# A FEASIBILITY STUDY OF OPENING AND OPERATING A PRECISION FARMING FIRM IN KENTUCKY

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ABSTRACT OF THESIS

A FEASIBILITY STUDY OF OPENING AND OPERATING A PRECISION FARMING FIRM IN KENTUCKY

In the recent past precision farming has become increasingly popular among farmers. However, little has been done to study the business aspect of precision farming, with most research focusing on the production side. This purpose of this thesis is to study the feasibility of successfully opening and operating a precision farming firm in Kentucky. To determine the feasibility of such a venture a computer model was created and a producer survey was designed and distributed to farmers in Western and Central Kentucky.

The purpose of the computer model was to determine the factors that would influence the successful operation of a precision farming firm including number of acres serviced per year, pricing of services, the cost of capital to borrow money, and many other factors. A break-even analysis was performed to determine what kind of annual increases in business would be required, what price range services should be in, and at what interest rate money could be borrowed and a simulated precision farming firm could still operate successfully.

The producer survey was mailed to 336 farmers in Western and Central Kentucky because of their geographical locations and the type of crops that are grown there. The survey response rate was 20 percent and of the 66 surveys that were returned 59 were appropriate and useful for research. After compiling the results of the surveys, regressions were run to determine any correlation between dependent and independent variables that affect the adoption rate of precision farming techniques. The results found that a negative correlation exists between age adoption rates of precision farming and that a positive correlation exists between farm size and adoption rates of precision farming.

After conducting the research, it is believed that given the right economic conditions and management a precision farming firm is very capable of thriving in Kentucky. However, the workforce must be very motivated and capable of constantly recruiting new clients to adopt precision farming.

KEYWORDS: Precision Farming, Precision Agriculture, Variable Rate Application, Site Specific Farming, Grid Soil Sampling

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THESIS

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# A FEASIBILITY STUDY OF OPENING AND OPERATING A PRECISION FARMING FIRM IN KENTUCKY

THESIS

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in the College of Agriculture at the University of Kentucky

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# CHAPTER ONE
# Introduction

## 1.1 The Ideology and Research Behind Precision Farming

Although the term "precision farming" is relatively new, it has been used frequently in the agriculture community in the last ten to fifteen years. However, the concept behind the term is not. This becomes quite apparent when defining precision farming. Lowenberg-Deboer defines precision farming as "using information technologies to tailor soil and crop management to fit the specific conditions found within a field." Given common knowledge that farming, in some form, has been around so long as humans have been in existence, we can safely conclude that precision farming has been in existence, as well. In the nineteenth century, the Irish people surely monitored their land to determine where potatoes would grow most suitably. Over centuries, Indians, using precision farming techniques such as careful cultivation practices, were able to transform Teosinte (a grass plant) into maize (corn) that was suitable for human consumption and many other uses. Farmers in the United States during the 20th century were able to choose certain hybrids of corn most suitable for different fields given the characteristics of such fields.

Until recently, using precision farming techniques, particularly site-specific management, had become increasingly difficult even as acreage, farm machinery, and time constraints had grown quite large. Given the large scale of many farming operations, site-specific management was limited to field and, in some cases, entire farm-size units. Each field or fields received a uniform application of nutrients, lime, seed, chemicals, and other inputs. Because of this uniformity, certain efficiencies were lost, thus decreasing the farmers profitability through overapplication in some areas and underapplication in other areas. However, in the past decade great advancements in technology have enabled willing farmers to attempt to gain the efficiencies that were lost as a result of the uniform application rates. With the incorporation of the Global Positioning System (GPS) into agriculture and many other technological advancements in precision agriculture, site-specific farming within fields is again becoming a practice that some farmers have adopted and others are continuing to adopt.

## 1.2 Objectives of Study

The objective of this study is to determine if it feasible to open and operate a precision farming firm in the state of Kentucky. If a precision farming firm can show an economically viable profit with a cash flow that meets the decision criteria then the project of opening the firm is considered feasible. This objective will be fulfilled by (1) developing a computer model to project earnings over a five year period and (2) conducting a survey pertaining to farmers views of precision farming and the likelihood of them adopting precision farming practices.

The computer model will be constructed using numbers derived from market trends insofar as possible, but will also consist of many assumptions that will be based on projected estimates that are consistent with research which has been conducted with regard to precision agriculture and adoption trends. With the results of the estimates from the model, many different decision tools can be calculated and decisions about opening and operating the firm can be made.

By conducting the survey it is possible to gain an understanding of how farmers in Kentucky feel about precision farming and to determine if a likely market exists, which is a necessary condition for people interested in opening a precision farming firm. The survey will be conducted in the areas of Kentucky that are most heavily concentrated with respect to grain farming, soybean and corn in particular.

## 1.3 Benefits of Study

The benefits of this study will probably be most recognized by parties interested in opening businesses related to precision agriculture. However, the research conducted for this paper may be beneficial to those in academia, current business operators, and farmers in the most heavily concentrated grain growing areas of Kentucky and other states.

For people interested in opening a precision-farming firm, the business model that was constructed will assist in answering questions about potential profitability, payback period, net present value, benefit cost ratio, and internal rate of return. These four factors are very important in determining if it is feasible to open and operate and precision farming firm. Logically, anyone who is interested in undertaking this kind of business venture would want to maximize their utility by maximizing profit and one would have an accurate estimate of what their cashflow situation would look like by using this computer model.

Much like those people who may be interested in opening and operating a precision farming firm, this study may benefit people who currently operate businesses that provide non precision farming related services, but may be considering expanding their business to offer precision farming services. These people can use the information from the business model to assist them in determining if expanding their business would be a viable alternative to operating in their current capacity.

For those involved in the academic world this study should answer some of the questions that have plagued academia with regards to the business side of precision farming. This research is an introduction in this area and can be used by others who are seeking to find a foundation on which to continue and further research in the area of precision agriculture.

Farmers are likely to benefit from this research both directly and in-directly. Based on the results of this research, people may have strong emotions about the potential success or possible failure of a precision farming firm. Building on the emotions of potential success, farmers could see many more precision farming firms opening in their areas as opposed to the few that are currently located sporadically across Western and Central Kentucky. The survey results may also influence a farmers decision to use precision farming techniques based on the opinions of other farmers who have seen positive returns from their employment of such techniques. Likewise, they may choose to continue to operate without utilizing precision farming techniques because certain farmers may not be receiving any benefits from using these said techniques.

# CHAPTER TWO
# Basics of Precision Farming

## 2.1 Precision Farming in Recent Years

Site-specific farming is a time-proven idea of crop management: doing the right thing, at the right time, in the right place (Lowenberg-Deboer). Thus, for many farmers and others, this definition in layman's terms is that of applying the right amount of inputs at the appropriate time intervals in the needed locations. However the motivation behind each farmers willingness to adopt site-specific farming is not simple and varies from one farmer to another. While the practice of precision farming has become a popular trend among many farmers, there have been many unanswered questions about its increasing popularity. This is not because of oversight, but because this practice of site-specific management has made a reappearance in the recent past and there is lacking empirical data to sufficiently answer many of the questions that have been raised.

Initially one would think that the sole reason for adopting precision farming practices would be to maximize profits. This thought would seem plausible given that many farmers produce agriculture commodities as an occupation and most people try to achieve profit maximization in their given occupation. However, this adoption of precision farming is not strictly for profit maximization, but rather utility maximization. In saying this, there are a very large number of options for achieving utility maximization. For instance, environmentally-conscious farmers may choose to use site-specific farming to allow for more appropriate levels of inputs to reduce runoff of pollutants and an increase in profit may be a bonus received from these varying levels of inputs. There also exist farmers who farm as a hobby and one of their greatest concerns may be caring for the land. They may choose to utilize site-specific farming in an attempt to manicure the land by applying varying levels of inputs to make the attributes of the soil more uniform. Obviously, there are as many reasons for employing precision farming as there are farmers. Thus the reasons are numerous and hard to quantify. Although the fact remains that different farmers have different reasons for using precision farming practices the specific types of employment of these practices are present and are quite quantifiable.

Depending on the farmer's size, he or she may perform all of these operations of site-specific management internally within the operation or hire someone else to perform some, or all, of these duties. So, who is doing what precision farming techniques? Unfortunately, a magic formula to determine who does what does not exist. A great deal of research has been completed with regard to the production side of precision farming in order to try to answer questions like the one above. Unfortunately, in the interest of trying to determine why farmers employ precision farming and if employing precision farming is profitable, the business aspect of precision farming has not been treated as kindly. Although research in this area is starting to increase there is not an overabundance of information to be found. Surveys and other types of research have been completed to determine how many precision farming firms exist, where they are located, what types of services they offer, and what the demographics of their clients are, but few, if any, studies have been conducted to determine if it is actually feasible to open and operate a precision farming firm.

**2.2 Aspects of Opening and Operating a Small Business**

It is safe to assume that most people are very cautious and a bit weary when considering opening a small business. Given the startling statistics related to small business ownership, this skepticism among potential business owners is not surprising. According to the Small Business Administration, since 1990, the number of small business births has consistently been well above 570,000 firms each year. Although this number seems impressive, it is important to note during this same period the number of terminated or closed small businesses has hovered around 550,000 firms each year with the number of bankruptcies ranging from 35,000 to 65,000 during these same years. These numbers are quite consistent with the general statistic, that 4 out of 5 small businesses fail within the first 5 years of opening. However, these numbers give a distorted sense of potential failure given the fact that not all of the businesses that are terminated each year are actually failures. An article found on the Small Business Administration website written by (Brian Headd) notes that a considerable number of terminated businesses are operating successfully at their closure. Head observed that some people opt to work for someone else, giving up the responsibility of operating their own business, while others close their business "when it is making a profit and before losses piles up. Designing an exit strategy and moving to other opportunities facilitates this process of a positive exit." Knowing that not all business closures are failures should give reassurance to those considering opening a small business. A positive aspect of business closure is the opportunity created for a new entrant into a market when a veteran business owner has decided to close their firm because of lack of interest or ambition to enter a new market.

When contemplating opening a new business, many details of small business ownership should be taken into consideration. Skills, potential sales, financial control, lack of funds, high cost of finance, insolvent customers, and marketing issues are the main aspects that one should take into consideration before jumping into business ownership. All too often, people are too caught up in the excitement of owning their own business and being their own boss to give these details explicit and serious consideration. In the end, many times within five years the enthusiastic entrepreneurs eventually become displaced and distressed business failures. The lack of skills, inadequate funding, and failed marketing become the death of the business before it ever gets to enjoy the transition from the newborn stage to maturity.

Seriously analyzing the aspects mentioned above and compiling future projections of earnings allows one to enter into small business ownership with a stronger foundation. If a person is weak in a certain area of business then they should combat that weakness with a solution or forego the opportunity to open their own firm. If these aspects can be met, in some form, then the interested party should move on to compiling projected future earnings. If projected future earnings look good then it is time to proceed with the project of opening and operating their own business.

**2.3 Articles**

Two articles were chosen as the primary basis for this literature review. These articles include "Adoption of Precision Agriculture Technology in Mississippi: Preliminary Results from a Producer Survey" (Darren Hudson and Diane Hite) and "The Economic and Environmental Impacts of Variable Rate Fertilizer Application: The Case of Mississippi" (Intarapapong, Hite, and Hudson). These two articles pertain to precision agriculture in Mississippi.

## 2.4 Empirical Objectives and Methods

The empirical objectives of these two articles are quite different. The article by Hudson and Hite determines why some farmers in Mississippi have chosen to adopt precision farming practices while others have not, even though the "technology has the promise to improve farm management through improved information and control over in-field variability of soil characteristics." Hudson and Hite chose this area of research because of the relatively low adoption of precision agriculture throughout the state of Mississippi.

Intarapapong, Hite, and Hudson, note that "despite the potential environmental benefit that would be realized from adopting precision application technology, farmers must at least perceive some economic benefits." Hence, the empirical objective of the article "attempts to investigate the environmental and economic impacts of precision agriculture technology associated with variable-rate fertilizer applications, as compared to a conventional, single rate application." More specifically, the authors are attempting to determine the change in fertilizer run-off between single-rate application methods and variable-rate applications.

Hudson and Hite's method was to gather the data via a survey questionnaire designed to elicit basic information about producer and farm characteristics such as age, education, income, soil characteristics, production regions, etc. The survey, mailed to nearly 800 farmers in Mississippi, asked farmers about their current use of SSM (site specific management) technologies, their primary sources of information about SSM, and what primary factors would be necessary to induce them to adopt SSM technologies. Five hundred fifty seven of the 780 surveys that were mailed out were returned and telephone follow-up was used to mitigate non-response bias. This means that telephone calls were made to non-respondents in hopes of collecting information from them to get rid of the bias that may have been present due to their lack of response. The survey was conducted by the Mississippi Agricultural Statistics Service the summer of 2000 and the sample was limited to farmers with more than 250 acres.

Intarapapong, Hite, and Hudson, use the Erosion Productivity Impact Calculator (EPIC) to assess the effect of precision agriculture practices on environmental parameters and farm net returns. The EPIC model was designed to simulate biophysical processes over a long period of time in a wide range of soil, climate, and crop conditions and is also capable of simulating agricultural yields and related environmental parameters under various management scenarios.

In addition to the EPIC model, the soil cation exchange capacity (C.E.C) is used. Soil C.E.C. determines the amount of nitrogen fertilizer that is recommended for crops based on soil type and phosphorous levels are prescribed in accordance with soil phosphorous levels. To estimate environmental impacts, the authors compare an agricultural practice consisting of a single fertilizer application rate on cotton, soybeans and corn to a variable rate as prescribed by soil characteristics. The single application rate refers to an unvaried fertilizer application rate on crops, regardless of soil characteristics within the field, while the variable rate is adjusted in accordance with soil C.E.C. and phosphorous levels (Intarapapong et al., 2002; NRCS-USDA, 1996). Farm budget data were used to estimate economic net returns so that net returns from conventional single rate fertilizer applications on cotton, soybeans, and corn could be calculated and compared with those from the scenario in which variable rates are applied (Intarapapong et al. 2002). Six different farm regions were analyzed in this study, these regions include: delta, upper brown loam, black belt, upper coastal plain, lower coastal plain, and lower brown loam. There were twenty-five different soil types found within the six different regions, each having a different soil C.E.C. (Appendix A).

Although actual soil samples were taken in each different region of Mississippi, the results that will be presented in the Empirical Results section are not based on actual field crop, real time numbers. This means that after the soil tests were taken, the crops were not actually planted, nurtured, and harvested, in order to determine the results that were published in this study. Several reasons can be responsible for this: a lengthy growing season, budget constraints, time consumption, and access to an accurate model that can simulate the numbers. In reality, if the study was based on actual field crops grown during the growing season, it would take at least six to seven months to raise the crops. In addition to the lengthy growing season, budget constraints would most likely be present and given the expense of seed, fertilizers, chemicals, fuel, labor, and other variable expenses, the budget constraint would probably not cover these variable costs. These crops would also require a great deal of time and the benefit of the study probably would not outweigh the cost of the time that would be required to raise the crops. Finally, having access to the EPIC model, which is very accurate, gives a great alternative to the deterring factors of production mentioned above.

**2.5 What the Authors Discovered**

The findings in the article written by Hudson and Hite were very interesting and seemed to be similar of what could be expected to be found in Kentucky, however they were far too numerous to include in this chapter but the conclusions that were drawn from the study were not. After reviewing all of the results from the survey, Hudson and Hite came to several general conclusions. Besides soil sampling, adoption and use of precision agriculture is low, due in part to the recent introduction of new technologies and the changes that have been taking place in agriculture in the past few years. "Awareness of SSM technologies is relatively high, and trade publications and the Extension Service apperar to be doing an adequate job of promoting awareness through educational programs (Hudson and Hite, 2001)." Lastly, Hudson and Hite note that the highest probability of farmers adopting precision agriculture will happen only if profitability is evident and if the technologies can be integrated into farming practices fairly easily.

Intarapapong et al. divided their empirical results into six different categories due to the fact that there were six different production regions in Mississippi and each category had three subcategories: cotton, soybeans, and corn. The results seemed to be mixed. Consistently, the most significant results for increased net returns were found in cotton acreage, however in a few cases the most significant results varied between corn and soybeans. In some of the cases runoff from the variable rate application actually increased by a small percentage, however this was due to the fact that levels of single rate application were generally lower than they needed to be and when the appropriate rate was applied it was natural that runoff would increase a slight bit. The general conclusion for the study was that variable rate application does have an economic incentive for farmers most of the time and sometimes there is an incentive for the environment as well.

# CHAPTER THREE
# Construction of a Business Model

## 3.1 Focus of Chapter

This chapter focuses on the business side of precision farming through the development of an agribusiness that sells precision farming services to farmers, the feasibility of operating such a business, and the revenue that can be generated by a business of this nature. The steps that must be taken in considering the feasibility of operating a precision farming firm are to first determine the primary business functions of the firm. Next, it must be determined if there is a sufficient market available to justify operating a precision farming firm. Are there many farmers who would consider utilizing the services offered by the firm? If a market exists, then the business details, including startup capital, employees, equipment, and location must be determined. At this point projections of earnings can begin to be compiled to predict future revenue streams. Finally, after the above steps are completed, decision factors must be analyzed to determine the feasibility of operating a precision farming firm and a decision can be made with respect to the feasibility of startup and operation of a precision farming firm.

## 3.2 Primary Business Functions

Given the uncertainty in demand for precision farming services it would be in the best interest of a potential business owner to enter into this market with the smallest capital outlay possible, but still be able to perform the necessary services. With this in mind, the services that might be offered include soil grid sampling and field mapping, database construction, prescription recommendations, and equipment sales, installation and maintenance. Soil grid sampling and field mapping will consist of mapping the fields into two and one-half acre grids and then collecting four soil samples from each grid within a field. The samples will then be sent to a laboratory to be tested for phosphorous, potassium and pH levels and the results from the test are considered to be valid for 3 years. Therefore, new soil samples will be taken every three years. Database construction includes recording the results from the soil test and yield monitor data into site-specific field maps. The maps include each grids specific level of pH, phosphorous, potassium and yield throughout the field, which is used to make the prescription recommendations for variable rate applications.

The prescription recommendations are calculated based on the levels of nutrients in the soil and yield history of the soil and are used to recommend different combinations of fertilizers, seed, and chemicals according to the location within the field. Precision farming equipment will also be sold, installed, and maintained. Equipment to be sold by the firm includes GPS guidance systems, yield monitor equipment, etc. and installation is included in the purchase price. Maintenance of the equipment is included in the price that farmers pay for the soil testing, database construction, and prescription recommendations, which is an annual contract fee. To perform these services, firms should charge the farmer between $7.00 and $8.00 per acre, for this paper $7.50 per acre was the chosen service fee. Given the law of supply and demand, it is obvious that more farmers would choose to utilize the services at $7.50 per acre than $8.00 per acre.

### 3.3 Establishing a Market

According to Morris and Blackmore, farmers who grow more than 250 acres of crops are more likely to choose to utilize precision agriculture because economies of scale play a great role in justifying the cost associated with precision agriculture. Gandonou, Stombaugh, Dillon, and Shearer note that a break-even analysis has shown that farmers wishing to purchase the appropriate equipment and perform the task of gathering information for field mapping and grid soil sampling would need to operate at the level of 4,981 acres. With this information it is obvious that the market for custom-hire precision farming services of the nature mentioned above exists for farmers between the size of 250 acres and 4,981 acres. Swinton and Lowenberg-DeBoer determined that SSM was profitable on corn some of the time, using this information and data provided by the Kentucky Agricultural Statistics Service it is found that the greatest need for precision farming in Kentucky is in the Purchase (Western Region) and Mid-Western regions of Kentucky. These two regions, which make up roughly one-third of Kentucky’s land area, produce nearly 80% of the states corn level annually. According to the 1997 census the 26 counties that comprise these two regions of Kentucky hold well over 1.5 million acres of harvested cropland that is farmed by farmers with more than 250 acres of crops. Given these large numbers it is expected that a precision farming firm could exist in this area of Kentucky given the appropriate sales and marketing techniques.

