A Comparison of Technical Efficiency in Alabama's Nursery and Greenhouse Sector from 2003 to 2008

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Introduction

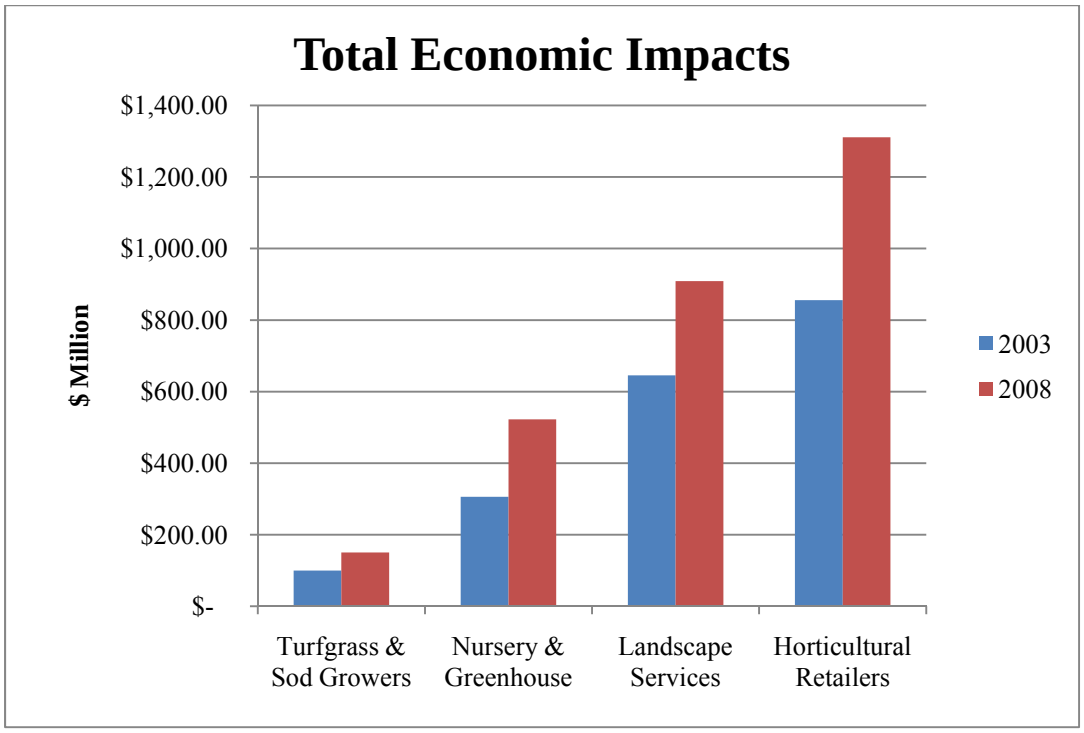
The United States leads the world in production and marketing of floriculture and nursery crops and has shown consistent increases in sales over the past three decades. Greenhouse and nursery contributes significantly to Alabama's agricultural industry and the nation's green industry. This industry represents the number one crop sector in Alabama agriculture and ranks 16th in the nation. The Alabama nursery and greenhouse industry has grown tremendously over the past five years and it has substantially outpaced the growth of all other agricultural commodities. In 2008, nursery and greenhouse accounted for 42.8 percent of Alabama's total crop cash receipts. IMPLAN was used to estimate the economic impact of the industry, and the analysis concluded that total output impact was $2.89 billion in 2008 with 3,453 green industry firms creating an employment impact of over 40,000 jobs. The objective of this study was to estimate technical efficiency in nursery and greenhouse industry in Alabama using a translog cost function and stochastic frontier production function. A similar study was conducted in 2005 by Bellenger, Fields and Hartarska that estimated technical efficiency in the green industry utilizing 2003 data collected for evaluating the economic impact of the industry. Data for this study was obtained from a 2008 survey of firms in the industry.

Background

The southern region contributes significantly to the United States greenhouse and nursery industry. Growers have opportunities to expand their operations in order to meet rapid growing domestic and international demand. Growers can take advantage of expanding sub-sectors of the industry by reallocating their resources within their business operations by switching to high valued nursery products (Muhammad et. al, 2005). The green industry is usually divided into the floriculture (greenhouse) sector and the environmental horticulture (nursery) sector. The

floriculture sector includes cut flowers, cut cultivated greens, potted flowering plants, potted foliage plants, and bedding and garden plants. The environmental horticulture sector includes crops usually grown outdoors and used primarily for landscaping purposes, such as trees, shrubs, ground covers, turfgrass or sod, bulbs, and planting stock. The industry is one of the fastest growing segments of the nation's and the state's agricultural economy, frequently experiencing growth and expansion even during recessionary periods as well as contributing significantly to personal income and job growth in the economy.

