DETERMINANTS OF ORGANIC FARMERS' DEMAND

FOR NON-FAMILY FARM LABOR

by

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(Under the Direction of Cesar Escalante)

ABSTRACT

Organic farms are recognized as displaying trends of more labor intensiveness than conventional farms, despite smaller average acreages and larger percentages of family-based operations. Results indicate only half of all organic farm operations hired some positive quantity of non-family labor, although in total numbers, the quantity of non-family labor was more than twice that of family labor. This study utilizes national organic farm level survey data to determine the significance of organic farming systems use of hired non-family farm labor as a function of individual farm characteristics, especially as the farm structure evolves through extensification and alternate markets. Results indicate individual farm management characteristics affect non-family labor hired, both in magnitude and in absolute terms.

INDEX WORDS: Organic Agriculture, Non-Family Farm Labor, Farm Labor Demand Estimation, Survey Data, Heckman Two-Step Procedure

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INTRODUCTION

United States Department of Agriculture (USDA) certified organic food is, by definition, produced by farmers who emphasize the use of renewable resources and conservation of soil and water (USDA 2006). USDA organic standards specify organic foods as being produced without using most conventional pesticides; fertilizers made with synthetic ingredients or sewage sludge; or bioengineering (USDA 2006). Standards also identify organic meat, poultry, eggs, and dairy products as those which originate from animals given no antibiotics or growth hormones. In addition to prohibition of inputs, these national standards also require individualized farm management plans that outline the techniques by which the operation will further improve managed soil and water quality for future generations.

Private organizations began certifying organic foods as early as 1970. However, it was not until the Organic Foods Production Act of 1990 that a national set of certification standards was adopted. Under this act, the National Organic Program (NOP) of the USDA was given authority over organic certification in the U.S. Accordingly, certifying accreditation has been granted to 15 state government agencies and 34 private organizations. There is at least one certifying body in each state as well as 43 foreign certifiers. It is recommended by the USDA to obtain certification through the agency in the state where the operation is located, although under the law, any national certifying agency is suitable (USDA 2006).

In 2003, the USDA recognized 8,035 certified organic farm operations in the U.S., comprised of cropland, pasture, and livestock productions. These operations include over two million acres and 8.9 million head of livestock and poultry. As such, organic agriculture is one of the fastest growing agricultural industries, with certified cropland and livestock production more than quadrupling over the past decade (USDA 2005). Even while demand continues to rise, organic farms have not adopted many of those management techniques characteristic of conventional agriculture productivity. Indeed, beyond even the dissimilarities derived from certification standards, organic farms have many noteworthy distinctions in regards to farmland management.

For the 2003 growing season, conventional average acreage was 441 acres compared to the organic average acreage of 273 acres (USDA 2005). Further data indicate 40% of organic operations farm 100 acres or less and 68% farm 300 acres or less, directly implying a majority of small organic farms and limited large-scale operations (OFRF 2004). National Organic Farmers' Survey (NOFS) data from the last decade also outline the consistent prevalence of family-based organic operations, with between 83% and 87% of organic farms listing their business structure as either single family or family partnerships (OFRF 1995, 1997, 1999, and 2004).

Despite these implications of smaller, family-run farms, organic operations display trends of more labor intensiveness than their conventional counter-parts. Characteristic limited use of synthetic inputs requires organic farms to implement alternative techniques for pest removal, soil additions and conservation, commonly depending on manual practices. Fertilizers are replaced with nitrogen-fixing cover crops and composted animal and green manures, which can require manual application as well as processing. Cultivations and hand weeding are used in lieu of pesticides to control invasive and unwanted plant species. Pest insects are suppressed by multi-crop rotations and often a type of comprehensive ecosystem management which creates a 'build-up' of beneficial/predator insect species. Studies consistently indicate higher labor demands for all spectrums of organic production as compared to conventional methods (Klepper, et al 1977, Lockeretz, Shearer and Kohl 1981, Lockeretz 1997, Jansen 2000, and Schneeberger, et al 2002).

National Organic Farmer's Survey (NOFS) data specific to organic farms for the 2000-20001 growing season indicate larger percentages of *yearly* hired farm workers derived from family labor pools rather than non-family sources, and in regards to the prevailing business structure of single family organic operations, this is to be expected (OFRF 2004). There are however, theoretical limitations of farm family labor supply; as family members have a finite limit, so do the number of laborers available in a family, especially those *seasonally* available. Concurrent NOFS data indicate that although nearly half (45.65%) of all organic operations hired only family labor or no labor at all, the actual number of non-family workers hired is more than double that from family sources (OFRF 2004). Labor hiring practices of national farm operations (both organic and conventional) specify hired farm labor occurring ten times as often as contracted labor, specifically seasonally hired migrant labor (NASS 2006). The first National Agricultural Workers survey reported foreign-born persons comprising 78% of all crop workers in the U.S., with 75% of all U.S. crop laborers being from Mexico (NAWS 2005). These data emphasize the importance of foreign-born migrant labor to the national agricultural industry as well as the potential effects of a growing organic sector on the market for agricultural laborers.

Problem Statement

Within the existing literature, there are no known studies which fully examine the range of potential factors affecting non-family labor demand of organic operations. Although individual characteristics have been singularly observed as significant factors, there has been no study of the complex management approach of organic agriculture and the influence of this approach on the organic labor market. This oversight, especially in view of the specific non-family labor requirements of organic operations, leads to significance in the study of determinants of organic farmers' demand for non-family farm labor.

Objective

This study will determine the significance of organic (and transitioning to organic) farming systems' use of hired non-family labor as a function of individual farm characteristics, especially as the farm structure evolves through extensification and alternate target markets. Non-family labor was chosen rather than family labor due to a desire to separate farm labor choices from inherently family labor choices, as well as its prevalent use by both conventional and organic farming systems. This is not a study of national market demand for hired labor, but rather an individual farmer's relative demand for hired labor and the magnitude by which their individual farm management characteristics affect this demand.

Procedures

This study will examine the current characteristics of organic farms and how variations in these characteristics affect a farm's non-family labor choices utilizing farm level survey data outlining farm operations for the 2000-2001 growing season obtained through the Organic Farming Research Foundation's 4th National Organic Farmers' Survey. Analysis will utilize the Heckman two-step procedure, essentially dividing the regression into two analyses. The first step will explore the farmer's "yes/no" decision to hired non-family labor using a Probit type model. This step considers only whether a farmer hired non-family labor and not at the quantity of labor hired, if any. The second step will utilize a corrected OLS model and examine only those operations which chose to hired non-family labor thereby determining the magnitude by which each farm characteristic affects the quantity of laborers hired. A comparative analysis will utilize a Tobit procedure which corrects for censored dependent variables characteristic of this data set. The resulting analysis is comparative to the Heckman OLS stage in which only those farms which chose to hired non-family labor are included. The Tobit analysis does not consider the choice mechanisms of those farms which do not employ non-family labor and does not differentiate between the variables affecting the ‘yes/no’ decision to hire labor and those affecting the quantity of labor hired.

Specific farm characteristics to be examined are divided into eight categories: structural, demographic, size, income, marketing, experience, perception, and location. The original study data set will be regressed on both the Tobit model and the Heckman two-step procedure. Two additional data subsets will be regressed on the Tobit model only. The subsets are separated by category of which one of two crops was primarily grown: vegetables and grains. This is due to the relatively more labor intensiveness of vegetable crops as well as the relatively larger acreage requirements of grain crops.

CHAPTER 2

LITERATURE REVIEW

To the knowledge of the author, there is no known study which attempts to examine the specific objectives formerly mentioned. Thus, the reviewed literature was comprised of two sections with the purpose of both further examining the background of the objective and also to obtain a more complete understanding of the components necessary to the formulation of the study's empirical model. The first section is devoted to an overview of the management practices in organic systems as determined by previous research. These studies allow for insight into variations in management techniques between organic and conventional systems which have underlying implications for labor demand. They also outline the evolution of organic agriculture from a derivative of conventional systems to a separate ecosystem management technique. Section two considers previous analysis concerning conventional farm labor demand estimation and the areas in which these studies deviate from organic farms. This section also assesses the limited research into determinants of organic farmers' labor demand and the recommendations of one scholar as to the direction these studies should assume.

Organic Management Practice Overview

Economic research regarding organic agriculture is largely devoted to direct comparisons to conventional farming operations. Cacek and Langner (1986) contend there are three types of research concerning the economic feasibility of organic farms, 1) direct comparisons of economic returns between organic and conventional farms, 2) analysis of economic returns based on research plot yield data, and 3) modeling comparisons of organic and conventional farms.

Generally, most of these studies agree organic farms incur lower variable input costs in comparison to conventional farms, but no consensus is reached when yields, prices, and costs are considered jointly. Lampkin (1994), for instance, contends that the combined effects of lower yields, higher prices (due to price premiums), and lower input costs allow organic farms to realize similar or lower gross margins than those of conventional growers. He does qualify, however, that this situation depends on the crop analyzed. Conversely, in a review of studies conducted by six land-grant universities in the Midwest on the production options of corn, soybean, wheat, and oat crops, Welsh (2000) found organic farms to be more profitable than conventional farms, even when price premiums were removed from the analyses, in half of the studies. The remainder of the studies, which indicated less profitable organic farms (sans consideration for price premiums), found that when price premiums were included organic farms showed more dominant profitability conditions than conventional farms.

Some research has indicated that organic crops endurance under drier conditions (leading to reduced input costs) combined with high price premiums have enhanced their relative profitability (Marra and Kaval, 2000, Jans and Fernandez-Cornejo, 2001, and Barkely, 2002). Yet other doubt the organic advantage due to higher labor costs; a SARE funded study found the production costs of organic apples in California were 10% to 25% higher than conventional farms as a result of more substantial material and labor costs (Friedman, SARE, 2003). Another SARE funded study of 18 conventional and organic potato farmers in Idaho found lower average material costs for organic production but higher organic labor costs. The overall effect of these two offsetting trends can be seen as the insignificance of differences in fixed and variable costs for the two types of farming systems.

Despite the foundations and findings of these studies, their critics remain. Holmes (1993) asserts that there are few accurate economic comparisons between conventional and organic farm system. Organic systems yield a variety of non-market goods such as reduced soil erosion and increased soil fertility, which are rarely assigned a value in cost-benefit analysis. Short-term studies tend to overlook these time sensitive benefits resulting from improved soil, water and air quality, while simultaneously ignoring the cost of environmental damage due to conventional farming methods.

Drinkwater (1995) further illustrates perceived limitations of face-value analysis of organic and conventional farms, especially when comparing organic research plots to commercially operated conventional agriculture. The controlled variables which make research plots so important can also lead to inadequacies in accurately representing a profit-maximizing organic farming system, as a commercially viable organic farmer must be able to respond to environmental and ecological stimuli without fear of study design. Drinkwater (1995) refers to this as the choice of researchers to continue with ‘optimal management versus consistent management’. A lack of experience with commercially operated organic systems can also lead to misleading research results or results which do not consider the whole-farm system when conducted on test plots.

With consideration for these previous findings as well as concern for the professed limitations, the following literature was selected to primarily reflect on-farm studies rather than test sites when possible. This review of farm management characteristics does not attempt to further evaluate economic comparisons or to include financial matters, especially those related to cost-benefit analyses relating to farm management techniques. Instead, the characteristics reviewed are those which outline the changing nature of organic management ranging from early management by exclusion to more current approaches of overall agroecosystem supervision, with a focus on the variations in technique from conventionally managed systems. This overview of organic techniques will lead to a greater understanding of the farm management regime characteristic of organic farmers and which variations from conventional methods might lead to an increased labor demand.

At its inception, organic farm certification was overseen by private interest organizations rather than governmental entities. Early certification looked to list prohibited substances (synthetic fertilizers, hormones, and pesticides) and did not regulate the physical methods by which farmers managed their resources. This oversight was criticized by many early organic enthusiasts, including J. I. Rodale, previous editor of O*rganic Gardening* (1942-Present). Rodale first prominently advocated farming based on understanding and symbiosis with natural ecosystems rather than control (Klonsky and Tourte 1998). Klonsky and Tourte (1998) explain that, due to the nature of organic production, organic farmers operate under a different set of constraints than their conventional counterparts. Essentially, conventional management in the absence of inorganic fertilizers and pesticides can not remain economically viable; organic farming must utilize a different set of resources (Klonsky and Tourte 1998).

The scientific community was somewhat skeptical of the claims set forth by Rodale and other early organic enthusiasts and remained so until organic farm studies of the 1970's began to give merit to these ideas (W., 1975). During this decade researchers became interested in the economic viability of organic farms, especially while faced with international petroleum issues and a national ban of many popular pesticides (DDT, chlordane, BHC, etc.). Low-input farming held potential as a safer and more energy efficient alternative but was still skeptically viewed by the majority of farmers and farm organizations (W., 1975). A number of comparison studies were introduced at this time to contrast the characteristics and performance of organic and conventional farms. Farming practices, energy efficiency, and relative profitability were all called into question by such researchers as Klepper, et al. (1977), Lockeretz, Shearer, and Kohl (1981), and Drinkwater, et al. The defining characteristics of both types of farming systems, as observed by these studies, are presented in the following subsections.

