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Estimation of Production Function and Related Labor Risk Considerations for Landscape  
and Lawn Care Firms in Georgia

(Under the Direction of WOJCIECH FLORKOWSKI)

The fast growing landscape and lawn care industry deserves attention, but research has been limited by data availability. Primary data, collected through a mail survey from firms providing services, allow disaggregated analysis. This study attempts to estimate the production function with a focus on labor associated risk of landscape maintenance and lawn care firms in Georgia, a state experiencing a rapid expansion of the “green industry.” A three stage estimation agricultural production function framework suggested by Pope and Just (1979) was applied to estimation of production function. The results suggest that labor costs, plant material costs, chemical costs, and acreage serviced by a firm are important for output of a firm and labor turnover is a potential source of risk for the landscape maintenance and lawn care industry.

INDEX WORDS: Risk, Production, Labor, Survey, Georgia.

ESTIMATION OF PRODUCTION FUNCTION AND RELATED LABOR RISK  
CONSIDERATIONS FOR LANDSCAPE AND LAWN CARE FIRMS IN GEORGIA

by

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## **DEDICATION**

*To my mother, Shyamala Devi,  
and my father, Vishwanath Reddy Sulgham*

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## **CHAPTER 1**

### **INTRODUCTION**

The “green industry” includes the production and marketing of floriculture, turfgrass and environmental horticulture crops. Crops include greenhouse and field-grown flower and foliage plants, landscape plants, bulbs, and turfgrass. The value of these crops contributes significantly to the economy (Bureau of Business and Economic Research, 1987). In many instances, production is integrated with the provision of landscaping services, florist and retail or wholesale garden center operations, marketing, and service related activities. In 1991, the green industry generated the second highest net value-added per dollar of gross income among all agricultural commodities nationwide (Stanton et al., 1992).

Retail expenditures for all floriculture and environmental horticulture products were estimated at \$54.8 billion or \$ 203 per capita in 1998 (USDA, 1999). Per capita expenditures were three percent higher than those reported in the previous year. Retail expenditures for environmental horticulture crops (i.e., nursery plants, trees, shrubs, ground covers and turfgrass) reached \$38.8 billion or \$120 per capita. Positive trends in retailing shown by the increasing cash receipts of the industry (Figure 1) fostered an examination of the Georgia green industry. Rapid growth of this industry in recent years led to its seventh spot among the top ten commodities in terms of total farm cash receipts in 1997 (Georgia Agricultural Facts, 1998). Industry accounted for 4.1 percent or \$252 million of total 1997 cash receipts. Gross sales of the sod and sprigs accounted for 15 percent of total cash receipts for the Georgia green industry or \$36 million. Sod and sprig sales increased 41 percent between 1991 and 1996 (Georgia Agricultural Facts, 1998).

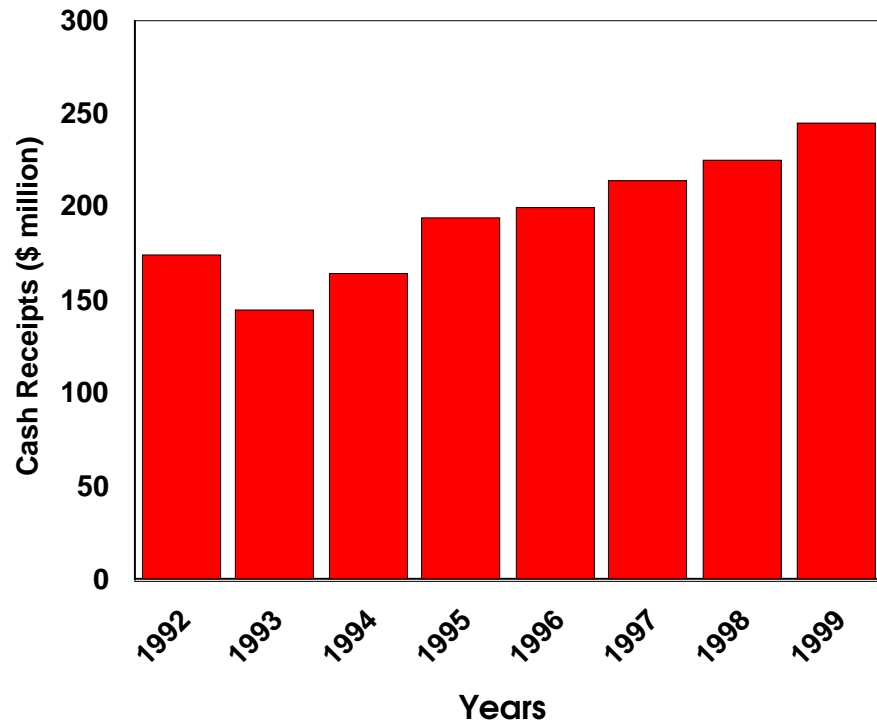


Figure 1. Cash Receipts of Nursery, Green House, and Turf Industry in Georgia.

Source: Anil et al., (2001).

Rapid growth of sod sales has been associated with an increase in lawn care and landscape maintenance demand.

The lack of a single, widely recognized definition of the type of firms that represent the “green industry,” requires that each empirical investigation of any aspect of the sector must involve a definition of scope. Furthermore, the absence of systematic data collection regarding this fast growing and changing industry limits aggregate level analysis. Therefore, region specific studies offer an alternative way of conducting empirical investigations. Georgia’s lawn care and landscape industry for example, is likely similar to those of neighboring states in the Southeast in the type of plants, pest pressure problems, and the relative importance of cultural practices. The focus of this thesis as described below, extends to an area of broad interest relevant to the whole sector. Therefore, results contribute to the knowledge base applicable in many regions.

The landscape and turfgrass industry is mainly a service industry; the supply of services is the fastest growing activity within the industry. Homeowners represent a significant consumer segment that purchases landscape design and installation services and landscape maintenance and lawn care (LM/LC) services. Results of a study by the National Gardening Association (NGA, 1999) showed that 10 percent of Southerners purchased LM/LC services in 1998-1999. Another survey revealed that 24 percent of Georgia homeowners purchased LM/LC services (Jordan et al., 1999). The relatively high percentage of homeowners buying LM/LC services reflects increasing incomes. In households where the opportunity cost of time, or the implicit value of time spent performing LM/LC tasks, is relatively high, hiring a LM/LC firm becomes relatively inexpensive given the time constraint. The household paying for landscape and lawn care services purchases labor and other inputs used to service the landscape plants. Labor is the most important input and has a decisive influence on the generated output in the LM/LC industry. LM/LC firms risk losing customers and revenue if the provision of services are

interrupted due to a high labor turnover or the need to train new unskilled laborers. The LM/LC sector is sensitive to the availability of labor and insufficient labor resources have potentially disastrous economic consequences suggesting an examination of the LM/LC service production with the emphasis on labor issues.

### *Objectives*

The combination of favorable economic and demographic trends and high population density in Georgia urban and suburban areas encouraged the development of professional turfgrass and landscape industries and continues to drive their growth. Such expansion prompted this study with the specific objective to estimate the production function with a focus on labor as the primary source of risk according to the LM/LC industry. The empirical investigation is based on data collected directly from businesses engaged in the design, installation, and maintenance of urban landscapes. It is the first attempt in the literature to estimate a production function for this industry

The study results should contribute to a better understanding of an LM/LC company's variable production costs. The contribution to the knowledge base regarding this fast growing, but little researched sector, is based on real world data. Information on the effects of input use on the generated output will contribute to improved decision-making and successful resource management. LM/LC companies recognize the importance of labor and its quality to the production of their services and this study attempts to quantify the relationship between labor and other inputs and the generated output. Knowledge of the measurable link between labor input and output produced by a company will enhance the company's ability to plan the resource use and accurately measure the contribution of each input to a unit of output. By accounting for risk of labor turnover, a LM/LC company will be able to link the issue to the change in output and consider the options it has in reducing labor turnover.

### ***Organization of the Study***

A review of literature covering the previous research related to the objective of this study is presented in chapter 2. Chapter 3 is organized under three subheadings. First, the theoretical framework for the production function estimation is presented. The methodology or the procedure of estimation forms the second section. The third section discusses the variables used in the model estimation. Chapter 4 describes the empirical results followed by the interpretation of their practical significance. Implications of this study are presented in chapter 5.

## **CHAPTER 2**

### **LITERATURE REVIEW**

The limited research to date on the industry has been in the descriptive form of economic profiles of a particular state or metropolitan area. Literature review showed that earlier research was focused on the growth of industry and the associated labor issues. Hence the review has been organized into studies focusing on 1) the growth of the industry, which are mostly region specific and use survey data, 2) the labor needs of the industry, 3) labor training and skills, and 4) agricultural production function framework.

#### ***Focus on Growth of the LM/LC Industry***

A report by Gineo (1987) indicated that the landscape industry was the fastest growing agricultural industry in Connecticut. A study by the Bureau of Business and Economic Research (1987) revealed that the fast growth of the LM/LC services contributed to the increase in employment and payroll at national level.

Since 1989 there have been three survey studies on the LM/LC industry in the State of Georgia, each of them trying to analyze different aspects of the industry. The first survey report by Hubbard et al. (1989, 1990) for the State of Georgia indicated that LM/LC services are a rapidly growing sector of the economy. Growth of these services occurred in response to demand factors, such as population increase and rising incomes. The return of many spouses to the workforce allowed two income families to allocate a share of their earnings towards purchasing LM/LC services. In Georgia, the rate of population growth and income growth, and a mild climate extending the growing season, contributed to the growth of the LM/LC segment of the green industry.

A study by Cox et al. (1994) showed that tracking growth in landscape services is complicated by the lack of data and outdated or inappropriate classification. The study also showed that landscape services are becoming more important as a source of employment relative to agricultural production. The size of the LM/LC industry will increase as more efforts are made to make natural scenic areas more accessible. The lack of data coupled with inappropriate classification increases the importance of the data collection through surveys to gain an insight of the factors influencing the industry growth.

Another survey report by Florkowski et al. (1996) supported an earlier report by Hubbard et al. (1989) that LM/LC industry in Georgia is a fast-growing sector of the economy. The firms involved in the business were relatively young, suggesting a lack of entry barriers into the industry. A study by Garber et al. (1996) showed that the fast growth of the LM/LC industry can be attributed to such factors as an improving economy and consumer emphasis on plant quality.

### ***Focus on Labor Needs of the LM/LC Industry***

The industry requires both year-round and seasonal workers because of the seasonally fluctuating needs for plant care responding to weather conditions. The fast growth of industry highlights the need to focus on labor needs because of its role in generating services to buyers of LM/LC services.

