FARMLAND VALUATION: A NET PRESENT VALUE APPROACH USING SIMULATION

by

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ABSTRACT

As the single largest asset class on the agriculture sector's balance sheet, real estate is clearly a significant component of America's farming community's well-being and key to production agriculture. Purchasing farmland requires a significant commitment of capital, and one of the chief considerations for producers when contemplating purchasing a property is the return they can expect to receive from their investment over the course of its productive life. The traditional Net Present Value approach to investment valuation is difficult to implement since estimating cash flows over the life of the property is extremely difficult due to uncertainty in yields and commodity prices. By using historical price, yield, and cost data, this thesis develops a net present value spreadsheet model that uses simulation to determine an expected cash flow per acre. This expected cash flow can then be used to determine the gross cash flow from a particular farm over the term of the investment. While not explicitly accounting for non-direct expenses in the model such as returns to management, the techniques discussed provide a solid foundation for a more thorough enterprise analysis and give the producer an estimate of cash flows independent of short-term management decisions.

TABLE OF CONTENTS

List of Figures v

List of Tables vi

Acknowledgments viii

Chapter I: Introduction 1

Chapter II: Land Values 3

2.1 U.S. Farm Assets 3

2.2 U.S. and Montana Cropland Values 4

Chapter III: Literature Review 6

Chapter IV: Data 16

4.1 Crop Yields and Prices 16

4.2 Direct Input Costs 20

4.2.1 Fertilizer 20
4.2.2 Crop Protection Products 22
4.2.3 Machinery Costs 24
4.2.4 Seed Costs 24

Chapter V: Methods 25

5.1 Regression 25

5.2 Simulation 29

5.3 Net Present Value 40

5.4 Sensitivity Analysis 42

5.5 Tax Deductibility of Interest Payments 43

5.6 Other Assumptions 43

Chapter VI: Results 45

6.1 Results 45

6.2 Analysis and Model Limitations 46

Chapter VII: Conclusion 50

References 52

Appendix I: Crop Yield Correlation Matrix for Sheridan County, Montana 54

Appendix II: Crop Yield History For Sheridan County, Montana 1990-2013 (bu/acre) 55

Appendix III: Correlation Matrix for Selected Crop Prices Received, Sheridan County, Montana 2006-2013 56

Appendix IV: Correlation Matrix for Selected Lagged Crop and Fertilizer Prices 57

LIST OF FIGURES

Figure 2.1: Real Estate as a Percentage of Total Farm Assets, U.S. 1960-2014.............3
Figure 2.2: U.S. and Montana Cropland Value per Acre, 1997-2014 ($US)...................5
Figure 4.1: Wheat Yield Trends, Sheridan County, Montana 1990-2013 (bu/acre)....17
Figure 4.2: Pea, Lentil, and Flax Yield Trends, Sheridan County, Montana 1990-2013 (bu/acre)....................18
Figure 4.3: Wheat Prices Received, Sheridan County, Montana, 1949-2013 ($/bushel)....................19
Figure 4.4: Pea, Lentil, and Flax Prices Received, Sheridan County, Montana, 1991-2013 ($/bushel)....................20
Figure 4.5: Urea Price Trend 1960-2013 ($US/ton)....................21
Figure 4.6: Diammonium Phosphate Price Trend 1965-2013 ($US/ton)....................21
Figure 4.7: Crop Protection Cost Price Trends 2004-2014 ($US/acre)....................23
Figure 5.1: Distributions For Crop Yield, Prices, and Fertilizer Prices....................31
Figure 5.1: Distributions For Crop Yield, Prices, and Fertilizer Prices (continued)...32
Figure 5.1: Distributions For Crop Yield, Prices, and Fertilizer Prices (continued)...33
Figure 5.1: Distributions For Crop Yield, Prices, and Fertilizer Prices (continued)...34
Figure 5.1: Distributions For Crop Yield, Prices, and Fertilizer Prices (continued)...35
Figure 5.1: Distributions For Crop Yield, Prices, and Fertilizer Prices (continued)...36
Figure 5.2: Cumulative Probability Distribution of Expected Gross Profit, by Crop.39
Figure 5.3: Cumulative Probability Distribution of Expected Gross Profit, Weighted by Cropping Pattern....................39

LIST OF TABLES

Table 2.1: Total Farm Sector Assets and Real Estate's Share of U.S. Farm Sector Assets 2010-2013 ($US 1,000) 3

Table 4.1: Summary Statistics for Selected Crop Yields in Sheridan County, Montana (bushels/acre).......... 17

Table 4.2: Summary Statistics for Selected Crop Price Received Data for Sheridan County, Montana, 2006-2013 ($/bushel) 18

Table 4.3: Summary Statistics for Urea and DAP prices, 2005-2013 ($US/ton).......... 22

Table 4.4: Summary Statistics of Crop Protection Costs, 2004-2014 ($US/acre) 23

Table 4.5: Summary of Custom Machinery Work Hired Costs 24

Table 4.6: Minimum and Maximum Cost for Seed ($US/acre) 24

Table 5.1: Regression Statistics Using Spring Wheat Yield As Independent Variable to Predict Crop Yield 26

Table 5.2: Regression Statistics Using Spring Wheat Price Received as Independent Variable to Predict Crop Price Received.......... 27

Table 5.3: Summary Statistics for Corn Average National Price Received, Marketing Year 1994-2013 ($US/bu).......... 28

Table 5.4: Regression Results for Lagged Corn Price as Independent Variable to Predict Fertilizer Prices 28

Table 5.5: Partial View of Gross Profit Simulation Data Table in Excel 37

Table 5.6: Summary Statistics of Simulated Gross Profit ($US/acre) 37

Table 5.7: Crop Rotation Weightings for Selected Crops in Calculating Average Expected Gross Profit Per Acre 38

Table 5.8: Calculation of Expected Gross Profit ($US/acre).......... 38

Table 5.9: Simple Example of Net Present Value Calculation Using Excel 41

Table 5.10: Example of Sensitivity Analysis Using Discount Rates and Net Present Values 42

Table 6.1: Initial Inputs into NPV Model Calculations 45

Table 6.2: Results of Using Goal Seek to Set NPV of Project to $0.......... 46

Table 6.3: Truncated Spreadsheet Model Showing Cash Flows at Select Time Periods 46

Table 6.4: Sensitivity Analysis of Debt Financing Costs and Discount Rates on NPV 47

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CHAPTER I: INTRODUCTION

Land is arguably the most important asset class for production agriculture, for without land, farmers and ranchers could not grow food necessary to feed the world. Even though it is a critical component for any farming operation, it is one of the most difficult assets to acquire and requires increasing amounts of capital. Since the size of commercial operations has continued to increase due to consolidation, the financial impact of a land purchase has increased in value dramatically over recent years, magnifying potential returns as well as losses. A key consideration, whether renting or buying, is how much to pay. While many factors affect the decision to buy, this thesis will address the purchase question through the use of financial tools such as net present value (NPV) and simulation to help farmers determine what price they could pay for a particular property and still expect a positive return on their investment.