Klepper, Lockeretz, Commoner, Gertler, Fast, O'Leary, and Blobaum (1977)

Klepper et al.'s (1977) early comparison contrasts the economic performance and energy intensiveness of both organic and conventional farms in the Corn Belt for the 1974 and 1975 crop years. The organic farms in this study were located primarily by word of mouth as there were no available survey data or similar listings of likely candidates. All information on farming practices, planting schedules, income and costs were derived directly from the recollection of the farm operators. These farms were qualified by their commercial scale production paired with management which seemingly mimics conventional farming in all but their use of chemical inputs. With the exception of one, all organic farms refrained from employing inorganic fertilizers, insecticides and herbicides.

Overall farm acreage means varied from 429 (organic) to 479 (conventional) however, mean cropland acreage was more inconsistent: 250 acres (organic) and 348 acres (conventional). Results showed differences in crop area being attributed to organic farms' dependence on hay and pasture rotation for green manures and legume additions (organic farms averaged 52% of acreage in cropland compared to 73% for conventional farms).

All farms had a mix of livestock and crop operations. Livestock manure was applied by both types of farms, with very similar rates of application and over a similar distribution of land area. As demonstrated by the results, conventional farms tended to have higher concentrations of livestock, whereas organic operations offered more grazing area on pasture and less confined pasture access. This practice again illustrates the land allocation differences in the two farming systems. Plowing machinery differed little in ownership but was segregated in usage. All organic farms used chisel plows compared to half of all conventional operations. Eighty-six percent of conventional farms utilize moldboard plowing, but only 29% of organic farms (moldboard plowing has the highest fuel and labor costs; both have high soil erosion and moisture loss potential).

Labor requirements were 19.8 hours per $1000 of crop output for organic farms and 17.8 hours per $1000 of crop output for conventional farms. However, the authors imply that this unit of comparison leads to a higher divergence in requirements than would a comparison by individual crop types. For example, corn and small grain labor requirement (hours per acre) were the same for both types of farms but organic farmers required slightly more labor (3.8 versus 2.6) for soybeans.

Lockeretz, Shearer and Kohl (1981)

Published four years after Klepper et al.'s study on organic farming in the Corn Belt, Lockeretz, Shearer and Kohl (1981) make use of the same data but focus instead on a general comparison of conventional and organic farming practices. Their study consists of 37 organic farms located in the Corn Belt studied over two time periods, 1974-1976 and again in 1977 and 1978. Interestingly enough, the farm practices mentioned were obtained not from the source of the current data but from separate surveys of organic farms, all located in the Corn Belt and all having a minimum size of 40 ha. The context of these early practices must be remembered as occurring during a time when homogenous organic certification was almost non-existent and organic farming was thought of as not much beyond conventional farming without chemicals.

Weed control by organic farmers varied from conventional farms by increased use of mechanical cultivation. At this early stage in certification, occasional spot use of herbicides was allowed for organic operations, but mostly avoided (Lockeretz, et al 1981). Crop rotation was the primary technique of insect control on organic farms. Integrated pest management and biological control techniques were not employed. Fertility additions were made with animal manure and some organic amendments, however conventional farms applied manure at almost the same rate as organic operations. Additional growth of legumes gave organic operations a secondary Nitrogen source, but again, conventional farmers also grew legumes, but primarily as a forage for livestock. Nine-tenths of organic farms had mixed operations of field crops and livestock, with the most prevalent crops being corn, soybeans, hay, oats and wheat. Median organic farm-size was reported as 18% less than all other farms within the same region. Labor requirements were deemed slightly higher for organic farms, but without much implication as to the reasons why.

Drinkwater, Letourneau, Workneh and van Bruggen, and Shennan (1995)

In contrast to earlier analysis that focused on economic considerations, "Fundamental Differences between Conventional and Organic Tomato Agroecosystems in California" instead regards the ecological benefits resulting from organic management (Drinkwater et al. 1995). The study utilizes a statistical design to recognize ecosystem properties resulting from organic farm management and to distinguish these from variations resulting from environmental factors. It is important to recognize the beginning of a noticeable divergence in technique between the two types of farm management.

The data are derived from fresh market tomato growers on 20 farms in close proximity of the Central Valley, California. Farms that supplied plant nutrients through the use of green manures or other organic soil amendments and used no synthetic fertilizers and pesticides were considered organic. All other farms were classified as conventionally managed. The authors state that 70% of all tomato producing organic farms with cropland of greater than 0.5 ha in this growing region were represented and that the majority of these organic farms were well established (4-10 yrs. of organic management).

Over-winter soil management techniques included cover-cropping and the use of winter annual weeds on all organic farms. Comparatively, the majority of conventional farmers followed the traditional practice of allowing fallow soil to remain bare. Nitrogen additions by organic farms were in the form of legume residue, earthworm casting, manure, compost and blood-meal. These practices were not mimicked by conventional farmers. Irrigation practices were similar between both groups and consisted of furrow, drip and sprinkle. No pest control was required in 35 % of organic fields. Where necessary, sulfur additions, Bacillus thuringiensis and soap application were the most prevalent methods of control. Weed control was limited to cultivation in organic fields, while all but two conventional farmers applied herbicides. Both farm types retained field borders consisting of various combinations of perennial crops, riparian zones and fallow fields. While this might not have necessarily been the intention of farm managers, this bordering practice can allow for a build-up of beneficial/predator insect species, thereby allowing the agroecosystem to efficiently manage pest species.

In the last decade the divergence of organic systems management has seen a broad gap narrowed to a slighter margin. The last element mentioned in the above section (field borders as inset banks) highlights a minor overlapping of management techniques. Whereas traditionally it has been conventional techniques which are utilized by both systems, this instance highlights a beginning of 'organic' techniques being implemented in conventional systems. Even as early as the 1990's, Holmes (1993) notices the gradual recognition of 'lower-input practices that prove to save money' by the mainstream farmers. Still, as Klonsky and Tourte (1998) profile emerging traits similar to both systems (land preparation, planting operations, cultivations and irrigation), soil and pest management are considered areas of lingering significant differences.

Hired Non-Family Labor

Traditional economic research regarding hired non-family labor has focused on supply and demand estimation of conventionally operated farms. Griliches (1959) was one of the first researchers to apply methods of demand estimation to hired family labor. He worked with time series data from 1912-1956 to estimate demand of farm inputs including fertilizer, tractors and hired labor. His estimation techniques were based on theory implying the desired level of any one input is dependent on the expected price of products, the price of the input, the prices of other inputs and the rate of interest (when applicable) (Griliches 1959). Although Griliches does not utilize simultaneous equations, he suggests that this is the appropriate approach for further research of hired labor supply and demand.

In Schuh (1962) and Tyrchniewicz and Schuh (1966 and 1969) it is again proposed that hired farm labor demand and supply should be estimated through the use of simultaneous equations. These studies, as well as Hammond (1973) and Duffield and Coltrane (1992) follow this recommended procedure. For these studies it is assumed that farm operators must accept as given the prices they pay for inputs (other than labor) and the prices they receive for their products. Farm operators will adjust the number of laborers hired to reflect these price constraints as well as the price of hired labor and the technological options available to them (Schuh 1962). Hired labor demand is given as a function of (1) real wage rates of hired farm labor, (2) an index of the prices of agricultural products, (3) an index of the prices of other inputs, and (4) a measure of technology (Schuh 1962, Tyrchniewicz and Schuh 1966 and 1969, Hammond 1973, and Duffield and Coltrane 1992).

These studies address the theory underlying the specific objectives presented in this study and additionally imply the separate constraints applied to the labor market for organic farms. The above factors of estimation can not be applied to organic farms without transformations to adequately reflect the differences in technique, management, and technology constraints. An index of the price of organic agricultural products (2) must represent the price premiums obtained for most organic goods as well as the alternate outlet of conventional markets and the corresponding prices. An index of the price of other inputs in organic systems (3) must recognize the heterogeneous nature of organic farm management as well as the presence of ecosystem-type management which might require few inputs other than labor. A price index of other inputs must also recognize the absence of certain substances vital to conventional agriculture (pesticides, fertilizers, etc.). A measure of technology for organic management (4) must recognize that organic farms follow few of the same technological advances or production techniques used on conventional operations. A measure of the real wage rates of hired farm labor (1) should be relatively comparable between organic and conventional systems, although one study has implied a preference of farm workers to organic systems due to the added costs associated with health risks resulting from conventionally used fertilizers and pesticides, essentially lowering the wage rate received (Moore 2002).

These contrasts outline the constraint differences between the two farming systems and the challenge in comparative estimation of farm labor supply and demand. While these considerations might lend to accurate labor demand estimation, they neither capture the labor allocation decisions of organic farmers, nor the rationale behind the more labor intensive nature of organic farms. Indeed, few studies have attempted to explain the factors affecting this labor intensive characteristic. Some have attempted to qualify the changes in labor demand as a result of conversion to organic by outlining the transitions in direct to consumer marketing (Rapp 1998) or the changes in labor requirements by individual crops (Bouwman 1996). Lampkin (1994) has suggested that labor requirements may be more telling of the individual farmer in regards to their experience or their inadequate management which results in lowered capital investments into the farming operation and more manual labor.

In an extensive review of the existing literature on organic labor use and allocation Jansen (2000) again observes the lack of available detailed information regarding the intricate changes that occur during conversion, specifically the transformation of production processes and farm organization, and the resultant effects on labor demand. Jansen (2000) goes further to suggest a group of ten factors which directly influence the patterns of labor distribution and labor demand by organic farms which have not been collectively studied. These are as follow:

1. Choice crop, more labor intensive crops: Alternatives to fertilizers include labor-intensive nitrogen-fixing crops and crops which can be recycled into green manures. Also, organic demand has traditionally been for labor intensive crops such as vegetables.

2. Rotation systems and mixed cropping: Rotation of crops leads to pest and disease resistance, but as rotations increase so does labor requirement. Multi-cropping is another technique by which pests are controlled for, however multiple crops on a single plot increase the likelihood of additional labor needs.
3. Non-chemical pest control, including weeding: Hand weeding and mechanical methods require more labor than herbicide spraying.
4. Nutrient supply: As mentioned above crops are recycled into green manures as a nutrient source. Another source is animal manure, both of which are commonly applied manually.
5. Degree of mechanization, especially in harvesting and transport: Specific farm structures lead to less applicable mechanization and more dependence on manual labor.
6. Degree of specialization/ number of agricultural activities: Mixed-farming activities allow for benefits from crop and livestock interactions, however they also result in greater labor requirements.
7. Level of knowledge intensity: Organic farming is knowledge intensive, especially during conversion. There is a learning curve associated with the ecosystem and agroecosystem interactions.
8. Timing: Preventive measures rather than corrective measures, especially with weed and pest control, can lead to many small tasks rather than a few large tasks.
9. On-farm processing: Value-adding and direct marketing take labor away from other on-farm activities, but are often necessary to obtain price premiums where markets are not well established.
10. Direct marketing: Same as for on-farm processing.

This study will consider the characteristics observed by Jansen as those which are the most probably to primarily affect the labor allocation discrepancies among conventional and organic agricultural systems. Due to the lack of existing literature which collectively considers these factors, they will be equally weighted in regards to their influence on labor demand. With additional concern for those areas of management which particularly vary between the two type of farming system (as outlined in the first section of the literature review), an estimation of the aggregate influence of these factors on non-family farm labor demand and distribution for organic farms will be analyzed.

CHAPTER 3

EMPIRICAL MODEL

Theoretical Background (Microeconomic)

Microeconomic theory tells us that production (or output), q, is a function of inputs, namely, land, M, labor, L, and capital, K. Theory also tells us that each of these inputs also has an associated cost: the wage rate for labor, *w*, the cost relating to natural resources used, *n*, and the rate of rent or interest for capital, *v*. Pure profits related to short-run production are equal to total revenue, TR, or output price time output, minus total costs, TC, or input price times inputs. Mathematically:

$$\pi = TR - TC,$$

$$\text{where } TR = pq, \text{ and } TC = wL + vK + nM.$$

For a conventional farmer this objective function takes the form:

$$\begin{aligned} \max \pi &= \max (TR - TC) \\ &= \max (pq - wL - vK - nM) \\ &= \max (p\, f(K, L, M) - wL - vK - nM). \end{aligned}$$

Because of certification standards mandated by law, organic farmers face an additional technological constraint, T, which is a function of all regulations associated with organic farming, i.e. limited fertilizers, pesticides, hormones, etc.:

$$\begin{aligned} \max \pi &= \max (TR - TC) \text{ s.t. } T \\ &= \max (p^o q - wL - vK - nM) \text{ s.t. } T \\ &= \max(p^o f(K, L, M) - wL - vK - nM) \text{ s.t } T \end{aligned}$$

Additionally, p, the output price of conventionally produced goods, and p^o, the output price of organically produced goods, are not equal considering the price premium obtained for most organic goods.

