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Assessing the influence of energy cost and other factors on profitability of greenhouse businesses in Tennessee

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Abstract

The greenhouse industry is an important sub-sector of agriculture. On average, greenhouse and nursery farms in the U.S. have 57 percent more cash receipts than all farms (Muhammed, 2000). Tennessee cash receipts for greenhouse and nursery farms was 307 percent above than the average in the US. However, greenhouse operations in Tennessee have declined over the years. The goal of this study was to acquire a better understanding of energy use by greenhouse businesses in Tennessee. The latest database containing greenhouse businesses was provided by the Tennessee Department of Agriculture. A mailed survey was used to collect data that covered questions on energy use, marketing and skill needs of the businesses. The respondents were mixed in terms of size of their operations, education and income levels. Out of the 279 surveys, 56 were returned, resulting in a 20 percent response rate. To determine the different factors affecting profitability of greenhouse operations, this study utilized correlation and chi-square tests using different variables. Results indicate that profitability of greenhouse operations is influenced by the rising energy cost, economic downturn and size of operation. The survey also indicates that growers would consider adopting alternative energy saving methods depending on their income and age. The study shows the need to assist the growers in learning more about alternative energy saving methods and technologies. This study is beneficial not only for greenhouse businesses but also other stakeholders including policy makers and those working with growers. Other researchers can also undertake similar studies using the approach used here with appropriate modification.

Key words: Greenhouse, energy use, middle Tennessee, profitability

Introduction

The greenhouse and nursery industries account for about 2.5 percent of all United States farms. According to the Census of Agriculture -by USDA, in 2012 - there were less than 100,000 greenhouse/nurseries in North America. Over the past few decades, there have been changes in the structure, conduct, and performance of the U.S. nursery and greenhouse industry. These industries can be very profitable for farmers and their communities. Yet, because of rise in energy costs, growers face the challenge of keeping their businesses profitable. One of the lessons learned over the years is that it is generally less expensive to consider energy conservation measures before implementing significant modifications to your heating system. Greenhouses in particular are harder to keep up, due to the many costs involved. The greenhouse structure is built to maintain proper temperature and climate for better gardening. This allows growers to extend their gardening season by growing plants inside when outside weather conditions are not ideal. Structures range from small to large buildings in an industry that has been around for more than a hundred years. Most greenhouses are seasonal businesses with maximum production in the spring. In Tennessee, it was reported that greenhouses must be heated from around October through April because Tennessee's weather can be very unpredictable (Trainer, 2010). Surveys have examined the present business climate, but little has been done to understand what types of changes are taking place and whether or not these changes are regional in nature (Trainer, 2010). A large number of farmers depend on this important enterprise for their livelihood. But in recent years the business has been facing challenges due to the economic downturn, decline in demand for many of the products and high-energy costs. When oil prices are high, a typical commercial greenhouse operation would experience significant difficulty making a profit, and the industry would be in peril (Hall, 2006). Researchers have been searching for easier ways for greenhouse growers to save money on energy. Record low oil prices following the early energy crisis have shifted much of the attention away from increased self-reliance and the development of alternative energy sources. The results of the research efforts in the 1970s and 1980s led to substantial reductions in greenhouse energy use. It is important to identify not only the annual or seasonal expenses, but also the peak energy consumption amount (Stegelin, 2007). During the winter/ summer months, greenhouse growers spend a lot on energy costs.

The greenhouse industry is one of the biggest sub-sectors in terms of economic output in the United States (Hall *et al*., 2006). The purpose of this study was to assess the benefit of considering alternative technologies for greenhouse businesses in Tennessee. Some of the specific objectives were to characterize current energy use, to examine consideration of alternative sources of energy and to assess the effect of energy costs on profitability by greenhouse businesses in Tennessee.