The fast growth of the industry suggests an increasing demand for LM/LC services. The increasing demand for services coupled with a long growing season provide employment opportunities on a full-time and part time basis. A survey report by Hubbard et al. (1989) for the State of Georgia reveals that the fast growth of LM/LC industry has contributed to an increase in demand for labor. The study revealed that the industry

created 4,000 full-time and over 3,000 part time seasonal jobs making industry a major source of employment in Georgia.

The increasing demand for labor may lead to labor retention problems because workers tend to look for the best available paying positions. Retention of the work force is an important aspect for a firm, as retention leads to trained labor which is superior to untrained employees. Efficient labor also increases the productivity of a company. Retention of labor also lowers the cost of production and there by potentially increasing profits. A report by Jackson (2000) states that hiring and retaining employees can be challenging at best. All firms want to hire dependable workers, but most LM/LC companies are only as solid as their weakest employee. Since the industry is largely seasonal and dependent on staffing through fairly low-paying manual labor positions, it is critical to make hiring the best possible employee a top priority. Many seasonal and entry level positions are filled by individuals with less than perfect work histories. They either have had significant periods of unemployment or are transient and continually move from job to job ( Jackson, 2000). Those who are frequently unemployed may have family responsibilities that can be financially and emotionally demanding, and their sketchy work histories can sometimes be traced to having had little guidance to prepare them for workplace responsibilities. Such a workforce will lead to poor quality of services thereby reducing the productivity of the firms.

### ***Focus on Labor Training and Skills of the LM/LC Industry***

The quality of labor plays an important role in the successful management of the company and thus influences productivity. Labor quality can indirectly be measured, by the training and education levels of the employed personnel. Jackson (2000) revealed that low-paying manual positions were usually filled with personnel who might not have graduated from high school or earned a GED equivalency degree. Often, such employees

were inexperienced in functioning within a structured work environment and might not have developed social skills involving relationships with coworkers and supervisors or adhering to workplace rules.

A study by Anil et al., (2001) showed that education level of the workforce in managerial positions is important for the profits earned by a company. Educated employees can be expected to keep track of the changes in the industry and adopt them to increase the productivity of the firms. Thus firms willing to improve productivity and raise profits should be employing educated personnel to carry out the operations.

A report by Reaves (2000) indicated landscape managers in most cases, wanted a reliable, skilled workforce made up of local citizens. However, since most Americans shun hard labor positions in the landscape industry, illegal workers from Mexico now make up a large portion of the seasonal landscape labor force in most areas of the country.

### ***Focus on Agricultural Production Function Framework***

Labor issues create a great deal of uncertainty for the LM/LC firms which supply services and, therefore, heavily depend on labor as an input. In this aspect labor can be considered as the single largest source of risk in the LM/LC industry. A study by Pope and Just (1979) specified an econometric production function which takes into account the risk associated with the input use. Their study proposed a framework for estimation of agricultural production function, treating an input as a source of risk. The estimation procedure involves three stages. The first stage of estimation is the nonlinear, heteroscedastic regression of dependent variable on the explanatory variable, leading to consistent parameter estimates of the independent variables in the model. The second stage involved the OLS regression of the error terms obtained from the first step on the explanatory variables. This step accounts for heteroscedasticity and lead to consistent parameter estimates which are asymptotically efficient. The third step involved non-linear

estimation of the transformed dependent variable on the transformed independent variables resulting in an asymptotically efficient, consistent and unbiased parameter estimates of the independent variables included in the model. Pope and Just express the variables included in the model in physical units following the conventional approach.

Conventional methods for estimation of production function use the physical units of inputs in the estimation procedure. However there have been studies where an alternate way of measuring the inputs in monetary terms has been adopted. A study by Battese et al. (1989) used gross total output value as the dependent variable in the estimation of the production function from survey data. The explanatory variables or the inputs in this case have been expressed in monetary terms. Battese et al., used the labor cost, total acreage covered, fertilizer expenditure, and pesticides cost as the explanatory variables showing that the production function can be expressed in monetary terms.

The LM/LC industry is growing fast in Georgia. The fast growth of the industry has resulted in increased demand for labor. The increased demand for labor is associated with problems like retention and availability of skilled workforce consequently, labor issues create a great deal of uncertainty for the LM/LC firms which supply services and, therefore, heavily depend on labor as an input. In this aspect labor can be considered as the single largest source of risk in the LM/LC industry. The fast growth, increasing labor needs, and associated labor issues of LM/LC industry warrants an investigation with the objective to estimate the production function, with a focus on labor as the primary source of risk. The agricultural production function estimation framework proposed by Pope and Just (1979) formed the base of the study for estimation of production function. The study conducted by Battese et al. (1989) helps in the selection of variables included in the model and allows to express the production function in monetary terms.

## CHAPTER 3

### THEORETICAL FRAMEWORK

#### *Theoretical Framework*

The process of transforming a set of elements called inputs into another different set of elements called outputs, is called production. Factors of production, called inputs are generally classified as land, labor or capital. In the context of the LM/LC industry these factors are described below.

Capital inputs are man-made resources like fertilizers and pesticides in the context of the LM/LC industry. Fertilizers are used to enhance the growth of the plant material by supplementing the nutrients in the soil. Pesticides include herbicides, insecticides, and fungicides. Herbicides are used in the control of the weeds which are a prominent source of risk to turfgrasses. Insecticides are used in the control of insect attacks on the plant material. Fungicides are used against the fungi damaging plants. Labor inputs are the time or service of the people put into production. These inputs are applied to transform the appearance of the land. Land is often considered as a separate input in agriculture because in crop production land or acreage directly decides about the output. The LM/LC industry offers services to develop the land, so indirectly the acreage serviced by firms can be considered as an input. The final appearance of landscape is the output for the LM/LC industry.

Firms are interested in turning inputs into outputs with the objective of maximizing profits. The relationship between inputs and outputs is formalized by a production function

$$q = f(K, L, M) \tag{1}$$

where  $q$  is the output of a particular commodity,  $K$  is capital,  $L$  is labor and  $M$  is land or raw material. Information on the effects of input use on the generated output will help the companies to concentrate on the effective resource management.

In an effort to provide information about the effect of inputs on output this study is conducted with a specific objective of estimation of production function for the LM/LC industry in Georgia. A review of agricultural economic literature resulted in adopting the agricultural production framework proposed by Pope and Just (1979) in treating an input as a source of risk. The study by Pope and Just showed the natural shortcomings of the popular production specifications. The study points to the important shortcoming of the traditional stochastic production function specification, where if an input has a positive effect on output, then a positive effect on variability of output is also imposed. Pope and Just specify arguments which imply that the effects of input on output should not be tied to the effects of input on the variability of output. To overcome this problem Pope and Just propose a three-stage production function estimation procedure which specify the effects of input on the mean of output and the effects of input on the variance of output. The three stages of estimation procedure are outlined as follows:

The first stage of estimation is the non-linear, heteroscedastic regression of dependent variable on the explanatory variable. One of the assumption classical linear model is the unobservable error has a constant variance known as homoscedasticity. The failure of this assumption that is the variance of error is not constant results in a problem called as heteroscedasticity. The standard t-test and F-test are based on the assumption of homoscedasticity and these tests can no longer be applied to the parameter estimates with heterosecdasticity problem. The step leads to consistent parameter estimates of the independent variables in the model:

$$y = \exp [\ln(X)\alpha]. \quad (2)$$

The second stage involves the OLS regression of the error terms obtained from the first step on the explanatory variables. This step accounts for heteroscedasticity and leads to consistent parameter estimates which are asymptotically efficient:

$$\ln|e| = \ln(X)\beta. \quad (3)$$

The third step involves a non-linear estimation of the transformed dependent variable on the transformed independent variables resulting in an asymptotically efficient, consistent and unbiased parameter estimates of the independent variables included in the model. This step also corrects the heteroscedasticity problem:

$$y * \exp[-1/2(\ln(X))^2 \beta] = \exp[\ln(X)\alpha - 1/2 (\ln(X))^2 \beta]. \quad (4)$$

These three steps help in achieving the objective of production function estimation. The efficient and consistent parameter estimates obtained at the end of estimation process help in identifying the impact of inputs on the output. This information should help the companies focus on efficient use of inputs.

### ***Data***

The information about sales of the LM/LC industry is available only at spatially aggregated levels, i.e., total sales in a single state or nationwide during a calendar year. Such data are inadequate to provide insights about factors influencing the economic performance of the industry. To obtain disaggregated, detailed data investigators must engage in primary data collection. Industry surveys are notoriously difficult because the nature of the data is often perceived as 'sensitive' by respondents although anonymity is guaranteed and data are used only for a research purpose.

Data used in this study were collected by faculty cooperating with the Center for Urban Agriculture, through a mail survey in the spring of 1999. The design of the survey

instrument was developed in conjunction with three major professional organizations, i.e., the Georgia Green Industry Association (GGIA), the Georgia Turfgrass Association (GTA), and the Metropolitan Atlanta Landscape and Turf Association (MALTA).

Mailing lists from these associations provided addresses of firms that received the questionnaire. The survey was conducted in three stages between February and April of 1999: following the first mailing, a postcard was sent a week later as a reminder; two weeks later, a second mailing of the questionnaires went to those firms which did not respond to previous mailings. In order to collect data within a reasonable time period, responses included in the study arrived within 6-7 weeks from the date of the first mailing. The rate of return was 45 percent. This rate of participation by a business sector is considered high, particularly when conducted during the major work season.

### ***Model Specification***

The output of LM/LC industry is measured in terms of the final appearance or outlook of the land, to which all the inputs are applied. It is difficult to measure the appearance of land in physical terms. Hence we express the output of LM/LC industry in monetary terms instead of the conventional way of measuring it in physical units. In this case, the dependent variable measuring output, is the gross revenue reported by a company. The explanatory variables include the labor cost, the total acreage covered by a company, the total chemical costs (fertilizers and pesticides), the total plant material cost (trees, shrubs, grass seed and sod) for LM/LC firms. In this study two additional variables were considered important, the ownership type (corporation vs. other types), and the risk perception of labor turnover reported by a company.

The selection of some of the explanatory variables was based on previous studies while some were selected based on the observed behavior of the industry. The labor cost, the total acreage covered by a company, the total chemical costs, the total plant material

cost were selected based on a study estimating the production function by Battese et al. (1989). Two separate studies by Hubbel et al., (2001) and Anil et al., (2001) indicated that ownership type was important for the revenues of a company, this observation influenced the inclusion of ownership type. The variable risk perception was deemed important based on the industry observations to focus on the risk associated with high labor turnover ratio.