### 3.4 Business Details

William Reinert, part owner of Precision Farming Enterprises located in Davis, California suggested that a precision farming firm that would be offering the services of soil grid sampling and field mapping, database construction, prescription recommendations, and equipment sales, installation and maintenance would require 2 salaried employees with knowledge of GPS, GIS, and precision farming. In the business model used for this paper these employees would be acting as manager and assistant manager of the firm earning $43,000 and $37,000 a year, respectively. In addition to the manager and assistant manager 2 salaried assistants and 2 part-time seasonal employees would be needed. The two salaried assistants would act as salespeople and data collectors and the seasonal employees would assist the two assistants in data collection. The two salaried assistants earn $30,000 annually and the two seasonal employees earn $7.00 per hour. These salaries are assumptions based on interviews with owners and employees of different precision farming firms across the United States.

For startup, Mr. Reinert recommended two computers, one desktop and one laptop, in order to build the databases and map fields. A laptop could be purchased for approximately $900.00 (BestBuy.com) and a desktop could be purchased for approximately $600.00. AgView 2.0 is the recommended software to construct the maps and databases, this software cost about $2,495.00. Roger Boyd of Ag One Co-op recommended using a Kawasaki Mule as a means of transportation within the fields to map the fields and gather the soil samples. According to a local Kawasaki dealer, a Kawasaki Mule of the type that Mr. Boyd recommended would cost $9,999.00. A Concord soil sampler would cost $3,995.00 and a GPS receiver would cost roughly $2,500.00, both of which are to be mounted on the Kawasaki Mule. A PDA, needed to record the information provided by the GPS receiver, could be purchased for $500.00. The largest capital investment is the land and building where the office will be located. These two investments are projected to cost approximately $52,500 for a 2-acre parcel and the construction expenses for the office would be about $65,000. Some additional items, such as desks and chairs, need to be purchased in order to facilitate staff and customers. These items are expected to cost $798.00 and $440.00 respectively. The total startup capital needed to open this precision farming firm is projected to be $139,727.00 (Table 3.1).

Table 3.1 Startup Capital Required

| Item | Cost of Item |
|---|---|
| Laptop Computer | $900.00 |
| Desktop Computer | $600.00 |
| AgView 2.0 | $2,495.00 |
| Kawasaki Mule | $9,999.00 |
| Concord Soil Sampler | $3,995.00 |
| GPS Receiver | $2,500.00 |
| P.D.A. | $500.00 |
| Two Acre Parcel of Land | $52,500.00 |
| Office Construction Expense | $65,000.00 |
| Desks | $798.00 |
| Chairs | $440.00 |
| Total Startup Capital Required | $139,727.00 |

In choosing a location for this precision farming firm it is important that the office be located in a central location accessible to all of the counties within the Purchase and Mid-Western regions.  Given Caldwell County, Kentucky's proximity to all of the counties in these two regions it is the most appealing location.  Christian and Hopkins County, Kentucky border this location and they are two of the biggest corn producers in the state and they also have a great deal of farmers that farm more than 250 acres.

**3.5 Generating Revenue**

A business model was constructed using Microsoft Excel to predict a revenue stream for this precision farming firm.  A time period of five years was considered because of the capital investment that is required to start the firm.  Chris Petty of Precision Management & Consulting indicated that a business of this nature could expect to operate unprofitably for 2 to 3 years.

Most months would have between 24 to 27 working days.  However, it is not feasible for a precision farming to operate full scale during the months between April and August.  During the month of April spring planting moves into full gear and for this reason it is unreasonable to assume that field mapping and soil grid sampling can be completed when crops are in the soil, thus it is assumed that in the month of April there would be 12 days in the month when services could be performed.  Similarly, during the months of May, June, and July when crops are in the ground services can not be performed at all. However, in August when harvest begins, the firm could resume services as the fields are harvested and yield monitor data is recorded, it is reasonable to assume that services could be performed 13 days in the month of August. The rest of the months are considered to be in full operation on every working day.

The business model is setup is in the form of a cash-flow statement. The model consists of operating revenue, operating expenses, depreciation expenses, operating profit (loss) pre-tax, operating profit (loss) post-tax, and net cash flow (table 3.2).

Under operating revenue there is a cell for average acres serviced per month, average acres serviced per day, average charge per acre, and from these three cells total monthly service sales, cost of goods sold, and cost of goods sold as a percentage are calculated. To determine the average number of acres serviced per day, the number of acres serviced per year is divided by the total number of days that services are performed that year. Then that number is multiplied by the number of days services are performed for that particular month to determine the average number of acres serviced that month. To determine total monthly revenue generated by services simply multiply the average acres serviced per month by the charge per acre, which was determined to be $7.50 per acre.

According to Kansas State University's soil testing laboratory there is a charge of $6.00 per soil sample. For every 2.5 acre grid four soil samples are taken. However, these samples are combined into one sample to be tested, therefore for every 2.5-acre grid there is a $6.00 charge for soil testing that the firm must pay. Because soil samples are good for 3 years this cost is spread out over that period. Thus the cost of goods sold is $2.00 per grid. By determining the number of acres serviced it is possible to determine the number of soil samples that are tested. This is calculated by dividing the number of acres serviced per month by 2.5 (the size of the grid). This number represents the number of soil tests that must be completed at the price of $2.00 per test. By multiplying these two numbers the cost of goods sold is then present. After finding cost of goods sold, simply divide that number into total monthly revenue generated by services and cost of goods sold as a percentage is then calculated.

Monthly equipment sales are assumed at $3,000.00 per month and the cost of goods sold for equipment is 60%. Obviously, if this is the case then $1,200.00 revenue is generated from equipment sales. To determine total monthly operating revenue add total monthly service sales and total monthly equipment sales together and then deduct cost of goods sold for each of these areas.

Operating expenses is composed of variable expenses that are necessary for the day-to-day operation of the firm. These expenses include the wages of the employees, which were explained earlier, vehicle lease expenses for 2 trucks at $600.00 per month, vehicle maintenance & operation which is assumed to be 1% of total monthly sales, and ATV maintenance and operation assumed to be 0.35% of total monthly sales. Some of the operating expenses are general utilities that range in a set monthly price from $25.00 to $75.00, including electricity, water, telephone, and Internet services. Subscription to data transmission network (DTN) is needed for up to date weather reports. This weather service is $39.00 a month when an annual contract is signed. The projected cost of insurance is $800.00 a month and includes insurance for full time employees, for liability purposes, and for property. Each full time employee should be provided with a cellular telephone, thus 4 cellular telephones at $70.00 a month totals $280.00 a month. The building and land payment is the biggest operating expense. Total capital borrowed for land and building purposes totaled $117,500.00 and is considered to be borrowed at 5.5% for a fixed 15-year term.

The depreciation expense column is made up of the items that were listed under business details. To determine depreciation for these items useful life and expected salvage value were designated, all useful life periods and salvage values are assumptions. The straight-line depreciation method was used in determining monthly and annual depreciation expenses. Computers have a useful life of 3 years with a salvage value of $350.00. To determine monthly depreciation subtract the salvage value from $1,500.00, the original purchase price, then divided the result by 3. This is the calculated yearly depreciation, to determine the monthly depreciation expense simply divide this number by 12. This same method is applied to all of the items in the depreciation expenses category. The AgView software has a useful life of 10 years and a salvage value of zero. The chairs for the office are expected to last for 6 years with an expected salvage value of

$20.00.  The Kawasaki Mule should be suitable for 7 years and will have a salvage value of $2,000.00.  The GPS, PDA, and Concord soil sampler all have salvage values of zero, however their useful lives are 4, 1, and 5 years respectively.  The building is expected to be in good condition for 30 years and have a salvage value of $5,000.00.  The land is not listed under depreciation expenses because it is expected to increase in value over time.

After determining operating revenue, operating expenses, and depreciation expenses the operating profit (loss) pre-tax can be found.  This is found by deducting total operating expenses and total depreciation expenses from total operating revenue.  To determine the amount of taxes that are paid annually, the total annual operating profit is multiplied by a set tax rate of 40%, this amount is then averaged out over the year.  The IF function is used to identify years where a loss would occur, in this case there is no tax for that year.  After determining the amount of taxes to be paid the operating profit (loss) post-tax can be found by subtracting the taxes from the operating profit (loss) pre-tax. Factoring in depreciation expenses determines the net cash flow, determined on a monthly and yearly level.

**3.6 Business Model and Decision Factors**

As indicated earlier, the business model was set up for five years given the substantial capital outlay.  Based on assumptions and conversations with people in this industry the acres serviced per year rise from 20,000 acres in the first year of business to 55,000 acres in the fifth year of business (tables 3.2 – 3.6).  The cash-flow statements from these 5 years are used to determine the decision factors including payback, net present value, benefit cost ratio, and the internal rate of return.

Table 3.2. Year 1 Monthly Cash-flow Analysis

| | | | January | February | March | April | May | June | July | August | September | October | November | December | Totals/Averages | # of Acres Serviced/Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of Days Open | | 27 | 24 | 27 | 25 | 27 | 26 | 26 | 27 | 25 | 27 | 25 | 25 | 311 | 20000 |
| | Number of Days Services Performed | | 27 | 24 | 27 | 12 | 0 | 0 | 0 | 13 | 25 | 27 | 25 | 25 | 205 | |
| **Operating Revenue** | Average Acres Serviced Per Month | | 2634 | 2341 | 2634 | 1171 | 0 | 0 | 0 | 1268 | 2439 | 2634 | 2439 | 2439 | 1667 | |
| | Average Acres Serviced Per Day | | 98 | 98 | 98 | 98 | 0 | 0 | 0 | 98 | 98 | 98 | 98 | 98 | 98 | |
| | Average Charge Per Acre | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | |
| | Total Monthly Service Sales | | $19,756.10 | $17,560.98 | $19,756.10 | $8,780.49 | $0.00 | $0.00 | $0.00 | $9,512.20 | $18,292.68 | $19,756.10 | $18,292.68 | $18,292.68 | $150,000.00 | |
| | Cost of Goods Sold | | $2,107.32 | $1,873.17 | $2,107.32 | $936.59 | $0.00 | $0.00 | $0.00 | $1,014.63 | $1,951.22 | $2,107.32 | $1,951.22 | $1,951.22 | $16,000.00 | |
| | Cost of Goods Sold as % | | 10.67% | 10.67% | 10.67% | 10.67% | 0.00% | 0.00% | 0.00% | 10.67% | 10.67% | 10.67% | 10.67% | 10.67% | 10.67% | |
| | Total Monthly Equipment Sales | | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $36,000.00 | |
| | Cost of Goods Sold | | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $21,600.00 | |
| | Cost of Goods Sold as % | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | |
| | **Total Operating Revenue** | | $18,848.78 | $16,887.80 | $18,848.78 | $9,043.90 | $1,200.00 | $1,200.00 | $1,200.00 | $9,697.56 | $17,541.46 | $18,848.78 | $17,541.46 | $17,541.46 | $148,400.00 | |
| **Operating Expenses** | Wages (Salary Experienced Emp.) | | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $80,000.00 | |
| | Wages (Salary Assistant Emp.) | | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $60,000.00 | |
| | Wages (2 Emp. Hourly at $7.00/hr.) | | $983.41 | $874.15 | $983.41 | $437.07 | $0.00 | $0.00 | $0.00 | $473.50 | $910.57 | $983.41 | $910.57 | $910.57 | $7,466.67 | |
| | Vehicle Lease Payment (2 at $300/mo.) | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $7,200.00 | |
| | Vehicle Maintenance & Operation | 1.5% | $296.34 | $263.41 | $296.34 | $131.71 | $200.00 | $200.00 | $200.00 | $142.68 | $274.39 | $296.34 | $274.39 | $274.39 | $2,850.00 | |
| | ATV Maintenance & Operation | 0.35% | $69.15 | $61.46 | $69.15 | $30.73 | $0.00 | $0.00 | $0.00 | $33.29 | $64.02 | $69.15 | $64.02 | $64.02 | $525.00 | |
| | Office Supplies | 1% | $197.56 | $175.61 | $197.56 | $87.80 | $100.00 | $100.00 | $100.00 | $95.12 | $182.93 | $197.56 | $182.93 | $182.93 | $1,800.00 | |
| | Electricity | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $420.00 | |
| | Water | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $300.00 | |
| | Telephone | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $720.00 | |
| | Broadband Internet | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $900.00 | |
| | DTN | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $468.00 | |
| | Insurance | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $9,600.00 | |
| | Cellular Phones | 4 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $3,360.00 | |
| | Building & Land Payment | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $11,520.88 | |
| | **Total Operating Expenses** | | $16,087.20 | $15,915.37 | $16,087.20 | $15,228.06 | $14,840.74 | $14,840.74 | $14,840.74 | $15,285.33 | $15,972.65 | $16,087.20 | $15,972.65 | $15,972.65 | $187,130.54 | |
| **Depreciation Expenses** | Computers | $1,500.00 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $383.33 | |
| | AgView Software | $2,495.00 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $249.50 | |
| | Desks | $798.00 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $69.80 | |
| | Desk Chairs | $240.00 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $36.67 | |
| | Office Chairs | $200.00 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $30.00 | |
| | Kawasaki Mule | $9,999.00 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $1,142.71 | |
| | GPS | $2,500.00 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $625.00 | |
| | PDA | $500.00 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $500.00 | |
| | Concord Soil Sampler | $3,995.00 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $799.00 | |
| | Building Depreciation | $65,000.00 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $2,000.00 | |
| | **Total Depreciation Expenses** | | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $5,836.01 | |
| **Operating Profit (Loss) Pre-Tax** | | | $2,275.24 | $486.10 | $2,275.24 | ($6,670.49) | ($14,127.07) | ($14,127.07) | ($14,127.07) | ($6,074.11) | $1,082.48 | $2,275.24 | $1,082.48 | $1,082.48 | ($44,566.56) | |
| | **Less Taxes** | | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | |
| **Operating Profit (Loss) Post-Tax** | | | $2,275.24 | $486.10 | $2,275.24 | ($6,670.49) | ($14,127.07) | ($14,127.07) | ($14,127.07) | ($6,074.11) | $1,082.48 | $2,275.24 | $1,082.48 | $1,082.48 | ($44,566.56) | |
| | **Plus Depreciation Expense** | | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $5,836.01 | |
| **Net Cash Flow (NCF)** | | | $2,761.58 | $972.43 | $2,761.58 | ($6,184.15) | ($13,640.74) | ($13,640.74) | ($13,640.74) | ($5,587.77) | $1,568.81 | $2,761.58 | $1,568.81 | $1,568.81 | ($38,730.54) | |

Table 3.3. Year 2 Monthly Cash-flow Analysis

| | | | January | February | March | April | May | June | July | August | September | October | November | December | Totals/Averages | # of Acres Serviced/Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of Days Open | | 27 | 24 | 27 | 25 | 27 | 26 | 26 | 27 | 25 | 27 | 25 | 25 | 311 | 30000 |
| | Number of Days Services Performed | | 27 | 24 | 27 | 12 | 0 | 0 | 0 | 13 | 25 | 27 | 25 | 25 | 205 | |
| **Operating Revenue** | Average Acres Serviced Per Month | | 3951 | 3512 | 3951 | 1756 | 0 | 0 | 0 | 1902 | 3659 | 3951 | 3659 | 3659 | 2500 | |
| | Average Acres Serviced Per Day | | 146 | 146 | 146 | 146 | 0 | 0 | 0 | 146 | 146 | 146 | 146 | 146 | 146 | |
| | Average Charge Per Acre | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | |
| | Total Monthly Sales | | $29,634.15 | $26,341.46 | $29,634.15 | $13,170.73 | $0.00 | $0.00 | $0.00 | $14,268.29 | $27,439.02 | $29,634.15 | $27,439.02 | $27,439.02 | $225,000.00 | |
| | Cost of Goods Sold | | $3,160.98 | $2,809.76 | $3,160.98 | $1,404.88 | $0.00 | $0.00 | $0.00 | $1,521.95 | $2,926.83 | $3,160.98 | $2,926.83 | $2,926.83 | $24,000.00 | |
| | Cost of Goods Sold as % | | 10.67% | 10.67% | 10.67% | 10.67% | 0.00% | 0.00% | 0.00% | 10.67% | 10.67% | 10.67% | 10.67% | 10.67% | 10.67% | |
| | Total Monthly Equipment Sales | | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $36,000.00 | |
| | Cost of Goods Sold | | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $21,600.00 | |
| | Cost of Goods Sold as % | | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | |
| | **Total Operating Revenue** | | $27,673.17 | $24,731.71 | $27,673.17 | $12,965.85 | $1,200.00 | $1,200.00 | $1,200.00 | $13,946.34 | $25,712.20 | $27,673.17 | $25,712.20 | $25,712.20 | $215,400.00 | |
| **Operating Expenses** | Wages (Salary Experienced Emp.) | | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $80,000.00 | |
| | Wages (Salary Assistant Emp.) | | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $60,000.00 | |
| | Wages (2 Emp. Hourly at $7.00/hr.) | | $1,475.12 | $1,311.22 | $1,475.12 | $655.61 | $0.00 | $0.00 | $0.00 | $710.24 | $1,365.85 | $1,475.12 | $1,365.85 | $1,365.85 | $11,200.00 | |
| | Vehicle Lease Payment (2 at $300/mo.) | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $7,200.00 | |
| | Vehicle Maintenance & Operation | 1.5% | $444.51 | $395.12 | $444.51 | $197.56 | $200.00 | $200.00 | $200.00 | $214.02 | $411.59 | $444.51 | $411.59 | $411.59 | $3,975.00 | |
| | ATV Maintenance & Operation | 0.35% | $103.72 | $92.20 | $103.72 | $46.10 | $0.00 | $0.00 | $0.00 | $49.94 | $96.04 | $103.72 | $96.04 | $96.04 | $787.50 | |
| | Office Supplies | 1% | $296.34 | $263.41 | $296.34 | $131.71 | $100.00 | $100.00 | $100.00 | $142.68 | $274.39 | $296.34 | $274.39 | $274.39 | $2,550.00 | |
| | Electricity | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $420.00 | |
| | Water | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $300.00 | |
| | Telephone | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $720.00 | |
| | Broadband Internet | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $900.00 | |
| | DTN | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $468.00 | |
| | Insurance | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $9,600.00 | |
| | Cellular Phones | 4 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $3,360.00 | |
| | Building & Land Payment | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $11,520.88 | |
| | **Total Operating Expenses** | | $16,860.43 | $16,602.69 | $16,860.43 | $15,571.72 | $14,840.74 | $14,840.74 | $14,840.74 | $15,657.63 | $16,688.61 | $16,860.43 | $16,688.61 | $16,688.61 | $193,001.38 | |
| **Depreciation Expenses** | Computers | $1,500.00 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $383.33 | |
| | AgView Software | $2,495.00 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $249.50 | |
| | Desks | $798.00 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $69.80 | |
| | Desk Chairs | $240.00 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $36.67 | |
| | Office Chairs | $200.00 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $30.00 | |
| | Kawasaki Mule | $9,999.00 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $1,142.71 | |
| | GPS | $2,500.00 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $625.00 | |
| | PDA | $500.00 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $500.00 | |
| | Concord Soil Sampler | $3,995.00 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $799.00 | |
| | Building Depreciation | $65,000.00 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $2,000.00 | |
| | **Total Depreciation Expenses** | | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $5,836.01 | |
| **Operating Profit (Loss) Pre-Tax** | | | $10,326.40 | $7,642.68 | $10,326.40 | ($3,092.20) | ($14,127.07) | ($14,127.07) | ($14,127.07) | ($2,197.62) | $8,537.26 | $10,326.40 | $8,537.26 | $8,537.26 | $16,562.61 | |
| | **Less Taxes** | | $552.09 | $552.09 | $552.09 | $552.09 | $552.09 | $552.09 | $552.09 | $552.09 | $552.09 | $552.09 | $552.09 | $552.09 | $6,625.04 | |
| **Operating Profit (Loss) Post-Tax** | | | $9,774.31 | $7,090.59 | $9,774.31 | ($3,644.28) | ($14,679.16) | ($14,679.16) | ($14,679.16) | ($2,749.71) | $7,985.17 | $9,774.31 | $7,985.17 | $7,985.17 | $9,937.57 | |
| | **Plus Depreciation Expense** | | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $5,836.01 | |
| **Net Cash Flow (NCF)** | | | $10,260.65 | $7,576.93 | $10,260.65 | ($3,157.95) | ($14,192.83) | ($14,192.83) | ($14,192.83) | ($2,263.38) | $8,471.50 | $10,260.65 | $8,471.50 | $8,471.50 | $15,773.58 | |