Materials and methods

For this study, primary data was collected from greenhouse operators. Certified growers from the Tennessee Department of Agriculture (2012) database were sent surveys in mail. There were 279 certified greenhouse growers on that list; in which

we chose all to be surveyed. The survey focused on four major parts and asked general questions about the greenhouse such as the size, years in business, future plans, and other factors that might affect the business. Another section of the questionnaire was designed to assess energy use and costs over the years, plans to use alternative sources of energy, factors affecting increase in energy cost and their effect on profitability. Other questions focused on the demographics of the greenhouse owner such as income, age, and education.

After getting approval from TSU's Institutional Review Board (IRB), the surveys were distributed via mail to 279 greenhouse growers in Tennessee. Out of the 279 respondents, we received 56 completed mailed surveys, which gave us a 20 percent response rate. The coded surveys were then analyzed by Microsoft Excel and SPSS using descriptive analysis, correlations, chi-square tests and cross-tabulations.

A series of statistical analyses were conducted using correlation models, contingency tables, and chi-square tests. Correlation models were used to investigate the strength of the relationship amongst variables. Contingency tables were formatted to display the frequency distribution of the variables. Chi-square tests were done in order to test our assumptions of what factors directly affected each other. Variables considered for contingency table are size, income, energy costs, and year in the business.

Results

Table 1 provides a summary of the section averaging the characteristics of the respondents. The table shows that 54 percent of the growers fell in the 60 + age group and only 3 percent of the respondents were under 30. The data also shows that a 32 percent of the respondents had an undergraduate degree and 64 percent had an annual income of less than $99,000 dollars.

The survey asked about the size of their business in square foot. Fig. 1 shows the sizes of their operation. According to expert opinion by Dr. Roger Sauve, a greenhouse operating in less than 10,000 sq-ft is considered small; 10,000- 30,000 sq-ft is considered medium and above 30,000 sq-ft is considered a large greenhouse. Results from the survey indicate that 61 percent of the respondents have small operations.

Table 1. Summary of the characteristics of the greenhouse operators

	Percentage
Age	
Under 30	3
31-45	2
46-60	38
Over 60	54
Education Level	
High School/ GED	21
Some College	14
Undergraduate Degree	32
Graduate Degree	25
Other	4
Income	
99,000 or less	64
100,000 - 299,000	23
300,000 - 399,000	2
400,000 - 499,000	4
500,00 or more	2

Based on data collected from the survey, the respondents have been in the greenhouse industry for an average of 24 years. In some instances, some of the businesses have been around for more than 100 years. Being around for an extensive period of time is extraordinary because of the challenges they are facing such as building maintenance/ upkeep, the economic downturn, and the rise of energy costs. Table 2 displays the percentage of how each factor affects the growers' businesses. A large number of respondents chose economic downturn and high-energy costs as the reason why their business is being affected. About 48 percent believed that economic downturn was the most important negative effect while 38 percent felt that high-energy cost was the most important negative factor affecting their business. A small number of respondents (18 percent) felt that competition and production problems were the reasons why their businesses were being affected.

Table 2. Factors affecting the greenhouse business

Category	Economic Downturn (%)	High Energy Cost (%)	Competition in Market (%)	Production Problem (%)
Most important	48.2	37.5	16.1	1.8
More important	21.4	28.6	19.6	0
Important	19.6	8.9	23.2	8.9
Less important	0	0	7.1	25
Least important	3.6	3.6	12.5	21.4

Energy costs are increasing yearly with an average cost of $18,791 in 2006, which has risen to $22,895 by 2011. Forty-six percent of the survey respondents indicated that there was decline in profitability in the business because of increase in energy costs. The following chart accurately displays a comparison between annual energy cost in 2006 and in 2011.