The first order conditions of this objective function yield the input (Labor) demand function as a function of the output price, p^o, the input (Labor) price, *w*, the change in production, q, and the change in technology, T. This reaffirms the theory presented in the second section of the literature review. Considering all organic firms face essentially the same output price, p^o (dependent on crop type), and a comparative wage rate, *w* (with slight discrepancies for locational variations), the variable of interest are those which affect production decisions and those tied to technological constraints of organic certification standards. These resulting variables of interest are categorized into 8 characteristic types as derived from the reviewed literature: structural, demographic, size, income, marketing, experience, perception, and location.

Theoretical Background (Econometric)

The dependent variable implemented in this analysis is quantitative in nature but censored at the point of zero. Farm characteristics influencing the demand for non-family labor led 46% of represented farms to hire some positive quantity of non-family farm workers. For these observations, the proxy value of their demand is equal to the number of laborers hired. These same characteristics affect the demand of the remaining percentage of represented farms, but as these farms hired no non-family labor, their demand is unobservable and their corresponding dependent variable is assigned the value of zero.

One view of the distortion in the data resulting from censoring is illustrated by figure 3.1, below, with the y-axis representing the dependent variable and the x-axis representing an explanatory variable. In view of the censored nature of the dependent variable, the coefficient estimates regarding the organic farms' labor hiring decisions cannot be estimated using ordinary least squares (OLS) regression because of inconsistent and biased results stemming from selectivity bias. This issue is further illustrated below.

Let $y_i^* = \beta x_i + \varepsilon_i^*$, with all basic assumptions satisfied, where y_i^* represents the number of non-family laborers demanded given x_i, an explanatory variable. β represents the change in y_i^* resulting from a one unit change in x_i, and ε_i^* represents the residual or error term. Graphically, ε_i^* represents the distance from the observation x_i to the line of estimation as determined by the coefficient estimate, β . For all farms hiring non-family labor, y_i^* takes on a positive value, but for all other farms, y_i^* represents the index or latent variable, i.e. the desire to hire (Kmenta 1997, Greene 1993). For this second set of farms y_i^* is unobserved and is assigned the value of zero. Therefore, instead of observing y_i^*, the tangible observation is y_i where y_i = max(0, y_i^*):

$$\begin{aligned} y_i &= 0 \quad if\ y_i^* \le 0, \\ y_i &= y_i^* \quad if\ y_i^* > 0 \end{aligned}$$

The resulting equation, $y_i = \beta x_i + \varepsilon_i$, is differentiable from $y_i^* = \beta x_i + \varepsilon_i^*$ also by the implications of non-equal means, μ, of both the dependent variables and residuals: $\mu_{y_i} \neq \mu_{y_i^*}$ and $\mu_{\varepsilon_i} \neq \mu_{\varepsilon_i^*}$, which results in misspecifications of an OLS estimate (Kmenta 1997).

A common approach to this resulting regression, $y_i = \beta x_i + \varepsilon_i$, where $y_i = \max(0, y_i^*)$, is the Tobit model, a censored regression technique that is conducted using maximum likelihood estimation. The maximum likelihood estimation of β within a correctly specified Tobit model yields consistent results. One drawback of the Tobit model is the assumption regarding those characteristics which affect a farm's hiring decisions. Tobit models offer no distinction between factors affecting the decision to hire labor and the factors affecting the quantity of laborers hired. This lack of distinction may not be correct as it is not wholly descriptive of the decision making process; certain characteristics affecting the choice to hire non-family labor might not influence the total quantity of labor hired, and vice-versa.

A second approach to this censoring problem is the Heckman two-step procedure which considers the variables affecting the decision to hire non-family labor (Z_i) as possibly different from the variables affecting the number of non-family laborers to hire (X_i) (Gujarati 2003). The Heckman procedure first utilizes the Probit model, a non-linear function based on the normal cumulative density function and using maximum likelihood estimation, which allows for coefficient estimation of Z_i . The Probit model also allows for estimation of the inverse Mills ratio which is a function of the standard normal density and the cumulative distribution function of the coefficients of Z_i (Johnson and DiNardo 1997). The inverse Mills ratio (λ) provides the means by which to correct for selectivity bias in an OLS regression utilizing censored data. In the final step of the Heckman estimation, the variables affecting the number of laborers hired, X_i, and the added correcting variable, λ, are regressed in an OLS model yielding consistent results.

For both the Tobit model and the Heckman two-step procedure, the same original form of the estimating equation is applied:

$$
\begin{aligned}
NFL_i = \beta_0 + \beta_1 \textit{STRUCTURAL} + \beta_2 \textit{DEMOGRAPHIC} + \beta_3 \textit{SIZE} + \beta_4 \textit{INCOME} \\
+ \beta_5 \textit{MARKETING} + \beta_6 \textit{EXPERIENCE} + \beta_7 \textit{PERCEPTION} \\
+ \beta_8 \textit{LOCATION} + \varepsilon_{i.}
\end{aligned}
$$

Variables listed in the estimating equation (*STRUCTURAL*, *DEMOGRAPHIC*, *SIZE*, etc.) represent a category of individual variables, with multiple coefficients being estimated within each set. Within the 8 variable categories, there are 33 individual independent variables.

Variable Description

The dependent variable, NFL_i, is the total number of non-family farm workers hired during the entire production year. This can include seasonal, yearly, part-time, or full-time workers and is representative of the implied demand for non-family labor. The eight categories of explanatory variables used in this study (structural, demographic, size, income, marketing, experience, perception, and location) are discussed below and summarized in table 3.1 below.

Structural variables outline those factors of individual farmland management arrangements which define the farm operation and which the individual farm operator has control over. These factors are not predetermined, and although some remain semi-permanent in nature, all have the ability to change from one season to the next. These variables are:

1. TENURERAT, the tenure ratio calculated as the proportion of owned land to total acreage farmed organically. This variable is used to distinguish owned acres from rented land or land used free of charge.
2. CROPSGRWN, representing the total number of commodities grown. Commodities are not segregated by use, whether for commercial value or for use on the farm operation.
3. CONVDUM, a dummy variable used to test for the production of conventional commodities as well as organic (1 = some conventional acres, 0 otherwise). This variable also considers the farm's devotion to organic methods.

4. SOLEPROP, a dummy variable comparing family farms to other business structures (1 = single family or sole proprietorship, 0 otherwise). The business structure indicates the mentality of the management (family vs. corporate) as well as the potential for a family labor source.
5. FULLTIME, a dummy variable to consider the time devoted to on-farm operations (1 = full time farm managers, 0 = part-time farm managers).
6. OFFFARM, a dummy variable indirectly assigning a value to the farm operation, essentially considering the trade-off between farm activities and off-farm income generating activities or investments (1 = no off-farm income activities, 0 otherwise)
7. VAPERDUM, a dummy variable allowing for whether any income is generated from value-added products processed by or for the farm (1 = some percentage of income derived from value-added products processed by or for the farm, 0 otherwise).

These farmland controls are telling of the mentality of the primary farm operator and how their actions might influence labor hiring decisions. For example, farms operators that own larger portions of the land they till are expected to invest more time working on the farm, i.e. they are more strongly bound to the land and its productivity. This also implies that these operators are more inclined to be full-time farmers and would try to avoid off-farm income generating activities unless prudence deemed it necessary. Conversely, family based business structures, such as sole proprietorships, are expected to rely less heavily on non-family labor than other, more complex business structures. These family operations might also be more inclined to seek income from non-farm sources in order to further invest in the farm operation. Jansen (2000) further attributes greater demand for hired labor to higher degrees of commodity diversification and increased on-farm processing activities which effectively result in higher price premiums.

Demographic variables are those background characteristics of the primary farm operator which inherently affect the farm management strategy. These variables are AGE (in years), GENDER (1 = male, 0 = female), and EDUDUM, an ordered dummy to capture the effects of different levels of educational attainment (0 for educational attainment at high school level or below, 1 for junior college/trade school and some college education, 2 for completed bachelor's degree and some graduate study work, and 3 for a completed graduate degree). Jansen (2000) contends that the knowledge-intensive nature of organic farming operations make both age and education crucial scalar variables. Additionally, Rooij et al (1995) have described women on smaller farms as having a much greater management influence than on larger farms and that women tend to place more emphasis on diversification and broadening farm activities rather than specialization.

Size variables, especially in regards to organic operations, are difficult to qualify. The mixed operations and product diversification common to organic farms lead to complex issues when discussing farm size significance. Duram's (1999) study of organic farms in Colorado show mean farm size as 1,611 acres but median farm size as only 170 acres. Farms studied also showed variable incomes on similar acreages: A 2 acre farm had a gross operational income of $40,000 or less and an 8 acre farm had a gross operational income of $150,000 or more.

As such, the variables chosen for this analysis are the percentage of acreage allocated to two crops, vegetables and grains (PERACRSVEG and PERACRSGR, respectively). These measures were chosen due to the generally accepted relationship of acreage to crops grown, i.e. grains are generally spatially demanding but lax in labor requirements, whereas vegetables generally require much less acreage but are relatively labor intensive, even by organic production standards.

Income variables are relatively straight-forward. INCDUM is an ordered dummy variable for income generated by the organic farming operation (0 if organic income is $4,999 or less, 1 if $5,000 to $29,999, 2 for $30,000 to $99,999, and 4 for income contributions of $100,000 and above). The distribution of this dummy variable is arranged so that each class of income represents roughly one quarter each of the represented farms. However, whereas higher overall income might indicate the *ability* to hire non-family labor, the percent of income from particular crops might be more telling of the *need* for non-family labor. Therefore, additional income variables, PERINCVEG and PERINCGR, represent the percentage of income derived from vegetables and grains, respectively, where high percentages of income derived from vegetable crops would indicate a greater need for labor than would a similar percentage of income from a grain crop.

Marketing variables examine the role of marketing outlets on the amount of labor required. Seventy-nine percent of organic farms surveyed in a study by Rapp (1998) were devoted to direct marketing techniques. One reason for this is the assurance of maximum price premium retrieval, especially in the absence of well established markets. In a separate study published the same year, Rapp (1998) also found that a change to direct marketing leads to a higher relative demand for labor. PERVEGW and PERGRW represent the percentage of vegetable and grain commodities, respectively, sold on wholesale markets. Similarly, PERVEGDTC and PERGRDTC represent the percentage of vegetables and grains sold directly to the consumer.

Experience variables depict both the farmer's overall experience and their experience with organic operations. YRSEXP (total number of years farming) gives an indication of the farmer's overall knowledge of farming techniques (but not necessarily organic techniques).

ORGYRSRAT (ratio of total number of years farming organic to total number of years farming) indicates the relative maturity of knowledge and technique concerning organic farming. This variable might also indicate the degree to which the farmer is willing or unwilling to adopt certain elements of organic farm management as determined by age since transition. Lampkin (1994) found evidence of an increase in labor requirements during the transitioning period between conventional and organic systems. CERTYRSRAT (ratio of years of certified organic farming to total years organic farming) is representative of the farmer's devotion to certification standards or their quickness in meeting certification standards. This variable can also indicate the availability of price premiums resulting from certified organic goods.

Perception variables take into account the role that a farmer's perception of market factors can have on their hiring decisions. PRICEPERCEP and DEMPERCEP are ordered dummy variables corresponding to the farmer's perception of product prices and market demand, respectively, for the 2000-2001 growing season (0 if poor, 1 if fair, 2 if good and 3 if excellent). When implementing these types of variables, the subjective nature of their origin must be remembered. The base for the farmers' expectations should be considered, especially whether they have recently experienced a loss or gain, as these factors can have a lagged effect and can affect the interpretation of the coefficient estimates. When this information is not available, as in this study, implications based on regression results should be regarded cautiously.

Location variables are included to indicate the influence a geographic region might have on labor requirements and labor availability thereby influencing a farm's hiring patterns. The chosen categorization is the USDA's classification of production regions, which recognizes state boundaries in defining the regions. This classification seems appropriate as it accounts for both physical characteristics affecting plant distribution and suitability (weather, climate, soil types, etc.), as well as civil characteristics of state and government boundaries which can influence transitory patterns of migrant farm workers. The location variables are NTHEAST (Northeast), LAKE (Lake States), CORNBELT (Corn Belt), NPLAINS (Northern Plains), APPAL (Appalachian), STHEAST (Southeast), DELTA (Delta States), SPLAINS (Southern Plains), and MTNS (Mountain States). The excluded geographical category is the Pacific Region. These regions are shown in figure 3.2 below.