Table 3.4. Year 3 Monthly Cash-flow Analysis

| | | | January | February | March | April | May | June | July | August | September | October | November | December | Totals/Averages | # of Acres Serviced/Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of Days Open | | 27 | 24 | 27 | 25 | 27 | 26 | 26 | 27 | 25 | 27 | 25 | 25 | 311 | 40000 |
| | Number of Days Services Performed | | 27 | 24 | 27 | 12 | 0 | 0 | 0 | 13 | 25 | 27 | 25 | 25 | 205 | |
| **Operating Revenue** | Average Acres Serviced Per Month | | 5268 | 4683 | 5268 | 2341 | 0 | 0 | 0 | 2537 | 4878 | 5268 | 4878 | 4878 | 3333 | |
| | Average Acres Serviced Per Day | | 195 | 195 | 195 | 195 | 0 | 0 | 0 | 195 | 195 | 195 | 195 | 195 | 195 | |
| | Average Charge Per Acre | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | |
| | Total Monthly Sales | | $39,512.20 | $35,121.95 | $39,512.20 | $17,560.98 | $0.00 | $0.00 | $0.00 | $19,024.39 | $36,585.37 | $39,512.20 | $36,585.37 | $36,585.37 | $300,000.00 | |
| | Cost of Goods Sold | | $4,214.63 | $3,746.34 | $4,214.63 | $1,873.17 | $0.00 | $0.00 | $0.00 | $2,029.27 | $3,902.44 | $4,214.63 | $3,902.44 | $3,902.44 | $32,000.00 | |
| | Cost of Goods Sold as % | | 10.67% | 10.67% | 10.67% | 10.67% | 0.00% | 0.00% | 0.00% | 10.67% | 10.67% | 10.67% | 10.67% | 10.67% | 10.67% | |
| | Total Monthly Equipment Sales | | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $36,000.00 | |
| | Cost of Goods Sold | | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $21,600.00 | |
| | Cost of Goods Sold as % | | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | |
| | **Total Operating Revenue** | | $36,497.56 | $32,575.61 | $36,497.56 | $16,887.80 | $1,200.00 | $1,200.00 | $1,200.00 | $18,195.12 | $33,882.93 | $36,497.56 | $33,882.93 | $33,882.93 | $282,400.00 | |
| **Operating Expenses** | Wages (Salary Experienced Emp.) | | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $80,000.00 | |
| | Wages (Salary Assistant Emp.) | | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $60,000.00 | |
| | Wages (2 Emp. Hourly at $7.00/hr.) | | $1,966.83 | $1,748.29 | $1,966.83 | $874.15 | $0.00 | $0.00 | $0.00 | $946.99 | $1,821.14 | $1,966.83 | $1,821.14 | $1,821.14 | $14,933.33 | |
| | Vehicle Lease Payment (2 at $300/mo.) | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $7,200.00 | |
| | Vehicle Maintenance & Operation | 1.5% | $592.68 | $526.83 | $592.68 | $263.41 | $200.00 | $200.00 | $200.00 | $285.37 | $548.78 | $592.68 | $548.78 | $548.78 | $5,100.00 | |
| | ATV Maintenance & Operation | 0.35% | $138.29 | $122.93 | $138.29 | $61.46 | $0.00 | $0.00 | $0.00 | $66.59 | $128.05 | $138.29 | $128.05 | $128.05 | $1,050.00 | |
| | Office Supplies | 1% | $395.12 | $351.22 | $395.12 | $175.61 | $100.00 | $100.00 | $100.00 | $190.24 | $365.85 | $395.12 | $365.85 | $365.85 | $3,300.00 | |
| | Electricity | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $420.00 | |
| | Water | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $300.00 | |
| | Telephone | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $720.00 | |
| | Broadband Internet | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $900.00 | |
| | DTN | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $468.00 | |
| | Insurance | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $9,600.00 | |
| | Cellular Phones | 4 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $3,360.00 | |
| | Building & Land Payment | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $11,520.88 | |
| | **Total Operating Expenses** | | $17,633.67 | $17,290.01 | $17,633.67 | $15,915.37 | $14,840.74 | $14,840.74 | $14,840.74 | $16,029.93 | $17,404.56 | $17,633.67 | $17,404.56 | $17,404.56 | $198,872.21 | |
| **Depreciation Expenses** | Computers | $1,500.00 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $383.33 | |
| | AgView Software | $2,495.00 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $249.50 | |
| | Desks | $798.00 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $69.80 | |
| | Desk Chairs | $240.00 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $36.67 | |
| | Office Chairs | $200.00 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $30.00 | |
| | Kawasaki Mule | $9,999.00 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $1,142.71 | |
| | GPS | $2,500.00 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $625.00 | |
| | PDA | $500.00 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $500.00 | |
| | Concord Soil Sampler | $3,995.00 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $799.00 | |
| | Building Depreciation | $65,000.00 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $2,000.00 | |
| | **Total Depreciation Expenses** | | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $5,836.01 | |
| **Operating Profit (Loss) Pre-Tax** | | | $18,377.56 | $14,799.27 | $18,377.56 | $486.10 | ($14,127.07) | ($14,127.07) | ($14,127.07) | $1,678.86 | $15,992.03 | $18,377.56 | $15,992.03 | $15,992.03 | $77,691.78 | |
| | **Less Taxes** | | $2,589.73 | $2,589.73 | $2,589.73 | $2,589.73 | $2,589.73 | $2,589.73 | $2,589.73 | $2,589.73 | $2,589.73 | $2,589.73 | $2,589.73 | $2,589.73 | $31,076.71 | |
| **Operating Profit (Loss) Post-Tax** | | | $15,787.83 | $12,209.54 | $15,787.83 | ($2,103.63) | ($16,716.80) | ($16,716.80) | ($16,716.80) | ($910.87) | $13,402.31 | $15,787.83 | $13,402.31 | $13,402.31 | $46,615.07 | |
| | **Plus Depreciation Expense** | | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $5,836.01 | |
| **Net Cash Flow (NCF)** | | | $16,274.17 | $12,695.88 | $16,274.17 | ($1,617.29) | ($16,230.47) | ($16,230.47) | ($16,230.47) | ($424.53) | $13,888.64 | $16,274.17 | $13,888.64 | $13,888.64 | $52,451.08 | |

Table 3.5. Year 4 Monthly Cash-flow Analysis

| | | | January | February | March | April | May | June | July | August | September | October | November | December | Totals/Averages | # of Acres Serviced/Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of Days Open | | 27 | 24 | 27 | 25 | 27 | 26 | 26 | 27 | 25 | 27 | 25 | 25 | 311 | 50000 |
| | Number of Days Services Performed | | 27 | 24 | 27 | 12 | 0 | 0 | 0 | 13 | 25 | 27 | 25 | 25 | 205 | |
| **Operating Revenue** | Average Acres Serviced Per Month | | 6585 | 5854 | 6585 | 2927 | 0 | 0 | 0 | 3171 | 6098 | 6585 | 6098 | 6098 | 4167 | |
| | Average Acres Serviced Per Day | | 244 | 244 | 244 | 244 | 0 | 0 | 0 | 244 | 244 | 244 | 244 | 244 | 244 | |
| | Average Charge Per Acre | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | |
| | Total Monthly Sales | | $49,390.24 | $43,902.44 | $49,390.24 | $21,951.22 | $0.00 | $0.00 | $0.00 | $23,780.49 | $45,731.71 | $49,390.24 | $45,731.71 | $45,731.71 | $375,000.00 | |
| | Cost of Goods Sold | | $5,268.29 | $4,682.93 | $5,268.29 | $2,341.46 | $0.00 | $0.00 | $0.00 | $2,536.59 | $4,878.05 | $5,268.29 | $4,878.05 | $4,878.05 | $40,000.00 | |
| | Cost of Goods Sold as % | | 10.67% | 10.67% | 10.67% | 10.67% | 0.00% | 0.00% | 0.00% | 10.67% | 10.67% | 10.67% | 10.67% | 10.67% | 10.67% | |
| | Total Monthly Equipment Sales | | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $36,000.00 | |
| | Cost of Goods Sold | | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $21,600.00 | |
| | Cost of Goods Sold as % | | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | |
| | **Total Operating Revenue** | | $45,321.95 | $40,419.51 | $45,321.95 | $20,809.76 | $1,200.00 | $1,200.00 | $1,200.00 | $22,443.90 | $42,053.66 | $45,321.95 | $42,053.66 | $42,053.66 | $349,400.00 | |
| **Operating Expenses** | Wages (Salary Experienced Emp.) | | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $80,000.00 | |
| | Wages (Salary Assistant Emp.) | | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $60,000.00 | |
| | Wages (2 Emp. Hourly at $7.00/hr.) | | $2,458.54 | $2,185.37 | $2,458.54 | $1,092.68 | $0.00 | $0.00 | $0.00 | $1,183.74 | $2,276.42 | $2,458.54 | $2,276.42 | $2,276.42 | $18,666.67 | |
| | Vehicle Lease Payment (2 at $300/mo.) | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $7,200.00 | |
| | Vehicle Maintenance & Operation | 1.5% | $740.85 | $658.54 | $740.85 | $329.27 | $200.00 | $200.00 | $200.00 | $356.71 | $685.98 | $740.85 | $685.98 | $685.98 | $6,225.00 | |
| | ATV Maintenance & Operation | 0.35% | $172.87 | $153.66 | $172.87 | $76.83 | $0.00 | $0.00 | $0.00 | $83.23 | $160.06 | $172.87 | $160.06 | $160.06 | $1,312.50 | |
| | Office Supplies | 1% | $493.90 | $439.02 | $493.90 | $219.51 | $100.00 | $100.00 | $100.00 | $237.80 | $457.32 | $493.90 | $457.32 | $457.32 | $4,050.00 | |
| | Electricity | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $420.00 | |
| | Water | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $300.00 | |
| | Telephone | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $720.00 | |
| | Broadband Internet | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $900.00 | |
| | DTN | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $468.00 | |
| | Insurance | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $9,600.00 | |
| | Cellular Phones | 4 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $3,360.00 | |
| | Building & Land Payment | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $11,520.88 | |
| | **Total Operating Expenses** | | $18,406.90 | $17,977.33 | $18,406.90 | $16,259.03 | $14,840.74 | $14,840.74 | $14,840.74 | $16,402.22 | $18,120.52 | $18,406.90 | $18,120.52 | $18,120.52 | $204,743.04 | |
| **Depreciation Expenses** | Computers | $1,500.00 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $383.33 | |
| | AgView Software | $2,495.00 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $249.50 | |
| | Desks | $798.00 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $69.80 | |
| | Desk Chairs | $240.00 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $36.67 | |
| | Office Chairs | $200.00 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $30.00 | |
| | Kawasaki Mule | $9,999.00 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $1,142.71 | |
| | GPS | $2,500.00 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $625.00 | |
| | PDA | $500.00 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $500.00 | |
| | Concord Soil Sampler | $3,995.00 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $799.00 | |
| | Building Depreciation | $65,000.00 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $2,000.00 | |
| | **Total Depreciation Expenses** | | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $5,836.01 | |
| **Operating Profit (Loss) Pre-Tax** | | | $26,428.72 | $21,955.85 | $26,428.72 | $4,064.39 | ($14,127.07) | ($14,127.07) | ($14,127.07) | $5,555.34 | $23,446.81 | $26,428.72 | $23,446.81 | $23,446.81 | $138,820.94 | |
| | **Less Taxes** | | $4,627.36 | $4,627.36 | $4,627.36 | $4,627.36 | $4,627.36 | $4,627.36 | $4,627.36 | $4,627.36 | $4,627.36 | $4,627.36 | $4,627.36 | $4,627.36 | $55,528.38 | |
| **Operating Profit (Loss) Post-Tax** | | | $21,801.35 | $17,328.49 | $21,801.35 | ($562.98) | ($18,754.44) | ($18,754.44) | ($18,754.44) | $927.98 | $18,819.44 | $21,801.35 | $18,819.44 | $18,819.44 | $83,292.57 | |
| | **Plus Depreciation Expense** | | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $5,836.01 | |
| **Net Cash Flow (NCF)** | | | $22,287.69 | $17,814.82 | $22,287.69 | ($76.64) | ($18,268.10) | ($18,268.10) | ($18,268.10) | $1,414.31 | $19,305.78 | $22,287.69 | $19,305.78 | $19,305.78 | $89,128.58 | |

Table 3.6. Year 5 Monthly Cash-flow Analysis

| | | | January | February | March | April | May | June | July | August | September | October | November | December | Totals/Averages | # of Acres Serviced/Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of Days Open | | 27 | 24 | 27 | 25 | 27 | 26 | 26 | 27 | 25 | 27 | 25 | 25 | 311 | 55000 |
| | Number of Days Services Performed | | 27 | 24 | 27 | 12 | 0 | 0 | 0 | 13 | 25 | 27 | 25 | 25 | 205 | |
| **Operating Revenue** | Average Acres Serviced Per Month | | 7244 | 6439 | 7244 | 3220 | 0 | 0 | 0 | 3488 | 6707 | 7244 | 6707 | 6707 | 4583 | |
| | Average Acres Serviced Per Day | | 268 | 268 | 268 | 268 | 0 | 0 | 0 | 268 | 268 | 268 | 268 | 268 | 268 | |
| | Average Charge Per Acre | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | $7.50 | |
| | Total Monthly Sales | | $54,329.27 | $48,292.68 | $54,329.27 | $24,146.34 | $0.00 | $0.00 | $0.00 | $26,158.54 | $50,304.88 | $54,329.27 | $50,304.88 | $50,304.88 | $412,500.00 | |
| | Cost of Goods Sold | | $5,795.12 | $5,151.22 | $5,795.12 | $2,575.61 | $0.00 | $0.00 | $0.00 | $2,790.24 | $5,365.85 | $5,795.12 | $5,365.85 | $5,365.85 | $44,000.00 | |
| | Cost of Goods Sold as % | | 10.67% | 10.67% | 10.67% | 10.67% | 0.00% | 0.00% | 0.00% | 10.67% | 10.67% | 10.67% | 10.67% | 10.67% | 10.67% | |
| | Total Monthly Equipment Sales | | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $3,000.00 | $36,000.00 | |
| | Cost of Goods Sold | | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $1,800.00 | $21,600.00 | |
| | Cost of Goods Sold as % | | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | 60% | |
| | **Total Operating Revenue** | | $49,734.15 | $44,341.46 | $49,734.15 | $22,770.73 | $1,200.00 | $1,200.00 | $1,200.00 | $24,568.29 | $46,139.02 | $49,734.15 | $46,139.02 | $46,139.02 | $382,900.00 | |
| **Operating Expenses** | Wages (Salary Experienced Emp.) | | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $6,666.67 | $80,000.00 | |
| | Wages (Salary Assistant Emp.) | | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $5,000.00 | $60,000.00 | |
| | Wages (2 Emp. Hourly at $7.00/hr.) | | $2,704.39 | $2,403.90 | $2,704.39 | $1,201.95 | $0.00 | $0.00 | $0.00 | $1,302.11 | $2,504.07 | $2,704.39 | $2,504.07 | $2,504.07 | $20,533.33 | |
| | Vehicle Lease Payment (2 at $300/mo.) | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $600.00 | $7,200.00 | |
| | Vehicle Maintenance & Operation | 1.5% | $814.94 | $724.39 | $814.94 | $362.20 | $200.00 | $200.00 | $200.00 | $392.38 | $754.57 | $814.94 | $754.57 | $754.57 | $6,787.50 | |
| | ATV Maintenance & Operation | 0.35% | $190.15 | $169.02 | $190.15 | $84.51 | $0.00 | $0.00 | $0.00 | $91.55 | $176.07 | $190.15 | $176.07 | $176.07 | $1,443.75 | |
| | Office Supplies | 1% | $543.29 | $482.93 | $543.29 | $241.46 | $100.00 | $100.00 | $100.00 | $261.59 | $503.05 | $543.29 | $503.05 | $503.05 | $4,425.00 | |
| | Electricity | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $35.00 | $420.00 | |
| | Water | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $25.00 | $300.00 | |
| | Telephone | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $60.00 | $720.00 | |
| | Broadband Internet | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $75.00 | $900.00 | |
| | DTN | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $39.00 | $468.00 | |
| | Insurance | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $800.00 | $9,600.00 | |
| | Cellular Phones | 4 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $280.00 | $3,360.00 | |
| | Building & Land Payment | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $960.07 | $11,520.88 | |
| | **Total Operating Expenses** | | $18,793.51 | $18,320.98 | $18,793.51 | $16,430.86 | $14,840.74 | $14,840.74 | $14,840.74 | $16,588.37 | $18,478.49 | $18,793.51 | $18,478.49 | $18,478.49 | $207,678.46 | |
| **Depreciation Expenses** | Computers | $1,500.00 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $31.94 | $383.33 | |
| | AgView Software | $2,495.00 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $20.79 | $249.50 | |
| | Desks | $798.00 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $5.82 | $69.80 | |
| | Desk Chairs | $240.00 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $3.06 | $36.67 | |
| | Office Chairs | $200.00 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $2.50 | $30.00 | |
| | Kawasaki Mule | $9,999.00 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $95.23 | $1,142.71 | |
| | GPS | $2,500.00 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $52.08 | $625.00 | |
| | PDA | $500.00 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $41.67 | $500.00 | |
| | Concord Soil Sampler | $3,995.00 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $66.58 | $799.00 | |
| | Building Depreciation | $65,000.00 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $166.67 | $2,000.00 | |
| | **Total Depreciation Expenses** | | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $5,836.01 | |
| **Operating Profit (Loss) Pre-Tax** | | | $30,454.30 | $25,534.15 | $30,454.30 | $5,853.54 | ($14,127.07) | ($14,127.07) | ($14,127.07) | $7,493.59 | $27,174.20 | $30,454.30 | $27,174.20 | $27,174.20 | $169,385.53 | |
| | **Less Taxes** | | $5,646.18 | $5,646.18 | $5,646.18 | $5,646.18 | $5,646.18 | $5,646.18 | $5,646.18 | $5,646.18 | $5,646.18 | $5,646.18 | $5,646.18 | $5,646.18 | $67,754.21 | |
| **Operating Profit (Loss) Post-Tax** | | | $24,808.11 | $19,887.96 | $24,808.11 | $207.35 | ($19,773.26) | ($19,773.26) | ($19,773.26) | $1,847.40 | $21,528.01 | $24,808.11 | $21,528.01 | $21,528.01 | $101,631.32 | |
| | **Plus Depreciation Expense** | | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $486.33 | $5,836.01 | |
| **Net Cash Flow (NCF)** | | | $25,294.45 | $20,374.30 | $25,294.45 | $693.69 | ($19,286.92) | ($19,286.92) | ($19,286.92) | $2,333.74 | $22,014.35 | $25,294.45 | $22,014.35 | $22,014.35 | $107,467.33 | |

The payback period is the amount of time that it takes for a firm to recoup its initial capital outlay. Given the assumed revenue stream and acres serviced per year, it is determined that the payback period for a firm of this nature would be 3 years (table 3.7). This is found by dividing the net investment by the average annual net cash flow. Three years is a reasonable amount of time to recoup an investment of $139,725.00.