Energy costs are the second largest cost for greenhouse owners behind labor costs, and heating totaling to about 70 percent of the total energy budget (Sanford, 2002). With the continuous rise in fuel cost, the survey focuses on key variables within the greenhouse industry that could potentially be altered to lower the

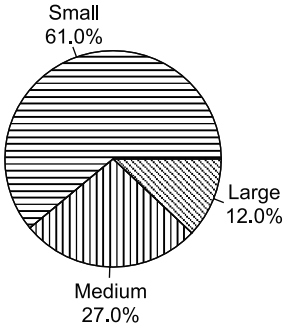

Fig. 1. Distribution of the respondents' greenhouses by size

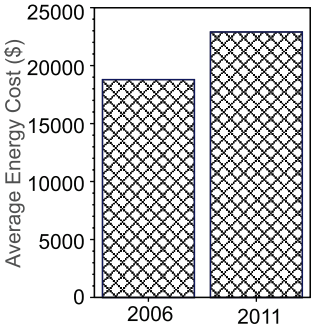

Fig. 2. Average energy cost of greenhouse businesses in 2006 and 2011.

grower's energy cost. The survey asked respondents to provide the size of their greenhouse, fuel types they used within a five-year period, and energy saving technologies they used in a five-year period. The results from Pearson's Correlations show that size of the greenhouse affected the respondent's energy cost in 2006 (ρ=0.795, p-value=0.000) and 2011 (ρ=0.825, p-value=0.000).

The respondents were also asked what fuel types they used in 2006 and what they used in 2011. Fig. 3 shows that many growers stopped using the same fuels. A percentage of growers stopped using kerosene (3.6 percent to 1.8 percent), propane (32.1 percent to 30.4 percent), and oil (12.5 percent to 8.9 percent) and switched to natural gas (26.8 percent to 30.4 percent), wood (1.8 percent to 5.4 percent), and electricity (5.4 percent to 7.1 percent).

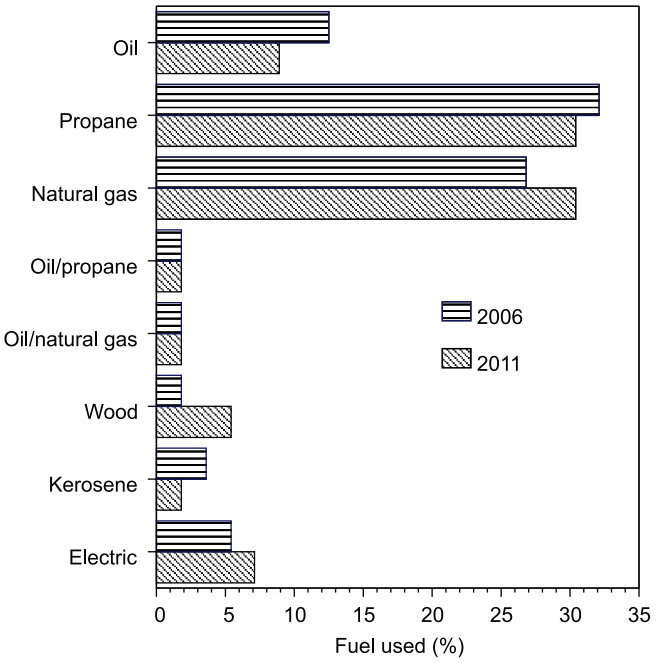

Fig. 3. Fuel type used within a five-year period percentages per greenhouse.

The survey also asked the respondents to share what changes they made to their energy saving technologies. Fig. 4 shows the percentage of energy saving technologies and how they changed in the next 5 years. Many of the respondents that started off using plastic walls (19.6 percent to 14.3 percent) and new coverings (3.6 percent to 1.8 percent) in 2006, switched to using energy curtains (7.1 percent to 12.5 percent), lower temperatures (17.9 percent to 26.8 percent), efficient heaters (3.6 percent to 8.9 percent), and new heaters (0 to 3.6 percent). Some of the greenhouse growers found it so hard to maintain cost and decided to close down for a portion of the year (5.4 percent to 12.5 percent) and to use less space (1.8 percent to 3.6 percent).

The survey asked the respondents to rank how optimistic they were about adopting a new energy source. In Fig. 5 about 25 percent of the respondents are optimistic about adopting a new source and a little over 30 percent are not sure. Only 5 percent were very optimistic and over 15 percent are not optimistic.