Earlier studies allow for some assumptions regarding the effect of the explanatory variables on the output of the LM/LC industry prior to the actual analysis. The following is a brief description of the explanatory variables and their expected impact on the output.

The LM/LC industry is labor intensive. Thus, labor costs are the most important cost in the operation of the business. A company must pass labor costs to consumers in order to remain in business. Labor costs are expected to have a significant and positive effect on the output measured in terms of gross revenues.

The total acreage covered by a company indicates the size of the business operation. A company operating on a large number of acres employs larger amounts of inputs to generate output. Because in the LM/LC industry services are tied to the land area serviced, there is a direct relationship between the acreage and gross revenues. The total acreage is likely to have a significant and positive impact on the dependant variable.

The chemical cost includes the fertilizer and pesticide cost incurred by a company. Fertilizers are used to enhance the growth of the plant material by supplementing the nutrients in the soil. Pesticides are used to protect the plant material from pest infestations. The chemical cost is expected to have a significant and positive impact on the dependent variable.

The plant material cost includes the grass seed, sod, and other plant material costs incurred by a company. Plant material is an important input used in transforming the

appearance of landscape which is the final output in the LM/LC industry. Hence plant material cost is hypothesized to have a significant and positive influence on the output.

The ownership type variable classified firms into two groups corporations and family owned firms or partnerships. The ownership type is not significant from the output point of view as output is mainly dependent on the inputs employed into the production process. However corporations tend to have broader technical support in the form of expertise in identifying potential production problems (Hubbell et al., 2001). Therefore, the ownership serves in this study as a proxy variable for improved use of inputs in the production. The anticipated relationship between this variable and the output is positive.

The risk variable reflects a company's perception of risks associated with a high labor turnover. A firm's perception about the risk associated with the high labor turnover is possibly because of a drop in revenues resulting from the number of employees leaving the firm over a period of time. A report by Fish (2001) shows that employees tend to leave of a firm because of the firm's inability to be flexible with pay scales. Firms concerned about risk associated with high labor turnover are possibly rigid with their pay scales there by losing their experienced workforce. This perception of risk will plausibly force the firms to employ few personnel and stay away from offering a wider range of services. A reduced workforce means a drop in the potential returns of a firm as labor is the means of providing LM/LC services. Hence risk is likely to have a significant and negative impact on the output.

The empirical model was specified based on the selected explanatory variables and expectations regarding the nature of influence these variables have on the output. The estimation procedure involves three sequential estimation steps. The first stage involves non-linear, heteroscedastic regression of gross revenue reported by a company on explanatory variables described above. The regression results in parameter estimates for the explanatory variables. But, the estimates have a potential problem of heteroscedasticity

which limits the hypothesis testing of variables included in the model. Apart from the heteroscedasticity problem the estimates are not useful in learning the effect of input use on risk. Further estimation of model as suggested by Pope and Just (1979) corrects for heteroscedasticity and provides an insight into the effect of input use on risk. The non-linear, heteroscedastic regression has the gross revenue reported by a company as the dependent variable and the natural log forms of the independent variables discussed above. The formal representation of first step of estimation procedure is shown below.

$$\begin{aligned} \text{Gr} = & \alpha_0 + \exp(\alpha_1 \ln(\text{Lab}) + \alpha_2 \ln(\text{Actot}) + \alpha_3 \ln(\text{Chem}) + \alpha_4 \ln(\text{Plmat}) + \alpha_5 (\text{Corp}) \\ & + \alpha_6 (\text{Risk})) \end{aligned} \quad (5)$$

The second step involves an OLS regression of the logs of absolute value of error terms obtained in the first stage of estimation on the logs of independent variables. This step is important, because if heteroscedasticity is present, the hypothesis testing about the importance of explanatory variables cannot be performed. By taking account of the heteroscedasticity, it is possible to gain efficiency asymptotically in estimation. The second step results in the consistent estimators for the explanatory variables giving an idea of heteroscedasticity problem. The estimates obtained are used to transform the dependent and explanatory variables in the final stage of estimation procedure. The estimation procedure is represented in the conventional form as shown below.

$$\begin{aligned} \ln(|e|) = & \beta_0 + \beta_1 \ln(\text{Lab}) + \beta_2 \ln(\text{Actot}) + \beta_3 \ln(\text{Chem}) + \beta_4 \ln(\text{Plmat}) + \beta_5 (\text{Corp}) \\ & + \beta_6 (\text{Risk}) \end{aligned} \quad (6)$$

The third step involves non-linear estimation of the transformed dependent variable using the parameter estimates  $\beta$ ; from the second step on the transformed independent variables. Transformation of the variables in the model is necessary for two reasons. Firstly, it helps to correct the heteroscedasticity problem. Secondly, results in an asymptotically efficient, consistent and unbiased parameter estimates of the independent variables included in the model. The transformation of dependent and explanatory

variables and the formal representation of the regression step is shown below.

$$\begin{aligned} & \text{Gr} * \exp[(-1/2)\beta_1(\ln(\text{Lab}))' + (-1/2)\beta_2(\ln(\text{Actot}))' + (-1/2)\beta_3(\ln(\text{Chem}))' \\ & + (-1/2)\beta_4(\ln(\text{Plmat}))' + (-1/2)\beta_5(\text{Corp})' + (-1/2)\beta_6(\text{Risk})'] = \\ & \alpha_0 + \exp[\alpha_1\ln(\text{Lab})' + \alpha_2\ln(\text{Actot})' + \alpha_3\ln(\text{Chem})' + \alpha_4\ln(\text{Plmat})' + \alpha_5(\text{Corp})' + \\ & \alpha_6(\text{Risk})' (-1/2)\beta_1(\ln(\text{Lab}))' + (-1/2)\beta_2(\ln(\text{Actot}))' + (-1/2)\beta_3(\ln(\text{Chem}))' \\ & + (-1/2)\beta_4(\ln(\text{Plmat}))' + (-1/2)\beta_5(\text{Corp})' + (-1/2)\beta_6(\text{Risk})' ] \end{aligned} \quad (7)$$

Table 1 shows the descriptive statistics of variables included in the empirical model. The average gross revenue of surveyed companies was \$1,097,797, three times the \$385,614 reported by Florkowski et al., (1994). The increased revenues can be attributed to the larger sample size and increasing demand for the LM/LC services in Georgia. The average labor was reported to be \$345,800 which is an approximate 70 percent increase from the \$204,448 reported by Florkowski et al., (1994). The average acreage serviced was 173 acres. The average of the chemical cost was \$40,160 which is much higher than the \$6000 reported by Florkowski et al., (1994). Showing that there is an increasing demand for chemical application. The mean of the plant material cost was \$159,789.

The dummy variable representing ownership type (corporation vs. other types), reveals that 63 percent of the companies fall under the corporation type and the rest, 37 percent, fall under the family-owned or partnership type. This is in stark contrast to the earlier findings by Florkowski et al., (1996) which reported that only seven percent of the firms surveyed were corporate type and the rest were either family-owned or partnership type. This reversal of a trend might be because the companies operating in the business have gained in experience and organized themselves into corporate types to take advantage of the lower tax rates and tax-deductible employee benefits. The other dummy

Table 1: Definitions of Variables Included in Model and their Descriptive Statistics.

Variable	Definition	Mean	Min	Max	Standard deviation
Gr	Gross revenue reported by a company, in thousand dollars	1,097.80	0.70	14,000	2,017.57
Lab	Labor cost reported by a company, in thousand dollars	345.80	0.40	4,000	600.02
Actotal	Total acreage serviced by the company, in acres	173	5	2,500	62.50
Chem	Total chemical cost incurred by a company i.e, fertilizers and pesticides	40,160	200	800,000	108,883.14
Plmat	Total cost incurred by a company on plant materials including sod, in dollars	159,788.67	700	1,950,000	380,491.02
Corp	Dummy variable: 1 if type of the company reported as corporation; 0 otherwise	0.63	0	1	0.49
Risk	Dummy variable: 1 if the company reported labor turnover ratio as a high risk source; 0 otherwise	0.31	0	1	0.50

variable representing the risk perception of labor turnover reported by a company reveals that 31 percent of the companies surveyed consider labor turnover as a high source of risk.

Earlier study by Hubbard et al., (1989) concluded that labor costs form one fourth of the total revenues earned by a company. A similar report by Florkowski et al., (1994) showed that average labor costs were \$204,448 one-half of the average revenue reported forming a major component of the expenditures incurred by a company. The data used here also show that labor costs form one third of the average revenue reported thus constitute a major component of the expenditures reported by a company.

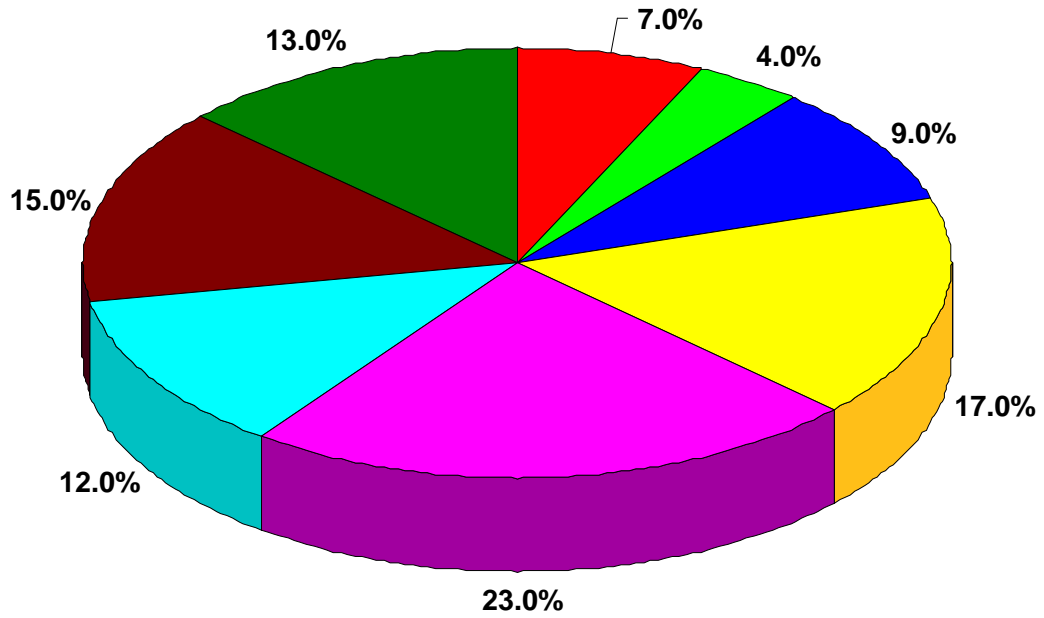
## **CHAPTER 4**

### **EMPIRICAL RESULTS**

#### *Preliminary Analysis Results of Survey Data*

A preliminary analysis of the survey data was conducted to group the firms based on the extent of revenues, expenditures, the acreage serviced, the ownership type and risk perception, reported. The objective of the preliminary analysis was to compare the results with the earlier survey studies. The analysis involved the creation of frequency tables measuring the distribution of firms converted into graphs for the case of visual presentation. Earlier studies by Hubbard et al., (1989); Garber and Bondari, (1996); and Florkowski et al., (1994) of the LM/LC industry helped in grouping the firms for computing the percentage of firms in a group. The preliminary survey results are summarized as given below.