Table 3.7. Feasibility Decision Factors

| | | | | |
|---|---|---|---|---|
| Net Investment | | $139,725.00 | | |
| Payback | | 3.07 | | |
| Cost of Capital | | 5.50% | | |
| | | | ***NCF*** | ***DNCF*** |
| Net Present Value Calculation | Year 0 | | ($139,725.00) | ($139,725.00) |
| | Year 1 | | ($38,357.67) | ($36,357.98) |
| | Year 2 | | $15,997.31 | $14,372.82 |
| | Year 3 (Plus comp. salvage value of $350.00) | | $53,024.81 | $45,156.65 |
| | Year 4 | | $89,352.31 | $72,126.68 |
| | Year 5 | | $107,691.06 | $82,398.13 |
| NPV | | $37,971.29 | | |
| Benefit Cost Ratio | | 1.27 | | |
| Internal Rate of Return | | 11.04% | | |

In order to determine the net present value, recall that the cost of capital is 5.5%. This is used in calculating the discounted net cash flow for each individual year (table 3.7), and the formula that is used is NCF of n year/(1+0.55)^n$^{th}$ year. After discounted net cash flows are found for the five years of operation, they are then summed to find the net present value. In this case the net present value after five years of operation was $37,971.29. Accordingly, because the net present value is above zero, this is a worthwhile business venture.

The benefit cost ratio, also known as the profitability index, is found by adding the discounted net cash flows for the five years and then dividing by the net investment of $139,725.00. This provides the measure of dollar benefit per dollar of cost and in this case the benefit cost ratio is 1.27. The decision factor in this case is to go ahead with the project if the benefit cost ratio is greater than 1.

The last measure used to determine the feasibility of this project is the internal rate of return (IRR) and the IRR is the interest that would be required to make the net present value equivalent to zero. The difference between the internal rate of return and the other three measures is that there is no specific formula to find the internal rate of return. Rather, it is a process of trial and error in determining what interest rate capital would have to be borrowed in order to make the net present value equal to the net investment. However, Microsoft Excel has a function that automatically determines the internal rate of return, this function is found under the insert tab. After clicking on insert go to function, then financial, then IRR. After clicking on IRR, highlight the cells in which the internal rate of return is to be found. This provides the IRR without having a trial and error process. For this precision farming firm the IRR was found to be 11%. Since the cost of capital is assumed to be 5.5% and the internal rate of return is 11%, this is a project that should be undertaken.

**3.7 Model Sensitivity Analysis**

Table 3.8 was constructed to show the impacts that occur to net present value and the internal rate of return when the cost of capital is varied. Six different scenarios were conducted with the cost of capital ranging from 4.5% to 8.5%. The interest rates of 4.5% and 8.5% were chosen as the low and high limits because in reality it is not expected that a financial institution would make a loan to a business at an interest rate less than 4.5% and a business owner would probably not borrow at an interest rate in excess of 8.5%.

In looking at the sensitivity analysis it appears that the model is sensitive to changes in the cost of capital. The variance in NPV and IRR is large as shown in Table 3.8. This high level of sensitivity is most likely due to the fact that the varying cost of capital affects two important aspects of the business model, the monthly payments on the borrowed amount to purchase the land and construct the building and the formula used to determine the net present value.

Table 3.8  Impacts of Varying the Cost of Capital on Model NPV and IRR

| Cost of Capital | Net Present Value | Internal Rate of Return |
|---|---|---|
| 4.50% | $47,116.80 | 11.20% |
| 5.50% | $36,872.54 | 10.88% |
| 6.50% | $27,059.17 | 10.55% |
| 7.50% | $17,654.18 | 10.21% |
| 8.50% | $8,636.74 | 9.86% |

In Table 3.9 the price per acre that is charged to provide the precision farming services is varied from $6.50 to $9.00 an acre.  This price includes soil grid sampling, field mapping, database construction, and prescription recommendations.  In recognizing that very few items or services are completely inelastic and not having any past research to cite, a constant price elasticity of demand of .5 was assumed to be reasonable for this model.  This means that with a 1% change in price there is a .5% change in demand. The model is highly responsive to changes in the price for services.  As one can see, varying the price from $6.50 to $9.00 results in a dramatic difference in the net present value and the internal rate of return.  In addition, these price differentials are very realistic given the fact that most businesses of this nature are charging between $7.00 and $8.00.  As seen in table 3.9, with each $.50 increase in price the net present value and the internal rate of return over a 5 year period are increasing at a significant rate.

Table 3.9  Impacts of Varying the Price Per Acre on Model NPV and IRR

| Price Per Acre | Net Present Value | Internal Rate of Return |
|---|---|---|
| $6.50 | ($30,985.36) | 0.79% |
| $7.00 | $6,538.77 | 6.47% |
| $7.50 | $36,872.54 | 10.88% |
| $8.00 | $63,634.90 | 14.65% |
| $8.50 | $90,546.35 | 18.36% |
| $9.00 | $110,420.96 | 21.05% |

.

Table 3.10 was developed to analyze the results of varying annual acreage percentage increases.  These annual acreage percentage increases range from 20% annual increases to 50% annual increases.  Earlier in this chapter it is stated that in the first year of operation the precision farming firm would expect to service 20,000 acres of cropland. Given this information the annual acreage increases start with the 20,000 acres that were assumed in earlier part of this chapter. From a percentage standpoint these annual increases seem to be very ambitious, however when recognizing the increases in the number of acres serviced they are not as overwhelming. For instance, a 50% increase seems very ambitious but stating it as an increase of 10,000 acres seems like a very attainable goal with a sales force of two individuals as assumed earlier in the chapter as well.

As seen in table 3.10 the annual acreage percentage increases must be kept above 30% for the precision farming firm to have a positive net present value. As mentioned above, with the sales force of two individuals, great customer service, and word of mouth it should be possible to expand the number of acres serviced by these amounts.

Table 3.10 Impacts of Varying Annual Percentage Acreage Increases on Model NPV and IRR

| Annual Acreage Percentage Increase | Net Present Value | Internal Rate of Return |
|---|---|---|
| 20% | ($108,788.08) | -14.34% |
| 30% | ($10,496.21) | 3.97% |
| 40% | $103,498.82 | 18.18% |
| 50% | $234,094.16 | 30.10% |

### 3.8 Chapter Conclusion

The global positioning system has introduced a new approach in precision agriculture in the last decade. Farmers, as always, have been skeptical about the adoption of precision farming, specifically site-specific management. However, with continued research and beneficial results, a positive sign exist for the increased level of adoption of precision farming, thus introducing a greater market for custom-hire precision farming firms given the appropriate marketing and promotion strategies.

The high levels of corn production and acreage in the Purchase and Mid-western regions of Kentucky indicate a potential market suitable for the services offered by a precision farming firm. A firm centrally located in these regions would be likely to survive.

In constructing a business model of projected revenue for 5 years the results indicate that a precision farming firm could operate successfully, however the sensitivity to changing economic conditions cast uncertainty. With a payback period of 3 years, a net present value of $37,971, a benefit cost ratio of 1.27, and an internal rate of return of

11%, and in looking at the sensitivity analyses, if the firm is able to borrow money at an interest rate less than 9.5%, keep their pricing at $7.00 an acre or greater and motivate their sales force to expand the number of acres serviced annually at a level of greater than 30% then this business venture seems to be highly feasible and a great opportunity for someone interested in this field of agriculture.

# CHAPTER FOUR
# Purpose of Survey and Survey Results

## 4.1 Focus of Chapter

The first part of this chapter focuses on introducing a survey that was conducted in the autumn months of 2004, the ideology behind this survey, the methods that were used to conduct it, and the means by which the information obtained from the surveys was used to provide meaningful answers about precision farming. The second part of this chapter reveals the results of the survey and attempts to answer questions about farmer's perceptions of precision farming, current adoption trends, and other related issues. The questions were posed in this survey to field basic demographic data about farmers, their knowledge of precision farming, their adoption rates for different precision farming techniques, their motivation for employing precision farming techniques, information about businesses that provide these precision farming services, their views about these businesses, and future plans with respect to employing precision farming techniques.

The information collected from the surveys was used to determine the average age of respondents, the percentage of farmers currently employing precision farming techniques, what the average age is of farmers who are using precision farming, etc. Using the information from the surveys it was also possible to draw parallels between adoption rates of precision farming techniques and different aspects about the farmers such as age, farm size, and farm income.

## 4.2 Ideology and Methods Behind the Survey

In seeking credible information related to precision farming from surrounding states two papers by Hite and Hudson and by Intarapapong, Hite, and Hudson again provided base information. A questionnaire was constructed similar to the one employed by Hudson and Hite (Figure 4.1). After designing the questionnaire, 336 farmers in Western and Central Kentucky were identified using Kentucky Farm Business Analysis personnel. These farmers were chosen because they were all located in areas of Kentucky that produce most of the states grain crops and all were members. Local farm analysis specialists mailed questionnaires to the farmers and followed up if a response was not received.

A response time of two months was permitted. The surveys were sent out in early October and this is a period of time when many grain farmers are extremely busy harvesting their crops. Farmers thus had a sufficient time period to complete the survey and return them. At the end of the two month time period 66 surveys had been returned, a 20 percent response rate. The population was limited to farmers who were grain crop producers, and 59 of the 66 completed surveys were valid. Seven of the survey respondents were outside of the population limits because they no longer farmed or did not produce grain crops. A spreadsheet document was then developed in Microsoft Excel that allowed a transfer of all of the responses to the surveys to one spreadsheet.

Figure 4.1 Producer Survey Mailed to 336 Farmers in Western and Central Kentucky

UK UNIVERSITY OF KENTUCKY
College of Agriculture

*Department of Agricultural Economics*

**The Department of Agricultural Economics at the University of Kentucky is conducting research relating to the producer adoption of "precision farming" technology and the feasibility of operating a precision farming firm in Kentucky. In order to assess these topics we need your assistance. Please take a few minutes to provide answers to the questions below. Your *voluntary* and *confidential* responses will aid us in conducting this research that may be beneficial to you in the future.**

Name ***(Optional)***_____________________________________

County__________________________________________

1. Age______

2. Educational Background ***Please check the most appropriate response:*** Some High School____
High School Diploma____ Some College____ Bachelors Degree____
Some Graduate School____ Graduate Degree____

3. Number of acres farmed: ______

4. Number of acres farmed that is owned: ______

5. Number of acres farmed that is rented: ______

6. Number of acres of cropland that is put into no-till: ______

7. Average 5 year Net farm income for last 5 years ***(see financial trends sheet from farm analysis reports***
_________________________

8. Net off-farm income for 2003: ______

9. Are you familiar with the concept of precision farming? ***Please check the appropriate response, if no then proceed to question 12***
Yes____ No____

10. When and how did you become familiar with this concept? ***Please explain in the following area***

11. What do you think the merit(s) of Precision Farming is(are)? ***Please explain in the following area***

12. Are you familiar with the following techniques of precision farming? ***Please answer Yes or No***

    GPS______
    Yield monitor______
    Grid Soil Sampling______
    Variable Rate Fertilizer______
    Variable Rate Pesticides______
    Variable Rate Seeding______
    Other ***(please describe)***______________________________________________________

13. Are you currently employing any of the following concepts of precision farming? ***Please answer Yes or No***

    Yield monitor with GPS______
    Yield monitor without GPS______
    Grid Soil Sampling______
    Variable Rate Fertilizer______
    Variable Rate Pesticides______
    Variable Rate Seeding______
    Other ***(please describe)***__________________________________________________

14. If you are employing any of the above techniques how long have you been doing so? ***Please indicate with number of years or months***

    Yield monitor with GPS______
    Yield monitor without GPS______
    Grid Soil Sampling______
    Variable Rate Fertilizer______
    Variable Rate Pesticides______
    Variable Rate Seeding______
    Other ***please identify technique***______

15. If you are employing any of the above techniques what is your main motivation for doing so? ***1 being very motivational and 5 being least motivational. Please rank in order of motivation, if any of the following is not a motivation do not rank. Increasing profit options can be weighted equally or one of the two concepts may be more motivating to you.***

    Increasing Profit through increased output____
    Increasing Profit through decreased input costs____
    Environmental benefits____
    Attempting to make the soil within fields more uniform by varying application rates____
    Other ***please identify technique***____

16. Do you feel that your motivation for employing the following techniques has been satisfied? ***Yes, No, Unsure***

Yield monitor with GPS______
Yield monitor without GPS______
Grid Soil Sampling______
Variable Rate Fertilizer______
Variable Rate Pesticides______
Variable Rate Seeding______
Other ***please identify technique*** ______

17. How do you determine if your motivation for employing precision farming techniques has been satisfied (i.e. higher yields than previous years, lower input costs than previous years, etc.)? ***Please explain in the following area***

18. How many production input providers are located in your trade area?______

19. Who is your main production input provider?________________________________

20. Do they offer any of the following services? ***Yes, no, unsure***

Grid Soil Sampling______
Variable Rate Fertilizer______
Variable Rate Pesticides______
Field Map Construction______
Variable Rate Prescriptions______
Other ***please identify technique*** ______

21. How long have they been offering these services? ***# of years***

Grid Soil Sampling______
Variable Rate Fertilizer______
Variable Rate Pesticides______
Field Map Construction______
Variable Rate Prescriptions______
Other ***please identify technique*** ______

22. Do you utilize any of their services and which? ***Yes or no***

Grid Soil Sampling______
Variable Rate Fertilizer______
Variable Rate Pesticides______
Field Map Construction______
Variable Rate Prescriptions______
Other ***please identify technique*** _______

23. What is your reason for utilizing these services? ***Please explain in the provided areas***

Grid Soil Sampling________________________________________________________
Variable Rate Fertilizer_____________________________________________________
Variable Rate Pesticides____________________________________________________
Field Map Construction_____________________________________________________
Variable Rate Prescriptions__________________________________________________
Other ***please identify technique***_____________________________________________________

24. What is the price for utilizing the following services from your input provider? ***Approximate dollar amounts per unit, i.e. per acre, per map, etc., please indicate unit***

Grid Soil Sampling__________
Variable Rate Fertilizer__________
Variable Rate Pesticides__________
Field Map Construction__________
Variable Rate Prescriptions__________
Other ***please identify technique*** ___________

25. Do you feel like these services are underpriced, overpriced, or reasonable? ***Please indicate in the provided area***

Grid Soil Sampling__________
Variable Rate Fertilizer__________
Variable Rate Pesticides__________
Field Map Construction__________
Variable Rate Prescriptions__________
Other ***please identify technique*** ___________

26. If you do not utilize your input providers services what are the main reasons:

Grid Soil Sampling________________________________________________________
Variable Rate Fertilizer_____________________________________________________
Variable Rate Pesticides____________________________________________________
Field Map Construction_____________________________________________________
Variable Rate Prescriptions__________________________________________________
Other ***please identify technique*** ____________________________________________________

27. Are there any businesses in your county that offer only precision farming services and do not sell inputs such as fertilizers, chemicals, seeds, etc. and how long have they been in business? ***If yes, please list in the provided area***

28. Are you aware of any precision farming firms that have opened but are currently out of business? **Yes or no**

29. If you are not employing any of the following, what is your reasoning? ***Please answer in the provided area***

    Yield monitor with GPS______________________________________________________
    Yield monitor without GPS___________________________________________________
    Grid Soil Sampling__________________________________________________________
    Variable Rate Fertilizer______________________________________________________
    Variable Rate Pesticides_____________________________________________________
    Variable Rate Seeding________________________________________________________
    Other please identify technique_______________________________________________

30. If you are not employing any of the following do you intend to do so in the future? ***Yes or no***

    Yield monitor with GPS______
    Yield monitor without GPS______
    Grid Soil Sampling______
    Variable Rate Fertilizer______
    Variable Rate Pesticides______
    Variable Rate Seeding______
    Other ***please identify technique***_____________________________

31. If you do plan to employ any of the following in the future what is the reasoning: (i.e., other farmers success, decreasing costs, etc.) ***Please explain in provided area***

    Yield monitor with GPS______________________________________________________
    Yield monitor without GPS___________________________________________________
    Grid Soil Sampling__________________________________________________________
    Variable Rate Fertilizer______________________________________________________
    Variable Rate Pesticides_____________________________________________________
    Variable Rate Seeding________________________________________________________
    Other ***please identify technique***__________________________________________________

### 4.3 Results of the Survey

### 4.3.1 Basic Demographics of the Respondents

The first part of the survey focused on basic demographics of the respondent. Name and County of the respondent were asked but were not used in any part of the research as few people who responded chose to reply to these questions. Age, educational background, number of acres farmed, average five year net farm income were all questions that were asked whose responses were used in the research.

**Age**

Fifty-eight farmers chose to include their age on this survey. The age groups were divided into four subsections as seen in Table 4.2. Thirteen farmers were 30 to 45 years old, 16 farmers were 46 to 52 years old, 16 farmers were 53 to 60 years old, and 13 farmers were over 60 years old.

**Educational Background**

When asked about their educational background 57 survey respondents chose to answer. As seen in Table 4.4, 15 of the respondents attended high school, 16 had attended college receiving no degree, 21 received a bachelors degree, and 5 earned graduate degrees.

**Farm Size**

Fifty-nine farmers replied with their farm size with the average farm size being approximately 1,967 acres with the average farmer owning 722 acres and renting 1,245 acres. Table 4.7 shows the four farm size groups that were formed. Fifteen farmers farm up to 700 acres, 15 farm 701 to 1,500 acres, 18 farm 1,501 to 3,000 acres, and 11 farm over 3,000 acres.

**Net Farm Income**

Only 33 of the farmers replied to the net farm income question. Again, net farm income was divided into four groups as shown in Table 4.10. As indicated in Table 4.10, 8 farmers had a 5 year average net farm income up to $35,000, 8 farmers were in the $35,001 to $75,000 group, 9 were in the $75,001 to $140,000 group, and 8 farmers had income greater than $140,000.

### 4.3.2 Knowledge and Thoughts about Precision Farming

It was important to determine farmer's knowledge and thoughts about precision farming because understanding what farmers were thinking about precision farming would be important in trying to determine the feasibility of opening and operating a precision farming firm. If a great deal of farmers did not understand what precision farming was then education about the aspects of precision farming would be important because it would not make sense to offer farmers a service of which they did not understand. Likewise, if farmers did understand the concept of precision farming but did not believe that it contributed any good merits to farming then it would be pointless to offer these services to them and expect them to pay for the services.

When asked about their familiarity with precision farming 59 farmers responded and 48 (81.36%) were familiar with the concept of precision farming. Most commonly, farmers indicated that they became familiar with the concept of precision farming from fellow farmers, extension agents, magazine publications, and representatives from farm related outlets. Many farmers believe that precision farming has good merits. 38 (64.4%) of the farmers consistently stated that the most common merits were decreased input costs, increased output, and more efficient uses of inputs across the entire field. Many believed that problem areas of fields such as drainage issues and bad soil types could be pinpointed using precision farming techniques and appropriate measures could be taken to fix these issues. Some interesting quotes about the merits of precision farming from farmers are “Makes me more aware of my management strengths and weaknesses”, “Theoretically to improve or maintain production while lowering input costs and to get the most efficient production out of every acre”, “Trying to make the most of every acre”, and “Efficient, efficient, efficient.” Although, the majority of farmers believed that precision farming has good merits a few farmers, as can be expected, were skeptical about the positive aspects of employing these techniques on their farms. 4 (6.8%) of the farmers made note on the surveys they did not think that the benefit of employing precision farming practices outweighed the associated costs. One farmer was quoted “I spent a lot of money for something that had no proven benefits. I made a lot of pretty colored maps that showed me things I could not do anything about. The only benefits is that it made landlords or possible landlords think the farmer was really doing great things and that he was on the cutting edge. It is mostly a load of crap to sell products based on junk science” while another farmer was quoted “All trials I have seen it does not pay.”

17 (28.8%) of the farmers were either unsure of the merits of precision farming or did not respond to this question.