There is no evidence to suggest that age of the greenhouse grower can affect his/her outlook on how they feel about future growth. Fig. 6 represents how different age groups felt about expecting to adopt new sources of energy. As indicated before, most of the respondents were from age 45 and above. Here we see that group

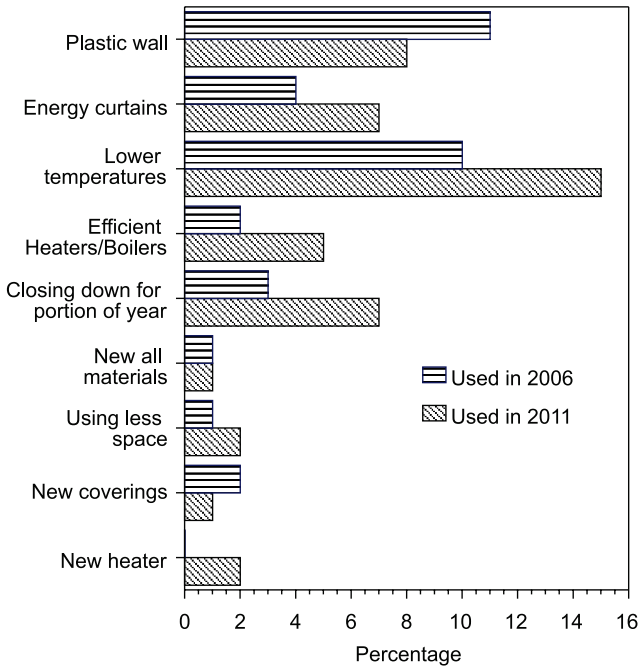

Fig. 4. Energy saving technology used within a five- year period percentage per greenhouse

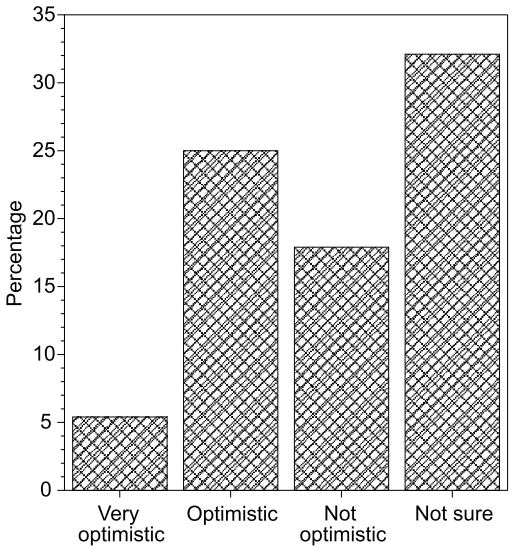

Fig. 5. Optimism among respondents about adopting a new source of energy

46- 60 were more optimistic about adopting new sources than the respondents over 60.

Another cross-tabulation was done for income vs. impacts rise in energy costs effect on profitability. A cross-tabulation was performed because rise in energy cost that affected profitability can also affect the greenhouse income range. Fig. 7 indicates that growers that fell in the $99,000 or less annual salary had either a significant decline or very little decline due to the increase in energy costs.

Table 3 shows tests that shows the relationship among energy cost, income, adoption of new energy sources and age. The test values and *p*-values show that rise of energy cost was found to be affecting the income, as expected, of the greenhouse. However, adoption of new energy source wasn't significantly related to income with a *p*-value of 0.091. The adoption of a new energy

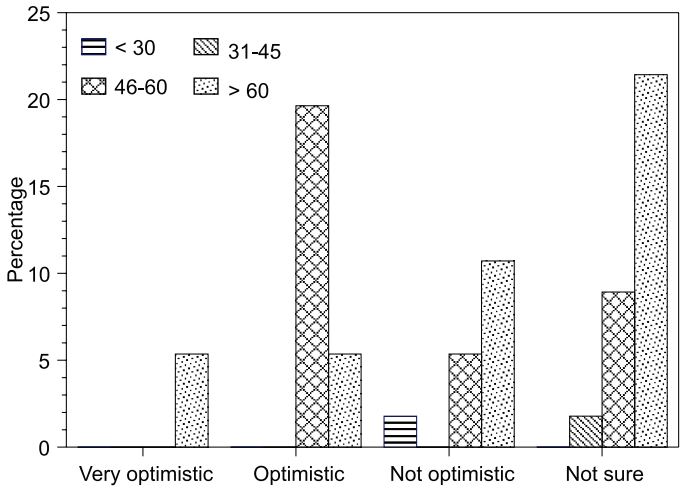

Fig. 6. How different age groups feel about adopting new energy sources.