Econometric Procedures

As previously mentioned, this thesis will utilize both the Tobit model and the Heckman two-step procedures applied to the estimating equation discussed above. All regressions are run using the statistical program Stata, version 9. For each of these regressions, a data set of 332 observations, representative of national organic farmer survey responses, will be used. Two additional regressions of the Tobit model will utilize data subsets derived by their represented farms' predominant production of two target crops: vegetables and grains. The vegetable subset has 138 observations and the grain subset has 169 observations. This separation attempts to isolate the effects of the inversely related labor and acreage production requirements of these commodities. Additionally, these two crops are the two most commonly produced commodities and have traditionally both been crops regarded with great market demand (ORFR 1995, 1997, 1999, 2004).

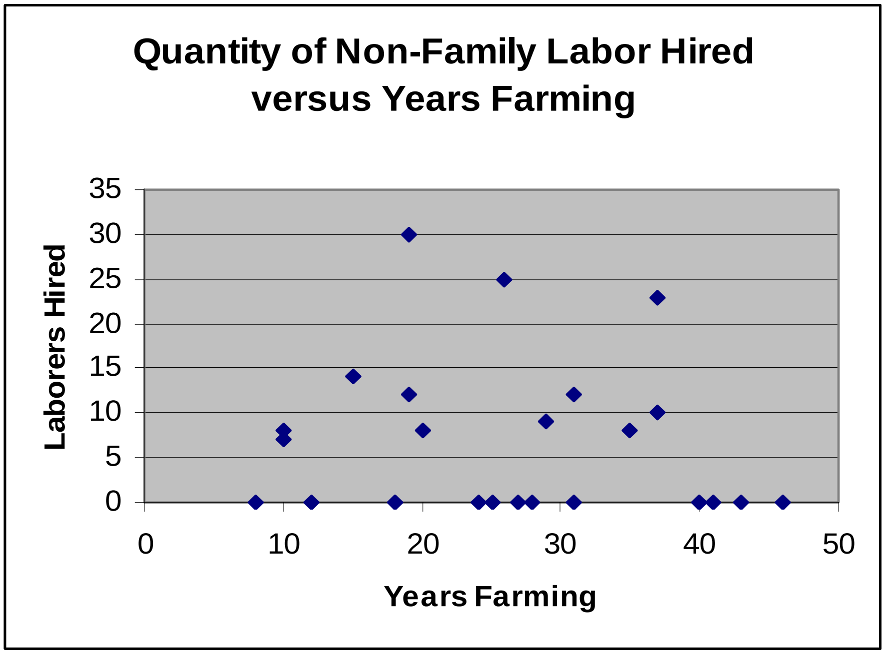

Figure 3.1 Distortions Resulting from Censored Data

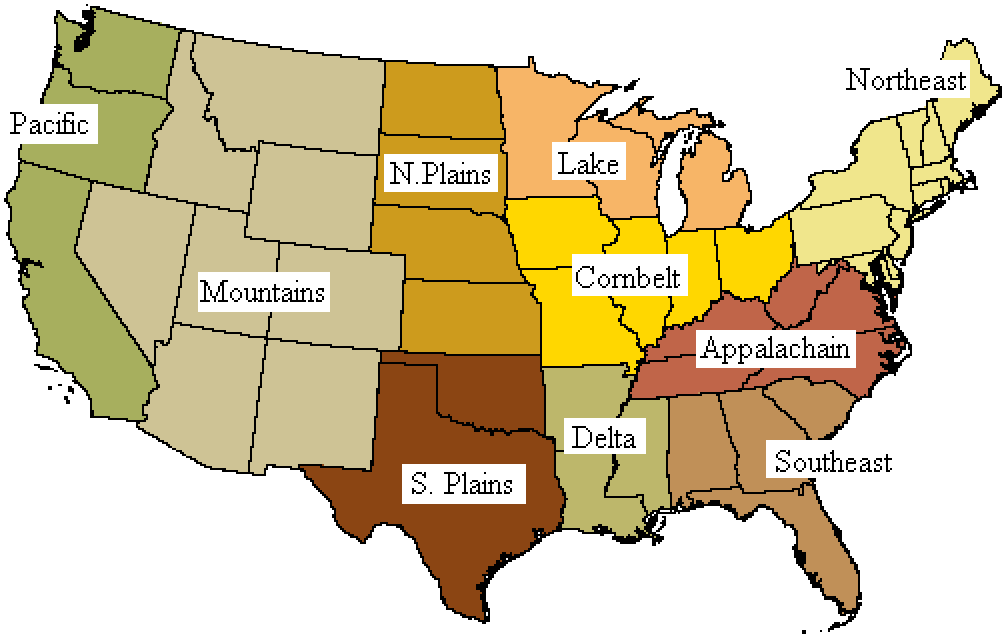

Figure 3.2 USDA Farm Production Regions

Table 3.1 Description of Explanatory Variables

Variable	Description
Structural Characteristics	
CONVDUM	Conventional acres (1 if some conventional acres, 0 otherwise)
TENURERAT	Ratio (owned acres to both owned and rented acres)
CROPSGRWN	Total number of commodities grown
SOLEPROP	Business structure (1 if single family/sole proprietor, 0 if other)
FULLTIME	Full or part time farm employment (1 if full time farming, 0 otherwise)
OFFFARMDUM	Off-farm employment (1 if no off-farm employment, 0 otherwise)
VAPERDUM	Income derived from value-added products processed by or for the farm (1=yes, 0=none)
Demographic Characteristics	
AGE	Operator's age
GENDER	Gender (1 if male, 0 if female)
EDUDUM	Education (0 if no formal education, some high school or completed high school, 1 if some college, completed junior college/trade school, 2 if completed bachelor's degree and some graduate work, 3 for graduate work)
Size Characteristics	
PERACRSVEG	Ratio (vegetable acres to all organic acres)
PERACRSGR	Ratio (grain acres to all organic acres)
Income Characteristics	
INCUMDUM	Income from organic operations (0 if $4,999 or less, 1 if $5,000 to $29,999, 2 if $30,000 to $99,999, 3 if $100,000 or more)
PERINCVEG	Percent of income from vegetables
PERINCGR	Percent of income from grains
Marketing Characteristics	
PERVEGDTC	Percent of vegetables sold Direct To Consumer
PERVEGW	Percent of vegetables sold Wholesale
PERGRDTC	Percent of grains sold Direct To Consumer
PERGRW	Percent of grains sold Wholesale
Experience Characteristics	
YRSEXP	Number of years farming
ORGYRSRAT	Ratio (years farming organically to total years farming)
CERTYRSRAT	Ratio (years certified organic to total years farming organically)
Perception Characteristics	
PRICEPERCEP	Perception of market prices (0 if poor, 1 if fair, 2 if good, 3 if excellent)
DEMPERCEP	Perception of market demand (0 if poor, 1 if fair, 2 if good, 3 if excellent)
Location Characteristics (Base is Pacific: AK,CA,HI,OR,WA)	
SPLAINS	Southern Plains (OK,TX) (1 if location, 0 otherwise)
LAKE	Lake States (MI,MN,WI) (1 if location, 0 otherwise)
STHEAST	Southeast (FL) (1 if location, 0 otherwise)
MTNS	Mountains (AZ,CO,ID,MT,NV,NM,WY,UT) (1 if location, 0 otherwise)
DELTA	Delta States (AR,LA) (1 if location, 0 otherwise)
NTHEAST	Northeast (CT,ME,MD,MA,NH,NJ,NY,PA,RI,VT) (1 if location, 0 otherwise)
CORNBELT	Corn Belt (IL,IN,IA,MO,OH) (1 if location, 0 otherwise)
NPLAINS	Northern Plains (KS,NE,ND,SD) (1 if location, 0 otherwise)
APPAL	Appalachian (KY,NC,VA,WV) (1 if location, 0 otherwise)

CHAPTER 4

DATA SOURCES AND DESCRIPTIVE ANALYSIS

The empirical models are regressed with data obtained through the Organic Farming Research Foundation's (OFRF) fourth National Organic Farm Survey. The OFRF has conducted four national surveys since 1995. However, there has not been an accessible record of time-series panel data on any particular farm, therefore only the most recent data are utilized and restricted to cross-sectional analysis. The fourth National Organic Farm Survey was conducted in spring 2002, collecting nation-wide data on individual organic farmers' 2000-2001 growing season. Participants were considered to be organic farmers in good certification standing, with contact information being obtained through organic certification agencies. The survey was distributed both to individual farmers and to select agencies that in turn dispersed surveys to their own growers. The survey consists of 1034 participating farmers' responses from 44 states with an overall response rate of 18%.

The survey instrument consists of eight sections and includes 76 questions, both open and close-ended, several with sub-sections. Questions allowed for fill-in type responses, selection of presented categories and 'yes/no' choices which lead to the presence of both qualitative and quantitative data, as is characteristic of surveys. In this thesis, open-ended questions were not utilized in the empirical analysis. Coverage and sampling size are estimated at 90% of the actual population being studied. Errors in measurement derived from inaccurate or unclear responses are variable throughout the sample. Observations were excluded if some portion of the questions used for the study data were unanswered or if the responses led to inaccuracies in interpretation.[1] Ultimately, 32% (332 observations) of the original observations were used for the analysis.

As illustrated by table 4.1, selectivity bias of the data is minimal. Means and standard deviations of both the original data (18% response rate) and the data used in analysis (6% response rate) are shown to be relatively comparable. There is some divergence among the variables directly related to the two sub-divisions of the sample, grain and vegetable farms (PERINCGR, PERINCVEG, PERACRSVEG, PERACRSGR). However, as these observations were chosen due to their relatively high percentage of either grain or vegetable crops, these discrepancies are expected. Incongruities in means among variables not related to either grain or vegetables production are present in a few cases. This is primarily attributable to some overlap the data sets. The original observations were divided into these sub-sets (grain and vegetables) by the predominant production of one crop (>40% acres or income). In certain cases, some farmers qualified for inclusion in either set of observations and were therefore incorporated into both.

Survey sections of primary interest are those regarding structural farm profiles, production and products details, marketing and market conditions, and farm household characteristics. The particular question of relevance to this study's dependent variable concerns the number of laborers hired by an organic operation over the span of one year. Each farm operator was asked to give detailed account of each employee (including themselves) hired for labor directly involved with organic production. Employees were segregated by family status (farm family/household members or non-family workers), time of employment (year-round or

[1] Ex. NOFS question 2 asked for total number of organic acres farmed. Question 3 asked, of those organic acres, how many were owned and how many were rented, implying the total quantities for question 3 should be equal or less than the quantities from question 1. Respondents giving higher quantities for question 3 were removed.

seasonal) and hours worked per week (full-time or part-time). Figure 4.1 shows the distribution of organic farm labor as reported by the respondents, with table 4.2 listing summary statistics. Detailed definitions of explanatory variables are discussed in chapter 3 of this thesis. Survey questions used for these data can be found in the appendix.

Table 4.3 summarizes the classification of the explanatory variables along with along with the expected sign of their estimated coefficients. Location characteristic variables' expected sign is unclear due to the interpretation relative to the Pacific region and other, more physical or geographic, factors that might be captured in these variables. Structural characteristic variables CONVDUM, FULLTIME, and OFFFARMDUM sign's are also uncertain. The presence of conventionally produced acres could indicate less devotion to organic farming methods and therefore, less labor demand. However, conventional acres could also simply imply primarily organic farming methods supplemented by some substances which violate certification standards, therefore comparable labor requirements to other organic operations. Full time farm employment can represent the farmer's devotion to the farm enterprise, but level of devotion without some qualifier is not enough to determine if this will equate to more or less labor requirements, i.e. a full-time family based operation might hire more family labor, whereas a full-time corporate farm might hire more non-family labor. Off-farm employment similarly requires clarification to determine whether the additional income either allows for the hiring of additional labor or if it is representative of the lack of income needed to hire more non-family labor.

Other variables whose signs are difficult to determine are AGE, YRSEXP, and PRICEPERCEP. Older farmers would seem more likely to hire non-family labor, as their source of family labor might have diminished (children leaving home or going on to higher education).

Alternatively, older farmers might also look to less labor intensive enterprises or to decreasing the size of their operation in order to reduce labor requirements. The total number of years farming is indicative of the farmers' experience, which can affect their non-family labor requirement either way. More experience should lead to more efficiency and either less need for additional labor, or more timely and efficient use of hired labor. The farmers' perceptions of market prices and market demand will influence non-family labor demand either way. A perceived increase in prices might lead to a farmer desiring to produce more of that particular commodity. However, an experienced farmer would realize that if many other farmers with a similar perception were to all plant more of that commodity, the resulting effect would be a price decrease unless the demand rose simultaneously with supply. Similar theory would apply to a farmer's perception of market demand especially with consideration for the lagged effect of the farmer's experience in the previous growing season paired with the farmer's perceptions of the last growing season. The remainder of the expected signs of the estimated coefficients are relatively straight-forward and do not require extensive explanation.