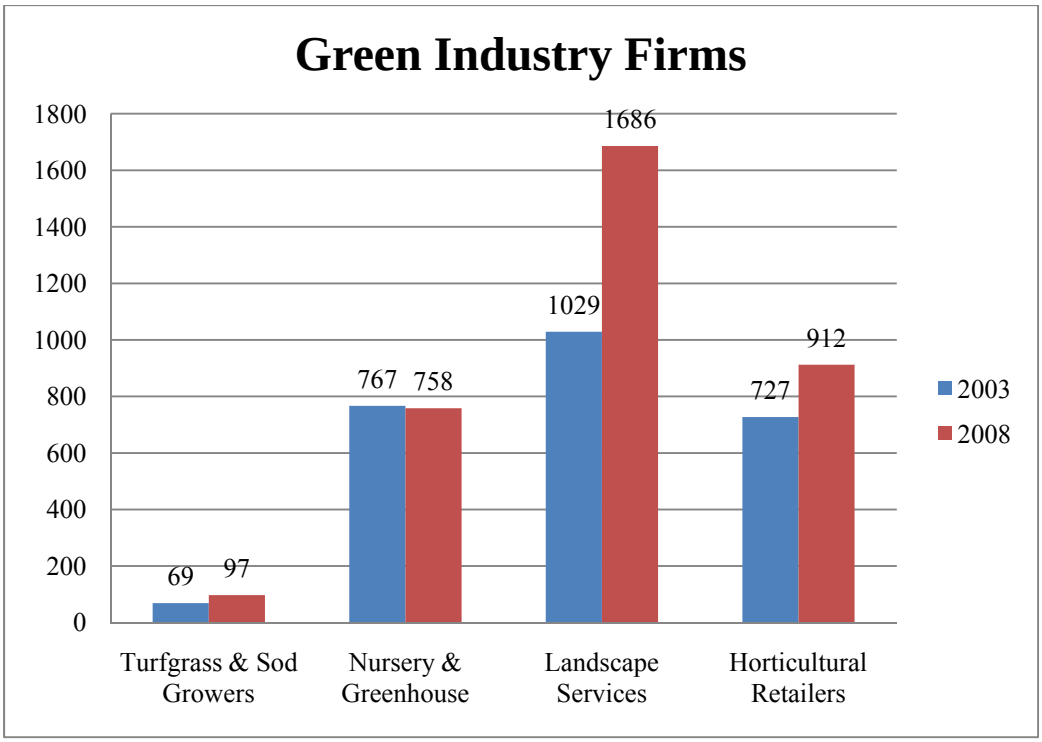
Figure 1. Total Output Impacts for the Alabama Green Industry, 2003 and 2008



The green industry in 2003 comprised nearly half of all crop sales, making it the state's leading crop and third leading agricultural commodity. Based on the 2008 statistics the green industry remains the leading cash crop in the state (Creamer 2009). Greenhouse, nursery and sod

sector accounted for about 43 percent of the total crop cash receipts in Alabama for 2008 and trailed only poultry and beef cattle production in terms of cash receipts in the state (USDA/NASS 2009). Alabama's green industry has grown tremendously since the 2003 economic study. Figure 1 shows Alabama's economic impact for 2003 and 2008. Alabama's economic impacts were estimated at $1.91 million in 2003 and increased to $2.89 million in 2008, an increase of just over 50 percent. All sectors in the green industry had increased economic impact. The total economic impact includes direct impact from industry sales and indirect impacts associated with consumer spending by industry employees. The total represents the sum of output impact, labor income and indirect business taxes. It is found that horticultural retailers account for 44 percent of the total economic impact which is the highest percentage.

Figure 2. Green Industry Firms in Alabama, 2003 and 2008



As shown in figure 2 the Alabama green industry totaled 2,592 firms in 2003 and 3,453 in 2008. All sectors have increased in number of firms except nursery and greenhouse. The nursery/greenhouse firms decreased from 767 to 758, a decline of 1.2 percent. The industry provided approximately 30,886 jobs in 2003, which increased 41 percent to 43,670 in 2008. Of the 43,670 jobs, the horticultural retailers accounted for 43 percent, which is the highest, reported. The nursery/greenhouse sector provided 21 percent of the total employment impacts. The nursery/greenhouse sector's employment increased from 5,726 in 2003 to 9,223 in 2008, an increase of 61.1 percent. Total value added impact for 2008 was $3.19 billion an increase from $1.55 billion in 2003. Horticultural retailers accounted for 71 percent of the total value added impact while nursery and greenhouse accounts for 8.8 percent. Value added is an important measure of an industry's contribution to a regional economy, given that it represents the difference between sales revenues and the cost of purchased inputs. Indirect business taxes include sales, excise, property and severance taxes, custom fees and other miscellaneous taxes paid. Indirect business taxes were $269.4 million in 2003 and increased to $410.3 million in 2008, an increase of 52 percent.