Since the concern is with the direct cash flow from a particular property, the model ignores overhead and operating costs that are not necessary to produce a crop. Therefore, such expenses as crop insurance, management, and overhead are ignored since they are management choices independent of price and yield; however, these should be considered as part of a complete analysis prior to purchasing a particular farm. The techniques discussed in this thesis are calculated on a per acre basis, and the final discounted cash flow model allows the user to enter the amount of acres being considered to provide a meaningful scale to the numbers. The intent of this thesis is to provide a solid conceptual model to determine cash flow using county and state level data. Producers can then enter specific information into the model to provide a value tailored to their particular circumstances; in fact, this model would be most accurate with grower information for the specific farm under consideration.

Modern agriculture is a capital-intensive operation, and real estate is the majority of asset value on the US farmer’s balance sheet. Chapter II begins by examining recent trends in farmland values on a national basis before moving to values specific to Montana. After an overview of these trends, Chapter III reviews selected literature; Chapter IV exhibits the data that is subsequently used in Chapter V to provide an explanation of the methods employed to develop the model to calculate an expected net present value. Chapter VI presents the results and analysis of using this expected value in the NPV model, as well as a discussion of the limitations inherent in this type of analysis. Chapter VII concludes the discussion of the model and provides some topics for future research.

CHAPTER II: LAND VALUES

2.1 U.S. Farm Assets

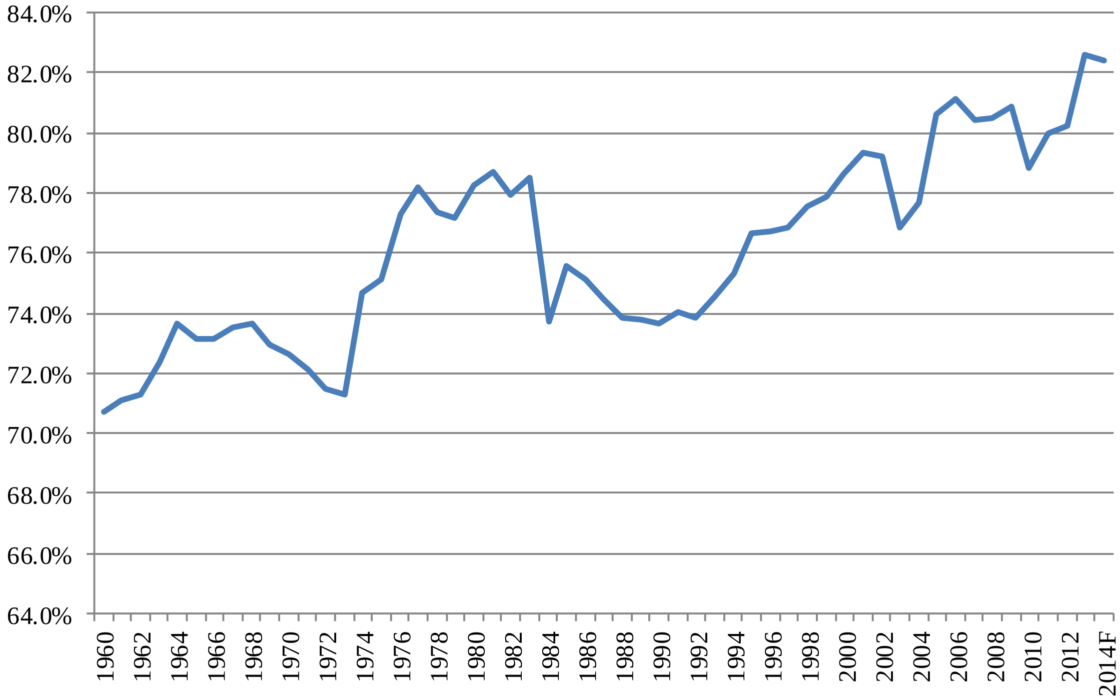
According to the United States Department of Agriculture's Economic Research Service, land is the single most valuable asset class on the US farm balance sheet with a gross value of $2.3 trillion nationwide in 2013. Real estate represents 83% of the value of total farm assets in this period, a proportion that has been increasing since 1960. Table 2.1 and Figure 2.1 illustrate trends in these values (USDA-ERS 2014).

Table 2.1: Total Farm Sector Assets and Real Estate's Share of U.S. Farm Sector Assets 2010-2013 ($US 1,000)

	2010	2011	2012	2013
Farm Sector Assets	2,313,227,907	2,478,046,166	2,734,400,674	2,886,548,026
Real Estate	1,823,264,197	1,981,972,765	2,193,965,395	2,384,831,345
Real Estate as Percent of Total	79%	80%	80%	83%

Source: USDA-ERS

Figure 2.1: Real Estate as a Percentage of Total Farm Assets, U.S. 1960-2014



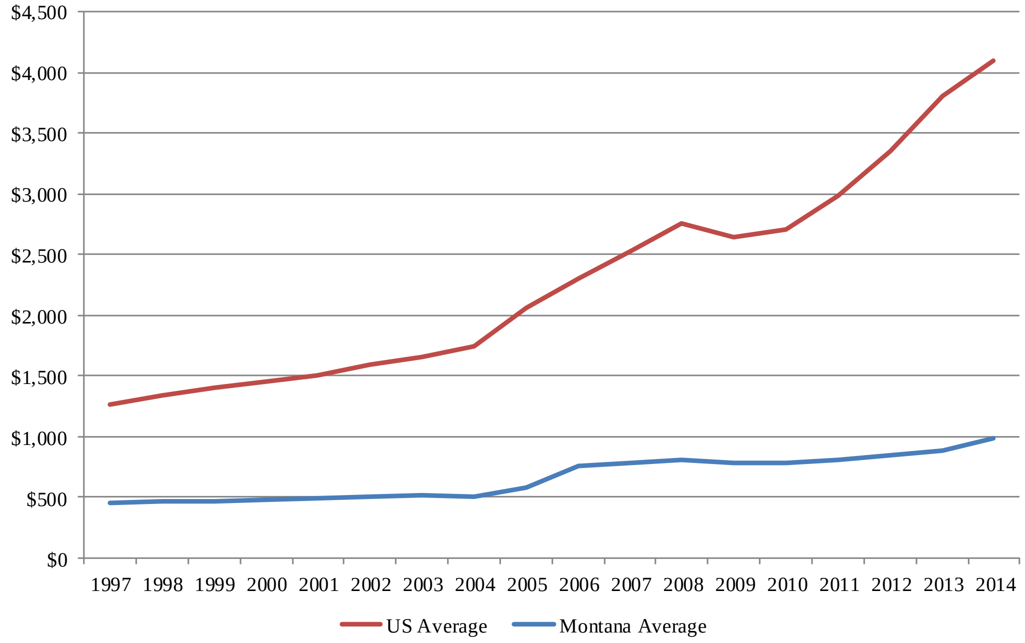
As can be seen in Figure 2.1, real estate has increased as a percentage of total farm assets from 1960 to 2014 (2014 is USDA's forecast). This is likely due in part to a rise in cropland value.

2.2 U.S. and Montana Cropland Values

The average value of cropland in the US has increased dramatically over the 1997-2014 period, rising from $1,270 per acre in 1997 to $4,100 in 2014. This may be due to several factors including increasing investor interest in cropland as well as higher profit margins in general for farmers, which drives up prices. From 1997-2014, on a national level, cropland exhibited an average annual growth rate of 7.25%.