58 (98.31%) farmers responded when they were asked if they were familiar with the following techniques of precision farming: GPS, Yield Monitor, Grid Soil Sampling, Variable Rate Fertilizer, Variable Rate Pesticides, and Variable Rate Seeding. 52 (89.66%) farmers indicated that they were familiar with both GPS and yield monitor. It was a bit confusing at first when a higher percentage of farmers were familiar with these two techniques of precision farming than they were with the general term precision farming, but this seems to be an indicator that farmers may need to be more educated on what precision farming is before they will embrace the techniques associated with precision farming. 48 (82.76%) farmers were familiar with grid soil sampling and 47 (81.03%) were familiar with variable rate fertilizer. 38 (65.52%) of those responding to this question were familiar with variable rate pesticides and 47 (81.03%) were familiar with variable rate seeding. It was not surprising that variable rate pesticides was the least known technique of precision farming given the fact that most farm service providers did not offer this service, found it to be the least feasible of all the services to provide to farmers, and indicated that variable rate pesticides was one of the newest techniques associated with precision farming.

### 4.3.3 Employment of Precision Farming

In opening any business it is important to target customers and know what percentage of potential customers are already utilizing the services that you will offer and what percentage of customers will be new and open to the idea. The purpose of the following section of the survey was to determine what number of the farmers responding to the survey were currently employing precision farming techniques, how long they have been doing so, their motivation for doing so, and if their motivation has been satisfied and how they can determine that.

Of the 59 farmers completing the survey, 34 (57.63%) were currently employing one or more forms of precision farming. A yield monitor, either with or without GPS, was the most commonly used technique related to precision farming. 32 (54.2%) farmers were using a yield monitor, 15 (25.42%) were using a yield monitor that was equipped with GPS and 17 (28.81%) were using a yield monitor only. This number was not surprising given the increased amount of newer combines that have been equipped with yield monitors from the factories. 18 (30.51%) farmers were using grid soil sampling and 11 (18.64%) were employing variable rate fertilizer application. One would expect that the number of farmers using these two services would be closer to the same, however the difference can be justified by farmers who are using the results from the grid soil sampling for variable rate lime application. Only 6 (10.17%) farmers were using variable rate seeding and 3 (5.08%) farmers were using variable rate pesticide application.

On average, with 15 people responding, the average farmer using a yield monitor with GPS has been doing so for 6.6 years and the average farmer employing a yield monitor without GPS has been doing so for 5.3 years. Grid soil sampling, for those choosing to use grid soil sampling, has been used for 4.66 years and variable rate fertilizer has been used for an average of 5.2 years. The average farmer who has been utilizing variable rate pesticides has been doing so for 7 years and variable rate seeding has been used, on average, 6.2 years.

When farmers were asked to rank their motivation for employing precision farming techniques they were given five options that they could rank from 1, being very motivational, to 5, being the least motivational. The five options were: increasing profit through increased output, increasing profit through decreased input costs, environmental benefits, attempting to make soil within fields more uniform by varying application rates, and other. 24 farmers ranked increasing profit through increased output with an average ranking of 1.375, 25 farmers ranked increasing profit through decreased input costs with an average ranking of 1.36, 20 farmers ranked environmental benefits with an average ranking of 2.55, and 22 farmers ranked attempting to make soil within fields more uniform by varying application rates with an average ranking of 2.455. No farmers chose to rank other as a motivational factor. Thus increasing profit through decreased input costs was ranked as the most motivational factor followed by increasing profit through increased output, attempting to make soil within fields more uniform by varying application rates, and environmental benefits, respectively. These results were in-line with what I had predicted they would be before the surveys were mailed out. Farmers, like most business owners, are highly focused on profit maximization and this is achieved by either reducing input costs or increasing output. As a result of employing some precision farming techniques, especially variable rate applications of fertilizer, lime, and pesticides, making soil within fields more uniform is a possible side benefit and is a good explanation of why the uniformity factor ranked third. It makes sense that environmental benefits ranked last because most farmers would not incur the hefty expense of precision farming solely for the purpose of improving the environment, especially if they were not required to by federal, state, or local regulations.

When the farmers were asked if their motivation for employing specific precision farming techniques was satisfied the results for each technique provided a positive outlook. Of the 14 farmers that responded in regards to yield monitor with GPS, 12 (85.71%) were satisfied, 1 (7.14%) were not satisfied, and 1 (7.14%) were unsure if their motivation had been satisfied. 14 farmers also replied to using yield monitor without GPS and 12 (85.71%) were satisfied and 2 (14.29%) were not satisfied. 11 (68.75%) of 16 farmers were satisfied with grid soil sampling, 3 (18.75%) were not satisfied, and 2 (12.5%) were unsure if their motivation to employ grid soil sampling had been satisfied. Of 11 farmers that responded to variable rate fertilizer, 8 (72.73%) were satisfied with the results and said their motivation had been satisfied as well, 2 (18.18%) said that they were not satisfied and 1 (9.09%) was unsure if his/her motivation had been satisfied. Only 2 farmers responded to variable rate pesticide, however both of these farmers indicated that their motivation for employing this technique had been satisfied. 4 (80%) of the 5 farmers responding to variable rate seeding were satisfied and 1 (20%) was unsure if their motivation had been satisfied. In each category the majority of farmers responding to the questions felt like their motivation for employing different techniques of precision farming had been satisfied. This is extremely positive news for someone who is contemplating opening a precision farming firm because satisfied customers are happy customers and happy customers tend to continue in the path that they have been traveling in the past. The customers are definitely out there, it is up to the business owner to try to capture them.

### 4.3.4 Existing Business Information

In opening any business it is important to know what kind of competition exists and to develop a plan to effectively compete against them to capture an appropriate share of the market in order to make business operation feasible. The next part of the survey focuses on input providers and precision farming firms in the areas that were surveyed, whether or not farmers utilize the services provided, how long these services have been provided, and pricing structures.

When asked about the number of input providers located in their trade area, 46 (78%) of the 59 farmers submitting surveys replied with an average number of 4.26 input providers being located in their trade area. It was important to know how many input providers are located in farmer's trade areas to determine how many of them are offering precision farming services. 26 (66.67%) of 39 farmers indicated that their main input provider offered grid soil sampling as a service to them and 26 (63.41%) of 41 farmers noted that their main input provider offered variable rate fertilizer application. 39 farmers replied to variable rate pesticide application and only 6 (15.79%) indicated that their main input provider was offering this service. 26 (61.9%) of 42 farmers replied that their main input provider offered field map construction and 16 (43.24%) of 37 replied that their input provider offered variable rate prescriptions. Certainly not all 59 farmers returning surveys answered every question and this results in a variance between variable rate fertilizer application, field map construction, and variable rate prescriptions that should be more closely related.

Of those input providers who are offering precision farming services most of them have been doing so between 2 to 10 years. However, for each individual technique of precision farming the average number of years that the services have been offered range from 5.62 years to 7.5 years. With 21 farmers responding, they indicated that their input providers have been providing grid soil sampling for an average of 6.14 years and 18 farmers indicated that variable rate fertilizer application had been offered for an average of 5.72 years. 4 farmers indicated that variable rate pesticide application had been offered for an average of 7.5 years, 21 farmers noted that field map construction had been offered an average of 5.62 years, and 13 farmers indicated that variable rate prescriptions had been offered for an average of 6.23 years.

I found it strange that variable rate pesticide application had, on average, been offered the longest of any of these services. However, I believe that some of the respondents may have defined the term variable rate pesticide application as adjusting the rate of chemicals per tank load within a field and this is different than what I meant, and this could have resulted in an average that I believe to be unusually high. When I mention variable rate pesticide application I mean application of pesticides using a machine that monitors weed presence using infrared technology and applies pesticides at points of weed presence and then quits applying the pesticides when the weed presence is non-existent.

When asked if farmers were utilizing any of the precision farming services that were provided by their input providers 13 (50%) of 26 farmers indicated that they were using grid soil sampling, 7 (33.33%) of 21 farmers were using variable rate fertilizer, no farmers were utilizing variable rate pesticide application, 11 (50%) of 22 farmers were utilizing their input providers field map construction, and 4 (30.77%) of 13 farmers were using variable rate prescriptions.

These numbers indicate that there are many farmers out there who are currently not utilizing input providers services for whatever reason. However, the possibility certainly exists that they could be potential customers of a precision farming firm if they were approached in the right manner. Many reasons could be at fault for them not utilizing these services that range from pricing to lack of knowledge about the service. In order to obtain these potential customers they must be approached in an effective manner to combat the obstacles that hinder their use of these services.

In determining how to price precision farming services, it is important to know farmers thoughts about existing businesses pricing structures, thus the survey contained a question that asked farmers if they thought that the precision farming services offered by their input providers were underpriced, overpriced, or reasonable. To very little surprise, the majority of farmers that chose to respond to this question believed that the precision farming services that were offered by input providers were overpriced. Very few believed that the services were underpriced and several were unsure if the services were underpriced or overpriced.

8 (53.33%) of the 15 farmers responding believed that grid soil sampling was overpriced, and 7 (46.67%) were unsure if grid soil sampling was underpriced or overpriced. 9 (64.29%) of the 14 farmers determined that variable rate fertilizer application was overpriced and 5 (35.71%) were unsure if variable rate fertilizer application was underpriced or overpriced. In regards to variable rate pesticide

application, 4 (80%) of 5 farmers thought that this service was overpriced and 1 (20%) farmer thought that variable rate pesticide application was underpriced. 7 (50%) of 14 farmers responding thought that field map construction was overpriced, 1 (7.14%) farmer thought that field map construction was underpriced, and 6 (42.86%) farmers were unsure if field map construction was underpriced or overpriced. Finally, 6 (75%) of 8 farmers thought that variable rate prescriptions were overpriced and 2 (25%) farmers were unsure if this service was underpriced or overpriced.

I was interested in knowing how many precision farming firms existed independently, having no affiliation with an input provider, because my research focuses on operating this type of precision farming firm. Thus, the farmers were asked in the survey if there were any businesses in their county that offered only precision farming services and did not sell inputs such as fertilizers, chemicals, seed, etc. and if the farmers were aware of any precision farming firms that have opened but are currently out of business. Of 37 farmers that responded to the first question only 7 (18.92%) of them knew of any precision farming firms that operated independently of an input provider. None of the 43 farmers responding to the business failure question knew of any precision farming firms that had been in operation but were currently out of business.

**4.3.5 Future Expectations**

The last 2 questions on the survey were related to expectations with regards to farmer's future employment of precision farming. This is an extremely important topic to keep in mind when considering opening a business of this nature because if customers are not going to be available in the future then operation is not feasible.

When asked if they planned to use a yield monitor that was equipped with GPS in the future, if they were not currently doing so, 9 (32.14%) of 28 farmers said yes, 14 (50%) said no, and 5 (17.86%) were unsure. 2 (9.09%) of 22 farmers said they plan on using a yield monitor without GPS in the future, 17 (77.27%) do not intend to, and 3 (13.64%) are unsure. Of the 29 farmers responding to grid soil sampling only 6 (20.69%) plan to use grid soil sampling in the future, 17 (58.62%) do not plan to, and 6 (20.69%) are unsure. 28 farmers responded to variable rate fertilizer application and 6 (21.43%) plan to use variable rate fertilizer application in the future, 16 (57.14%) do not plan to do so, and 6 (21.43%) are unsure. 4 (13.33%) of 30 farmers believe that they will use variable rate pesticides in the future, 20 (66.67%) do not believe they will, and 6 (50.85%) are unsure. Finally, of 34 farmers responding, 10 (29.41%) intend to use variable rate seeding in the future, 18 (52.94%) do not plan to do so, and 6 (17.65%) are unsure. While these numbers may look bleak for future adoption, it is important to know that such a business does not rely on every farmer utilizing their services or any of their competitors.

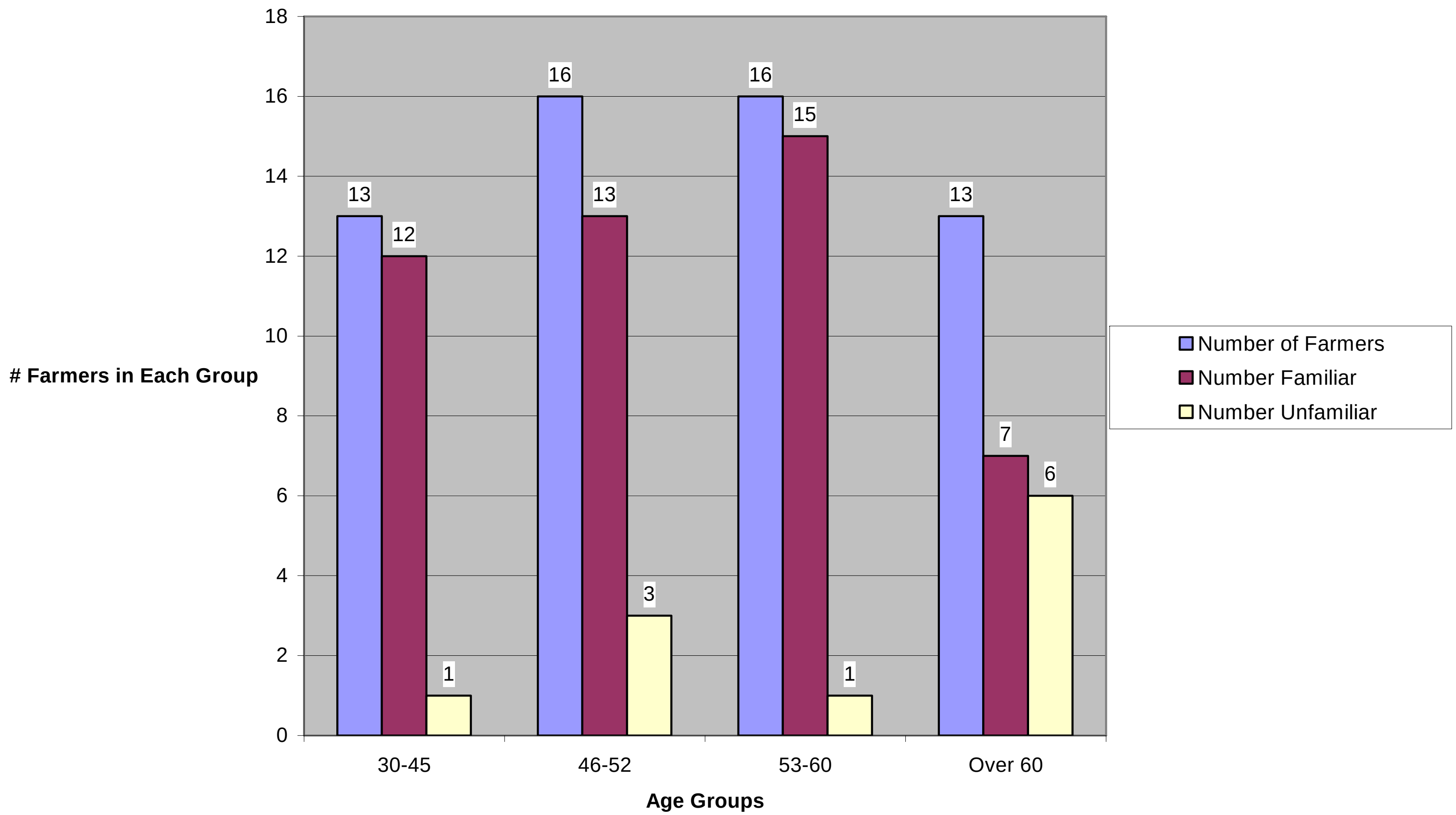
### 4.4 Age and Familiarity with Precision Farming, Adoption of Precision Farming and Future Employment of Precision Farming

Because of the high percentage of farmers that were familiar with precision farming one might not expect to see a link between age and familiarity with precision farming. However, in looking at Table 4.1 and Figure 4.2 a link does become apparent. If one expected a link between the two variables, they might expect the link to be that younger farmers are more familiar with precision farming than older farmers. This is precisely the case in this instance. Only 53.85% of farmers over 60 years old are familiar with precision farming as compared to an average of 89% between the other three groups. After seeing the results in the table and chart, it is safe to assume that younger farmers are more familiar with precision farming than older farmers. However, this trend between age and familiarity of precision farming does not occur until the over 60 years old age group which is an interesting phenomenon. The interesting question then becomes is there a reason why this trend would occur in this age group but does not occur in the other age groups? Maybe marketing, publications about precision farming, etc. are targeted toward farmers under 60. Interestingly, too, is the fact that this trend is very likely to change in the future. It is expected that in the future when the same relationship between age and familiarity with precision farming is studied the negative relationship that they currently have would become less apparent because people that are getting older are not likely to forget about a technique like precision farming and as they get older they begin to fall into different age groups.

Table 4.1 Relationship Between Age Groups and Familiarity with Precision Farming

| Age Groups | Number of Farmers | Number Familiar | Percentage Familiar | Number Unfamiliar | Percentage Unfamiliar |
|---|---|---|---|---|---|
| 30-45 | 13 | 12 | 92.31% | 1 | 7.69% |
| 46-52 | 16 | 13 | 81.25% | 3 | 18.75% |
| 53-60 | 16 | 15 | 93.75% | 1 | 6.25% |
| Over 60 | 13 | 7 | 53.85% | 6 | 46.15% |

**Figure 4.2 Relationship Between Age Groups and Familiarity With Precision Farming**

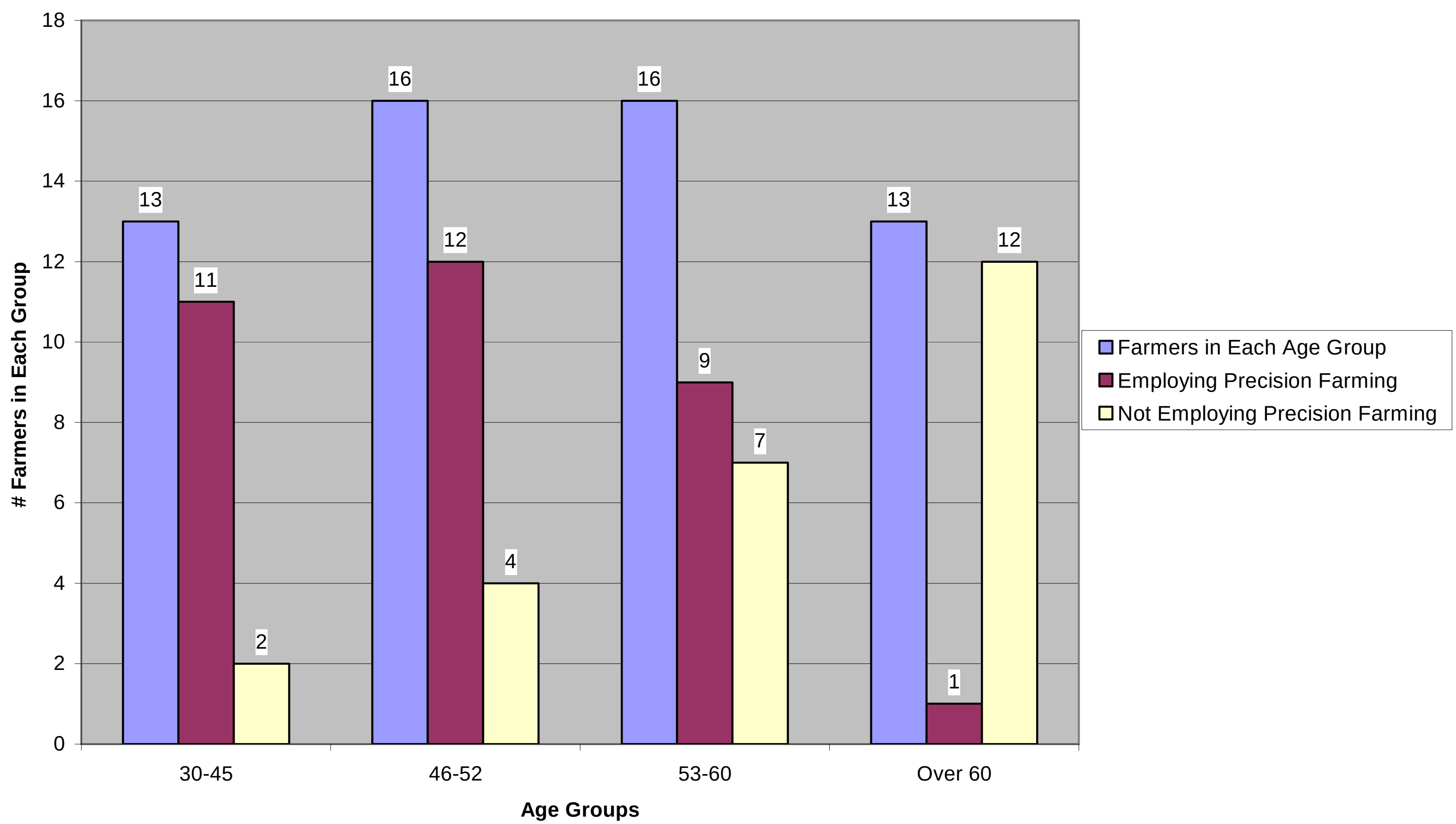


After conducting a comparative analysis between age and employment of precision farming the link between age and employment is much easier to see than the link between age and familiarity with precision farming.  The difference is that the link between age and familiarity with precision farming becomes extremely apparent at over 60 years old and the link between age and employment of precision farming indicates that the number of farmers employing precision farming is decreasing at an increasing rate as their age increases.  As indicated in Table 4.2 the employment of precision farming falls from 84.62% in the 30-45 years old range to an extremely low 7.69% employment rate in the over 60 years old group. This negative relationship between age and employment of precision farming is easily justified by the notion that younger individuals are more familiar with technology and stay attuned with technology more so than older individuals.  Also, younger individuals are probably not as easily intimidated by the different tools that are used for precision farming.  Understanding the maps, variable rate prescriptions, yield monitors, the Global Positioning System, and many other devices used in precision farming can sometimes become overwhelming and older individuals may not feel like devoting the time to understand how the concepts or devices work.