LITERATURE REVIEW

The nursery and greenhouse industry has been touted as one of the fastest-growing sectors of U.S. agriculture; however, there are challenges facing the industry. Some of these challenges faced include energy cost, labor cost, weather uncertainty as well as the ability to attract and retain competent employees (Mattson, 2008). In order to maintain strong growth in the industry, continuous improvements in the skills of the workforce and their year-round availability are necessary. These workers perform various roles and are subjected to different

working conditions. Many jobs in the industry require large amounts of stooping, lifting of heavy containers, and exposure to chemicals, dust, and plant materials. These tend to be relatively-low paying jobs making it difficult for managers to compete for and retain workers in currently tight domestic labor markets. Despite these challenges, the nursery and greenhouse industry has contributed enormously to improving the income of producers, wholesalers and retailers. Total sales of U.S. greenhouse and nursery crops in 2006 increased by $52 million from 2005 a marginal gain over almost $17 billion in gross receipts. The market value of nursery and greenhouse sold increased from $5.74 billion in 1987 to $15.2 billion in 2002, which is a 154 percent growth in market value of sales. Nursery and greenhouse crop sales represented about 6.7 percent of the total market value of all agricultural products sold in 2004, a decline of 1.1 percent from the 7.8 percent figure recorded in 2002 (Ekanem et. al 2005).

In 2002, there were surveys done to analyze the nursery and greenhouse economic impact of different states in the U.S. Hall et. al (2002) combined data from different states to determine the economic impact of U.S. nursery and greenhouse. They used Implan models to determine these impacts and found that there was $1.47 billion in output, 1.9 million jobs created, $95 billion in value added, $64.3 billion in labor income and $6.9 billion in indirect business taxes. Total value added impacts were largest in the Midwest region ($19.2 Bn), followed by the Pacific region ($18.4 Bn), Northeast ($17.9 Bn), and Southeast ($13.5 Bn) in 2002. Studies of state level economic impact were also estimated at different time periods. In 2002, total output impact was $9.9 billion for Florida, 147 thousand jobs were created and $7 billion in value added impact making the state number one in the U.S. The economic impacts for the green industry in Texas were estimated at $14.9 billion in output, 171,415 jobs created and $8.4 billion in value added. For the production and manufacturing sectors, including nursery and greenhouse, total output impacts were $2.5 billion, 23,905 jobs created and value added impacts were $1.4 billion (Palma and Hall, 2009). The economic impact of Georgia's

green industry for 2004 showed a total value added impact of $3 billion which represented about 1 percent of the state's gross state product. Of the $3 billion, nursery and greenhouse industry accounted for $567 million. The employment impact for the sector totaled 62,493 jobs of the same year.

The Southern U.S. contributes about 40 percent of the total U.S. grower cash receipts for the greenhouse and nursery industry. In 2004, three southern states were among the top five states in the U.S. with the highest shares of total sales receipts (Muhammad et. al, 2005). Together the three states represent about 25 percent of total sales receipt in the country. Alabama nursery and greenhouse industry has seen significant improvement over the decade. United States Department of Agriculture (USDA)/ Economic Research Service (ERS), (2007) reported a consistent increase in the Alabama nursery and greenhouse crop cash receipts from 1997 to 2006, from $100 million to approximately $350 million. Of all the states reported, California accounts for the highest percentage share of total U.S. cash receipts for the period 1997 to 2006. From 2003 to 2008 Alabama's nursery and greenhouse grew by approximately 71 percent, lawn and landscape grew by 41 percent, horticultural sales grew by 53 percent and turfgrass and sod by 51 percent.