Information provided by respondents enabled the classification of the companies into eight categories according to gross revenue received in 1998 (Figure 2). The largest number of firms (23 percent) reported annual revenue between \$200,001-\$500,000. A similar study by Hubbard, et al. (1989) reported 25 percent of the firms were in the range of \$200,001-\$500,000. However, 40 percent of firms reported greater earnings, with 28 percent of the total number of firms generating more than \$1 million in revenues. The 40 percent is much higher when compared to the 34 percent reported by Hubbard, et al. (1989). Relatively few firms (20 percent) earned \$100,000 or less. In comparison to earlier studies (e.g., Hubbard, et al., 1989), firms surveyed in 1999 reported a considerably higher level of revenue. Two factors may explain this difference. First, the current survey included landscape maintenance and installation firms. Second, the green industry earnings growth reflects the increasing demand for these services.



**Legend:**

- |                    |                       |                         |
|--------------------|-----------------------|-------------------------|
| Less than \$25,000 | \$100,001-\$200,000   | \$1 million-\$2 million |
| \$25,001-\$50,000  | \$200,001-\$500,000   | More than \$2 million   |
| \$50,001-\$100,000 | \$500,001-\$1 million |                         |

Figure 2. Gross Revenue Reported by LM/LC Firms in Georgia, 1998

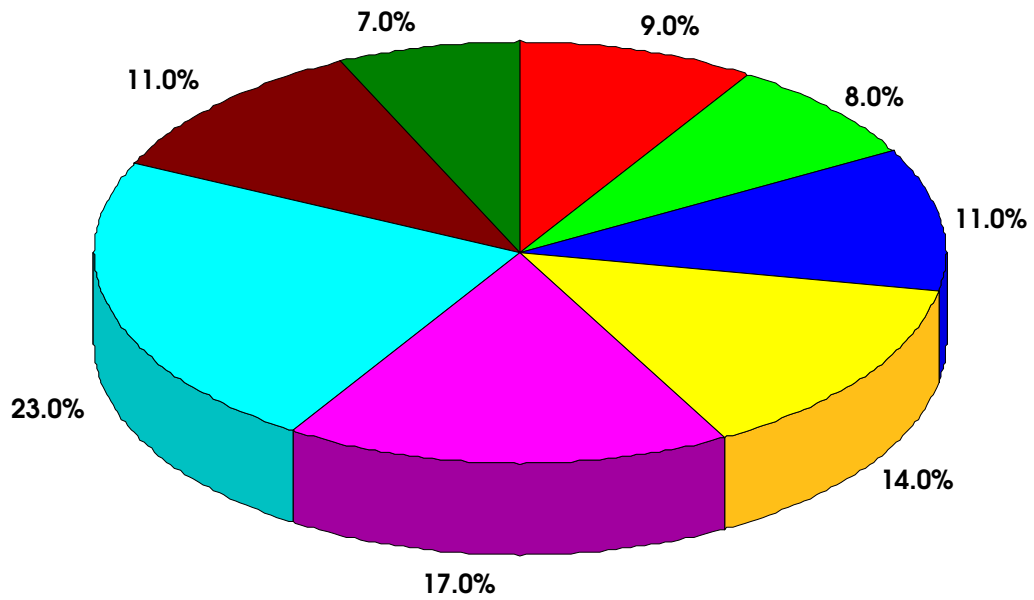
Source: Florkowski and Landry, (2000).

Note: Percentages calculated based on the number of firms reporting gross revenues.

Hubbard, et al.(1989) reported that labor costs were the major expense of the industry forming one fourth of the total revenue earned by a company. According to this survey, 58 percent of firms spent in excess of \$100,000 on labor (Figure 3). In addition, seven percent of firms reported gross revenue more than \$1 million in 1998. Such spending has considerable effect on Georgia's economy. The increasing labor costs show the increase in demand for labor. The increasing demand for labor led, in turn, to the employment opportunities. Hubbard et al. (1989) reported that the LM/LC firms employ part-time and full-time employees, thus emerging as a prominent source of jobs in the agricultural sector of Georgia. The industry is primarily one of service hence labor intensive. In this context, labor costs affect the profitability, pricing strategies and competitiveness.

Apart from the labor costs the other input costs are fertilizer, pesticides, plant material, sod and grass seed expenditures. Seventeen percent of the firms were responsible for the bulk of fertilizer purchases in 1998. Fifty-seven percent of the firms spent no more than \$5,000 on fertilizer (Figure 4). About a third of the firms spent no more than \$1,000; however, another third spent \$10,000 to more than \$50,001. Thus most fertilizer application services are supplied by a limited number of firms, suggesting that companies willing to expand services can include fertilizer application services and expect to increase their revenues.

Earlier study (Florkowski et al., 1994) showed that on an average a firm spent around \$ 3,501 on herbicides thus forming a major component of pesticide expenditures reported by the LM/LC industry in Georgia. Turfgrasses are used as a permanent vegetative cover and are subject to an invasion of a variety of weeds that germinate and grow at different times of the year (Murphy, 1998). In Georgia, weeds are a major turfgrass pest, followed by disease and insect problems. Spring and summer weed



**Legend:**

<span style="color: red;">■</span> \$10,000 or less	<span style="color: yellow;">■</span> \$50,001-\$100,000	<span style="color: brown;">■</span> \$500,001-\$1 million
<span style="color: green;">■</span> \$10,001-\$25,000	<span style="color: magenta;">■</span> \$100,001-\$200,000	<span style="color: darkgreen;">■</span> More than \$1 million
<span style="color: blue;">■</span> \$25,001-\$50,000	<span style="color: cyan;">■</span> \$200,001-\$500,000	

Figure 3. Labor Expenditure Reported by LM/LC Firms in Georgia, 1998

Source: Florkowski and Landry, (2000).

Note: Percentages calculated based on the number of firms reporting labor expenditures.

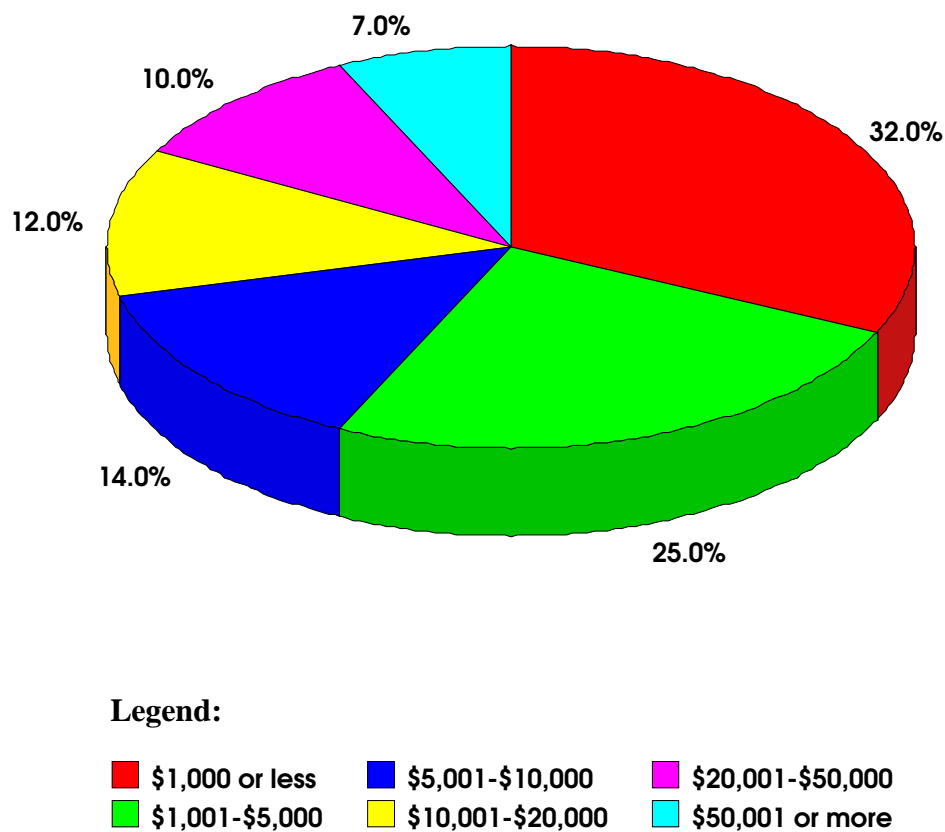


Figure 4. Fertilizer Expenditure Reported by LM/LC Firms in Georgia, 1998

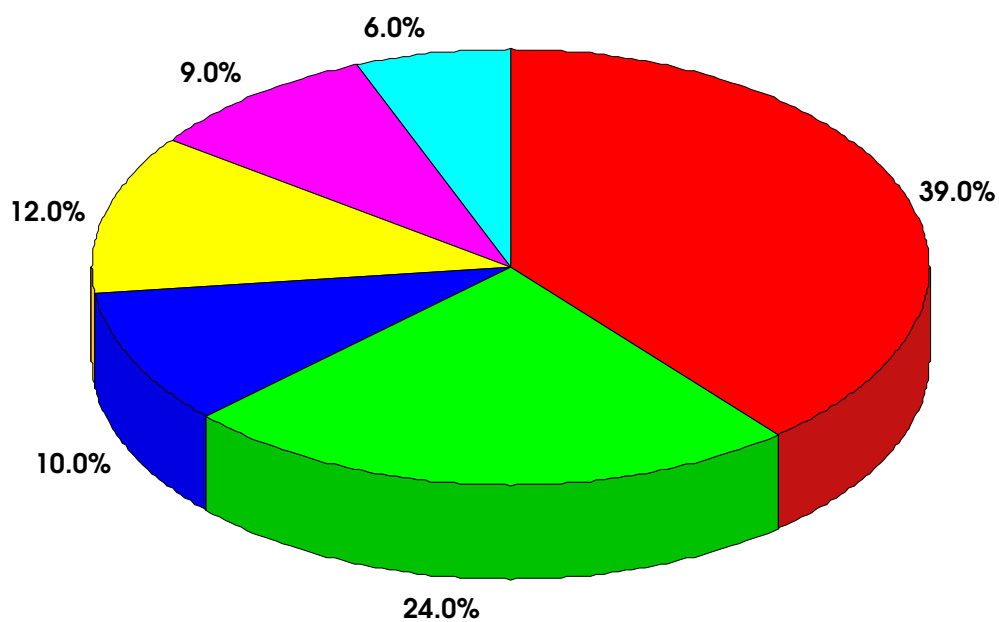
Source: Florkowski and Landry, (2000).