Mirroring the national trend, Montana cropland values have also increased over this period, albeit not as fast or as high, with a statewide average value of $978 per cropland acre in 2014. This includes both irrigated and non-irrigated cropland; it would be expected that irrigated land commands a premium compared to non-irrigated land. In 2014, the average value of non-irrigated cropland in Montana was $800 per acre, while that of irrigated cropland was $2,950 per acre. Figure 2.2 compares recent price trends for national and Montana average cropland values for the period 1997 through 2014.

Figure 2.2: U.S. and Montana Cropland Value per Acre, 1997-2014 ($US)



As illustrated in Figure 2.2; Montana cropland did not appreciate as quickly as the nationwide average over this time period, exhibiting an average annual growth rate of 3.78%, significantly less than the national average of 7.25%. This may be due to the lower average productive capacity of Montana cropland compared to the US average, which is influenced by the corn-producing states of the Midwest. Thus, higher relative profit margins for corn and soybean production during 2005 to 2010 could explain some of the divergence in growth rates for Montana versus the nation as a whole, since Montana isn't a significant producer of these crops.

CHAPTER III: LITERATURE REVIEW

There is a plethora of material regarding valuation approaches to farmland, many using net present value analysis. While it is difficult to model projected cash flows with certainty; this section contains a brief review of selected literature related to the topic of farmland valuation.

According to Forster, absence the potential for land redevelopment, farm real estate values are a function of the expected future net returns from crop and/or livestock production. Factors affecting land value include soil productivity, climate, and proximity to markets. Real interest rates also affect farmland values, that is, a lower real interest rate implies a higher land value for a given property, and vice versa. Real options also may play a role in farmland values, providing the owner of the land the option to repurpose the property at some point in the future. Returns to farmland also compare favorably to other potential investments, such as bonds or Treasury Bills. Farmland has historically exhibited less risk, measured by price variation, than stocks and is seen as a hedge against inflation; as well as exhibiting low correlation with other investment types, leading one to believe that some of the value applied to a given property is due to diversification benefits and not necessarily cash flow (Forster 2006).

In their 2003 paper titled *What's Wrong with Our Models of Agricultural Land Values*, Goodwin, Mishra, and Ortalo-Magne, using a multiple regression model, analyzed a sample of 13,606 farms across the United States to determine effects of various sources of cash flow on land values. In this study, they examined not only cash flows from sales of crops produced but also cash received from government payments. In particular, they discuss the issues surrounding farm policy and its potential effects on land values, examining the effects from five types of government payments: payments received under the production flexibility provisions of the 1996 Federal Agricultural Improvement and Reform (FAIR) Act, loan deficiency payments (LDP), disaster payments, Conservation Reserve Program (CRP) payments, and an aggregate of all other program payment types. They also suggest that inasmuch as policies that transfer income to farmers are capitalized into land prices; it is landowners, rather than producers, who ultimately benefit in the form of higher selling prices. They also discuss the concept of different discount rates for each cash flow source (i.e. crop sales versus government payments) to reflect the difference in uncertainty for those cash flows. In their analysis, they also take into account the possibility of farmland being repurposed in the future, such as for commercial or residential real estate development. They point out, as with all projections, the assumptions about future cash flows being a fundamental difficulty with the discounted cash flow model, and failing to account for future payments is parallel to the omitted variable problem in econometric analysis. They treat the various sources of payments from the government differently (e.g. CRP payments and LDP payments), which they state can compound the missing variable problem and lead to multiple explanatory variables error.

All of their models include, as the basis, net returns computed using the farm's average relative yield and weighted average normalized commodity price. Farmers self-reported via the USDA Agricultural Resource Management Survey what they felt was the value of their land.

The first model in Goodwin, Mishra and Ortalo-Magne included an aggregate measure of total government payments and omitted any nonagricultural factors that may affect land values. In this analysis, an additional dollar per acre government payment implied an increase in land values of $4.69 per acre. The second model included variables to capture effects of nonagricultural factors, such as redevelopment potential. In this case, each additional person per square mile in the county (on average) increased the land value by $2.07 per acre; while an increase in the growth rate of the county population by each 1% increased the land value by $59.59 per acre. Their third model addressed the effects of each type of government program (LDP, Disaster, Agricultural Market Transition Act [AMTA], and Other) and found that LDP payments had the greatest effect; increasing the value of the land by $6.55 per acre for each dollar received. They found that CRP payments reduced the land value by $15.15 per acre for each dollar received, which would be expected since the CRP program is designed to remove marginal quality land from production. They caution, however, that cash flow can vary greatly from year to year and their results change as commodity prices vary. Their study showed regional variability in results, with the Northern Great Plains exhibiting lower values in general versus the Heartland (regions defined by USDA-ERS as having relatively homogeneous growing conditions) while also exhibiting a greater response to potential for development. They found cash flows from government programs affect land values, however, they caution that their model contains inherent limitations due to the uncertainty surrounding expected cash flows that may or may not come to fruition (Goodwin, Mishra and Ortalo-Magne 2003).

Regarding the briefly aforementioned real options, Turvey (2002) discusses in his working paper the theory that observed land prices are systemically higher than their fundamental value (as measured by NPV) due to the presence of real options arising from uncertainty regarding future cash flows. The benefit of this option typically accrues to the seller, who can postpone the decision to sell; whereas the buyer doesn’t (usually) hold a similar option to postpone the purchase. He suggests that researchers have been unable to show a correlation between cash flows and market values of farmland due to the presence of uncertainty regarding those cash flows, illustrating a wedge between the econometrically modelled prices and what is believed to be rational by present value analysis. He posits this is due to the seller holding what is essentially a perpetual American-style put option; which can help explain some of the discrepancy between fundamental valuation and actual values. To convince the seller to sell the property, the (potential) buyer must buy the present value of all expected future cash flows, plus part or all the “premium” of the real option.

Turvey applied this analysis technique, based on Dixit and Pindyck’s real options framework (Dixit and Pindyck 1996) to a sample of farmland prices in Ontario and found it useful in explaining some of the discrepancy between predicted and actual values. He argues there must be some reason that land with no cash generating capacity is generally not “given” away, and suggests that this is due to the owner’s sunk costs in the property and the presence of a real option, representing the hope or belief that prices will rise high enough in the future to justify converting the land back into production. He asserts that bubbles, defined as asset prices that exceed their predicted values, can be explained in part by hysteresis as an extreme form of a real option, providing a better explanation than time-varying discount rates or government programs. He contends real options help explain some of the uncertainty in land transactions with regards to timing of the land sale and resulting loss of potential future cash flows due to the irreversibility of the land sale when completed. The economic result of the theory of real options is that the holder of the land has a valuable option to postpone the sale while the buyer possesses no such asset. Option values increase as risk and/or growth rates increase or the cost of capital decreases, which can alter the value of the real option (and underlying fundamental value) depending on current expected future outcomes.

Using Ontario data from 1975 to 1998, Turvey found that for 9 years the market value of land was very close to the predicted values using fundamental analysis plus a real option. In 15 of 24 years the market price was no more than 1.5 times the economic value of the land, while in 9 of 24 years the results supported the existence of a speculative bubble in farmland prices. He feels the presence of a bubble does not refute the theory behind his analysis; only that speculative fervor has led to a mispricing of either the fundamental value, real option value, or both. He does admit to some shortcomings in his paper, however, namely to understand why bubbles exist in the first place and how persistent is the hysteresis argument; as well as the easily questionable assumption that there is a perfect correlation between cash flows and land values at a given moment in time (Turvey 2002). It is also reasonable to assume that different inputs into the NPV model could dramatically affect the final value for a given property, leading to under- or overvaluation.