Table 4.2 Relationship Between Age and Employing Precision Farming

| Age Groups | Farmers in Each Age Group | Employing Precision Farming | % Employing Precision Farming | Not Employing Precision Farming | % Not Employing Precision Farming |
|---|---|---|---|---|---|
| 30-45 | 13 | 11 | 84.62% | 2 | 15.38% |
| 46-52 | 16 | 12 | 75.00% | 4 | 25.00% |
| 53-60 | 16 | 9 | 56.25% | 7 | 43.75% |
| Over 60 | 13 | 1 | 7.69% | 12 | 92.31% |

**Figure 4.3 Relationship Between Age and Employing Precision Farming**

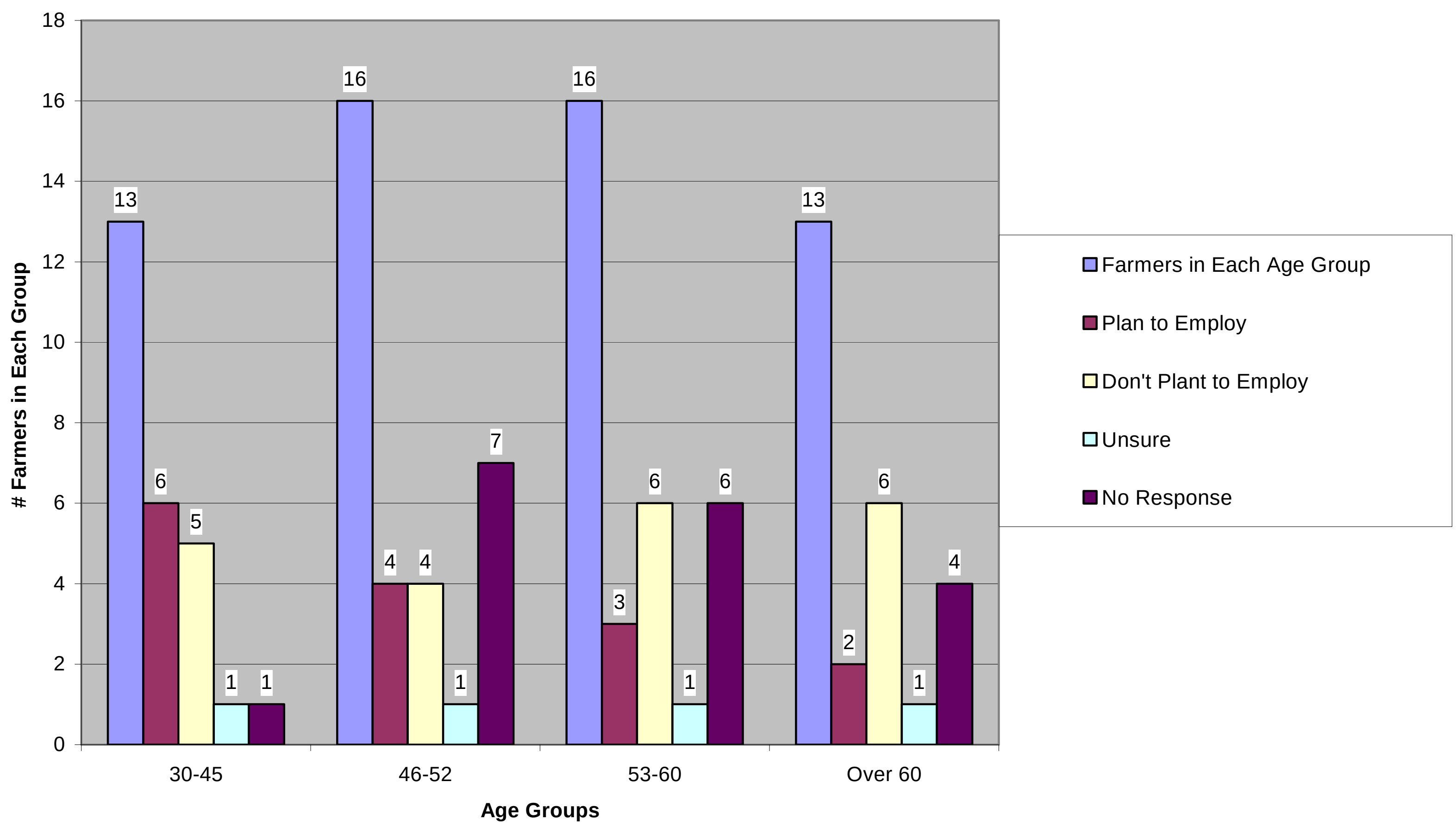


Because of the number of people that chose not to respond to the "plans to employ precision farming in future" question it is harder to determine a link between age and future plans to employ precision farming. It is expected that the number of farmers that plan to employ precision farming would fall with age and the number who do not plan to employ should increase with age. This however is not the case, as seen in Table 4.3 and Figure 4.4. Although the percentage of farmers that plan to employ precision farming in the future falls with age, as expected, the opposite can not be said for the percentage of farmers who do not plan to employ precision farming in the future. In fact, the two middle age groups reflect a fall in the percentage of farmers that do not plan to employ. This is due to the number of farmers that are unsure about their future plans and those farmers who chose not to respond to this question at all. Because of this, a link between farmers age and their plans to employ precision farming in the future is not found.

Table 4.3 Relationship Between Age and Plans to Employ Precision Farming in the Future

| Age Groups | Farmers in Each Age Group | Plan to Employ | % Plan to Employ | Don't Plant to Employ | % Don't Plant to Employ | Unsure | % Unsure | No Response | % No Response |
|---|---|---|---|---|---|---|---|---|---|
| 30-45 | 13 | 6 | 46.15% | 5 | 38.46% | 1 | 7.69% | 1 | 7.69% |
| 46-52 | 16 | 4 | 25.00% | 4 | 25.00% | 1 | 6.25% | 7 | 43.75% |
| 53-60 | 16 | 3 | 18.75% | 6 | 37.50% | 1 | 6.25% | 6 | 37.50% |
| Over 60 | 13 | 2 | 15.38% | 6 | 46.15% | 1 | 7.69% | 4 | 30.77% |

**Figure 4.4 Relationship Between Age and Plans to Employ Precision Farming in the Future**



## 4.5 Education and Familiarity with Precision Farming, Adoption of Precision Farming and Future Employment of Precision Farming

When looking at Table 4.4 and Figure 4.5 showing the relationship between educational background and familiarity with precision farming a link between the two is hard to determine. Those individuals with a bachelors degree or a graduate degree would be expected to be the most familiar with precision farming. Given their education level one would think they would be the most in tune with agricultural practices that could streamline their farming operation from an input standpoint. However the results from the survey indicate something very different. The group that has the highest percentage of members familiar with precision farming is the group of farmers that have some college. However, the high school group does have the lowest percentage of farmers that are familiar with precision farming, which is what one might expect. Given the fact that the percentage levels of farmers familiar with precision farming do not increase as the education level increases, and are thus inconsistent, it is concluded that no link exists between education level and familiarity with precision farming.

Table 4.4 Relationship Between Education Level and Familiarity with Precision Farming

| Education Level | Number of Farmers | Number Familiar | Percent Familiar | Number Unfamiliar | Percent Unfamiliar |
|---|---|---|---|---|---|
| High School | 15 | 10 | 66.67% | 5 | 33.33% |
| Some College | 16 | 15 | 93.75% | 1 | 6.25% |
| Bachelors Degree | 21 | 18 | 85.71% | 3 | 14.29% |
| Graduate Degree | 5 | 4 | 80.00% | 1 | 20.00% |

**Figure 4.5 Relationship Between Education Level and Familiarity with Precision Farming**

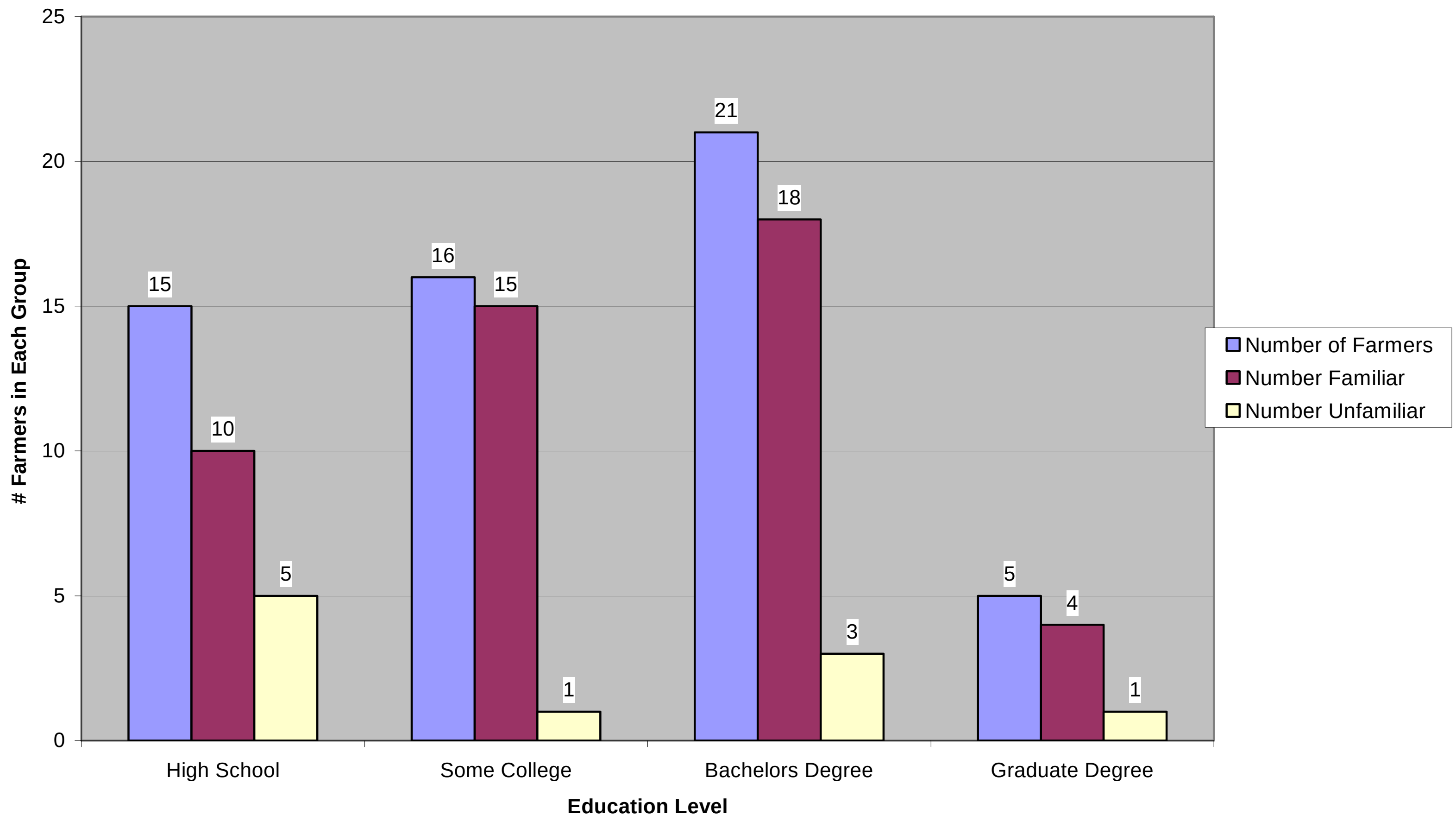
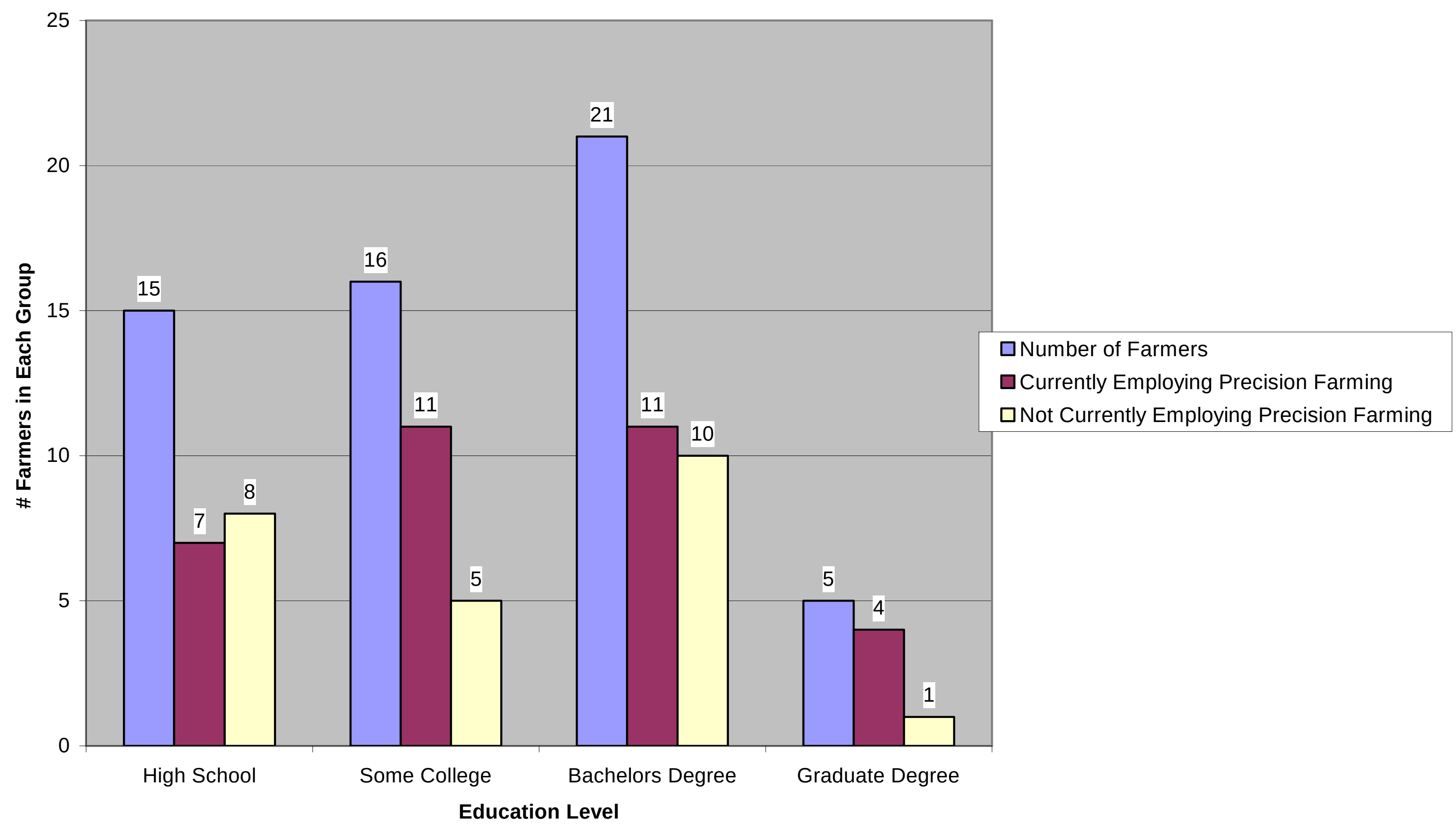


Table 4.5 indicates that the high school group has the lowest percentage of farmers who are employing precision farming and farmers who have a graduate degree are those who have the highest percentage employing precision farming. Both of these scenarios are consistent with what is expected. One would expect that as education level increases so would the percentage of farmers employing precision farming in that group. Those people who chose to go on to college may be more innovative and forward thinking than those who chose to start a career immediately after high school. The discrepancy in this logic lies in the results with the group of farmers who had some college and the group of farmers that hold a bachelors degree. It is not easily understood why a lower percentage of farmers who hold bachelors degree are employing precision farming than those farmers who have only some college. The possibility exists that those people who chose to leave college before obtaining a degree are just as innovative and forward thinking as those who went on to receive bachelors degrees but chose to get a headstart on their career. To take this a step further, it may be possible that those people that went on to receive graduate degrees are the most innovative and forward thinking group of farmers which would explain why they are the highest percentage employing precision farming. A link between education and employing precision farming does not seem to exist for all of the education groups, although it seems to have a positive relationship in regards to those having high school degrees and graduate degrees.

Table 4.5 Relationship Between Education Level and Employing Precision Farming

| Education Level | Number of Farmers | Employing | % Employing | Not Employing | % Not Employing |
|---|---|---|---|---|---|
| High School | 15 | 7 | 46.67% | 8 | 53.33% |
| Some College | 16 | 11 | 68.75% | 5 | 31.25% |
| Bachelors Degree | 21 | 11 | 52.38% | 10 | 47.62% |
| Graduate Degree | 5 | 4 | 80.00% | 1 | 20.00% |

**Figure 4.6  Relationship Between Education and Employment of Precision Farming**



In looking at Table 4.6 a link seems to exist between education level and plans to employ precision farming in the future. At first inclination one would expect as education levels rose the percentage of farmers that plan on employing precision farming in the future would rise as well. However, this is not the case as the relationship is a negative one considering that as education levels go up the number of farmers who plan to employ precision farming in the future decrease. This does not necessarily mean that these farmers do not plan to employ precision farming in the future many of them were unsure or chose not to respond to the question. It is clear that there is a negative relationship between education level and plans to employ precision farming in the future. A possible explanation for this relationship could be that farmers that are currently using precision farming, a higher percentage being those that are better educated, may not be seeing significant results and this may result in the decrease in the percentage of farmers that plan to employ precision farming in the future. Maybe these farmers are unsure if they plan to employ precision farming or chose not to answer this question at all for whatever reason.