Note: Percentages calculated based on the number of firms reporting fertilizer expenses.

problems include crabgrass (*Digitaria sanguinalis* L.) and goosegrass (*Eleusine indica* L. Garten); in fall, winter, and late spring problems include annual bluegrass (*Poa annua* L.), henbit (*Lamium amplexicaule* L.), clovers (*Trifolium* spp.), and dandelions (*Taraxacum officinale* Weber). Herbicides are effective in controlling weeds. Pre-emergence herbicides are applied routinely for crabgrass often in combination with fertilizers, to reduce the labor cost by fertilizing and controlling weeds in one visit.

A report (Florkowski et al., 1994) showed that on an average a firm spent around \$864 on insecticides. Insecticide expenditures were the second largest expenditures on pesticides reported by the LM/LC industry in Georgia. This suggests that insecticides are the second most often applied group of pesticides. A report by Florkowski et al. (2000) showed that fire ants are well established in Georgia and commonly found on lawns; insecticides provide the most effective control. In addition, several insect species feed on turf and may occasionally require insecticidal control. Increase of environmental concerns influences new landscapes and lawn management practices. Insecticide use is subject to the increased regulation and may change in response to customer demands. A study by Hubbell et al., (2001) trying to advocate the use of integrated pest management practices (IPM) showed that 50 percent of the LM/LC firms use customer request as a criterion for making chemical treatment decisions. This suggests that there is a good opportunity for reducing the LM/LC chemical usage through consumer education about IPM and other pest-control alternatives. The reduction in usage of chemicals in turn may reduce pollution there by minimizing the environmental concerns.

Nearly two-thirds of firms spent no more than \$5,000 on the purchase of all types of pesticides (Figure 5). Fifteen percent of the firms were responsible for the major volume of pesticide purchases. This high concentration of pesticide expenditures among a few firms is consistent with the fertilizer application suggesting that a relatively few number of firms are involved in pesticides application. Fungicides are used to protect the



**Legend:**

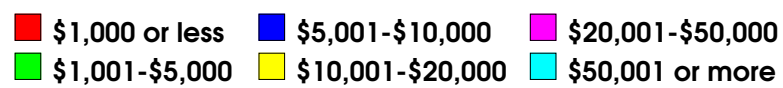


Figure 5. Pesticide Expenditure Reported by LM/LC Firms in Georgia, 1998

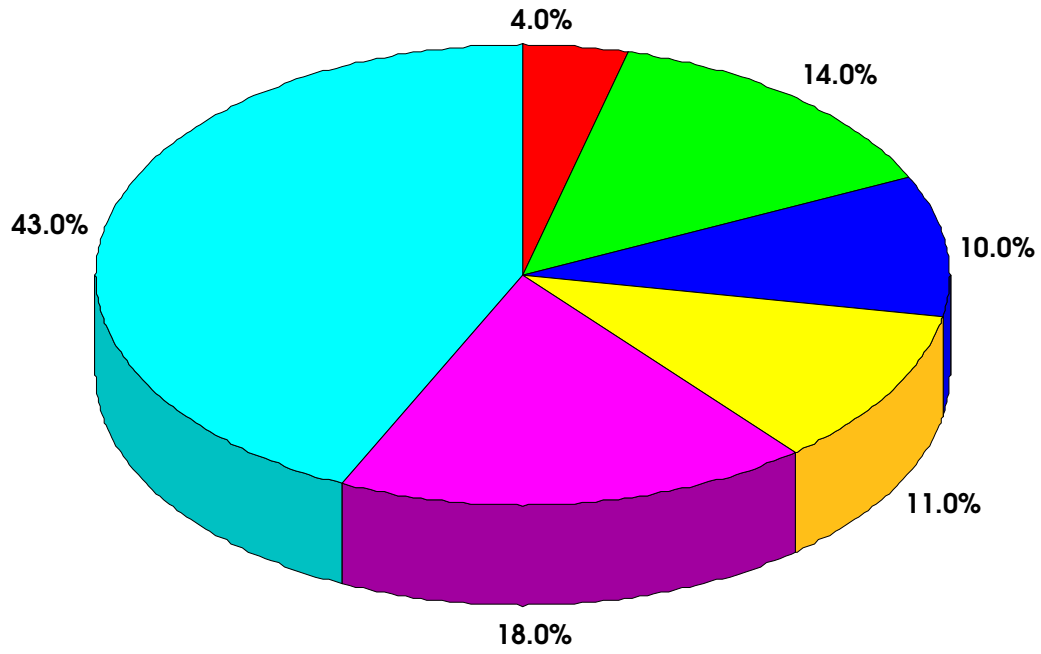
Source: Florkowski and Landry, (2000).

Note: Percentages calculated based on the number of firms reporting pesticide expenses.

turfgrasses and ornamental plants from fungal attacks. Many pathogenic fungi are indigenous to Georgia. In Georgia, massive fungal infestations are infrequent. Hence, the fungicide forms the lowest segment of the pesticide expenditure. Earlier study (Florkowski et al., 1994) showed that on an average a firm spends around \$452 on fungicides thus representing the lowest share of the pesticide expenditures.

Plant material purchases showed that more than 40 percent of firms spent in excess of \$50,000 on plant material (Figure 6). Nearly another 30 percent spent between \$10,001 and \$50,000 while fewer than 20 percent reported expenditures less than \$5,000 on plant material purchases. Plants seem to be a major input in the surveyed firms, likely reflecting the demand for new landscaping caused by sustained residential construction and landscape renovations. The plant material used in the maintenance of landscape originates from the nurseries and greenhouses in Georgia. The cash receipts from the sale of nursery, greenhouse and sod crops for year 1998 stood at \$252 million placing the receipts in seventh position among the top ten agricultural commodities of Georgia (Georgia Agricultural Facts, 1998). It is likely that plant material expenditures of LM/LC firms is a significant contribution to these cash receipts.

Seventy percent of the firms spent no more than \$5,000 on grass seed (Figure 7). However, 10 percent of the firms spent more than \$20,000 on seed. Likely these firms specialized in turf seeding. However sod installation was popular because sodding is the fastest, and best way to establish a lawn. The grass plants used in sodding reach maturity and are tough enough to survive the shock of transplanting and provide an instant visual effect. Sodding is also cost effective in reducing soil erosion (Carroll, 1992). Because sod is fully mature the day it is installed, it immediately controls erosion with a carpet of root mass and grass plants. Also turf filters the pesticide and fertilizers runoff (N & P), so it has beneficial effect on the environment limiting surface water pollution. Sixty percent of firms spent in excess of \$10,000 on sod (Figure 8). The total amount spent on sod was



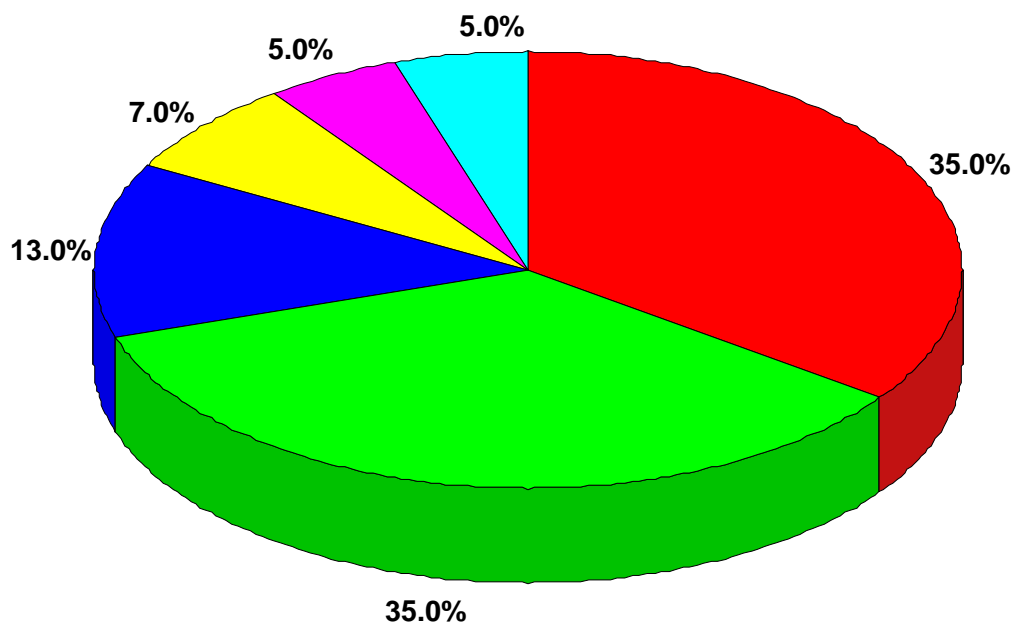
**Legend:**

- \$1,000 or less
- \$1,001-\$5,000
- \$5,001-\$10,000
- \$10,001-\$20,000
- \$20,001-\$50,000
- \$50,001 or more

Figure 6. Plant Material Expenditure Reported by LM/LC Firms in Georgia, 1998

Source: Florkowski and Landry, (2000).

Note: Percentages calculated based on the number of firms reporting plant material expenses.



**Legend:**

■ \$1,000 or less   ■ \$5,001-\$10,000   ■ \$20,001-\$50,000   ■ \$50,001 or more  
■ \$1,001-\$5,000   ■ \$10,001-\$20,000

Figure 7. Grass Seed Expenditure Reported by LM/LC Firms in Georgia, 1998

Source: Florkowski and Landry, (2000).

Note: Percentages calculated based on the number of firms reporting grass seed expenses.