Falk and Lee suggest that farmland valuation has three components: permanent fundamentals, temporary fundamentals, and nonfundamentals. Each of these three components exhibits some effect on farmland prices. Shocks that alter each of these can change the value that is assigned to a particular piece of farmland. A fundamental shock is one that may influence the paths (up or down) of interest rates or rental rates for farmland. Examples of each type of change, or shock, that could alter farmland values: permanent fundamental changes could be breakthroughs in crop genetics, climate change, trade agreements, or new medical findings that increase demand for a particular crop type.

Temporary fundamental shocks might be seasonal weather variations, changes in food fads, or new tools that temporarily increase productivity. Nonfundamental shocks are those that influence the path of price, but not of rents or interest rates. The study's authors liken them to the "animal spirits" that are viewed as much of the source of volatility in stock markets. By examining farmland rent and price data for Iowa from the period of 1922-1994; they found that nonfundamental shocks account for 50% of year to year price volatility in farmland prices, although this decreases over time until only representative of 11% of variance at the 24 year level. Conversely, permanent fundamental shocks explain nearly 85% of the 24 year forecast variance in price. Thus, fads (nonfundamental shocks) and overreactions (to temporary fundamental shocks) explain a greater proportion of short run price movements than they do long run price movements of farmland values (Falk and Lee 1998).

Moss examined the sensitivity of farmland values to changes in inflation, returns, and the cost of capital, finding that inflation provided the most information on farmland values; although some regional variations existed. Most studies he analyzed showed that farmland values increased with returns and declined with rising interest rates; although one study concluded that values overreact in the short term to changes in market fundamentals. His study reexamines farmland valuation by exploring the explanatory power of returns to agricultural assets, interest rates, and inflation vis a vis each other. He utilized Theil's bits of information concept when explaining his regression results on a state, regional, and national basis. For Florida, the focus of his study, returns to agricultural assets provided 14.17% of the bits of information, while the cost of capital contributed 6.13% and the rate of inflation provided 79.7% of the information. More generally, inflation explains the greatest proportion of land value, although it ranges from 6.33% in Maryland to 98.13% in Tennessee. Returns to assets ranged from 0.07% in Virginia to 73.31% in New Jersey; while cost of capital ranged between 0.17% in Tennessee to 90.48% in Maryland. His research suggests that the cost of capital contributes more to explaining land values than does returns to agricultural assets, as shown by the higher median value (8.48% vs 2.6%, respectively). Regional results generally followed the same pattern as the state-by-state comparisons, although Moss did find two exceptions: the relative explanatory power of inflation is approximately 80% except in the Northeast and Southern Plains, which are 39% and 61.4%, respectively; while the Appalachian region has a significantly higher value of 91.2%. In the Northeast region, the cost of debt capital is the most significant explanatory variable instead of inflation, primarily due to its high level of effect on one of the constituent states, Maryland. The Corn Belt and Delta States regions are more sensitive to returns on assets and possess a greater proportion of government income as a percentage of net farm income. Overall, inflation is the greatest explanatory variable of changes in farmland values in this study, although regional differences exist. Specifically, a higher explanatory power for agricultural returns tends to be found in regions that have a greater proportion of government payments as a share of net farm income (Moss 1997).

De Fontnouvelle and Lence found that the constant discount rate present value model (CDR-PVM) should be rejected through an empirical analysis; however, when the model includes transaction costs the behavior of actual land prices is consistent with the CDR PVM that is commonly applied to farmland valuation. They report previous research that shows transaction costs average 3% of the land value before brokerage fees, which range from 3 to 10% of the value in addition to other transaction costs; although it can be as high as 15% in certain markets. Using kernel regression techniques and a sample of twenty states as well as a national data set, they found that the frictionless (that is, no explicit transaction costs included) model is strongly rejected for the U.S. as a whole, as well as for a majority of states. As an aside, they do note that although the frictionless CDR PVM can be rejected for farmland, it cannot be rejected for farm assets (which include inventory and machinery). They also note that studies have shown that land sold privately, as opposed to through a broker, sells at a discount to comparative broker-led sales, lending support to the transactions costs argument. Of the twenty states and the U.S. total farm real estate assets analyzed, they found that models including transactions costs performed better for the U.S. total in all but four individual states (de Fontnouvelle and Lence 2002).

The most recent analysis of farmland values examined was that of Nickerson et al. Like many others, they examined the extent to which farmland values are influenced by factors that drive expected cash flows; such as soil productivity, proximity to delivery points (ie elevators), and potential for redevelopment. Their study found that there are periods when the farmland values have been supported by underlying factors, although periods exist where values do not exhibit such a relationship. On a national level, they found that prices in 2009-2010 are consistent with fundamental values; but over the periods 2005-2008 and 1978-1985 land was valued higher than fundamentals would suggest. There are, however, regional and local differences, and valuation of a particular parcel is dependent upon factors affecting that specific parcel, as would be expected. For example, higher producing land is valued higher than lower producing land; and land closer to urban centers is valued higher than land more distant from urban centers. This relationship was strengthened as the farmland in question increased its distance from urban areas, especially those more than 40 miles from population centers with greater than 50,000 residents, although regional differences exist. As found in previous studies, there is also a correlation that varies by region and payment type for government payments and cropland values. Other nonfarm income sources also affect cropland, particularly in the Southern Plains regions, where income streams such as hunting leases contribute to increasing values. Indeed, in the rent-to-value (RTV) approach to farmland valuation, they state that there is a decreasing RTV ratio. For instance, if all rents were applied to the purchase price of farmland, in 1951 the parcel would pay for itself in about 14 years, but this had risen to more than 33 years by 2007, giving support to the theory of factors besides productivity in the form of crop cash flows as a major determinant of farmland values. They found that farm operators who owned land and acquired it from relatives (versus non-relatives) paid less that those who purchased from unrelated parties.

Nickerson et al found that more productive soils are correlated with higher farmland values, which is not surprising and is consistent with the present value theory of expected future cash flows. They conclude with the observation that while in recent years (relative to the study’s publication date) farmland values are supported by fundamental measures (i.e. cash flows from operating income), in longer terms the trend is for farmland values to become less correlated with fundamentals and thus more susceptible to influences of outside factors (2012).

As can be seen by this review of selected related research works, there are many factors that influence the price of farmland, ranging from traditional measures such as net present value of expected cash flows available to operators, real options available to landowners, and the effects of interest rates. Inflation, the cost of capital, and the proximity to urban centers also exhibit influences on the values placed on farmland. Several of the studies also referenced works suggesting that transactions between related parties usually had lower land selling prices when compared to nonrelated party transactions. All of these factors affect the net present value of the investment in farmland, either by increasing the income (i.e., urban proximity, higher land productivity) or by decreasing the expenses (i.e., lower cost of capital, lower inflation).

CHAPTER IV: DATA

The objective of this thesis is to determine the net present value for farmland using a simulation-based cash flow model. To determine this, cost data is needed to provide direct expenses, and yield and price data to determine gross income; subtracting the direct expenses from gross income to arrive at a gross profit per acre. For the purposes of this thesis, overhead costs such as insurance and management are fixed. A more complete enterprise analysis would include these costs and more; however, the purpose is to determine the relative value of a particular piece of cropland, independent of other management decisions. Simulation is used to determine an expected outcome of gross profit, and this value is entered into the net present value model.