Table 4.1 Dependent Variable Mean Values and (Standard Deviations)

Variable	All		Vegetable		Grain		Original Data	
AGE	50.61	-11.37	48.98	-10.26	49.43	-10.53	50.89*	-11.07
APPAL	0.04	-0.20	0.07	-0.26	0.03	-0.17	0.03	-0.18
CERTYRSRAT	0.67	-0.29	0.66	-0.29	0.66	-0.29	0.67*	-0.29
CONVDUM	0.14	-0.35	0.09	-0.28	0.18	-0.38	0.21*	-0.40
CORNBELT	0.11	-0.32	0.11	-0.31	0.17	-0.38	0.14	-0.34
CROPSGRWN	2.29	-1.47	3.23	-1.65	2.56	-1.52	2.29	-1.60
DELTA	0.01	-0.08	0.01	-0.12	0.00	0.00	0.01	-0.08
DEMPERCEP	2.03	-0.83	2.29	-0.77	1.98	-0.79	1.92*	-0.86
EDUDUM	1.53	-1.00	1.74	-0.98	1.30	-1.04	1.53*	-1.00
FULLTIME	0.70	-0.46	0.72	-0.45	0.74	-0.44	0.67*	-0.47
GENDER	0.81	-0.39	0.73	-0.44	0.88	-0.32	0.78*	-0.41
INCDUM	1.52	-1.02	1.38	-0.95	1.74	-0.98	1.39*	-1.04
LAKE	0.13	-0.33	0.09	-0.29	0.24	-0.43	0.12	-0.32
MTNS	0.11	-0.31	0.09	-0.28	0.10	-0.30	0.09	-0.29
NPLAINS	0.06	-0.24	0.01	-0.12	0.11	-0.32	0.05	-0.22
NTHEAST	0.24	-0.43	0.36	-0.48	0.26	-0.44	0.24	-0.43
OFFFARMDUM	0.52	-0.50	0.53	-0.50	0.48	-0.50	0.55*	-0.50
ORGYRSRAT	0.68	-0.34	0.86	-0.26	0.58	-0.33	0.68*	-0.34
PERACRSGR	0.33	-0.39	0.19	-0.30	0.65	-0.30	0.28*	-0.37
PERACRSVEG	0.18	-0.33	0.43	-0.39	0.04	-0.12	0.15*	-0.29
PERGRDTC	5.75	-21.45	6.33	-22.73	11.30	-29.04	5.30	-20.85
PERGRW	27.31	-43.61	11.06	-30.16	51.87	-48.33	23.29	-41.44
PERINCGR	31.77	-43.36	11.21	-27.19	61.83	-42.36	22.37	-39.37
PERINCVEG	28.07	-40.35	67.52	-35.37	15.18	-31.30	24.54	-38.83
PERVEGDTC	22.52	-37.67	51.25	-42.09	12.89	-30.50	24.16	-38.98
PERVEGW	18.58	-34.46	38.93	-40.67	13.59	-31.20	18.13	-34.53
PRICEPERCEP	1.83	-0.85	2.04	-0.75	1.84	-0.78	1.76*	-0.84
SOLEPROP	0.72	-0.45	0.75	-0.44	0.69	-0.47	0.71*	-0.46
SPLAINS	0.03	-0.16	0.04	-0.20	0.02	-0.13	0.02	-0.15
STHEAST	0.01	-0.08	0.01	-0.09	0.00	0.00	0.01	-0.09
TENURERAT	0.78	-0.33	0.78	-0.34	0.73	-0.33	0.79*	-0.33
VAPERDUM	0.42	-0.49	0.49	-0.50	0.35	-0.48	0.41*	-0.49
YRSEXP	20.54	-12.42	16.59	-9.97	23.04	-12.27	20.35*	-13.35
n =	332		138		169		1034	

* : Denotes total observations less than n = 1034

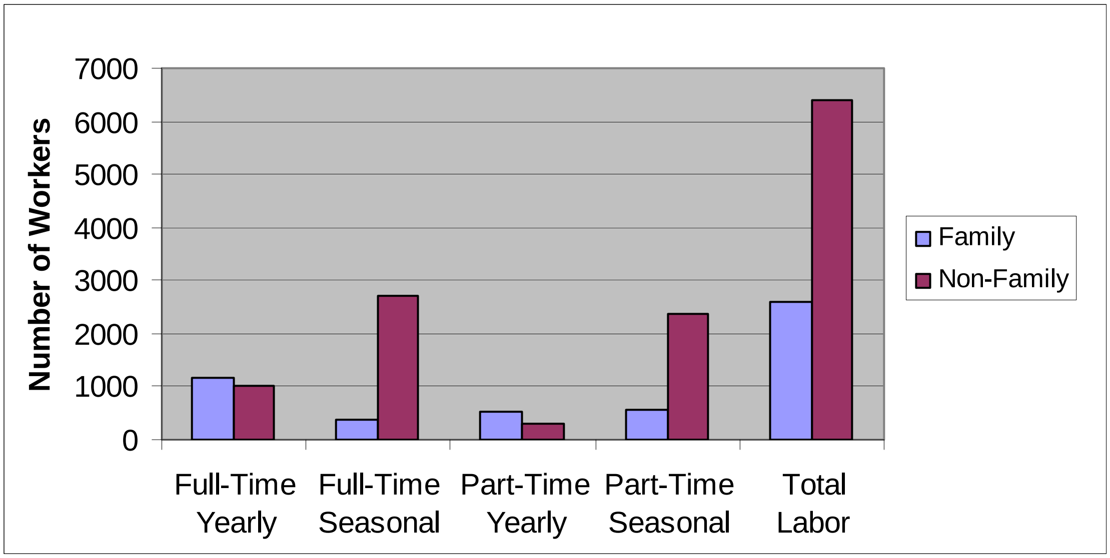

Figure 4.1 Distribution of Family and Non-Family Labor

Table 4.2 Descriptive Labor Statistics for the 2000-2001 Growing Season

Family		Sum	Mean	Standard Deviation	Maximum	Number of 0's	Number of observations
Full-Time	Yearly	1155	1.1170	1.3004	12	398	1034
	Seasonal	360	0.3482	1.1221	15	854	1034
Part-time	Yearly	515	0.4981	0.9305	6	721	1034
	Seasonal	578	0.5590	1.5522	20	794	1034
	Total Family Labor	2608	2.5222	2.5162	30	88	1034
Non-Family							
Full-Time	Yearly	1033	0.9990329	5.5456391	100	864	1034
	Seasonal	2707	2.6179884	20.384734	400	849	1034
Part-time	Yearly	286	0.2765957	1.3144861	20	919	1034
	Seasonal	2385	2.3065764	8.3264595	124	677	1034
	Total Non-Family Labor	6411	6.2001934	24.428166	430	472	1034

Table 4.3 Expected Sign of Explanatory Variables

	Variable	Expected Sign
Structural Characteristics	CONVDUM	+/-
	TENURERAT	-
	CROPSGRWN	+
	SOLEPROP	-
	FULLTIME	+/-
	OFFFARMDUM	+/-
	VAPERDUM	+
Demographic Characteristics	AGE	+/-
	GENDER	-
	EDUDUM	-
Size Characteristics	PERACRSVEG	+
	PERACRSGR	+
Income Characteristics	INCUMDUM	+
	PERINCVEG	+
	PERINCGR	-
Marketing Characteristics	PERVEGDTC	-
	PERVEGW	+
	PERGRDTC	-
	PERGRW	+
Experience Characteristics	YRSEXP	+/-
	ORGYRSRAT	-
	CERTYRSRAT	-
Perception Characteristics	PRICEPERCEP	+/-
	DEMPERCEP	+/-
Location Characteristics	SPLAINS	+/-
	LAKE	+/-
	STHEAST	+/-
	MTNS	+/-
	DELTA	+/-
	NTHEAST	+/-
	CORNBELT	+/-
	NPLAINS	+/-
	APPAL	+/-

CHAPTER 5

ECONOMETRIC ANALYSIS

Heckman Two-Step Procedure Results

The estimation results, including coefficient estimate and standard errors, of the Heckman two-step procedure are presented in table 5.1 below. Also presented are the levels of significance if at the 90% confidence level or higher. The second column reports the estimation results of the first-step Probit regression, which indicates the willingness of the farm to hire non-family labor in absolute terms. The last column reports the estimation results of the second-step OLS regression, which indicates the factors affecting the quantity of labor hired, after the decision to hire non-family labor is made. The inverse Mill's ratio (λ = 53.9793) is derived from the coefficient estimates of the Probit regression. As previously mentioned, this λ is included in the OLS regression so as to yield unbiased coefficient estimation. The Wald Chi-squared (χ^2) indicates the extent to which the estimates fit the null hypothesis, H_o: $\beta = 0$ (Johnston and DiNardo, 1997). A χ^2 of 119.41 allows for rejection of the null hypothesis, implying the amount of variation explained by the model is significantly different from zero.

In a linear function, the coefficient estimate, β, generally represents the marginal effect of the corresponding variable; that is, the estimate represents the change in the dependent variable, y_i^* resulting from a one unit change in the explanatory variable, x_i, all other variables held constant. Unlike the OLS regression, the Probit model is a non-linear function and the coefficient estimates do not represent the marginal effects. Additionally, the Probit model is a likelihood model which means that the marginal effects are not measuring the change in the value of y_i^* resulting from a one unit change in x_i. Rather, the marginal effects of a Probit model measure the effect of a one unit change in x_i on the probability that y_i^*=1: that the farm will hire non-family labor. The linear prediction of Y_p, 0.2566, is used to calculate the marginal effect estimates of the significant variables in the Probit model, which are presented in table 5.2. See also, table 5.6 for the marginal effects of all models, categorized by characteristic type.

According to the estimated results, only 3 categories of characteristics are statistically significant for both the Probit model and the OLS model of the Heckman procedure: Income, Experience and Location. These results indicate that income, experience and location are the only categories of characteristics to significantly affect both the probability of hiring non-family farm labor and the quantity of farm labor actually hired. For an increase in income (INCUDUM) to the next categorical level, the probability of hiring non-family labor rises by 0.32% and the actual number of laborers increases by 13. One additional year of overall farming experience (YRSEXP) raises the probability of hiring non-family labor by 0.02% and increases the number of laborers hired by 1. Five location characteristics are negative and significant for both Heckman models, Lake, Northeast, Cornbelt, North Plains, and Appalachian. The estimated coefficients of these variables indicate that farms located in each particular region are less likely to hire non-family farm labor than the excluded Pacific region, i.e. location of a farm in say, Pennsylvania, lowers the probability of hiring non-family farm labor, relative to the Pacific region, by 0.7%, and decreases the total number of laborers hired, relative to the Pacific region, by 29 workers.

Two variables have estimated coefficients which are negative and significant only for the OLS portion of the Heckman procedure, SOLEPROP and DEMPERCEP. The negative coefficient estimate for structural characteristic, SOLEPROP, indicates that family based farm structures will hire 20 fewer non-family laborers than all other business categories. The coefficient estimate for the perception characteristic, DEMPERCEP, implies that as the farmer's perception of market demand rises they will hire 16 less employees from non-family sources. These estimates do not influence the decision to hire non-family labor, only the quantity of labor hired.

Five variables have estimated coefficients which are statistically significant only for the Probit portion of the Heckman procedure, implying these variable affect only the probability of hiring non-family labor and not the quantity of labor hired. Two structural characteristics, CONVDUM and VAPERDUM, have positive and significant coefficient estimates. For a positive amount of conventionally farmed acres, the probability of hiring non-family labor increases by 0.7%. Farms receiving income from value-added products produced by or for the farm are 0.5% more likely to hire some positive quantity of non-family labor. The demographic characteristic, GENDER, was the only one in the category to have a significant coefficient estimate. This estimate indicates that male farm operators are 0.4% less likely to hire non-family labor than female farm operators. The coefficient estimate for the income characteristic, PERINCGR, shows that for a 1% increase in the amount of income derived from grain crops, the probability of hiring non-family farm labor decreases by 0.01%. As a farmer's perception of market prices improves, the farmer is 0.3% more likely to hire non-family farm labor, as illustrated by the significant and positive coefficient estimate of the perception characteristic, PRICEPERCEP.

Two characteristic categories, size and marketing, have no significant coefficient estimates for either step of the Heckman procedure, implying no significant effect on either the probability of hiring non-family farm labor or the total number of laborers to hire. The marketing result seemingly contradicts the Rapp (1998) study which found labor increases as a result of transitioning to organic farming. However, this previous study looked more to quantify the changes rather than to indicate the statistical significance to organic management of changes resulting from transition. The implication is that some areas of significant changes during conversion to organic agriculture don't necessarily have a significant effect on the management decisions of the organic operation.