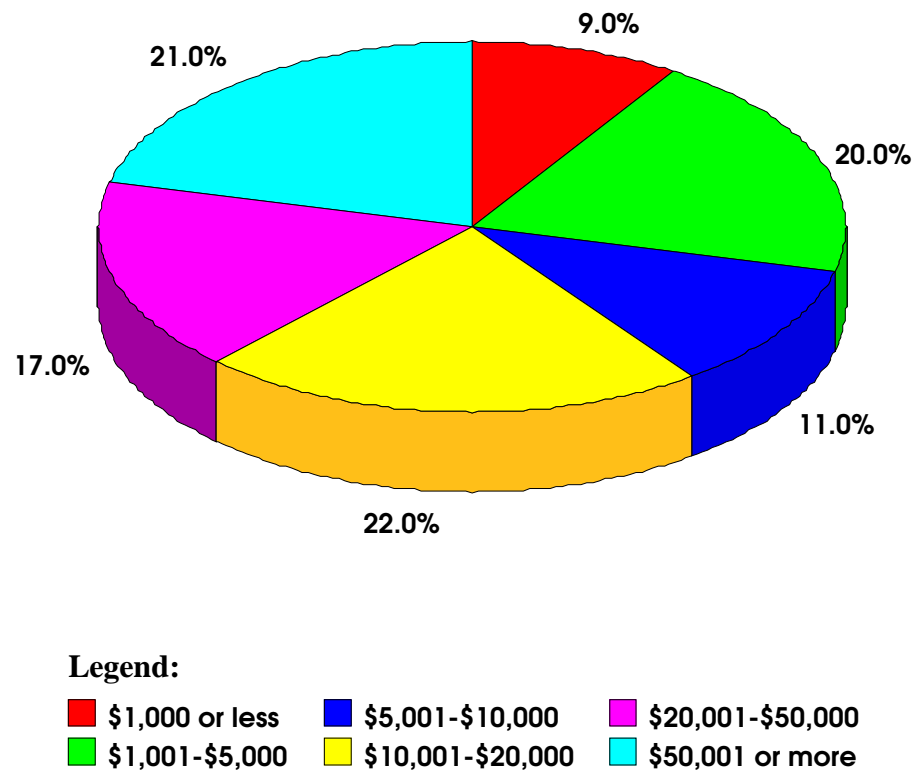


Figure 8. Sod Expenditure Reported by LM/LC Firms in Georgia, 1998

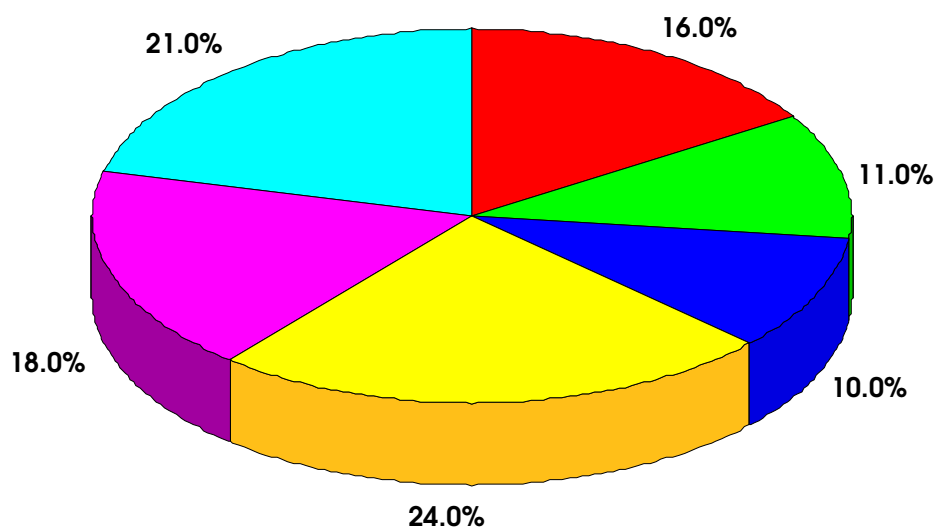
Source: Florkowski and Landry, (2000).

Note: Percentages calculated based on the number of firms reporting sod expenses.

\$5.85 million. Very few firms (Figure 8) were classified in the lowest expenditure category. The use of sod obviously is becoming more affordable. In 1999, Landry reported that the 1997 Georgia farmgate value of sod was \$52.1 million, a 50 percent increase over the 1992 value from 17.134 acres (Landry, 1999b). The good economic environment i.e., increasing personal incomes through much of 1990s and improved techniques of sod production and installation have helped to popularize the use of sods.

Firms were classified into six categories according to the number of serviced acres (Figure 9). Overall, the majority of firms (63 percent) serviced at least 100 acres. Approximately one-fourth of surveyed firms serviced 25 acres or less; another one-third provided maintenance to 26 acres to 100 acres. The remaining firms were closely split between those servicing 100 acres to 200 acres and those servicing more than 200 acres. Residential clients are defined as homeowners. Earlier study by (Florkowski et al., 1994) showed that on an average an LM/LC firm served around 1,004 square meters of residential area and 9,393 square meters of commercial plot. Thus suggesting that commercial clients likely subscribe to LM/LC services on larger scale. Commercial clients are defined as non-residential customers. Non-residential customers include retail outlets owning a landscape which requires maintenance, companies located on parcels of land consisting of lawns and landscaped areas (e.g., landscaped parking lots, parks). Also they do not have in-house maintenance crews and must hire professional service providers for the purpose of proper landscape upkeep. Commercial clients may own parcels of land of various sizes, but they consistently purchase maintenance services. In this context the commercial clients form a consistent source of input landscape for which they subscribe the LM/LC services.

The responding firms were classified into corporate type and family-owned or partnership firms. Corporations formed approximately 63 percent of the firms responding to the current survey. Independently owned firms formed approximately 37 percent of the



**Legend:**

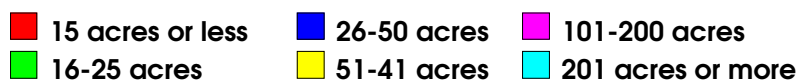


Figure 9. Acreage Serviced Reported by LM/LC Firms in Georgia, 1998

Source: Florkowski and Landry, (2000).

Note: Percentages calculated based on the number of firms reporting acreage serviced.

surveyed firms (Figure 10). Cox et al. (1989) noting the lack of data on corporate returns to landscape services, reported that in the late 1970s, about 13 percent of landscape service firms were corporations. Florkowski et al.(1996) reported that majority (93 percent) of the firms in Georgia were family-owned or in partnerships and only seven percent of the firms were organized as corporations. This could be because the firms gained experience in business and understood the different organizational structures and their benefits. The experienced firms might have organized themselves into corporations to take advantage of the tax benefits.

The surveyed firms were classified into companies particularly concerned about risks associated with high labor turnover ratio and companies which do not consider labor turnover ratio as a high source of risk. The risk perception is an unconventional measure. It is a proxy for the lack of a more accurate measure of the major problem encountered by the industry. The companies concerned about the risk associated with labor turnover ratio cannot expect to generate greater revenues because the LM/LC industry depends on labor to generate revenues. A study by Fish (2001) pointed that labor turnover is probably influenced by the inability of a firm to offer a competitive pay scale. The survey data reveals that approximately 31 percent (Figure 11) of the companies considered the labor turnover ratio as the highest source of risk to the industry.

The earlier studies were descriptive in approach showing the distribution of firms using the frequency tables and deriving implications. This study went a step further and conducted empirical investigation of the production function for the LM/LC industry in Georgia thus making it the first attempt of its kind in the literature.

### ***Empirical Model Estimation Results***

The specific objective of this study was to estimate the production function for the LM/LC industry in Georgia. The review of earlier studies helped in adopting the

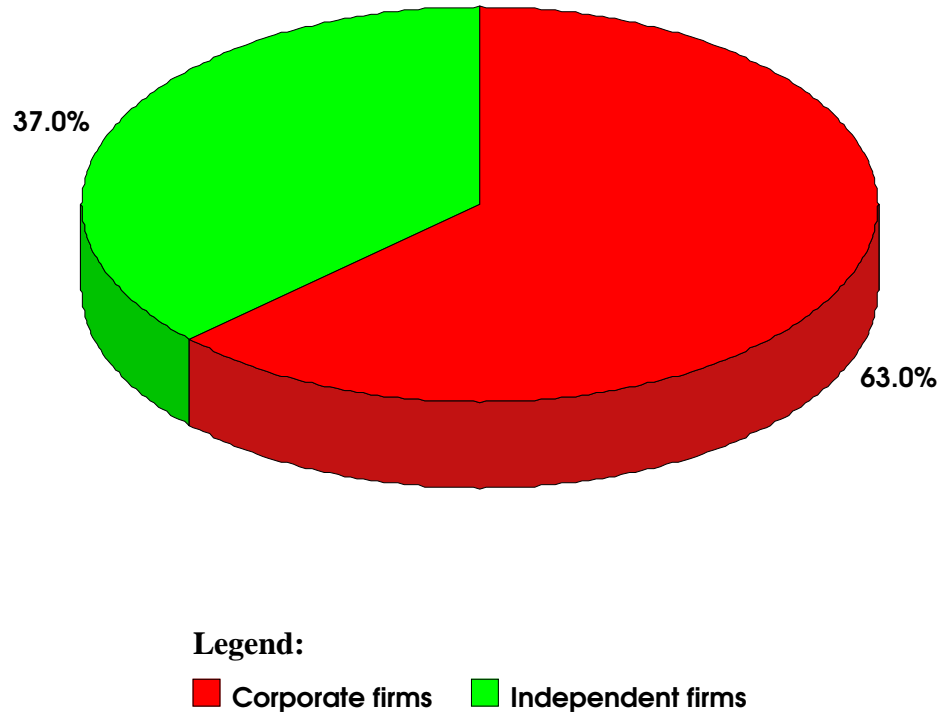
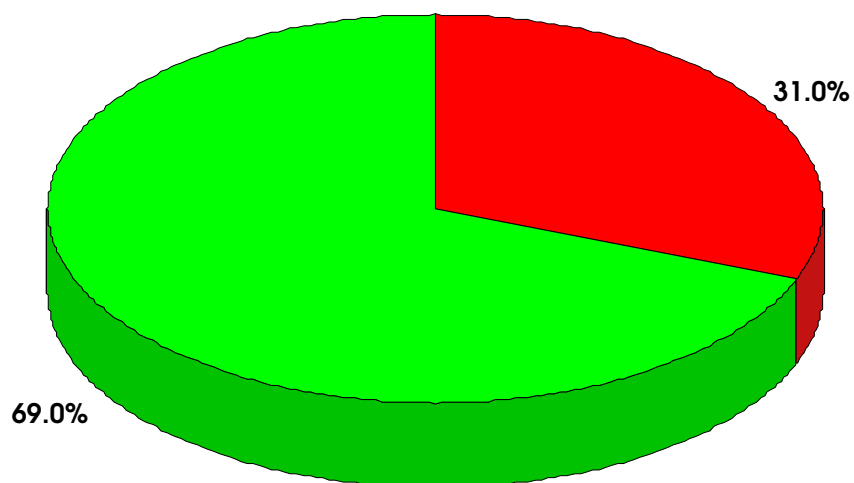


Figure 10. Ownership Type Reported by LM/LC Firms in Georgia, 1998

Source: Florkowski and Landry, (2000).