Data used in this thesis were collected from a variety of sources in the public domain. Cost data for fertilizer prices were obtained from USDA's Economic Research Service online database, and yield information and price received data are county-level for Sheridan County, Montana; retrieved from USDA's National Agriculture Statistics Service. Crop protection data is from North Dakota State University's (NDSU) projected crop budgets for the northwest region of North Dakota. Custom farming rates are also from NDSU's survey of rates paid by farmers. These sources were chosen for two reasons: first, to protect individual information; and second, the larger datasets provide a greater number of observations for statistical analysis than is available from personal experience.

4.1 Crop Yields and Prices

Gross sales for cropland are determined from two factors: price and yield. Table 4.1 summarizes the yield data for Sheridan County, which is then used in the simulation.

Table 4.1: Summary Statistics for Selected Crop Yields in Sheridan County, Montana (bushels/acre)

	Durum	Spring Wheat	Lentils	Peas	Flax
Year Range:	1990-2013	1990-2013	1999-2013	1998-2013	1990-2013
Average:	27.4	27.3	20.8	24.7	18.6
Standard Deviation:	4.8	5.6	4.9	5.8	2.4
Maximum:	34.4	39.9	27.8	33.5	24.0
Minimum:	17.0	20.0	10.7	13.3	14.5
Range:	17.4	19.9	17.2	20.2	9.5
Coefficient of Variation:	0.175	0.206	0.237	0.236	0.129

These crops were chosen as they are the most commonly grown in the area due to climatic and logistic considerations. By observing trends in yields, it can be observed that they appear to be relatively range bound over time, as shown in Figures 4.1 and 4.2.

Figure 4.1: Wheat Yield Trends, Sheridan County, Montana 1990-2013 (bu/acre)

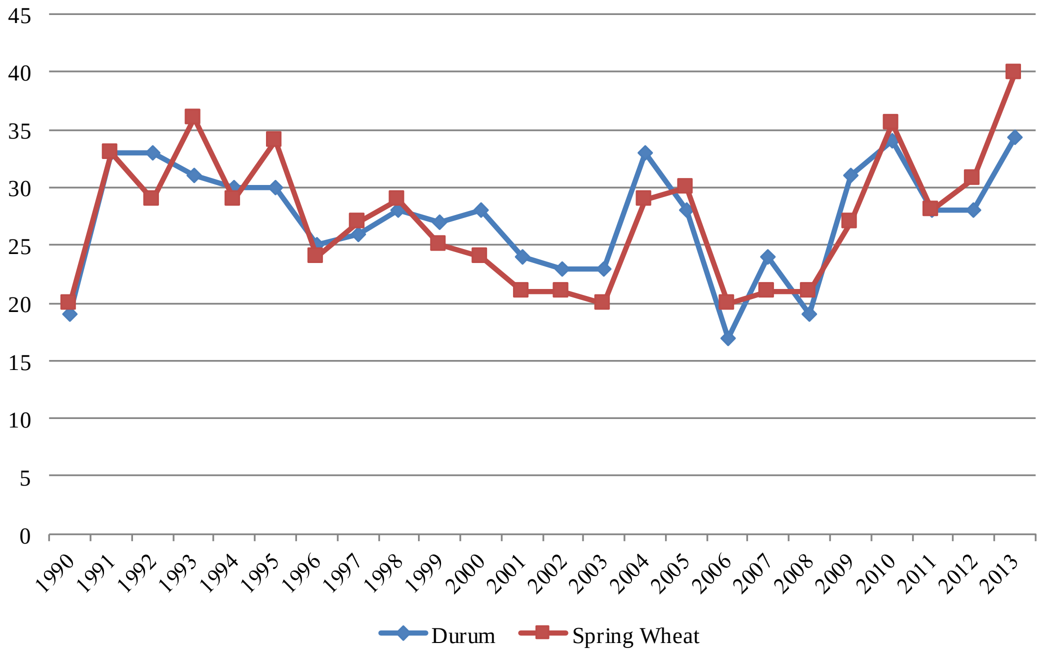
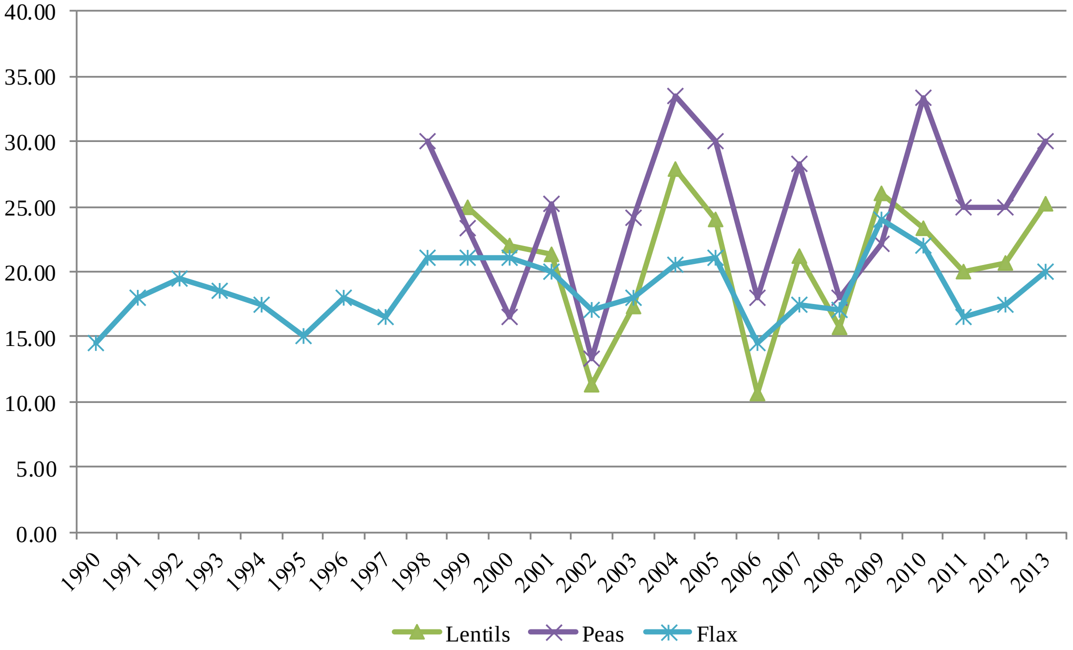


Figure 4.2: Pea, Lentil, and Flax Yield Trends, Sheridan County, Montana 1990-2013 (bu/acre)



To calculate gross income, NASS marketing year price received data was used instead of futures prices for two reasons: first, futures markets do not exist for any of the crops in Table 4.1 except spring wheat, leading to a lack of data; and second; the county level price would, in theory, more accurately reflect basis levels and quality adjustment factors. Table 4.2 shows summary statistics for prices received.