Technical efficiency is measured by the distance of an observed input-output point of a firm from the frontier curve. There are several efficiency studies done on different industries to determine their level of efficiency. Raj (2007) used a translog stochastic frontier production function to determine the level of efficiency of the unorganized manufacturing sector in the India state of Kerala. They found that high level of inefficiency characterized the unorganized manufacturing enterprises in Kerala. They found that the size, ownership, location and nature of seasonality of operation significantly influence technical efficiency in most of the industry groups. Rios and Shively (2005) applied a two step methodology to examine the efficiency of coffee farms in Vietnam. In the first step technical and cost efficiency were calculated using a

DEA approach. In the second step, farm characteristics were used in a series of Tobit regressions to explore factors correlated with inefficiency. They observed that there was lower technical and cost efficiency on small farms which may have been due to factors other than the farm size. Munir et al (2002) also applied stochastic frontier production function the one-stage modelling approach to a more comprehensive data representing various cropping systems of Pakistan and extended the scope of the analyses by exploring the issues of farm-size and efficiency relationship, and sustainability of the rice-wheat cropping system in comparison with the cotton-wheat zone. They reported on the results of efficiency analysis that the technical efficiency was about 68 percent, which meant, on average, a farmer operated 32 percent below the achievable potential output. They found that technical inefficiency was negatively associated with farm size.

Featherstone et. al (1997) applied technical, allocative and scale efficiency measures to Kansas beef cow farms to examine their competiveness. It was found that on average the farms were 78 percent technically efficient, 81 percent allocatively efficient and 95 percent scale efficient. The study showed that inefficiency was related to herd size and degree of specialization. There was only one known study that analyzed efficiency of Alabama green industry. Bellenger et al. (2005) applied a translog cost function and stochastic frontier production function to estimate the efficiency of green industry firms. They found that firms were operating at a 21 percent inefficiency level, or in other words they are operating 21 percent above the minimum cost level. This can be changed positively if the firms find ways of improving output given their inputs.

Data and Methods

The data used in this study was drawn from a 2008 survey of Alabama green industry producers. Primary data for the study were collected using a set of structured questionnaires mailed to 802 nursery and greenhouse growers of which 184 responded, which yields a 23 percent response rate. For this study only operations with nonzero responses in input categories were included due to the assumed functional form. This reduced the number of usable responses to 52.

Economic literature on production efficiency on average distinguishes between technical efficiency and allocative efficiency (Rios and Shively, 2005). Technical efficiency is measured by the distance of an observed input-output point of a firm from the frontier curve. A technically efficient production firm is one that produces the maximum level of output that can be obtained given input and technology. Therefore, a firm operating below the frontier is considered technically inefficient. Technical efficiency for a given firm is the ratio of its mean production to the corresponding mean production if the firm utilized its level of inputs most efficiently. Technical efficiency can be measured by using either a parametric or a nonparametric approach. The parametric approach assumes a functional form and then measures the distance of observations from the estimated function. The nonparametric approach does not impose parametric restrictions on the underlying technology (Chambers 1988). This study uses the parametric approach to estimate technical efficiency.

Stochastic frontier approach has found wide acceptance within the agricultural economics literature and industrial settings (Battese and Coelli,1992; Coelli and Battese,1996), because of their consistency with theory, versatility and relative ease of estimation. A frontier production function provides the maximum output attainable for any combination of inputs. When a firm

deviates from its optimal production frontier, it is interpreted as technical inefficiency. Technical efficiency for a given firm is the ratio of its mean production to the corresponding mean production if the firm utilized its level of inputs most efficiently. Frontier production function models are able to separate out deviations from the frontier into random and inefficiency components and statistical inference about the response function

The translog cost function is used to estimate the efficiency of firms with multiple outputs. The cost function used in this study can be written as:

$$\ln TC = \alpha_0 + \alpha_1 \ln Y + \alpha_2 \ln W + \alpha_3 \ln K + \alpha_4 \ln Chem + \varepsilon$$

where,

TC is each firm's total recorded annual expense,

Y is each firm's total recorded gross sales,

W is each firm's average wage,

K is each firm's annual capital expense,

Chem is each firm's annual chemical and fertilizer expense, and

ε is the error term for each observation.

The variables for each observation are weighted, or divided by each firm's total miscellaneous expense. Efficiency is then estimated as:

$$\ln E = \ln TC + v + u,$$

where,

E represents each firm's estimated level of efficiency,

TC is the translog cost function for each firm,

v is the component of the error term due to random error,

u is the component of the error term due to inefficiency, and

u and v are assumed to be independently distributed.

The measure of inefficiency, u is predicted for each observation as,

$$\hat{u} = \sum \gamma z + \varepsilon,$$

where,

$\hat{u}$ is each firm's predicted inefficiency,

z is the set of explanatory variables used in the translog cost function, and

ε is the error term for each observation.