To further clarify the estimation results, the elasticities for the variables with significant coefficient estimates were calculated, as represented in table 5.7. The elasticities, calculated as the percent change in y_i^* resulting from a percent change in x_i, give a comparative measure for variables with different until of measurement, essentially removing the scale effect (Wetzstein 2005). The elasticities allow for a measure of responsiveness which can be compared among all variables when the entire model is considered as a whole. An elasticity of 0 indicates perfect inelasticity, that is, a percentage change in x_i lead to no response in y_i^*. An elasticity of 1 indicates an equal response in y_i^* from a percent change in x_i, and a measure greater than 1 indicates a response in y_i^* greater than the percent change in x_i. Those elasticities between 0 and 1 indicate are considered inelastic, i.e. y_i^* is relatively unresponsive to x_i. For the Probit portion of the Heckman model, the elasticities were calculated using the linear prediction of Y_p (0.2566). For the OLS portion of the Heckman model, the elasticities were calculated using the expected value of Y_{ols} given the probability of Y_p (1.9690). Due to the binary nature of select significant dummy variables in this model, only those significant variables with continuous values or ordered dummy variables are discussed. These elasticities and the elasticities for the Tobit model are presented in table 5.8.

PRICEPERCEP is shown to be the explanatory variable with the most responsiveness in regards to the choice to hire non-family labor as shown by a 1.1 elasticity, indicating that for a one percent change in the perception of market prices, a farmer's probability of hiring non-family labor increases by more than one percent. Comparatively, all other significant variables within the Probit portion of the Heckman model are inelastic. For a one percent increase in years of farming experience, the probability of hiring non-family labor increases by less than one percent (0.8). Similarly, as the category of income-level derived from organic operations increases one percent and as the percentage of income derived from grains increases by one, the probability of hiring non-family labor is changed by less than one percent (PERINCGR = -0.5, INCDUM = -0.9). OLS elasticities indicate all significant variables are elastic in nature, that is, a one percent change in x_i leads to a greater than one percent change in y_i^*. Again, a perception variable was the most elastic (DEMPERCEP = -4.4), indicating that for a one percent increase in the farmer's perception of market demand, the quantity of labor hired decreases by 4 percent. Comparatively, as the category of income-level derived from organic operations increases one percent and as the number of years of farming increases by one percent, the total number of non-family laborers hired increases by greater than one percent (INCDUM = 2.6, YRSEXP = 3.7). In either step, Probit or OLS, the farmer's labor decisions showed the greatest responsiveness to the farmer's perception of the market, followed closely by the income category and the total number of years experience farming.

Tobit Results

The estimation results of the Tobit regression obtained for the three data sub-sets are summarized in table 5.3. These results include coefficient estimates, standard errors, level of significance if at the 90% confidence level or higher, Log-likelihood, and pseudo-R^2. The likelihood-ratio Chi-squared (χ^2) again is indicative of the amount by which the variation explained by the model is significantly different from zero, H_o: $\beta = 0$. A χ^2 of 126.81 rejects the null hypothesis. The pseudo R^2's are characteristically low, however Tobit estimates are not chosen to maximize the R^2, rather they are chosen to maximize the Log-likelihood (Wooldridge 2000). The Log-likelihood values are reported for the All, Vegetable, and Grain data sets, respectively, as -1004.15, -474.65, and -426.23.

Again, like the Probit portion of the Heckman procedure, the Tobit model is non-linear, therefore the coefficient estimates are not the marginal effects and they must be calculated separately. Unlike the Probit model, these marginal effects are the unit change in y_i (rather than the change in probability of y_i) resulting from a unit change in x_i. Because a Tobit model is censored at the point y,*, three derivatives are possible, with respect for any one observation, determined by E[y_i^* |X], E[y_i |X], and E[y_i |X, y_i >0] (Johnson and DiNardo 1997). As such, most literature recommends a decomposition utilizing the mean value of the independent variable and the expectations of y_i, the observed variable, which accounts for both the conditional expectation (E[y_i |X, y_i >0]) and the 'unconditional expectation' (E[y_i |X]) (Johnson and DiNardo 1997, and Woolrich 2000). Marginal effects of the significant Tobit coefficient estimates are derived from this decomposition and are presented in table 5.4 below. The particular decomposition used in this study sets y = E[y_i |X, y_i >0], therefore the results must be interpreted with respect to those farms that hired a positive number of off-farm workers, rather than all farms included in the sample. Essentially, the marginal effects consider that the choice to hire non-family labor has already been made, and a positive quantity of labor will be hired.

According to the estimated results, only three categories of characteristics (structural, size and location) were statistically significant for each of the three Tobit models, all, vegetables, and grains. For all farms, predominantly vegetable, and predominantly grain farms, a one unit increase in the percent of acres devoted to vegetable crops leads to an increase in the quantity of non-family labor hired, specifically, 7 workers for all, 11 for vegetable farms, and 69 for grain farms. These numbers illustrate the extreme differences in labor requirement among vegetable and grain farms. These numbers also imply a difficulty in conversion or diversification from a primarily grain operation to another type of operation. As the percentage of land owned (as opposed to rented or used free-of-charge) increases, the number of non-family farm laborers demanded will decrease for all farms (-5), vegetable farms (-12), and grain farms (-6). The location of any type of organic farm operation within the Lake region will result in the farmer hiring less non-family farm labor compared to the base Pacific region. All farms require 9 less workers, vegetable farms require 13 less workers, and grain farms require 11 fewer workers.

All other location characteristics with significant coefficient estimates are negative and significant for only two of the three farm sub-sets. All farms and vegetable farms located in the Northeast and Appalachian regions are inclined to hire less non-family farm labor than the base Pacific region by anywhere from 6 to 13 fewer employees. All farms and grain farms in the Cornbelt and North Plains regions are likely to hire fewer non-family laborers than the Pacific region by 8 workers on average. Two income characteristics, INCUDUM and PERINCGR, are significant for only two sets of farms. As the income from organic operations rises by one category, all farms demand 2 more employees and vegetable farms demand 4 more employees.

For all farms and grain farms, as the percent of income derived from grain crops increases by one, the number of non-family farm labor demanded decreases, but by less than one individual (All = -0.08, Grain = -0.08). The negative and significant coefficient estimate for SOLEPROP for both all farms and grain farms implies that when these operations are single family or sole proprietor types of farms they are less likely to hire non-family farm labor, each by a quantity of 4 workers. As years of experience on a farm (organic or conventional) increase by one year, the number of laborers demanded increases by less than one on both all and vegetable farms (All = 0.3, Vegetable = 0.6). An increase in the farmer's perception of market demand on all farms and vegetable farms leads to a decrease in labor demand by 3 and 5 workers, respectively.

The marginal effects of only three variables with significant coefficient estimates are significant for only one type of farm sub-set. As the number of organic crops grown on a farm increases, only on all farms does it result in an increase in non-family labor demand (All = 1.0). Also on all farms only, income derived from value-added products processed on or by the farm will increase labor demanded by almost 3 workers (2.8). For vegetable farms, as the percent of acres devoted to grain crops increase by one, the farm demand will increase by 18 non-family farm workers. Two characteristic categories, demographic and marketing, have no variables with significant coefficient estimates, implying that as marketing outlet vary, there is no significant effect on the amount of non-family labor demanded. This also implies that, considering the choice to hired non-family farm labor and the choice regarding quantity of farm labor to hire as one and the same, no demographic characteristics will have a significant effect on this choice.

As with the Heckman model, it is again beneficial to further clarify the estimation results by calculating the elasticities associated with the continuous variable which have significant coefficient estimates. Again, also, the elasticities represent a measure of responsiveness which can be compared among all variables, regardless of unit of measurement. An elasticity of 0 indicates a percentage change in x_i lead to no response in y_i^*. An elasticity of 1 indicates an equal response in y_i^* from a percent change in x_i, and a measure greater than 1 indicates a response in y_i^* greater than the percent change in x_i. Those elasticities between 0 and 1 indicate are considered inelastic, i.e. y_i^* is relatively unresponsive to x_i. For all data sub-sets of the Tobit model, the elasticities were calculated using the expected value of Y_{ols}, given $Y_{ols} > 0$ (All = 26.5057, Vegetable = 32.3647, Grain = 25.1855). The elasticities for the Tobit model, along with the elasticities for the Heckman model, are presented in table 5.8.

Within the all farms sub-set of the Tobit model, all significant variable elasticities are relatively inelastic, i.e. the demand for non-family labor is relatively unresponsive to changes in the significant variables. The variable of the greatest influence is the farmer's perception of market prices, with a -0.9 elasticity, indicating for a one percent change in the farmer's perception, the amount of labor hired decreases by less than one percent. Additionally, as the years of experience a farmer has increase by one percent, the number of laborers hired increases by less than one percent. A one percent increase in the measure of all other significant variables, CROPSGRWN, INCDUM, PERACRSVEG, PERINCGR, and TENURERAT, leads to approximately a less than 0.5% change in the demand for non-family farm labor. Also within the grain data sub-set, all elasticities of variables with significant coefficient estimates are inelastic. A one percent increase in either the percent of income derived from grain crops or the percent of land owned by a farm, both lead to a less than one percent change in the amount of labor demanded (PERINCGR = -0.6, TENURERAT = -0.6).

Two of the elasticities of variables significant to vegetable farms are considered elastic (DEMPERCEP and YRSEXP), whereas the labor demand is relatively unresponsive to changes in all other significant variables. As the farmer's perception of market demand increases by one percent, the amount of labor demanded decreases by 1.2%. Also, as the farmer's experience increases by one percent, the amount of labor hired increases by 1.4%. The elasticity associated with the amount of land owned by a farmer is almost unitarily elastic, as a one percent change in land ownership results in a 0.9% decrease in labor demand. All other significant variable for vegetable farmers, INCDUM, PERACRSGR, and PERACRSVEG, are inelastic: an approximate change in labor demand of 0.5% or less for a one percent change in the variable measure.

Comparative Results of All Models

A comparison all significant variables' marginal effects are presented in table 5.5 and by characteristic type in table 5.6. Generally, the expected sign of the significant variables were supported. Three variables were shown to have significant coefficient estimates only for the Probit portion of the Heckman procedure (CONVDUM, GENDER, and PRICEPERCEP), implying they are only significant regarding the choice to hire non-family farm labor and not the quantity, regardless of primary farm production. Despite theoretical implications to the contrary, marketing characteristics were shown to be insignificant for both models and all data sets. Location characteristics were the most consistently significant variables across all models and data sets, all being inclined to hire less non-family labor than the base Pacific region.

In regards to the elasticities, DEMPERCEP was the variable with the most consistent responsive nature to demand of labor. In all but the Probit portion of the Heckman model and the grain sub-set of the Tobit model, a one percent change in the farmer's perception of market demand led to an approximately greater than one percent change in the amount of labor demanded. The farmer's perception of market prices also lead to a responsive change in labor demanded, but only for the OLS model of the Heckman procedure. Overall, the variables invoking the greatest response on the amount of non-family labor demanded, as seen by their elasticities, are farmer's perception (both of market demand and market price), years of farming experience, and amount of income derived from organic farm operations.