Table 4.2: Summary Statistics for Selected Crop Price Received Data for Sheridan County, Montana, 2006-2013 ($/bushel)

	Durum	Spring Wheat	Lentils	Peas	Flax
Average:	7.56	6.93	13.51	7.05	11.67
Standard Deviation:	2.13	1.29	4.20	1.93	3.02
Maximum:	10.30	8.39	20.94	8.88	13.90
Minimum:	4.61	4.58	6.48	3.98	5.80
Range:	5.69	3.81	14.46	4.90	8.10
Coefficient of Variation:	0.281	0.187	0.311	0.273	0.259

Prices received data were used for this time period following an examination of historical data. Prices appear to reach a new, higher trading range during these years compared to previous years, as shown in Figures 4.3 and 4.4.

Figure 4.3: Wheat Prices Received, Sheridan County, Montana, 1949-2013 ($/bushel)

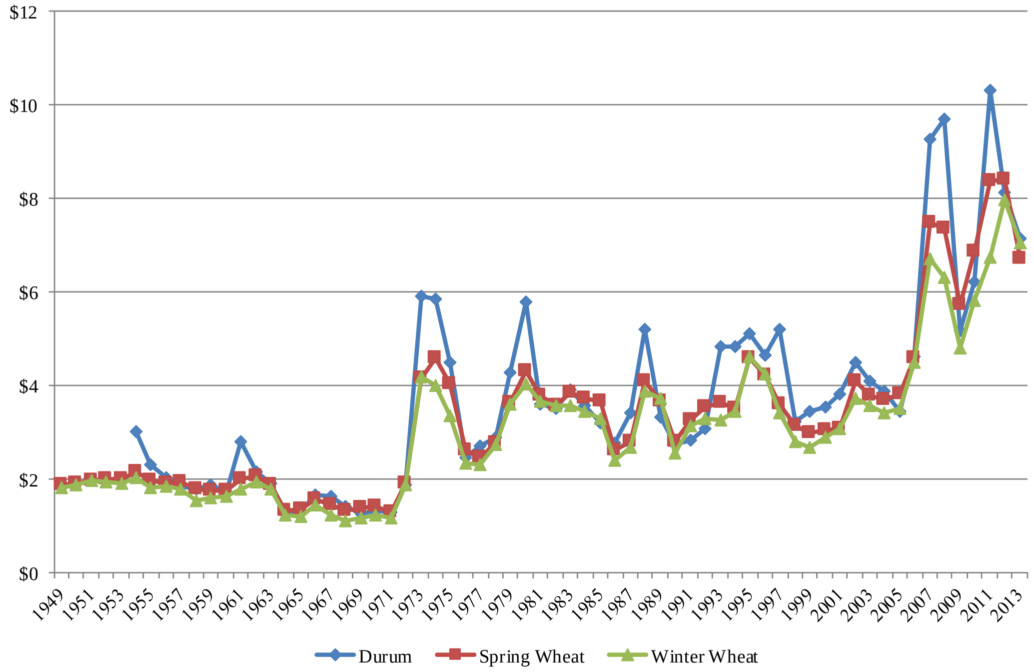
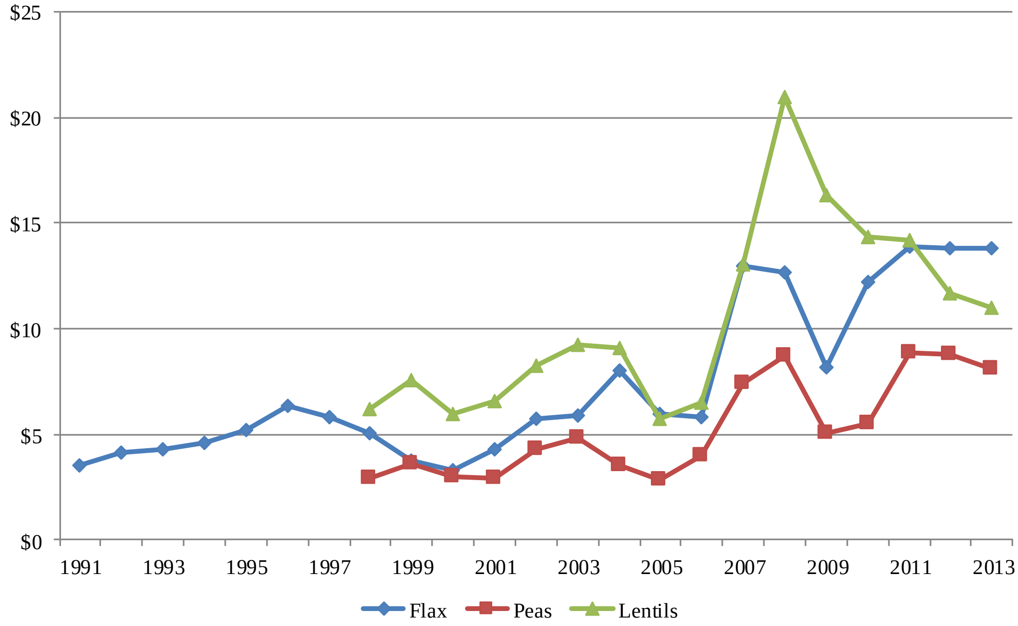


Figure 4.4: Pea, Lentil, and Flax Prices Received, Sheridan County, Montana, 1991-2013 ($/bushel)



Whether these price trends will continue to be high remains to be seen, and substituting an older, lower price range for the newer, higher one could provide an interesting topic for a sensitivity analysis.

4.2 Direct Input Costs

Section 4.1 provides insight on the income side; and now we turn our attention to the other component: costs. As previously stated, this analysis is concerned with direct cash flow per acre, fixing other management decisions such as overhead. Primary components of direct costs include fertilizer, crop protection products, allowance for machinery, and seed. These are determined to be the direct inputs that affect profitability and are under direct control of the farmer.

4.2.1 Fertilizer

To develop the fertilizer cost component of the model, historical prices from USDA's Economic Research Service for urea and diammonium phosphate (DAP) were obtained. These two are the most common fertilizer types applied to small grains in Montana. Figures 4.5 and 4.6 show price trends for urea and DAP, respectively.

Figure 4.5: Urea Price Trend 1960-2013 ($US/ton)

