. Nursery Directory. Columbia, South Carolina.

SPSS 16 for Windows. 2008. SPSS Inc., Chicago, Illinois.

Tennessee Nursery and Landscape Association. 2006. Buyers Guide. McMinnville, Tennessee.