Table 5.1 Heckman Two-Step Regression Results

Variable	Step One: Probit Coef. Est.	Step One: Probit Std. Err.	Step Two: OLS Coef. Est.	Step Two: OLS Std. Err.
AGE	-0.0117	0.0099	-0.2155	0.4591
APPAL	-1.8349 ***	0.4897	-71.5490 *	36.8815
CERTYRSTAT	0.3606	0.3162	3.5815	16.1729
CONVDUM	0.7141 **	0.2859	18.0595	15.2445
CORNBELT	-1.0021 ***	0.3392	-44.9382 **	21.9138
CROPSGRWN	0.0539	0.0677	4.1269	3.1187
DELTA	-1.2572	0.9256	-49.1427	49.3393
DEMPERCEP	-0.2615	0.1628	-16.6768 **	7.9907
EDUDUM	-0.0497	0.0917	1.5713	4.3431
FULLTIME	-0.0974	0.2207	-7.6334	10.2534
GENDER	-0.4637 **	0.2258	-5.2413	11.7664
INCDUM	0.3237 ***	0.0966	13.3361 **	6.4724
LAKE	-1.2556 ***	0.3374	-47.7485 *	24.7897
MTNS	-0.4920	0.3281	-2.3009	14.4809
NPLAINS	-1.0630 **	0.4189	-45.2559 *	26.9321
NTHEAST	-.06996 **	0.2729	-29.0777 **	14.7205
OFFFARMDUM	-0.1366	0.1919	-3.3676	8.6161
ORGYRSRAT	0.3012	0.3596	22.6566	17.1176
PERACRSGR	0.4223	0.3736	18.1085	18.5466
PERACRSVEG	0.1601	0.4327	25.6732	19.2184
PERGRDTC				
PERGRW				
PERINCGR	-0.0100 ***	0.0035	-0.3660	0.2377
PERINCVEG	0.0009	0.0037	-0.0013	0.1694
PERVEGDTC				
PERVEGW				
PRICEPERCEP	0.3434 **	0.1541	8.2120	8.6954
SOLEPROP	-0.3106	0.1960	-20.1622 **	8.9640
SPLAINS	-0.8566	0.5282	-20.8235	26.1312
STHEAST	6.3681	.	20.1132	43.2491
TENURERAT	0.0494	0.2758	-20.0257	12.2046
VAPERDUM	0.4591 **	0.1829	12.2506	9.9458
YRSEXP	0.0210 *	0.0111	1.3773 **	0.5956
Constant	0.4917	0.7473	-20.1353	39.5392
Wald Chi-squared	119.41			
Number of Obs	332		332	
Censored Obs			146	
Uncensored Obs			186	
Mill's Lambda	53.9793			

***, **, * : Denote statistical significance at the 99%, 95% and 90% confidence level, respectively

Table 5.2 Heckman Marginal Effects and Standard Errors of Significant Variables

	Probit		OLS	
Variable	dy/dx	Std. Err.	Coef. Est.	Std. Err.
AGE				
APPAL *	-1.8349	0.48975	-71.5490	36.8815
CERTYRSTAT				
CONVDUM *	0.7141	0.28594		
CORNBELT *	-1.0021	0.3392	-44.9382	21.9138
CROPSGRWN				
DELTA				
DEMPERCEP			-16.6768	7.9907
EDUDUM				
FULLTIME				
GENDER *	-0.4367	0.22584		
INCDUM	0.3237	0.09662	13.3361	6.4724
LAKE *	-1.2556	0.3374	-47.7485	24.7897
MTNS				
NPLAINS *	-1.063	0.41888	-45.2559	26.9321
NTHEAST *	-0.6996	0.27293	-29.0777	14.7205
OFFFARMDUM				
ORGYRSRAT				
PERACRSGR				
PERACRSVEG				
PERGRDTC				
PERGRW				
PERINCGR	-0.0100	0.00352		
PERINCVEG				
PERVEGDTC				
PERVEGW				
PRICEPERCEP	0.3434	0.15411		
SOLEPROP			-20.1622	8.9640
SPLAINS				
STHEAST				
TENURERAT				
VAPERDUM *	0.4591	0.18286		
YRSEXP	0.0210	0.01113	1.3773	0.5956
Y	0.2566 $_1$			

* : Denotes dy/dx is for discrete change of dummy variable from 0 to 1

$_1$: Denotes Y = Linear prediction of Yp

Table 5.3 Tobit Regression Results

	All		Vegetable		Grain	
Variable	Coef. Est.	Std. Err.	Coef. Est.	Std. Err.	Coef. Est.	Std. Err.
AGE	-0.0969	0.2894	-0.3941	0.6196	0.1066	0.5736
APPAL	-50.2182 ***	16.5307	-57.8071 **	26.0461	-44.3895	33.2695
CERTYRSRAT	1.6837	10.0460	22.8461	22.7947	-25.2599	17.3001
CONVDUM	13.0456	8.1738	-7.4979	21.6791	3.9291	12.2657
CORNBELT	-30.5421 ***	10.7711	-25.1382	19.4140	-43.8554 **	19.5523
CROPSGRWN	3.4897 *	2.0480	4.2761	3.8269	1.9845	3.6005
DELTA	-35.3190	31.9855	-32.4459	39.8598		
DEMPERCEP	-11.8425 **	4.9494	-17.5813 *	10.0481	-5.4478	8.6736
EDUDUM	0.8960	2.8371	5.7500	5.3904	-0.2433	4.6472
FULLTIME	-3.4042	6.8716	7.9630	13.5042	16.9669	12.8859
GENDER	-1.0784	6.6066	-2.9131	11.7530	8.6482	13.1860
INCDUM	9.3986 ***	2.9812	13.5082 *	6.9091	6.6758	4.8353
LAKE	-37.4206 ***	10.9235	-59.5725 **	23.3028	-53.1504 ***	18.1905
MTNS	-3.0049	9.1932	14.5731	18.4854	-2.9551	18.9222
NPLAINS	-33.5116 **	14.0600	-43.1391	38.5391	-44.5089 **	20.8725
NTHEAST	-24.8783 ***	8.0820	-33.5306 **	14.3821	-26.3945	16.7484
OFFFARMDUM	-1.8095	5.8051	3.7361	10.8520	7.5111	9.6027
ORGYRSRAT	14.6370	11.0866	36.0129	29.2584	14.4450	18.1324
PERACRSGR	17.3185	11.6378	58.3519 **	24.7218	24.4731	17.3995
PERACRSVEG	25.7939 **	13.0451	36.6684 *	18.9761	267.1792 ***	40.8223
PERGRDTC					-0.0334	0.1531
PERGRW					0.1917	0.1249
PERINCGR	-0.2808 **	0.1096	-0.2496	0.3096	-0.3041 *	0.1579
PERINCVEG	-0.0404	0.1155	-0.7062	0.2160	-0.2187	0.2065
PERVEGDTC			-0.2695	0.2077		
PERVEGW			0.2155	0.2106		
PRICEPERCEP	5.9194	4.7968	9.8850	10.3336	2.6097	8.1295
SOLEPROP	-14.8367 ***	5.6491	-14.7229	12.2420	-16.4011 *	8.9641
SPLAINS	-18.1560	16.3476	-12.7619	25.4079	7.7041	30.0099
STHEAST	3.1851	28.2536	-20.2029	51.2145		
TENURERAT	-17.2016 **	8.1239	-39.4617 **	15.4546	-24.0211 *	13.8581
VAPERDUM	9.2835 *	5.4531	11.3785	10.4723	7.0416	8.9773
YRSEXP	0.9014 ***	0.3365	2.0516 **	0.8783	0.4879	0.5780
Constant	-5.6969	22.6839	-64.4579	53.1575	-19.5324	41.4560
Log likelihood	-1004.1481		-474.65065		-426.22601	
LR Chi-square	126.81		83.81		114.87	
Pseudo R2	0.0594		0.0811		0.1187	
Number of Obs	332		138		169	

***, **, * : Denote statistical significance at the 99%, 95% and 90% confidence level, respectively
Note: DELTA and STHEAST dropped from Tobit regression of Grain data due to collinearity

Table 5.4 Tobit Marginal Effects and Standard Errors of Significant Variables

Variable	All dy/dx	All Std. Err.	Vegetable dy/dx	Vegetable Std. Err.	Grain dy/dx	Grain Std. Err.
AGE						
APPAL *	-10.7913	2.4886	-13.4071	4.3669		
CERTYRSRAT						
CONVDUM						
CORNBELT *	-7.6816	2.2653			-9.3822	3.4917
CROPSGRWN	1.0467	0.6144				
DELTA						
DEMPERCEP	-3.5521	1.4841	-5.5261	3.1677		
EDUDUM						
FULLTIME						
GENDER						
INCDUM	2.8191	0.8964	4.2459	2.1568		
LAKE *	-9.1388	2.1650	-13.9380	4.0370	-11.6027	3.3753
MTNS						
NPLAINS *	-8.0625	2.6881			-9.1816	3.3994
NTHEAST *	-6.7825	2.0115	-9.9565	4.0589		
OFFFARMDUM						
ORGYRSRAT						
PERACRSGR			18.3411	7.7107		
PERACRSVEG	7.7369	3.9195	11.5256	5.9550	69.8906	11.4410
PERGRDTC						
PERGRW						
PERINCGR	-0.0842	0.0327			-0.0796	0.0410
PERINCVEG						
PERVEGDTC						
PERVEGW						
PRICEPERCEP						
SOLEPROP *	-4.7004	1.8916			-4.5055	2.5798
SPLAINS						
STHEAST						
TENURERAT	-5.1596	2.4398	-12.4036	4.8897	-6.2836	3.6284
VAPERDUM *	2.8207	1.6790				
YRSEXP	0.2704	0.1007	0.6449	0.2778		
Y	26.5057 [1]		32.3647 [1]		25.1855 [1]	

* : Denotes dy/dx is for discrete change of dummy variable from 0 to 1

[1] : Denotes Y= E(yols | yols>0)

Table 5.5 Comparison of Marginal Effects of Significant Variables

	Heckman		Tobit		
	Probit	**OLS**	**All**	**Vegetable**	**Grain**
Variable	dy/dx	Coef. Est.	dy/dx	dy/dx	dy/dx
AGE					
APPAL *	-1.8349	-71.5490	-10.7913	-13.4071	
CERTYRSTAT					
CONVDUM *	0.7141				
CORNBELT *	-1.0021	-44.9382	-7.6816		-9.3822
CROPSGRWN			1.0467		
DELTA					
DEMPERCEP		-16.6768	-3.5521	-5.5261	
EDUDUM					
FULLTIME					
GENDER *	-0.4637				
INCDUM	0.3237	13.3361	2.8191	4.2459	
LAKE *	-1.2556	-47.7485	-9.1388	-13.9380	-11.6027
MTNS					
NPLAINS *	-1.0630	-45.2559	-8.0625		-9.1816
NTHEAST *	-0.6996	-29.0777	-6.7825	-9.9565	
OFFFARMDUM					
ORGYRSRAT					
PERACRSGR				18.3411	
PERACRSVEG			7.7369	11.5256	69.8906
PERGRDTC					
PERGRW					
PERINCGR	-0.0100		-0.0842		-0.0796
PERINCVEG					
PERVEGDTC					
PERVEGW					
PRICEPERCEP	0.3434				
SOLEPROP *		-20.1622	-4.7004		-4.5055
SPLAINS					
STHEAST					
TENURERAT			-5.1596	-12.4036	-6.2836
VAPERDUM *	0.4591		2.8207		
YRSEXP	0.0210	1.3773	0.2704	0.6449	
Y	0.2566 $_1$		26.5057 $_2$	32.3647 $_2$	25.1855 $_2$

* : Denotes dy/dx is for discrete change of dummy variable from 0 to 1

$_1$: Denotes Y = Linear prediction of yp

$_2$: Denotes Y = E(yols | yols>0)

Table 5.6 Comparison of Marginal Effects of Significant Variables by Category

Characteristic Type	Variable	Model				
		Probit	**OLS**	**All**	**Vegetable**	**Grain**
Structural Characteristics	CONVDUM	0.7141				
	TENURERAT			-5.1596	-12.4036	-6.2836
	CROPSGRWN			1.0467		
	SOLEPROP		-20.1622	-4.7004		-4.5055
	FULLTIME					
	OFFFARMDUM					
	VAPERDUM	0.4591		2.8207		
Demographic Characteristics	AGE					
	GENDER	-0.4637				
	EDUDUM					
Size Characteristics	PERACRSVEG			7.7369	11.5256	69.8906
	PERACRSGR				18.3411	
Income Characteristics	INCUDUM	0.3237	13.3361	2.8191	4.2459	
	PERINCVEG					
	PERINCGR	-0.0100		-0.0842		-0.0796
Marketing Characteristics	PERVEGDTC					
	PERVEGW					
	PERGRDTC					
	PERGRW					
Experience Characteristics	YRSEXP	0.0210	1.3773	0.2704	0.6449	
	ORGYRSRAT					
	CERTYRSRAT					
Perception Characteristics	PRICEPERCEP	0.3434				
	DEMPERCEP		-16.6768	-3.5521	-5.5261	
Location Characteristics	SPLAINS					
	LAKE	-1.2556	-47.7485	-9.1388	-13.9380	-11.6027
	STHEAST					
	MTNS					
	DELTA					
	NTHEAST	-0.6996	-29.0777	-6.7825	-9.9565	
	CORNBELT	-1.0021	-44.9382	-7.6816		-9.3822
	NPLAINS	-1.0630	-45.2559	-8.0625		-9.1816
	APPAL	-1.8349	-71.5490	-10.7913	-13.4071	

Table 5.7 Elasticities of Significant Variables

Variable	Heckman Probit	OLS	Tobit All	Vegetable	Grain
AGE					
APPAL	-0.1382	-0.3914	-0.5938	-0.9519	
CERTYRSTAT					
CONVDUM	0.1844				
CORNBELT	-0.2473	-0.6673	-0.1147		-0.2125
CROPSGRWN			0.3113		
DELTA					
DEMPERCEP		-4.3924	-0.9356	-1.2377	
EDUDUM					
FULLTIME					
GENDER	-0.6737				
INCDUM	0.8861	2.6370	0.5574	0.5747	
LAKE	-0.2835	-0.7837	-0.1500	-0.1284	-0.3623
MTNS					
NPLAINS	-0.1144	-0.3537	-0.6313		-0.1362
NTHEAST	-0.3884	-0.9933	-0.2124	-0.3458	
OFFFARMDUM					
ORGYRSRAT					
PERACRSGR				0.3365	
PERACRSVEG			0.1866	0.4879	0.3829
PERGRDTC					
PERGRW					
PERINCGR	-0.5678		-0.3472		-0.6489
PERINCVEG					
PERVEGDTC					
PERVEGW					
PRICEPERCEP	1.1225				
SOLEPROP		-1.8994	-0.4483		-0.4799
SPLAINS					
STHEAST					
TENURERAT			-0.5219	-0.9413	-0.6195
VAPERDUM	0.3439		0.1532		
YRSEXP	0.7719	3.6792	0.7263	1.4612	
Y	0.2566 $_1$	1.969 $_2$	26.5057 $_3$	32.3647 $_3$	25.1855 $_3$