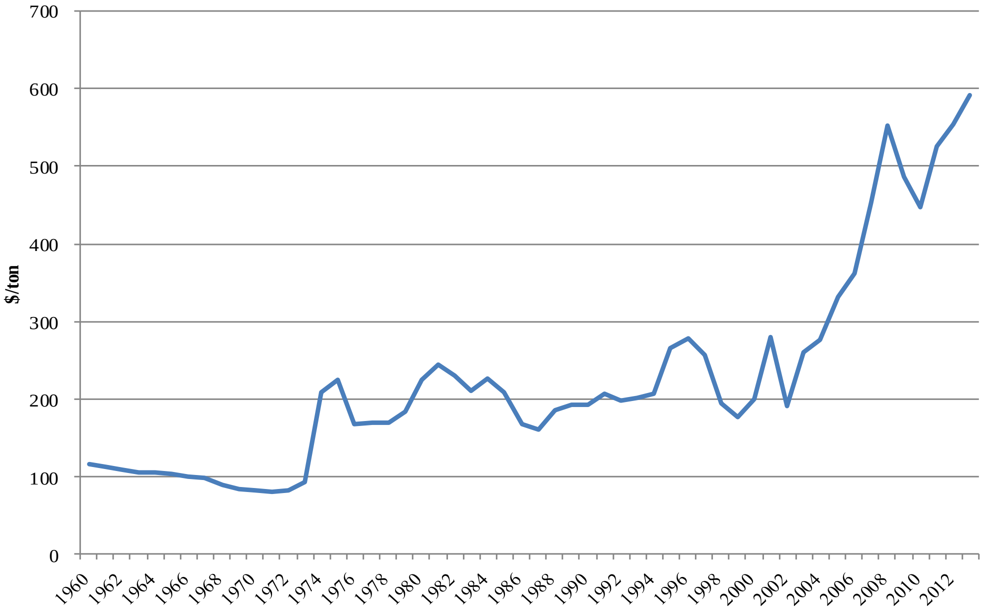
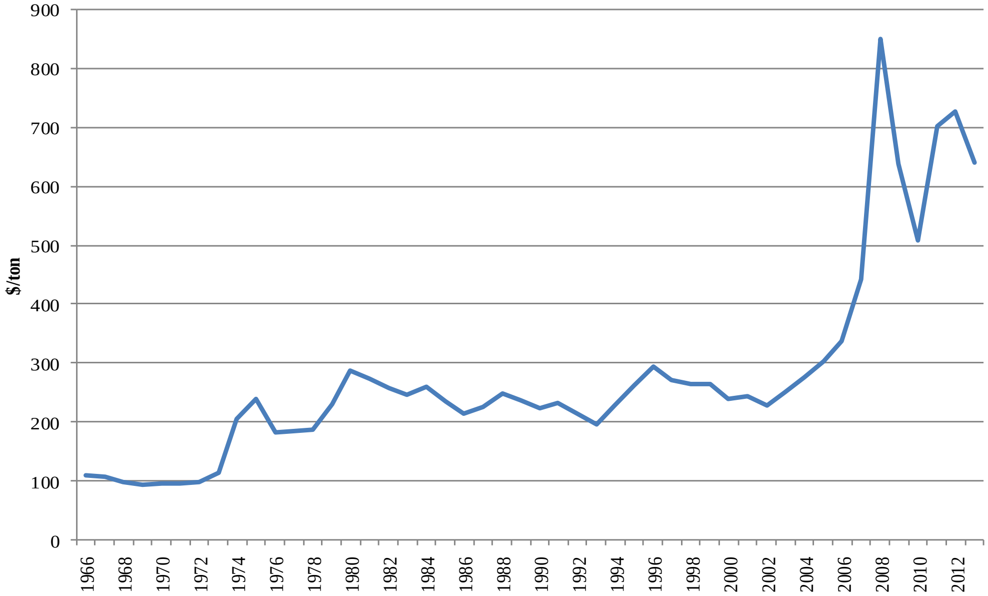


Figure 4.6: Diammonium Phosphate Price Trend 1965-2013 ($US/ton)



As can be seen in the Figures 4.5 and 4.6, prices have dramatically increased since 2005, from a high of roughly $300/ton in the preceding years to approximately $850/ton in 2008 for DAP; and roughly $250/ton to a high of $600/ton for urea. As with the grain prices received, it would be useful to examine the effects of different price ranges for the types of fertilizer to see the subsequent effect on NPV. It can be noted that fertilizer prices exhibit an upward shift in cost roughly parallel to the timeframe that prices received for crops also appear to shift to a higher trading range (see Figures 4.3 and 4.4 for crop prices received). For this analysis, as with crop prices, we will initially use the higher trading range. Table 4.3 shows summary statistics for both fertilizer types for this time period (2013).

Table 4.3: Summary Statistics for Urea and DAP prices, 2005-2013 ($US/ton)

	Urea	DAP
Average:	478	571
Standard Deviation:	88.7	185.6
Maximum:	592	850
Minimum:	332	303
Range:	260	547
Coefficient of Variation:	0.186	0.325

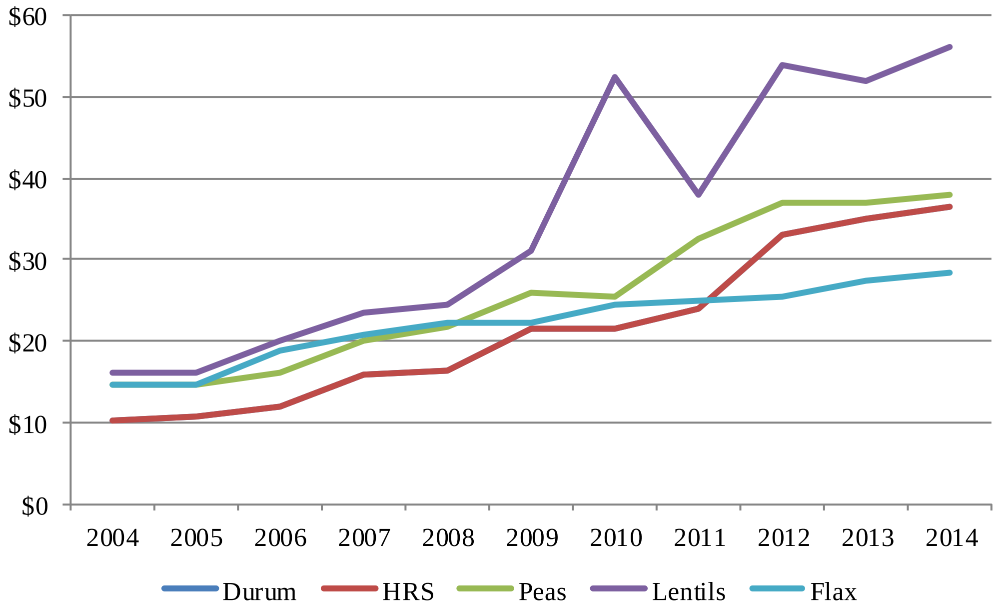
4.2.2 Crop Protection Products

Data for crop protection (fungicides, herbicides, and insecticides) was obtained from North Dakota State University’s crop budgets for the Northwest Region of the state; which is immediately adjacent to Montana and has a similar cropping mix and climate. Data were available for each crop type from 2004-2014. Summary statistics for per acre costs for each crop type are shown in Table 4.4; price trends are shown in Figure 4.7.

Table 4.4: Summary Statistics of Crop Protection Costs, 2004-2014 ($US/acre)

	Durum	HRS	Peas	Lentils	Flax
Average:	21.49	21.49	25.72	34.90	22.19
Standard Deviation:	9.71	9.71	9.16	16.11	4.65
Maximum:	36.50	36.50	38.00	56.00	28.30
Minimum:	10.20	10.20	14.64	16.14	14.71
Range:	26.30	26.30	23.36	39.86	13.59

Figure 4.7: Crop Protection Cost Price Trends 2004-2014 ($US/acre)



As can be seen in Table 4.4 and Figure 4.7, cost per acre has been increasing relatively consistently over the last decade. Since durum and HRS (spring wheat) are similar crops that use similar products, they are not distinguishable from each other in Figure 4.7. It should be noted in this model, we are not explicitly accounting for this trend. Instead, we are randomizing the per acre expenses on a given year for two reasons: first, the university data doesn't account for the use of generic products, which offer a significant cost savings compared to name brand products when available; second, products applied depend upon what environmental and pest pressures are observed in a given year, which is difficult to forecast prior to field scouting.

4.2.3 Machinery Costs

To provide an allowance for machinery costs (small grains must be planted and harvested to have inventory that can be converted into cash); the model assumes custom rates for four operations: planting, pre-plant and in-crop application of crop protection products, and harvest. These are taken from custom rates calculated by the NDSU Extension service, and are summarized in Table 4.5 (Aakre 2014).