With the 2005 study conducted on Alabama firms, Bellenger, et al. found a positive coefficient of 0.21 percent. The positive coefficient for total output reflects increasing returns to scale in the industry and suggests that a 1% change in total output raises total costs by 0.21%. In the test for inefficiency, the mean value of u_i is 0.21, which indicates that on average the level of inefficiency in the industry was 21%. In other words, on average, firms in the industry were operating at 21% above the minimum cost level. Additionally, Σu is far greater than Σv,

meaning that the majority of each observation's error term can be attributed to inefficiency, rather than random error.

After evaluating the descriptive statistics presented in tables 1 and 2, the initial hypothesis was that over the past five years firms have become more efficient. However, the 2008 data set included a number of missing variables, which prevented the estimation of a model similar to the 2005 model. As a result differences in efficiency are only able to be evaluated utilizing descriptive results provided by survey respondents.

Table 1 provides a summary of nursery and greenhouse sector sales and expenses for 2003 and 2008 as reported by survey respondents in Alabama. The results show that the 2008 respondents were significantly larger firms than 2003 respondents. A total of 139 respondents to the 2008 survey reported over $181 million dollars in gross sales as compared to about $71 million in 2003. The standard deviation calculated indicates a much wider dispersion in the 2008 data as compared to 2003. This dispersion can partially be attributed to the shifts in farm size over the past five years, which will be further discussed from table 2. The average sales per firm increased by nearly $680,000 to $1,304,180 in 2008. We acknowledge that the firms represented in each survey are larger than the average firm in the sector and the average figures could not be extrapolated to the entire population of nursery and greenhouse firms.

The data also shows that in 2008 the percentage of expenses as compared to gross revenue actually decreased. Total expenses (excluding wages paid) per dollar of sales decreased from 37.1 percent in 2003 to 27.7 percent in 2008. Wage expense per dollar of sales also decreased less dramatically from 22.2 percent to 19.7 percent. These results were not initially expected from the survey given the definite increases in input costs, such as energy, fertilizers,

and chemicals. However, it is likely that the larger firms are able to operate a more efficient level than the smaller firms represented in 2003. As margins tighten, it is also likely that firms in the industry look for more methods to reduce input costs and operate at a more efficient level.

Table 1: Alabama Nursery and Greenhouse Sector Gross Revenue by Survey Respondents, 2003 and 2008

	2003 (N=114)	Std. Dev	2008 (N=139)	Std. Dev
Gross Sales	$ 70,840,892	$1,145,570	$ 181,281,150	$ 6,931,056
Average Sales	$ 621,411		$ 1,304,180	
Total Expenses	$ 26,292,997	$1,008,966	$ 50,279,444	$ 2,707,532
Expenses/$ of Sales	37.11%		27.73%	
Employment (jobs)	1,096	19.3	1,247	15.2
Wages	$ 15,748,293	$ 345,128	$ 35,772,249	$ 2,219,727
Wages/$ of Sales	22.23%		19.73%	

Table 2 shows that firms in the industry have increased in size as a whole. Firms that produce less than $100 thousand in gross sales decreased from 62.6 percent to 53.3 percent from 2003 to 2008. In all other categories the number of firms increased with the largest increase in the $100 to $249 thousand dollar category. There are a total of eight fewer firms in the industry from 2003 to 2008.

Table 2: Breakdown by Farm Size of Alabama Nursery and Greenhouse Operations, 2003 and 2008

	2003		2008	
Farm Size	**# of Farms**	**% of Farms**	**# of Farms**	**% of Farms**
$1,000,000 or more	61	7.95%	70	9.23%
$500,000 to $999,999	62	8.08%	78	10.29%
$250,000 to $499,999	70	9.13%	83	10.95%
$100,000 to $249,999	94	12.26%	123	16.23%
$50,000 to $99,999	480	62.58%	404	53.30%
Total	**767**	**100%**	**758**	**100%**

Conclusion

The green industry continues to be one of the largest contributors to the nation's agricultural industry. The recent economic downturn has impacted this sector more than most other crop sectors due to its close relationship to the housing market. The industry experienced rapid growth from 2003 to 2006 and began to contract beginning in 2007. In addition to a down housing market, the cost of many production inputs increased substantially. Survey data suggests that firms have dealt with the unfavorable economic situation by increasing production efficiency.

The initial purpose of the study was to econometrically compare technical efficiency of green industry firms from 2003 to 2008. Missing variables in the 2008 data prevented the estimation of a stochastic frontier model to compare to the 2003 data. As a result descriptive statistics were used to provide insight into changes in firm efficiency from 2003 to 2008. Results suggest that the average firm size has increased over the period, while average expenses have decreased. This finding suggests that firms are finding methods to cut costs and operating at a more efficient level. Additional methods of estimating technical efficiency will be evaluated to determine a method to be used on both data sets.

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