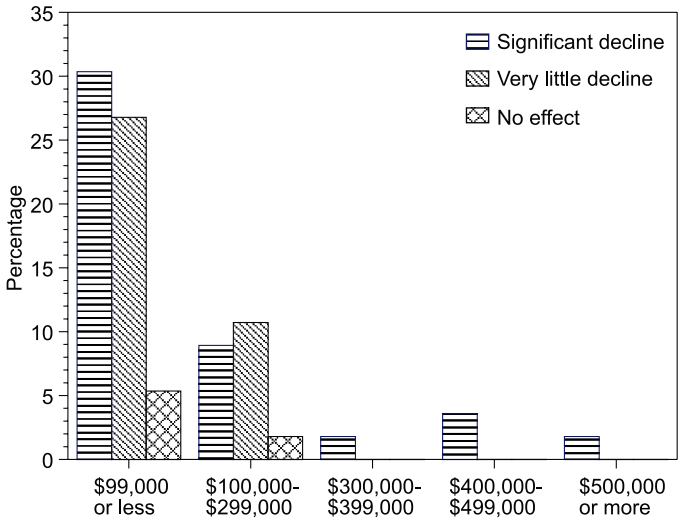

Fig. 7. Did a rise in energy cost affect profitability for Income – Groups?

sources was significantly related to age of the business owner. This result was particularly interesting since there are no previous studies that relate age with any significant factor of a business. The result shows that experience of the business owners play a role in decision making.

Table 3. Chi-Square values and significance at P=0.05 level

Variables	χ^2 Value	P-value
Effect of energy cost related to Income	25.627[a]	0.042
Adoption of new energy source related to age	27.322[a]	0.038
Adoption of new energy source related to income	28.862[a]	0.091

Results confirm the assumption that size affects the greenhouse energy cost. It also shows the relationship between age and adoption of a new energy source as well as the correlation between income and the effects that energy cost had in profitability.

This study was focused on the certified growers because they highly depend on the operation. On this list there were 279 certified greenhouse operations in the state of Tennessee. The study analyzed the operations of greenhouse growers in the state of Tennessee and factors affecting their energy costs. The analysis showed that there is a high correlation between energy cost and size of the greenhouse. Results also indicate that the rise in energy cost directly affects profitability of the greenhouse business. Other important factors affecting profitability were economic downturn and cost of operation. This study also indicates that income level and the age of the grower have a significant positive effect in the interests of adopting new energy sources in the future.

Understanding the fundamentals of what can greatly affect energy cost can help save greenhouse growers money in the future. Significant efforts are required to improve knowledge of greenhouse growers in Tennessee regarding energy cost. Findings of this study are consistent with other studies showing greenhouse growers have limited understanding of what factors affect their operations the most and what factors help lower costs. To enhance awareness there is a need to introduce different studies being done to analyze the effects of high-energy costs. It was found that a mix of factors affected their operations.

The study relies on the people's educated guess (survey questions-answers) and just like any other primary data, opinions and guesses can change with time. From a policy stand point, one-time survey has its limitations in terms of sufficient information it can provide. Multiple surveys over time would serve as a more accurate measure for analysis and policy recommendations.

The findings of this study can provide insights for other researchers on energy use by greenhouse operators. Cost efficient energy use is a key to maintaining profitability. It is also important that growers capture opportunities to acquaint themselves with alternative energy sources to enhance their knowledge and make choices that will give them positive economic returns.

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