Note: Percentages calculated based on the number of firms reporting ownership type.



**Legend:**

■ Labor turnover high risk    ■ Labor turnover not high risk

Figure 11. Risk Perceptions Reported by LM/LC Firms in Georgia, 1998

Source: Florkowski and Landry, (2000).

Note: Percentages calculated based on the number of firms reporting risk perception.

agriculture production function framework suggested by Pope and Just (1979) to carry out model estimation. The proposed framework involves a three stage estimation process. Hence the empirical analysis is executed in three stages and results are presented for each stage of the estimation process.

The first stage involves the non-linear, heteroscedastic regression of gross revenues reported by a company on explanatory variables included in the model. The parameter estimates for the first stage of estimation are presented in Table 2. The measure of goodness of fit of the equation estimated using cross sectional data was good indicating 91 percent of the variation in the dependent variable, i.e., the output of a LM/LC firm was explained. But the estimates obtained have a potential problem of heteroscedasticity and are not efficient.

The LM/LC industry employing labor in the production of landscape appearance must manage the labor resources efficiently to sustain growth and maximize the profits. The positive and significant parameter estimate of the variable accounting for labor costs in Table 2, suggests that companies were able manage the labor costs efficiently a condition needed to sustain growth.

The total acreage serviced by a company indicates the size of business conducted by a company. A company operating on a large number of acres plausibly employs larger amount of inputs because in the LM/LC industry services are tied to the land area serviced. There is a direct relationship between the acreage and output of a company. The non-linear least square parameter estimate revealed that the total acreage covered by company had a positive and significant impact on the dependent variable, gross revenue measuring the output of LM/LC firms.

The chemical cost is the sum of fertilizer and pesticide costs reported by a firm. Fertilizers and pesticides are the man made resources constituting the capital inputs used in LM/LC industry. Fertilizers are applied to the soils deficient in nutrients to supplement

TABLE 2: Non-Linear Least Square Coefficient Estimates for the First Step of Estimation.

Variable Name	Variable Description	Coefficient Estimate	<i>t</i> -statistic
Constant	-	-27.64*	-9.45
Lab	Total labor cost reported by a company, in thousand dollars	0.26*	4.70
Actotal	Total acreage serviced by the company	0.06**	2.32
Chem	Total cost incurred by a company on chemical inputs i.e., fertilizers and pesticides	0.14*	3.77
Plmat	Total cost incurred by a company on plant materials including sod	0.05*	1.69
Corp	Dummy variable: 1 if type of the company reported as corporation; 0 otherwise	0.07	0.68
Risk	Dummy variable: 1 if the company reported labor turnover ratio as a high risk source; 0 otherwise	-0.17*	-3.21
	Number of observations	76	
	F-value	122	
	Adjusted R-square	0.91	
	Degrees of freedom	69	

\* Indicates significance at 0.01 confidence level or higher

\*\* Indicates significance at 0.05 confidence level or higher

the nutrients and enhance the plant growth. Pesticides are used as a protective cover against pest infestations and diseases. The results of the first stage analysis show that chemical cost as predicted had a positive and statistically significant impact on the gross revenue quantifying the output of LM/LC firms.

The sum of the grass seed, sod, and other plant material expenditures incurred by a company form the plant material cost. According to survey results plant material is the second largest input in this industry as measured by firms expenditures. The appearance of landscape is transformed by using different types of plant material. Plant materials provide the necessary aesthetic scenery by their greenery. Results of the first step of estimation reveal that plant material cost had a positive effect on the output.

Companies organized as corporations incline to have a wider technical back up in the form of proficiency in identifying likely production problems. Earlier research by Hubbell et al., (2001) showed that companies organized as corporations were having better production results by adopting the integrated pest management (IPM) practices. The first stage of analysis shows statistically insignificant parameter estimate for the variable representing the firms organized as corporations.

Risk variable distinguished between companies particular perception of risk associated with a high labor turnover ratio. As expected, the risk variable had a negative and significant impact on the gross revenue measuring the output of LM/LC firms. The companies concerned about the risk associated with high labor turnover ratio perhaps tried to minimize the risk by employing few laborers. But labor is the most important factor input for the LM/LC firms having a direct bearing on the output. Thus minimizing the number of employees means reducing the potential output of a firm.

There are two main reasons for further estimation of the model. First, the results obtained in first step are consistent but there is a potential problem of heteroscedasticity

because the data used are cross-sectional. Second, further estimation results in asymptotically efficient parameter estimates as proven by Pope and Just (1979).

The second step is the OLS regression of the error terms on the values of the independent variable expressed in logs. This step is important because if heteroscedasticity is present, then the hypothesis testing about the importance of explanatory variables cannot be performed. By correcting for heteroscedasticity, it is possible to gain efficiency in estimation asymptotically. The parameter estimates generated from the second stage of estimation are presented in Table 3.

The second stage estimation results reveal that labor, chemical and plant material costs, along with the total acreage serviced by firm and risk perception variable, had a statistically insignificant parameter estimates. The lack of significance implies that heteroscedasticity was not a problem associated with the inclusion of these variables in the model.

The variable representing the companies listed as corporation was the only exception which had a negative and statistically significant parameter estimate in the second stage of estimation. The significance means there was a heteroscedasticity problem associated with the inclusion of the variable representing the corporate type of firms. But this problem of heteroscedasticity is corrected by carrying out third stage of estimation procedure as suggested by Pope and Just (1979).

The parameter estimates generated in the second stage of estimation process are used in the third and final stage of estimation to transform the dependent and explanatory variables included in the model. The variables are transformed for two reasons. First, transformation of variables included in the model allows to correct the heteroscedasticity associated with the use of the variable describing corporate ownership. Second, parameter estimates generated by using the transformed variables gain asymptotic efficiency according to the method demonstrated by Pope and Just (1979).

TABLE 3: Ordinary Least Square Coefficient Estimates of the Second Step of Estimation.

Variable Name	Variable Description	Coefficient Estimate	<i>t</i> -statistic
Constant	-	3.98*	5.76
Lab	Total labor cost reported by a company, in thousand dollars	-0.08	-0.90
Actotal	Total acreage serviced by the company	-0.02	-0.22
Chem	Total cost incurred by a company on chemical inputs i.e., fertilizers and pesticides	-0.10	-1.37
Plmat	Total cost incurred by a company on plant materials including sod	-0.02	-0.29
Corp	Dummy variable: 1 if type of the company reported as corporation; 0 otherwise	-0.62**	-2.60
Risk	Dummy variable: 1 if the company reported labor turnover ratio as a high risk source; 0 otherwise	0.08	0.42
	Number of observations	76	
	F-value	6.26	
	Adjusted R-square	0.29	
	Degrees of freedom	69	

\* Indicates significance at 0.01 confidence level or higher

\*\* Indicates significance at 0.05 confidence level or higher

The third and final stage of estimation is intended to achieve asymptotically consistent and efficient parameter estimates. The results of non-linear least square estimation i.e., the third stage of estimation are presented in Table 4. The measure of goodness of fit of the estimated equation indicated that 76 percent of the variation in the output was explained by the specified model. The adjusted R-square was less than the value of the adjusted R-square for the number of degrees of freedom presented in Table 2, but is considered very good for an estimation using cross-sectional data. The parameter estimates generated by following the additional two steps are corrected for heteroscedasticity, and, therefore more consistent and asymptotically efficient.

Labor use is tied to the application of other inputs to the landscape such as planting and the use of chemical. Labor in combination with the other inputs determines the output in the LM/LC industry. The level of significance of parameter estimate for labor (Table 4) improved compared to the first stage. This suggests an increased efficiency resulting from the additional estimation steps. The positive and significant impact of the labor costs on the dependent variable i.e., the output of the LM/LC firms shows that as anticipated labor is an essential factor deciding the output of an LM/LC firms.

The total acreage representing the number of acres serviced, is a proxy for the measure of size of business conducted by a firm. The acreage serviced determines the extent of services provided by a firm because all the LM/LC services are connected to the landscape. Thus there exists a direct relation between the acreage and the revenues generated from the services applied. The non-linear least square parameter estimate generated in the final stage of estimation reveals that acreage serviced loses the statistical significance but retains the positive impact on the output. Though acreage serviced lost its statistical significance it is still considered as a major input in LM/LC industry as it

TABLE 4: Non-Linear Least Square Coefficient Estimates of the Third Step of Estimation.

Variable Name	Variable Description	Coefficient Estimate	t-statistic	Elasticity <sup>z</sup>
Constant	-	-5.34*	-7.83	-
Lab	Total labor cost reported by a company, in thousand dollars	0.35*	6.01	3.2E-4
Actotal	Total acreage serviced by the company	0.03	1.10	2.7E-5
Chem	Total cost incurred by a company on chemical inputs i.e., fertilizers and pesticides	0.09**	2.88	8.2E-5
Plmat	Total cost incurred by a company on plant materials including sod	0.06***	1.98	5.4E-5
Corp	Dummy variable: 1 if type of the company reported as corporation; 0 otherwise	-0.09	-1.08	-
Risk	Dummy variable: 1 if the company reported labor turnover ratio as a high risk source; 0 otherwise	-0.24*	-4.16	-
	Number of observations	76		
	F-value	37.27		
	Adjusted R-square	0.76		
	Degrees of freedom	69		

\* Indicates significance at 0.01 confidence level or higher

\*\* Indicates significance at 0.05 confidence level or higher

\*\*\* Indicates significance at 0.10 confidence level or higher

<sup>z</sup> Elasticities were calculated using the formula:  $\alpha_i(1/\bar{x})$  where  $\alpha$  is the estimated coefficient for the independent variable  $i$  and  $\bar{x}$  is the mean of the dependent variable (Gujarati, 1995).

directly determines the extent of services being applied to the land. Therefore, the variable representing the acreage serviced by a firm is still included in the model.