1 : Denotes Y = linear prediction of Yp
2 : Denotes Y = E(Yols* │ Pr(Yp))
3 : Denotes Y = E(Yols │ Yols>0)

Table 5.8 Elasticities of Continuous Significant Variables

	Heckman		Tobit		
Variable	Probit	OLS	All	Vegetable	Grain
CROPSGRWN			0.3113		
DEMPERCEP		-4.3924	-0.9356	-1.2377	
INCDUM	0.8861	2.6370	0.5574	0.5747	
PERACRSGR				0.3365	
PERACRSVEG			0.1866	0.4879	0.3829
PERINCGR	-0.5678		-0.3472		-0.6489
PRICEPERCEP	1.1225				
TENURERAT			-0.5219	-0.9413	-0.6195
YRSEXP	0.7719	3.6792	0.7263	1.4612	
Y	0.2566 [1]	1.969 [2]	26.5057 [3]	32.3647 [3]	25.1855 [3]

1 : Denotes Y = linear prediction of Yp

2 : Denotes Y = E(Yols* │ Pr(Yp))

3 : Denotes Y = E(Yols │ Yols>0)

CHAPTER 6

SUMMARY AND CONCLUSIONS

This study was designed to examine the factors affecting an organic farmers' demand for non-family farm labor as shown by the significance of characteristics relating to farm management. The ability to distinguish these significant characteristics as individual determinants within an organic farming system makes possible a more accurate concept of why organic farms are more labor intensive than their conventional counterparts. As seen by their elasticities, a farmer's years of experience farming, a farmer's perception of market demand, and the amount of income generated from organic operations create more of a significant response in labor demand than other significant determining factors. The discernment of the relative significance of variables also enables the more efficient management of organic systems with regards to cost efficiency and resources allocation.

An additional purpose of this study allows for the separation of factors which affect the choice to hire non-family labor and the factors affecting the quantity of labor to hire. Not surprising, these factors were not homogenous across farm types, nor were the same factor responsible for both decisions. Certain characteristics such as gender, farmer's price perception and conventional production affect only the choice to hire non-family labor, but not the quantity of labor to hire. These factors can be seen as being directly related to the choice between family and non-family labor. This separation implies male farm operators as being more likely to hire family labor rather than non-family. This separation also implies that farms with a more positive outlook on market price perceptions and farms with some quantity of conventional acres are more willing to hire non-family labor than other farms. Also of importance are the significance related to location characteristics. The significance of these characteristics are the most consistent throughout all models and data types. However, this study can not distinguish whether these regions are significant due to some set of physical characteristics (soil, climate, etc.) or whether migrant labor patterns might be more accountable. This discrepancy will require further analyses.

The further implications of this study are far reaching. The acreage of organic farms as well as the market for organic goods are constantly expanding. USDA certification of organic meat and poultry lagged behind that of most other commodities; certification standards for meat and poultry have just recently become homogenized. According, the markets (and demand) for these good have just begun to become comparable to other organic markets. Farmers are shifting the allocation of their lands, and devoting more acreage to livestock grazing and to feed crops for livestock production. In a recent new release, Wal-Mart announced its intention to begin stocking substantial quantities of organic goods in all of its retail stores (Warner 2006). There are uncertain implications as to what this might do to price premiums obtained by organic farmers and even the market structure for organic goods. The market for organic production is changing.

Corresponding to these market changes, the market for agricultural workers is also shifting. Department of Labor (2004) survey data show foreign born persons comprising 78% of all crop workers in the U.S., with 75% of all U.S. crop workers being from Mexico. Incidentally, 53% of U.S. hired crop labor force interviewed did not have legal authorization to work (USDOL 2004). With the increase in organic demand markets and the labor-intensive nature of organic operations, this sector has the potential to be directly related to any ‘guest-worker’ legislation or any migrant worker issues.

In conclusion, there are still many uncertainties regarding the changing face of organic goods and the way these changes will affect the management of organic operations. A better understanding of the factors which are significant in labor demand decisions will allow farmers to manage their lands more efficiently and hopefully remain economically viable. The significance of years of farming experience will hopefully lead to extension programs which focus on organic methods and the dissemination of these methods to all farmers for the benefit of production. The presence of market perception as a highly significant factor should emphasize the importance of market data availability, especially within a sector that has such potential for change in such a short amount of time. Time-series and panel data would be helpful in chronologically following organic farms as they transition and grow as enterprises. Studies concerning homogeneous groups of organic farms following the same sort of rotations, despite the total number of crops grown, would further aid in identifying specific agricultural interactions affecting labor allocation and demand, even if confined to one geographic location. The thesis results show the definitive characteristics reinforcing general labor allocations and the areas requiring further research.

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APPENDIX

A.1 Questions used from the Organic Farming Research Foundation's Fourth National Organic Farmers' Survey, "Sustaining Organic Farms in a Changing Organic Marketplace".

2. What was your farm's PRODUCTION ACREAGE in 2001? Please fill in how many acres you farmed in each category below. (Acreage estimates are OK. Please show parts of an acre as decimals. For example: 1.25, 4.75, 23.5, etc.. Write "O" next to categories that don't apply to your farm.)

Total number of acres farmed:
Number of acres certified organic:
Number of organically farmed acres not certified, or in transition to certified organic:
Number of acres farmed conventionally:

3. How many ORGANICALLY FARMED acres were OWNED by your farm in 2001? How many acres were RENTED, LEASED or used FREE-OF-CHARGE? (Fill in acres.)
Number of organic acres owned by you/your farm:
Number of organic acres rented, leased, or used free-of-charge:

4. How many ORGANIC ACRES did your farm produce in the following categories in 2001? What
PERCENT OF TOTAL ORGANIC FARM SALES did each category represent? (Fill in acres and percentages for each category.)
Note: Under organic acres, where appropriate, you may represent multiple types of production on the same piece of land. For example, if livestock grazed on 20 acres that also produced grains, you may show those 20 acres under both "Pasture" and "Grains" categories. Estimates are OK--we're looking for a good ballpark representation of how your land in organic status was used. Under percent of organic farm sales, your percent totals for the column should add up to 100%.

Production categories	**Organic acres in 2001**	**Percent of organic**
Vegetable crops (including melons & sweet corn)	**Percent of organic**	**farm sales in 2001**
Herb crops	....	.... %
Nursery, floriculture and/or greenhouse crops	....	.... %
Apiculture (honeybees)	....	.... %
Wildcrafted land	....	.... %
Brambles, berries	....	.... %
Tree or vine fruit and/or nut crops	....	.... %
Grains, alfalfa, mixed hay and/or other field crops	....	.... %
Pasture, grazed land, livestock yards and facilities	....	.... %
Fallow or idle (acres not in production at all in	....	.... %
2001)	....	.... %
Acres cover-cropped your entire growing season	....	.... %
Other (Fill in)	....	.... %
	....	.... %

5. What CONVENTIONALLY GROWN products, if any, did your farm produce in 2001?
(Select all that apply.)
O None
O Vegetable crops
O Herb crops
O Nursery/floriculture and/or greenhouse crops
O Brambles, berries
O Tree or vine fruit and/or nut crops
O Grains/alfalfa/mixed hay or other field crops
O Poultry
O Eggs
O Beef
O Lamb
O Pork
O Dairy products (from cows)
O Honey
O Other:

9. Which of the following business structures best describes your farm operation? (Select one response.)
O Single family - sole proprietor
O Family farm partnership
O Family farm corporation
O Partnership, other than family
O Corporation, other than family
O Farm cooperative
O Property management
O Educational/research farm
O Other:

10. In what state is your farm located?

11. And in what county is the largest value of your organic agricultural products produced?

24. What percentage of your farm's gross sales were derived from value-added products that were processed by or for your farm (those items represented in column A above)?
(Select one response.)

O None O 1% - 25% O 51% - 75% O 26% - 50% O 76% - 100%

25. Where did you sell your organic products in 2001? From the following categories, indicate what percentages of your volume were delivered to the following marketing channels. (Write in the approximate percentage of your products by weight or volume delivered each way. Your percentages for each column should add up to 100%.)

A. Vegetable, herb, floriculture, mushrooms &honey products

B. Fruit, nut and tree products
C. Grain and field crop products
D. Livestock products

A	B	C	D	
Consumer-direct				
________%	________%	________%	________%	Direct on-farm, farm stand, U-pick
________%	________%	________%	________%	Farmers markets
________%	________%	________%	________%	CSA or subscription (pick up or home delivery)
________%	________%	________%	________%	Mail order
________%	________%	________%	________%	Other consumer-direct: ________________
Direct-to-retail (wholesale)				
________%	________%	________%	________%	Natural food stores or food coops
________%	________%	________%	________%	Conventional supermarkets
________%	________%	________%	________%	Restaurants or caterers
________%	________%	________%	________%	Nurseries or florists
________%	________%	________%	________%	Other direct-to-retail:__________________
Other wholesale markets				
________%	________%	________%	________%	Natural food store chain buyer
________%	________%	________%	________%	Conventional supermarket chain buyer
________%	________%	________%	________%	Private grain elevator
________%	________%	________%	________%	Processor, mill or packer
________%	________%	________%	________%	Seed company
________%	________%	________%	________%	Livestock feed company
________%	________%	________%	________%	Distributor or handler
________%	________%	________%	________%	Through a grower cooperative
________%	________%	________%	________%	Through an independent broker
________%	________%	________%	________%	Other wholesale:______________________
= 100%	**= 100%**	**= 100%**	**= 100%**	

31. How was your season last year? How were PRODUCTION and MARKET conditions for your organic farm operation in general? (Select one response per category.)

A. Excellent (few problems)
B. Good
C. Fair
D. Poor (severe problems)

Production conditions	**A. B. C. D.**
Weather	O O O O
Pest or disease problems	O O O O
Weeds	O O O O
Yields	O O O O
Crop or product quality	O O O O

Market conditions

Market demand	O O O O
Prices	O O O O

63. What best describes your relationship to this organic farm? (Select one response.)
O I am the owner or co/owner of this farm business
O I am a hired manager or caretaker
O Other

64. How many years have you been farming? (Fill in.) _____________ years.

65. How many years have you been farming organically? (Fill in.) _____________ years.

66. How many years has your farm been certified organic? (Fill in.) _____________ years.

69. Do you farm FULL TIME or PART TIME? (Select one response.)
O Full time
O Part time

70. INCLUDING YOURSELF and any farm family/household members, how many people were employed in your farm's organic operation, full-time, part-time, and or seasonally in 2001? (Select one response.)

Number of organic farm employees/workers (include yourself)

	Farm family/ Household members	Non-family workers
Full-time, year-round	______________	______________
Full-time, seasonally	______________	______________
Part-time, year round	______________	______________
Part-time, seasonally	______________	______________

71. Do you work at all off-farm, and if so, for what reasons? (Select all that apply.)
O I have no off-farm employment
O To subsidize farm & capital investments
O For health insurance or other benefits
O As a primary income source
O As a secondary income source
O As primary career
O For personal interest
O Other

72. What percentage of your net HOUSEHOLD INCOME came from ORGANIC farm production in 2001? (Select one response.)
O 1% - 25% O 51% - 75% O 26% - 50% O 76% - 100%

73. What was your farm's GROSS ORGANIC farming INCOME in 2001? NOTE: ALL SURVEY RESPONSES, INCLUDING FINANCIAL FIGURES, ARE STRICTLY CONFIDENTIAL! (Select one response.)
O No income or loss
O $100,000 to $249,999
O Less than $5,000
O $250,000 to $499,999
O $5,000 to $14,999
O $500,000 to $999,999
O $15,000 to $29,999
O $ 1 million to $4.9 million
O $30,000 to $49,999
O $5 million to $19.9 million
O $50,000 to $99,999
O $20 million or more

74. What is your highest level of formal education? (Select one response.)
O No formal education
O Some high school
O Completed high school
O Some college
O Completed junior college/trade school degree (specify major) ________________________
O Completed bachelor's degree (specify major) ______________________________
O Some graduate work (post baccalaureate)
O Graduate degree (specify degree and major) _____________________________

75. What is your age? (Fill in.) _____________ years

76. Your gender. (Select one response.)
O Female
O Male