Table 4.6 Relationship Between Education Level and Plans to Employ Precision Farming in the Future

| Education Level | Number of Farmers | Plan to Employ | % Plan Employ | No Plan to Employ | % No Plan to Employ | Unsure | % Unsure | No Response | % No Response |
|---|---|---|---|---|---|---|---|---|---|
| High School | 15 | 5 | 33.33% | 5 | 33.33% | 1 | 6.67% | 4 | 26.67% |
| Some College | 16 | 5 | 31.25% | 5 | 31.25% | 0 | 0.00% | 6 | 37.50% |
| Bachelors Degree | 21 | 4 | 19.05% | 10 | 47.62% | 2 | 9.52% | 5 | 23.81% |
| Graduate Degree | 5 | 0 | 0.00% | 1 | 20.00% | 2 | 40.00% | 2 | 40.00% |

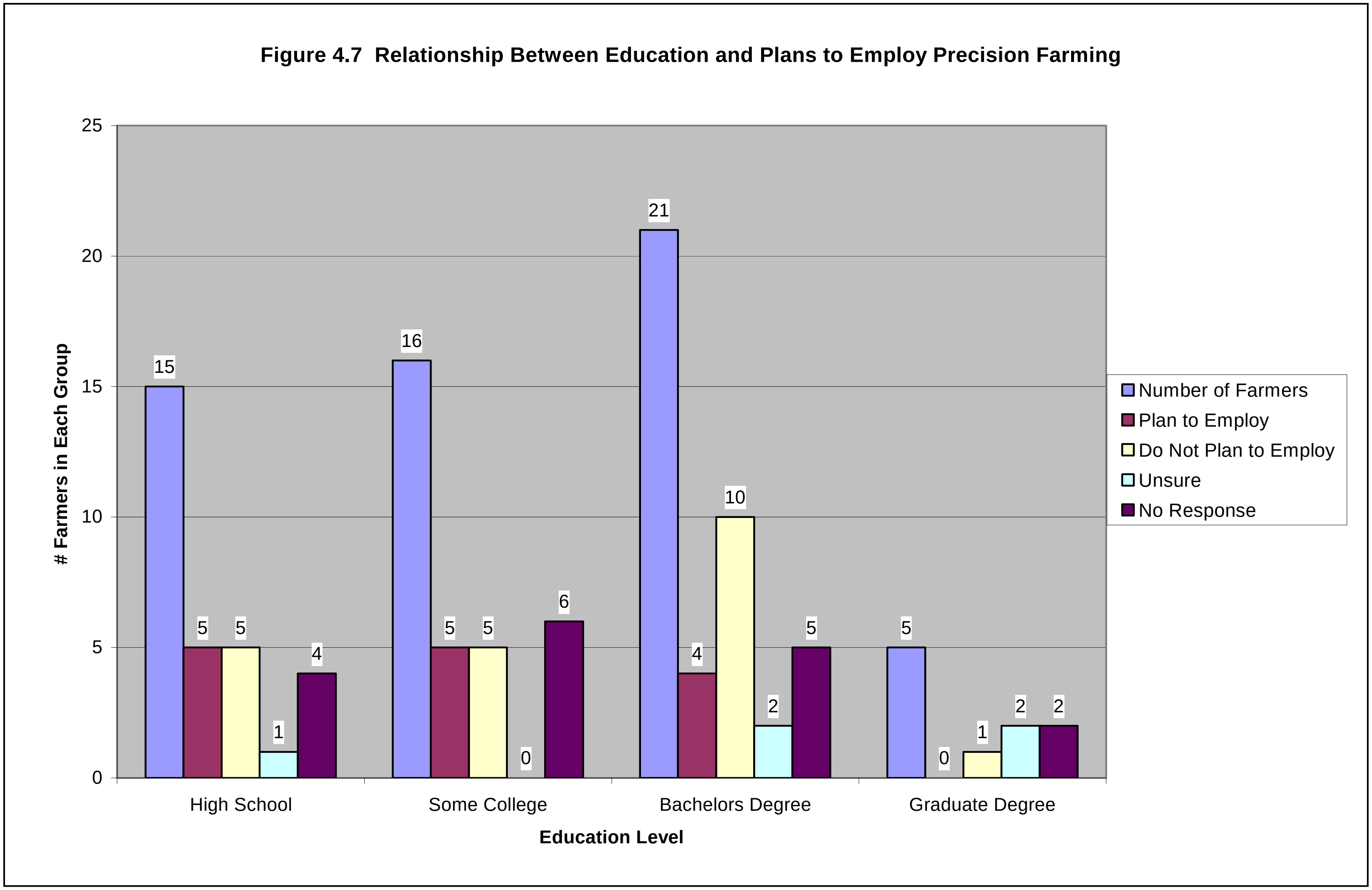


Figure 4.7 Relationship Between Education and Plans to Employ Precision Farming
# Farmers in Each Group
Education Level
High School
Some College
Bachelors Degree
Graduate Degree
Number of Farmers
Plan to Employ
Do Not Plan to Employ
Unsure
No Response
25
20
15
10
5
0
15
5
5
1
4
16
5
5
0
6
21
4
10
2
5
5
0
1
2
2

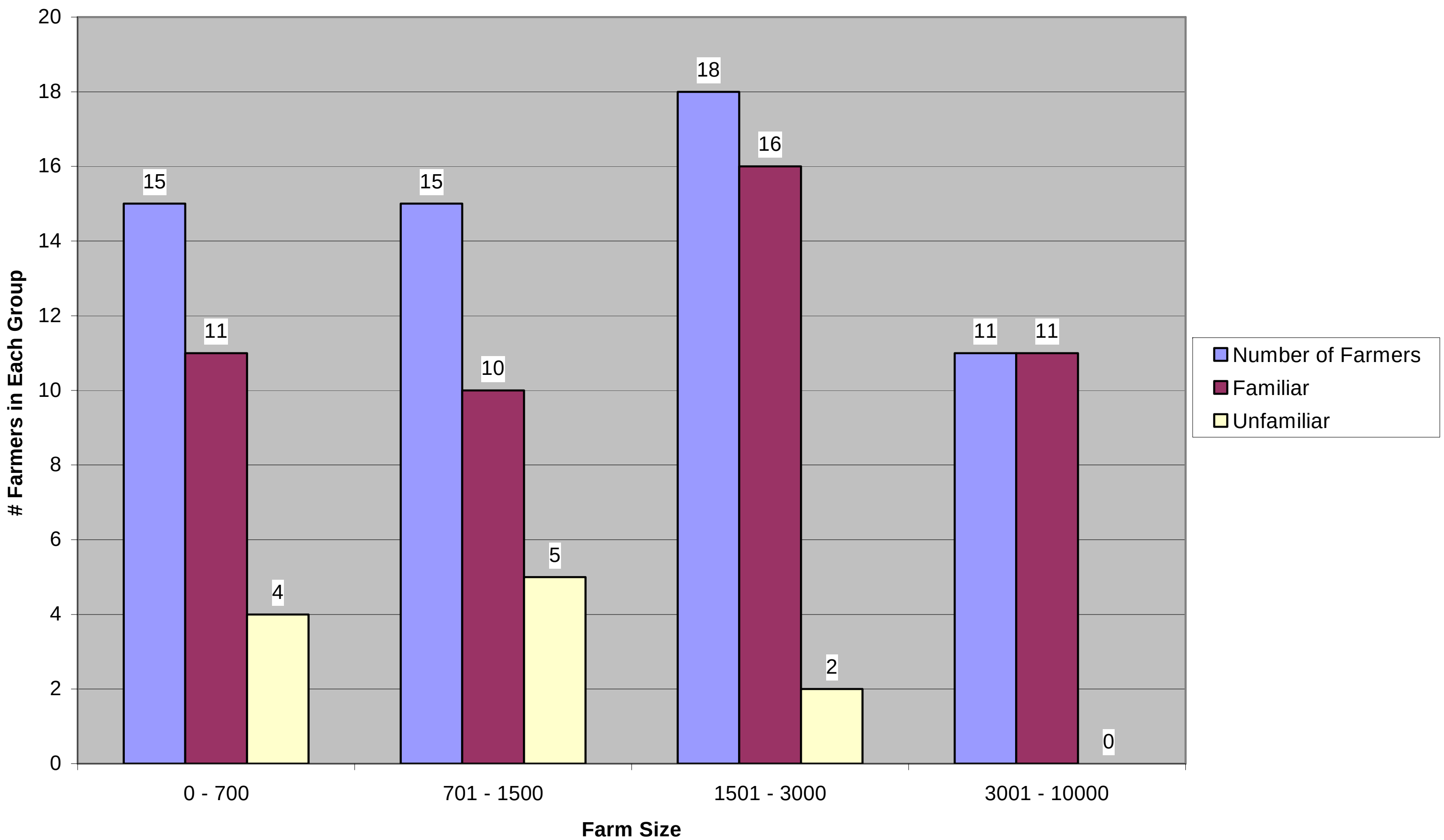
## 4.6 Farm Size and Familiarity with Precision Farming, Adoption of Precision Farming and Future Employment of Precision Farming

Table 4.7 shows the relationship between farm size and familiarity with precision farming and in looking at this table a link can be established between the number of acres that a person farms and their familiarity with precision farming. When I began this research I expected that as farm size increased the percentage of farmers that were familiar with precision farming would increase as well. According to the results in the chart it becomes apparent that a positive relationship exists between farm size and familiarity with precision farming. As farm size increases the percentage of farmers that are familiar with precision farming increases as well. Although, there is a slight decrease in the percentage of farmers that are familiar with precision farming from the 0 – 700 acre group and the 701 – 1500 acre it is only a slight decrease and is offset by the large increase in the number of farmers that are familiar with precision farming in the 1501 – 3000 acre group and the over 3000 acre group. Nearly 90% of the farmers in the 1501 – 3000 acre group are familiar with precision farming and 100% of the farmers farming over 3000 acres are familiar with precision farming. As expected a link does exist between farm size and familiarity with precision farming. This is probably due to the fact that larger farmers read more materials and attend more producer meetings and in turn pick up more information about precision farming than those smaller farmers who do not keep up with the cutting edge of agricultural technology.

Table 4.7 Relationship Between Farm Size and Familiarity with Precision Farming

| Farm Size (Acres) | Number of Farmers | Familiar | % Familiar | Unfamiliar | % Unfamiliar |
|---|---|---|---|---|---|
| 0 - 700 | 15 | 11 | 73.33% | 4 | 26.67% |
| 701 - 1500 | 15 | 10 | 66.67% | 5 | 33.33% |
| 1501 - 3000 | 18 | 16 | 88.89% | 2 | 11.11% |
| 3001 - 10000 | 11 | 11 | 100.00% | 0 | 0.00% |

**Figure 4.8 Relationship Between Farm Size and Familiarity of Precision Farming**

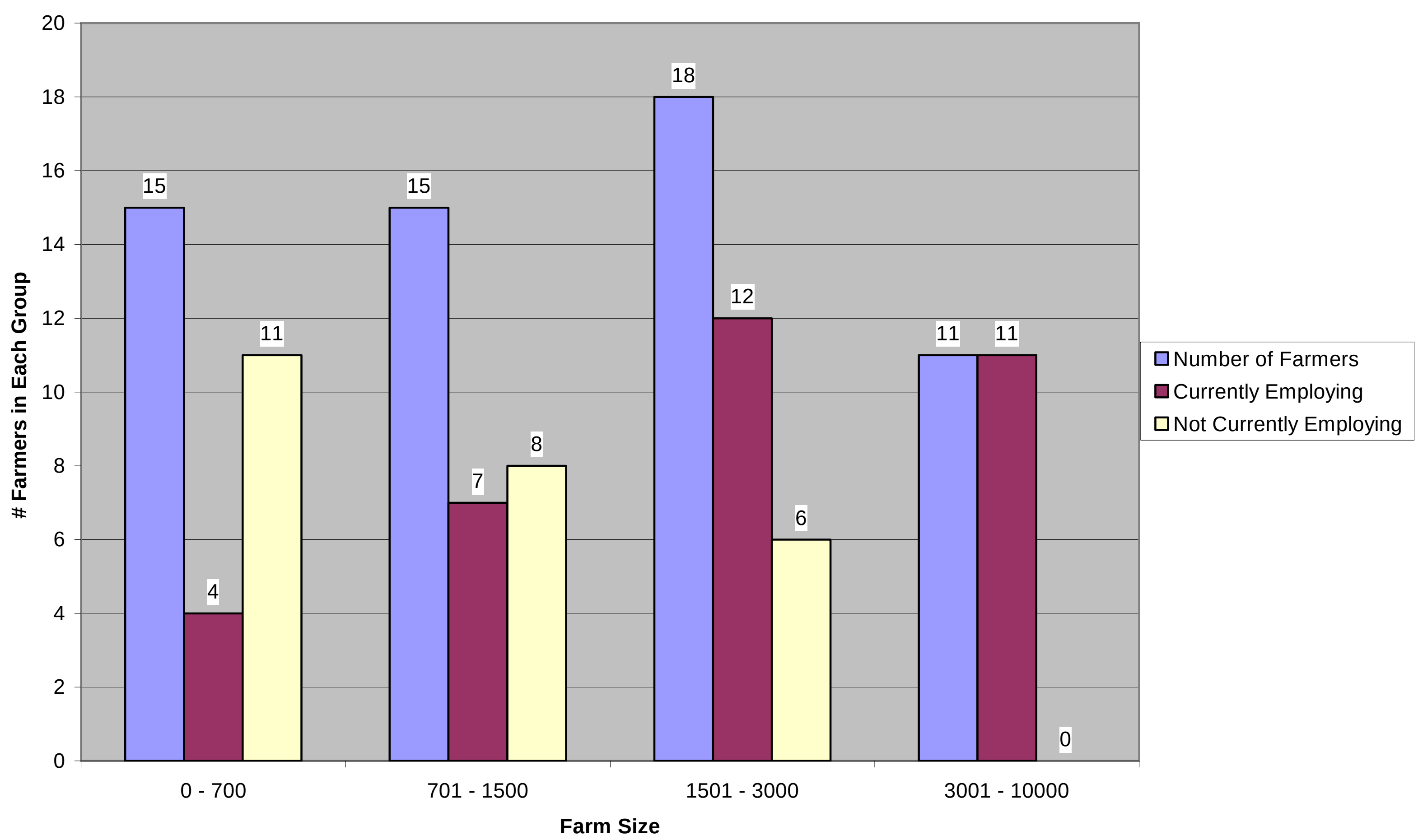


In no other table in this chapter has the link between two variables been as evident as the link between farm size and employment of precision farming. As can be seen in Table 4.8, a positive relationship certainly exists between farm size and employing precision farming. There is a 20% increase in the percentage of farmers that are employing precision farming between each of the first 3 farm size groups and then a 33.33% increase between the 1501 – 3000 acres group and over 3000 acres group. This certainly indicates that as farm size increases the number of farmers that employ precision farming increases as well. Most likely the reason for this is the fact that larger farmers can more easily afford the equipment that is required for precision farming and the larger farmers are probably targeted much more by people offering precision farming services than smaller farmers. One person mentioned that his precision farming firm targets farmers over 1500 acres as potential customers because it is hard to turn a profit on farmers whose operations are smaller than 1500 acres and these farmers are much less likely to be interested in the services that they offer.

Table 4.8 Relationship Between Farm Size and Employing Precision Farming

| Farm Size (Acres) | Number of Farmers | Currently Employing | % Currently Employing | Not Currently Employing | % Not Currently Employing |
|---|---|---|---|---|---|
| 0 - 700 | 15 | 4 | 26.67% | 11 | 73.33% |
| 701 - 1500 | 15 | 7 | 46.67% | 8 | 53.33% |
| 1501 - 3000 | 18 | 12 | 66.67% | 6 | 33.33% |
| 3001 - 10000 | 11 | 11 | 100.00% | 0 | 0.00% |

**Figure 4.9 Relationship Between Farm Size and Employment of Precision Farming**

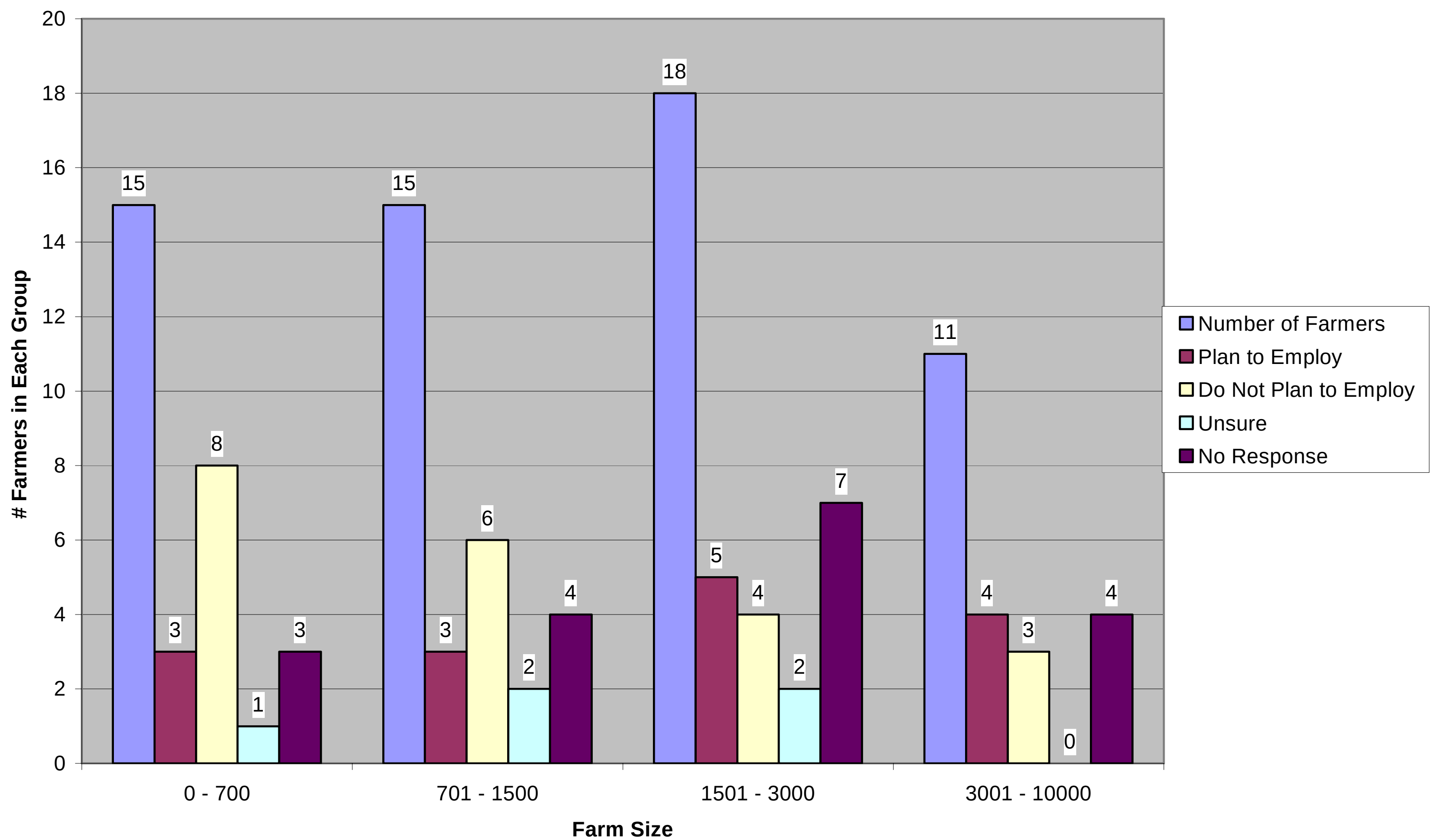


Of any of the tables comparing plans to employ precision farming in the future and another variable, Table 4.9 comes closest to linking the two. Although the percentages are low they still head in the direction that one would expect. As expected there is a positive relationship between farm size and plans to employ precision farming in the future, albeit a small one. As farm size increases the percentage of farmers planning on employing precision farming is increasing as well. Unlike the other tables comparing plans to employ precision farming in the future and another variable, Table 4.9 reveals that as the farm size increases plans not to employ precision farming in the future decrease, with the exception of the over 3000 acres group. There was a slight increase in the percentage of farmers that do not plan to employ precision in the future but it was a small increase.