Chemicals are used either as supplements for the nutrients in the soil to nourish the plants or as a protective cover against the pests. Fertilizers form the nutrient source while the pesticides form the protective gear against the pests. Chemical cost comprises of fertilizer and pesticide costs reported by a firm. The results of the third step (Table 4) show that chemical cost had a significant and positive impact on the dependent variable gross revenue representing the output. The parameter estimate generated by following the additional two steps lost some statistical significance in comparison to the result in Table 2. But the non-linear least square estimate obtained in the final step is more efficient and consistent than the earlier result.

Plants form an important component of the landscape because they help in transforming the appearance by providing the necessary aesthetic scene and pollution free atmosphere. Landscape maintenance involves the use of different kinds of plant material such as grass seed, sod, and other ornamental plants. Plant material costs covers the expenditures reported by a firm on grass seed, sod, and other ornamental plants. The results of third step (Table 4) substantiate earlier assumption of plant material cost having a positive and significant impact on the gross revenue quantifying the output of the LM/LC firms. The parameter estimate gained statistical significance over the result generated in step one of the applied estimation approach (Table 2).

The binary variable describing the ownership type separated firms into two groups, corporations and family-owned firms or partnerships. Corporations likely to have a wider capital base tend to have access to superior technical support in distinguishing potential production problems than the family owned companies. The variable corporation served as a proxy for the improved use of inputs in production. Earlier study by Hubbell et al., (2001) focusing on the adoption of integrated pest management techniques showed that firms organized as corporations were more likely to adapt to a wider range of services

than firms with other types of ownership structure. The parameter estimate obtained (Table 4) for the corporation variable proves that ownership type gains in significance over the result in the first step but still lacks statistically significant effect on the LM/LC firms. Corporate ownership of the LM/LC firms may be important for adoption of specific technology as reported by Hubbell et al. (2001), but for specified the production function the ownership type is not important.

The risk variable reflects a firms perceptions of risks associated with high labor turnover ratio. This perception is based on the historical observations made by the firms. A report by Fish (2001) showed that employees are looking for the best paying positions and tend to move for alternate available positions when the firm is not flexible with pay scales. A firms perception of risk associated might have been influenced by the number of employees quitting jobs and lack of alternate replacements during the peak season there by reducing the potential output. The two additional stages of estimation had resulted in increased statistical significance for the risk variable over the result in step one (Table 2). This is uniform with earlier expectation of risk variable having a negative and statistically significant effect on the dependent variable gross revenue acting as output.

Table 4 also shows the elasticities calculated for the non-binary variables. The elasticity value shows the percentage change in the dependent variable as the independent variable changes by one percent. Each elasticity is calculated using the mean value of the dependent variable and their respective coefficient estimates. The purpose of the elasticity calculation is to measure the change in the output, measured by gross revenues in this study to show the effect of explanatory variables on output. For example, a one percent increase in the labor cost generates the output increase of 3.2E-4 percent. Also, in response to a one percent increase in the acreage serviced by a firm the output will increase by 2.7E-5 percent. This positive and significant effect supports the importance of the acreage serviced by a firm in generating the output. A company can expect an additional growth in output at a rate of about 8.2E-5 percent for every one percent

increase in the expenditures on chemicals. The elasticity value for plant material cost suggests that one percent increase in the plant material expenditures will increase the output by  $5.4E-5$  percent confirming the significance of the plant material in generating the output.

Based on the values of elasticities obtained, the returns to scale for the LM/LC industry were calculated by summing up the individual elasticity values. The sum shows the returns to scale of  $4.8E-4$ , i.e, less than one suggesting diseconomies of scale for the LM/LC industry. The diseconomies of scale for the LM/LC industry show that if all the inputs i.e, the labor, chemical, plant material, and acreage serviced by a firm are doubled that would not result in doubling the output.

## **CHAPTER 5**

### **IMPLICATIONS**

The study met with the objective of estimation of production function for the LM/LC industry in Georgia. The risk associated with the high labor turnover issue was addressed. The empirical model was estimated using survey data collected directly from the firms involved in the business allowed this research. The labor, the plant material, and the chemical costs reported by firms were positively related to the gross revenues measuring output of the LM/LC firms. The risk factor associated with the high labor turnover had negative effect on gross revenue.

The study focused on empirical aspects of the LM/LC industry and represents the first attempt to estimate the production function of this sector. It also tested the application of a method applied to address the issue of heteroscedasticity in estimating agricultural production functions using cross sectional data.

#### ***Methodological Implications***

Pope and Just (1979) proposed a framework for estimation of agricultural production function, treating an input as a source of risk. Their framework allowed the use the risk perception of high labor turnover ratio to account for source of risk associated with labor. The results from the current study confirm that the adopted procedure is an efficient method of estimating a production function with input related risk considerations.

The data used in the study were obtained from a survey. Hence their cross-sectional nature creates a potential problem of heteroscedasticity and demands an estimation procedure which can address the problem. The three stage estimation procedure suggested by Pope and Just (1979) was deemed ideal because the procedure

allowed to test for heteroscedasticity and then offered a procedure to correct the problem. The second stage results obtained in this study suggested that there was a heteroscedasticity problem because of the inclusion of the corporation variable describing the ownership type in the model. By following the additional step of estimation as suggested by Pope and Just (1979) this problem was solved. The results of the study confirm the appropriateness of the applied agricultural production function framework for the estimation involving the use of cross-sectional data.

This study estimated the production function using an unconventional approach where the inputs were expressed in dollar terms. The generated results are consistent with the observations made by Battese et al., (1989). Thus this study demonstrates that a production function can be expressed in monetary terms, and can be used as a base for similar studies in future where the information about inputs expressed in physical terms is not available.

### ***Practical Implications for the LM/LC Industry***

The importance of labor in generating output in the LM/LC industry was confirmed. The detrimental effects of the labor turnover ratio on output reflected in perceptions are a major industry's problem. The LM/LC industry as a service industry tends to rely heavily on labor. It is this heavy reliance on labor that makes the LM/LC firms equally susceptible to the labor associated problems. In this context, hiring the right people is important for an LM/LC firm. Employment ads form a source of meeting right people and hence a great attention should be given to provide a right description of job requirements while placing an advertisement. Well crafted ads help in hiring the right people thereby provides a good start of the relationship between a firm and employee as suggested by Fish (2001).

After recruiting good people it is important for a firm to retain its employees because retention leads to an experienced workforce and provides consistent flow of services. A firm needs to look after the needs of the employees to win their loyalty. A constant flow of information both ways in a firm can help in addressing the problems faced by employees and managers thereby reducing the potential risk of labor turnover.

Results showed that acreage serviced by a firm had positive relationship with the output of a firm. Earlier Anil et al. (2001) showed that commercial clients could play an important role in generating revenues. Commercial clients tend to be more likely than residential clients to purchase highly specialized services such as planting and maintenance of annuals. The acreage input from a commercial account is more than that of residential accounts on an average as shown by Florkowski et al. (1994). This means that firms serving larger number of commercial clients are likely to cover larger acreage; and generate greater outputs because the services provided are tied to the land.

The LM/LC services include the use of chemicals to enhance the growth of plants and control the unwanted pests on the residential and commercial properties. The appearance of lawns and landscapes plays an important role in fulfilling a property owner's demands. A reliable, fast and cost-effective service can be provided by choosing to use the chemicals according to a prescribed schedule. Such an approach assures the LM/LC firms of revenues and increases the potential for repeat business satisfying the goal of profitability. The positive impact of chemical cost on output confirms the significance of chemical use by an LM/LC firm.

Landscape installation and landscape maintenance involves the use of different types of plant material to transform the appearance of landscape according to the demands of the owners. The supplier of LM/LC services seldom has a choice over the selection of plants in a landscape. The LM/LC firms should hence try to keep track of the changing demands of the owners subscribing to their services and include the installation of plants satisfying the demands of landscape owners. The ability of a firm to meet the demands of

clients by providing the desired plant material increases the potential for the contract renewal and expands the business. The positive impact of plant material expenditures on output further confirms the importance of plant material as an input for an LM/LC firm.

This study attempted to address the importance of ownership type corporation to the output serving as a proxy for the enhanced use of inputs. An earlier study by Anil et al. (2001) suggested that companies organized as corporations might be able to raise more capital than the individually owned firms thereby allowing the expansion of the customer base. Corporate firms with a wide capital base tend to offer a broad range of services. The service mix attracts customers interested in various services, leading, in turn, to larger revenues. A study by Hubbell et al. (2001) showed that corporate firms adopt modern technologies like integrated pest management (IPM) and this may generate more revenues for a firm. However, results of this study showed that organizational structure (corporation), while being important for the revenues of a firm does not contribute to the output of a firm in the production function specified here.

### ***Limitations of the Study***

The study used an unconventional approach of estimating the production function where all the variables were expressed in the monetary terms instead of the physical units. The conventional approach of estimating agricultural production function involves the use of the physical terms for expressing the explanatory variables included. Hence it would be interesting to see if the results differ when a conventional approach is applied.

The study used the data collected from the businesses located in Georgia, therefore the focus of the study was Georgia. The results need to be interpreted carefully when deducing implications for states other than Georgia because of different weather patterns, resident's preferences for landscape type, income levels and demographics.

The study addressed the issue of risk associated with labor using a measure of the risk perception reported by a firm. This unconventional measure is a proxy for the lack of

a more accurate measure of the major problem encountered by the industry. There remains a need to develop an accurate measure of risk associated with labor.

### ***Recommendations for Future Studies***

Lack of data prevents an examination of various aspects of the rapidly growing LM/LC industry at the national level. There is a need for coordinated effort to collect the data about this rapidly growing industry to gain a broad picture of the industry. Studies based on such data will enable the formulation of implications for the whole industry. The cooperation of individual firms and the whole sector in gathering the data will be essential to implement wide-scale national studies.

This study estimated the production function for the LM/LC industry, the first of its kind in literature. An unconventional method of measuring the inputs in dollar terms is adopted. Hence, in the future there is a need to conduct an investigation using the conventional approach of measuring the inputs in physical units. However, currently it is easier for many firms to provide information about their input use in terms of dollars than physical units. Reporting physical units of inputs used in the LM/LC industry is complicated by the composition of chemical inputs. For example various fertilizers contain different volumes of N, P, and K making accurate reporting of quantities difficult. Similarly, pesticides vary in their composition although they may accomplish the same task.

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