Table 4.9  Relationship Between Farm Size and Plans to Employ Precision Farming in the Future

| Farm Size (Acres) | Number of Farmers | Plan to Employ | % Plan to Employ | Do Not Plan to Employ | % Do Not Plan to Employ | Unsure | % Unsure | No Response | % No Response |
|---|---|---|---|---|---|---|---|---|---|
| 0 - 700 | 15 | 3 | 20.00% | 8 | 53.33% | 1 | 6.67% | 3 | 20.00% |
| 701 - 1500 | 15 | 3 | 20.00% | 6 | 40.00% | 2 | 13.33% | 4 | 26.67% |
| 1501 - 3000 | 18 | 5 | 27.78% | 4 | 22.22% | 2 | 11.11% | 7 | 38.89% |
| 3001 - 10000 | 11 | 4 | 36.36% | 3 | 27.27% | 0 | 0.00% | 4 | 36.36% |

Figure 4.10  Relationship Between Farm Size and Plans to Employ Precision Farming



**4.7 Regressions of Familiarity of Precision Farming, Employment of Precision Farming, and Future Employment of Precision Farming as Dependent Variables.**

Regressions were estimated to determine the significance of independent variables on the dependent variables of the survey. In three of the regressions the independent variables age, education, farm size, and net farm income were used to determine their impacts on the dependent variables familiarity of precision farming, employment of precision farming, and plans to employ precision farming in the future, and in three of the regressions net farm income was excluded from the independent variables but the other independent and dependent variables remain unchanged. Included in this section are the basic results of the regressions and their interpretation. When net farm income was included the model was: $Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4$ where $Y_1$ = 0,1 the farmer is currently employing precision farming, $Y_2$ = 0,1 the farmer is familiar with the concept of precision farming, $Y_3$ = 0,1 the farmer is planning to employ precision farming in the future, $X_1$ = Survey Age, $X_2$ = Survey Education, $X_3$ = Survey Farm Size, $X_4$ = Survey Net Farm Income and when net farm income was excluded the model was: $Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3$ where $Y_1$ = 0,1 the farmer is currently employing precision farming, $Y_2$ = 0,1 the farmer is familiar with the concept of precision farming, $Y_3$ = 0,1 the farmer is planning to employ precision farming in the future, $X_1$ = Survey Age, $X_2$ = Survey Education, $X_3$ = Survey Farm Size. In all cases the variables assumed a value of 0 if the farmer did not employ precision farming, was not familiar with the concept of precision farming, or did not plan on employing precision farming in the future and the variable assumed a value of 1 if the farmer did employ precision farming, was familiar with the concept of precision farming, or did plan on employing precision farming in the future.

Table 4.10 are the results of a regression using the 0,1 decision to employ precision farming as the dependent variable and it indicates that two of the independent variables have a significant impact on the dependent variable employing precision farming. When looking at the t-statistic it is evident that age and farm size have an impact on the decision to employ precision farming. According to the results in the table, as a persons age is increased by 1 year they are 2.4% less likely to be employing precision farming. Thus, younger farmers are more likely to be employing precision farming than older farmers. Also, the table indicates that farm size has an impact on the likelihood that a farmer employs precision farming. With each additional 1,000 acres, a farmer is 9.18% more likely to be employing precision farming. Because the t-statistics are so low for education and net farm income, it can be concluded that they do not have a significant impact on the current employment of precision farming. Given the fact that this regression has a significance f of 0.0004939 and an R square of 0.512 this regression appears to be acceptable given the considerable amount of information in cross sections.

Table 4.10 Regression Including Net Farm Income with Employing Precision Farming as Dependent Variable

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.715 |
| R Square | 0.512 |
| Adjusted R Square | 0.440 |
| Standard Error | 0.368 |
| Observations | 32 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 4 | 3.839 | 0.960 | 7.078 | 0.0004939 |
| Residual | 27 | 3.661 | 0.136 | | |
| Total | 31 | 7.5 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | 1.664 | 0.390 | 4.273 | 0.000214 |
| Age | -0.024 | 0.006 | -3.990 | 0.000454 |
| Education | 0.010 | 0.067 | 0.150 | 0.882 |
| Farm Size | 0.0000918 | 0.0000514 | 1.786 | 0.085 |
| Net Farm Income | 0.000000321 | 0.000000554 | 0.578 | 0.568 |

As seen in Table 4.11, when net farm income is excluded as an independent variable age with a t-statistic of -4.630 and farm size with a t-statistic of 3.078 continue to have a significant impact on the employment of precision farming. According to the results of this regression for every year older that a farmer is they are 2.3% less likely to employ precision farming and with each additional 1,000 acres, the farmer is 9.38% more likely to employ precision farming. Again, one can conclude that this regression is reasonable given the Significance F of 0.00000123 and the R Square of 0.406.

Table 4.11  Regression Excluding Net Farm Income with Employing Precision Farming as Dependent Variable

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.662 |
| R Square | 0.438 |
| Adjusted R Square | 0.406 |
| Standard Error | 0.385 |
| Observations | 56 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 3 | 6.007 | 2.002 | 13.511 | 0.00000123 |
| Residual | 52 | 7.707 | 0.148 | | |
| Total | 55 | 13.714 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | 1.494 | 0.303 | 4.930 | 0.00000878 |
| Age | -0.023 | 0.005 | -4.630 | 0.00002479 |
| Education | 0.041 | 0.054 | 0.756 | 0.453 |
| Farm Size | 0.0000938 | 0.0000305 | 3.078 | 0.003 |

Table 4.12 are the results of using the 0,1 familiarity with precision farming survey variable as the dependent variable.  The results from the regression in tables 4.12 are marginally acceptable.  Given the low R Square of 0.277 and the Significance F of 0.060, being relatively close to the threshold of 0.05, we can determine from the t statistic that familiarity with precision farming is affected by a farmers age.  According to the results from the regression, as a farmers age increases by one year they are 1.3% less likely to be familiar with precision farming.

Table 4.12 Regression Including Net Farm Income with Familiarity of Precision Farming as Dependent Variable

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.526 |
| R Square | 0.277 |
| Adjusted R Square | 0.170 |
| Standard Error | 0.383 |
| Observations | 32 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 4 | 1.514 | 0.379 | 2.585 | 0.060 |
| Residual | 27 | 3.954 | 0.146 | | |
| Total | 31 | 5.469 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | 1.194 | 0.405 | 2.949 | 0.007 |
| Age | -0.013 | 0.006 | -2.074 | 0.048 |
| Education | 0.049 | 0.069 | 0.707 | 0.486 |
| Farm Size | 0.0000697 | 0.0000534 | 1.305 | 0.203 |
| Net Farm Income | 0.000000262 | 0.000000576 | 0.455 | 0.652 |

In Table 4.13 net farm income is omitted and again, the results are marginally acceptable because of the low R Square of 0.163. However, the Significance F of 0.025 is acceptable. In looking at table 4.13 one can see that as a farmers age increases by one year they are 1.2% less likely to be familiar with precision farming.

Table 4.13 Regression Excluding Net Farm Income with Familiarity of Precision Farming as Dependent Variable

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.404 |
| R Square | 0.163 |
| Adjusted R Square | 0.115 |
| Standard Error | 0.364 |
| Observations | 56 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 3 | 1.340 | 0.447 | 3.378 | 0.025 |
| Residual | 52 | 6.875 | 0.132 | | |
| Total | 55 | 8.214 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | 1.267 | 0.286 | 4.425 | 0.0000497 |
| Age | -0.012 | 0.005 | -2.528 | 0.015 |
| Education | 0.052 | 0.051 | 1.011 | 0.317 |
| Farm Size | 0.00002876 | 0.00002879 | 0.999 | 0.323 |

Table 4.14 are the results using the 0,1 plans to employ precision farming survey variable as the dependent variable. None of the explanatory variables are significant in this equation.

Table 4.14  Regression Including Net Farm Income with Plans to Employ Precision Farming as Dependent Variable

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.361 |
| R Square | 0.131 |
| Adjusted R Square | -0.052 |
| Standard Error | 0.522 |
| Observations | 24 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 4 | 0.778 | 0.195 | 0.714 | 0.593 |
| Residual | 19 | 5.180 | 0.273 | | |
| Total | 23 | 5.958 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | 1.111 | 0.704 | 1.579 | 0.131 |
| Age | -0.008 | 0.011 | -0.747 | 0.464 |
| Education | -0.146 | 0.123 | -1.191 | 0.248 |
| Farm Size | 0.0000250 | 0.0000769 | 0.325 | 0.749 |
| Net Farm Income | 0.000000480 | 0.000001114 | 0.431 | 0.672 |

The results from the regressions in tables 4.14 and 4.15 are not acceptable. Given the extremely low R Squares and the Significance F's of 0.593 and 0.334, respectively, from these tables, it is obvious that these regressions provide no useful data. One of the possible reasons for this is the low number of observations in these two equations. Because many of the farmers responded that they were unsure if they would employ precision farming in the future much of the data had to be deleted to estimate these regressions.

Table 4.15 Regression Excluding Net Farm Income with Plans to Employ Precision Farming as Dependent Variable

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.320 |
| R Square | 0.102 |
| Adjusted R Square | 0.016 |
| Standard Error | 0.493 |
| Observations | 35 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 3.000 | 0.860 | 0.287 | 1.179 | 0.334 |
| Residual | 31 | 7.540 | 0.243 | | |
| Total | 34 | 8.4 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* |
|---|---|---|---|---|
| Intercept | 0.999 | 0.517 | 1.932 | 0.063 |
| Age | -0.008 | 0.009 | -0.865 | 0.394 |
| Education | -0.124 | 0.097 | -1.280 | 0.210 |
| Farm Size | 0.0000393 | 0.0000593 | 0.663 | 0.512 |

**Correlation Matrices**

Two correlation matrices were configured to determine if any correlation existed between the independent and dependent variables that were used to estimate the regressions.

In Table 4.16 net farm income was included and the model is: Y1 = Employing precision farming, Y2 = Familiarity with precision farming, Y3 = Plans to employ, X1 = Age, X2 = Education, X3 = Farm size, X4 = Net farm income. Several variables are correlated in Table 4.16. A high level of correlation exists between the dependent variables employing precision farming and familiarity with the concept of precision farming. A negative correlation exists between age and employing precision farming and age and familiarity with the concept of precision farming. A positive correlation exists between farm size and employing precision farming.

Table 4.16  Correlation Matrix Including Net Farm Income

| | *Employing* | *Familiar with Concept* | *Plans to Employ* | *Age* | *Education* | *Farm Size* | *Net Farm Income* |
|---|---|---|---|---|---|---|---|
| Employing | 1 | | | | | | |
| Familiar with Concept | 0.546594394 | 1 | | | | | |
| Plans to Employ | 0.36705849 | 0.144841365 | 1 | | | | |
| Age | -0.581763267 | -0.519847423 | -0.186257068 | 1 | | | |
| Education | -0.04794633 | 0.214422507 | -0.263986613 | -0.047200136 | 1 | | |
| Farm Size | 0.458324769 | 0.399988792 | 0.114839202 | -0.162736353 | 0.105722997 | 1 | |
| Net Farm Income | 0.327159328 | 0.226115868 | 0.209574811 | -0.209918575 | -0.161007139 | 0.379470824 | 1 |

In Table 4.17 net farm income was included and the model is: Y1 = Employing precision farming, Y2 = Familiarity with precision farming, Y3 = Plans to employ, X1 = Age, X2 = Education, X3 = Farm size.  A negative correlation exists between age and employing precision farming and a positive correlation exists between farm size and employing precision farming.

The results from the correlation matrices confirm the results from the regressions that there isn’t much of a relationship between the variables.

Table 4.17  Correlation Matrix Excluding Net Farm Income

| | *Employing* | *Familiar with Concept* | *Plans to Employ* | *Age* | *Education* | *Farm Size* |
|---|---|---|---|---|---|---|
| Employing | 1 | | | | | |
| Familiar with Concept | 0.343491248 | 1 | | | | |
| Plans to Employ | 0.39804897 | 0.061898446 | 1 | | | |
| Age | -0.578932813 | -0.365610903 | -0.220448678 | 1 | | |
| Education | 0.0485345 | 0.175185327 | -0.225884951 | 0.111401783 | 1 | |
| Farm Size | 0.562955141 | 0.296825543 | 0.14591765 | -0.319096109 | 0.112072029 | 1 |

### 4.8 Chapter Conclusion

After compiling all of the farmers responses and comparing their key demographics (age, education level, and farm size) with the three aspects of precision farming that were chosen: familiarity with precision farming, employment of precision farming, and plans to employ precision farming in the future, it is clear that a link exists between some of the demographics and these aspects.

After reviewing all of the tables it seems clear that there are some relationships between key demographics and precision farming that would be helpful for someone that was interested in opening a precision farming firm to use to determine who their best potential customers would be. The results of the survey indicate that a positive relationship exists between farm size and familiarity with precision farming. The larger the farm operation the more likely it is that the farmer is familiar with precision farming. The question here is what does a person do in this situation in offering a precision farming service. Do they target the farmers who are less familiar with precision farming and hope to educate them and in return hope that they choose to use their precision farming service or do they go to the larger farmers who need less education and focus more time on attempting to sell the service to the farmer?

There are two links that are clear with respect to employing precision farming. The first is that as farm size increases the farmers are much more likely to employ precision farming. The second is that older farmers, particularly those over 60 years old, are much less likely to employ precision farming. Again, how a person uses this information can vary from individual to individual. If a greater percentage of large farmers are already using precision farming should one target the smaller farmers in hopes of capturing a larger market share that has not been targeted before? Also, does one focus on selling to younger farmers or do they attempt to persuade older farmers to use their precision farming service by educating them?

Perhaps the most important question that a person who offers precision farming services is “what group should I be targeting that is not currently using precision farming but plans to in the future?” In this case that person may want to target larger farmers. The most clear link between plans to employ precision farming in the future and another variable was found between farm size and future plans. In this case it seems clear that the person offering the services should be targeting the larger farmers because they are the group with the largest percentage of farmers that indicated they planned on employing precision farming in the future.

After running six different regressions some of them paint a similar picture to the figures and tables that were used to come to the conclusions above. The two regressions that were acceptable indicate that age and farm size have an impact on farmers employing precision farming. The results show that as a farmers age increases they are less likely to employ precision farming and as farmers farm size increases they are more likely to employ precision farming.

The two regressions that used familiarity of precision farming as the dependent variable were marginally acceptable. The results from these regressions indicate that with each year older a farmer is they are less likely to be familiar with precision farming.

Using the results from the regressions and the tables and figures from this chapter it becomes evident that a person that is interested in opening a precision farming firm should target younger and larger farm operators. From the results in this chapter it is evident that younger and larger farm operators are going to be the most likely to use precision farming services. With this being said, it is a reassuring fact to know that half of the farmers who responded to the survey were under 52 years of age and that the average number of acres that the respondents farmed was 1,967 acres.

# CHAPTER FIVE
# Concluding Comments

## 5.1 Thesis Conclusion

After developing a computer model and looking at all of the surveys and interpreting the results it is obvious to me that a precision farming firm is certainly capable of existing in Kentucky, particularly the Western and Central part of the state. Although a number of these firms already exist, whether independent of or associated with an input provider, the market for precision farming services is certainly not saturated. Given the fact that only 7 out of 37 farmers knew of any independent precision farming service in Western or Central Kentucky is a good indicator that more independent precision farming firms could survive.

The number of farmers that are currently employing different techniques of precision farming is a reassuring factor of success for a precision farming firm. If a firm prices competitively and provides excellent service there is a good chance for them to get a piece of the market share. Also, as more research shows that employing precision farming pays off and as prices of equipment and services become more efficient it is likely that more farmers will become interested in precision farming.

The key to success is going to be the firms ability to show farmers how precision farming is beneficial to them and their operations. According to the survey that was conducted, farmers are primarily concerned with increasing profit and it is important to show them how precision farming can help them obtain their goals. Past research has shown that it is difficult to quantify the results of using precision farming to increase output. Given the fact that crop yields are dependent on weather conditions and weather conditions are constantly changing it is hard to show the farmer how much precision farming has improved their yields and what their yields would have been if they had not chosen to employ precision farming. However, increasing profit by decreasing inputs required to grow a crop is easily quantifiable. If a farmer was going to use a single rate application method but chose to use a variable rate application for lime or fertilizer instead, then it is very easy to show the farmer their cost savings, especially if a majority of the fields require rates lower than the single rate the farmer would have used. This seems to be the best opportunity for a precision farming firm hoping to grow and gain new business.

The business model that was developed in chapter three certainly indicates that a precision farming firm could be a sustainable and feasible operation given the right economic conditions. Three important aspects of running this type of business that should be focused on are recruiting new customers, keeping the price for the services at a competitive and profitable level, and borrowing the money to operate at a reasonable interest rate. In order to make the business profitable the salespeople are going to have to focus on increasing the customer base every year. The model that is used in chapter three assumes an aggressive increase in the number of acres serviced every year. Keeping the price for services at a competitive and profitable level is an important aspect because if the price is too low then the business is going to incur a loss and will not be feasible to operate and if the price is too high then they are going to lose both current and potential customers. A good deal of time should be spent shopping competitors, their prices, and the services that are included in the price. Profitability for a firm of this nature is tied to the interest rate at which the firm borrows money. The model was sensitive to changes in the interest rate and anyone attempting to start a business of this nature should analyze all possibilities of price and acres serviced and search for a reasonable interest rate. An interest rate that is too high could keep the business from turning a profit. Particularly in the first few years, which are the most crucial years to turn a profit.

After conducting the survey and running the regressions in chapter four it is evident that younger farmers and larger farmers should be target clients for anyone wanting to open and operate a precision farming firm. However, it is important to note that the percentage of farmers bias may be upward given the fact that the population that was sampled might be more interested in adopting precision farming. These results are positive for precision farming firms because the recent past has shown that small, part time farmers are giving up farming and large farms are becoming more evident. After conducting the survey, it became apparent that if a survey is going to ask for a farmer to report their farm income then it should not also ask for their name and their home county. The fact that the survey asked all three of these questions resulted in a lower number of farmers reporting their five year average net farm income. However, there were still enough farmers that did report their income that a regression could be run that would be statistically sound.

While no business can begin operation sure of success there are always economic assumptions that can be made to project the future success of the business with a degree of certainty. However, knowing that economic conditions, climatic conditions, and personal conditions can always change without our control, so too, can the projections that have been made. That stated, under the right ownership, management, and operation there is little doubt that a precision farming firm could be very successful.

## Bibliography


Bestbuy website. Accessed 2004. Computers. www.bestbuy.com.

Boyd, Roger. Ag-One Coop. Personal Communication. July 2003.

Davis, Larry. DTN. Personal Communication. January 2004.

Hudson, D. and D. Hite. 2001. Adoption of Precision Agriculture Technology in Mississippi: Preliminary Results from a Producer Survey. Research Report 2001-001, Dept. of Agricultural Economics, Mississippi State University.

Intarapapong, W. 2002. The Economic and Environmental Impacts of Variable Rate Fertilizer Application: The Case of Mississippi. Department of Agricultural Economics, Mississippi State University.

Gandonou, J.M., Dillon C., Stombaugh T., and S. Shearer. 2001. Precision Agriculture: A Break-Even Acreage Analysis. Dept. of Agricultural Economics and Biosystems and Agricultural Engineering, University of Kentucky.

Headd, B. 2002. Redefining Business Success: Distinguishing Between Closure and Failure. Small Business Administration. U.S. Small Business Administration.

Kansas State University Soil Testing Laboratory website. Accessed 2004. Schedule of Fees. http://www.oznet.ksu.edu/agronomy/SoilTesting/p_fees.htm.

Kentucky Agricultural Statistics Service website. Accessed 2004. Kentucky Agricultural Statistics 2002 - 2003 Bulletin. http://www.nass.usda.gov/ky/B2003/b2003.html.

Lowenberg-DeBoer, J. and K. Erickson. 2000. Precision Farming Profitability. Agricultural Research Programs, Purdue University.

Mayes, T. and T. Shank. Financial Analysis with Microsoft Excel. Second Edition. 2001. pp 262 – 272.

Morris, F. and B. Blackmore. 1997. Precision Farming Techniques for Sustainable Agriculture. Paper presented to the 1st European Conference on Precision Agriculture, September 8-10, 1997 Warwick University Conference Center, Warwick, United Kingdom.

Petty, Chris. Precision Management and Consultants. Personal Communication. July, 2003.

Swinton, S. and J. Lowenberg-DeBoer. 1998. Evaluating the Profitability of Site Specific Farming. *Journal of Production Agriculture, 11.*

Reinert, William Reinert. Precision Farming Enterprises. Personal Communication. June, 2003.

National Agricultural Statistics website. Accessed 2004. Data Queries. www.nass.usda.gov/census/.

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