Table 4.5: Summary of Custom Machinery Work Hired Costs

Operation	Per Acre Cost
Planting	$16.92
Sprayer (2 applications)	$5.97
Harvest	$29.70

4.2.4 Seed Costs

Seed costs are estimated by using the market year’s average price and adding cleaning and handling costs for each particular crop. For all crops, it was estimated to be $1.50 per bushel for cleaning and handling expenses. This cost is added to the simulated price received to arrive at the total seed cost (per acre). Table 4.6 displays the minimum and maximum value that each crop will cost using this method, on a per acre basis.

Table 4.6: Minimum and Maximum Cost for Seed ($US/acre)

	Durum	Spring Wheat	Peas	Lentils	Flax
Minimum	$5.86	$5.83	$7.73	$7.98	$7.30
Maximum	$11.55	$9.64	$12.63	$22.44	$15.40

CHAPTER V: METHODS

Utilizing the data outlined in Chapter IV, we now turn to the tools that are used to answer the question: what can we expect to pay for a particular piece of farmland and be confident our investment will be profitable?

5.1 Regression

Regression is an essential component of econometrics; its purpose is to quantitatively illustrate a general relationship among variables. Specifically, regression analysis is a statistical technique used to try and explain movements in a "dependent" variable using "independent" or "explanatory" variables. This involves a three step process:

1. Specify the model or relationships to be studied
2. Collect the data needed to quantify the models, and
3. Quantify the models using the data.

For this specific case, in Step 1; we use regression to determine the extent to which crop yields move together and the extent to which fertilizer prices are also influenced by crop prices. Here, we are assuming that crop yields tend to move together, especially in this case where we are looking at a narrow geographic scope (see Appendix V for a correlation matrix for crop yields in Sheridan County, Montana). We will use spring wheat as our independent variable, and then test the predictive ability of spring wheat yield versus yields of our other crops. The general relationship is illustrated in the following equation:

$$Y_x = f(Y_S)$$

Where Y_x is the county average yield for crop "x" (durum, peas, lentils, or flax), and Y_S is the county average yield for spring wheat.

Step 2, data collection, is discussed in Chapter IV, so we move to Step 3, inputting this data into a software tool capable of statistical analysis; such as Excel or Stata. We estimate four models, using spring wheat yields to predict the yields of durum, peas, lentils, and flax for a given year. Table 5.1 summarizes the regression results.

Table 5.1: Regression Statistics Using Spring Wheat Yield As Independent Variable to Predict Crop Yield

Dependent Variable	Coefficient	T-statistic	P-value	Maximum Residual	Minimum Residual	Adjusted R-squared
Durum	0.721	7.66	0.000	4.42	-5.09	0.7150
Peas	0.672	3.27	0.006	3.82	-3.98	0.3918
Lentils	0.517	2.81	0.015	2.67	-6.23	0.3302
Flax	0.126	1.46	0.159	4.44	-5.45	0.0467

We add the maximum residual to the high end of our randomization function and subtract the minimum from the low end. This reduces the systemic risk in our yield models; that is, the risk associated with macro factors such as variable climate and geography. We then have remaining the unsystematic risk associated with each particular crop type and its specific agronomic characteristics. Appendix I shows crop yield correlations for Sheridan County, Montana.

Spring wheat prices are likewise used to eliminate the systemic risk in commodity prices. Like yields, commodity prices tend to move as a group, although the trend is not as evident as with yields since prices are typically based on a more macro level (i.e. national and global supply and demand). This general relationship can be illustrated as follows:

$$P_x = f(P_S)$$

Where P_x *is* the county average price received for crop “x” (durum, peas, lentils, or flax), and P_S is the county average price received for spring wheat. Table 5.2 exhibits the regression results.

Table 5.2: Regression Statistics Using Spring Wheat Price Received as Independent Variable to Predict Crop Price Received

Dependent Variable	Coefficient	T-statistic	P-value	Maximum Residual	Minimum Residual	Adjusted R-squared
Durum	1.419	4.17	0.006	1.58	-1.44	0.7010
Peas	1.321	4.71	0.003	1.37	-1.49	0.7512
Lentils	1.278	1.05	0.335	6.95	-3.98	0.0141
Flax	2.135	5.50	0.002	2.66	-0.94	0.8070

As with yields, we add the maximum residual to the high end of our randomization function and subtract the minimum from the low end. This allows us to remove the systemic risk in crop prices; that is, leaving factors that relate to the particular commodity's supply and demand balance. It can be observed by comparing Tables 5.1 and 5.2 that the adjusted R-squared is generally higher for prices than it is for yields. Appendix III details the crop price correlation matrix for crop prices received in Sheridan County, Montana.

Likewise, we use U.S. national average price received for corn to predict fertilizer prices for urea and diammonium phosphate (DAP). We used the corn price lagged by one year, based on the theory that farmers determine their planting decisions on relative crop prices from the prior year. Thus, a crop with a higher relative price, and usually higher profitability, is more likely to see increased acres the subsequent year as farmers respond to market signals. To produce on the crop production frontier, fertilizer is typically applied. Corn is used since the crop is grown nationwide and accounts for, on average, 43% of urea and 42% of DAP use from 1960-2013 (USDA-ERS 2013). National prices for urea and DAP are used since they are nationally traded (and used) commodities and can be shipped anywhere, with the chief variable in local prices being the difference in transportation costs. Therefore, if we determine in Step 1 that urea price is a function of the lagged corn price, our general theory equation would look like the following:

$$F_t = f(P_{t+1})$$

Where F_t is the fertilizer price in year t and P_{t-1} is the marketing year average price for previous year's corn crop.

To determine the quantitative relationship among these variables, in Step 2 we collect historical data for fertilizer prices and corn prices. We already have fertilizer prices from Chapter IV; corn prices were obtained in the same method from USDA's national average price received for the period 1994 to 2013. Summary statistics for this data are presented in Table 5.3.

Table 5.3: Summary Statistics for Corn Average National Price Received, Marketing Year 1994-2013 ($US/bu)

Corn Price Received	
Average	3.23
Standard Deviation	1.50
Maximum	6.89
Minimum	1.82
Range	5.07

We now run two models, one with urea prices as the dependent variable and another with DAP prices as the dependent variable; using the lagged corn price as the independent variable in both models. After running two regressions (Step 3); we can calculate residuals. Regression results are summarized in Table 5.4.

Table 5.4: Regression Results for Lagged Corn Price as Independent Variable to Predict Fertilizer Prices

Dependent Variable	Coefficient	T-statistic	P-value	Maximum Residual	Minimum Residual	Adjusted R-squared
Urea	48.738	6.30	0.000	106	-52	0.8288
DAP	80.912	2.84	0.025	332	-111	0.4681

Then, we use the same procedure as that applied to crop yields; that is, subtracting the minimum residual from the low fertilizer price in our simulation and adding the maximum residual to the high fertilizer price.

5.2 Simulation

Simulation is the use of statistics and modeling to forecast a range of outcomes for a given range of inputs. In this case, it involves a number of observations of historical prices for various inputs and outputs; and then we assign the proper statistical function depending upon the distribution type. For our model, we are using simulation to predict values for the following variables:

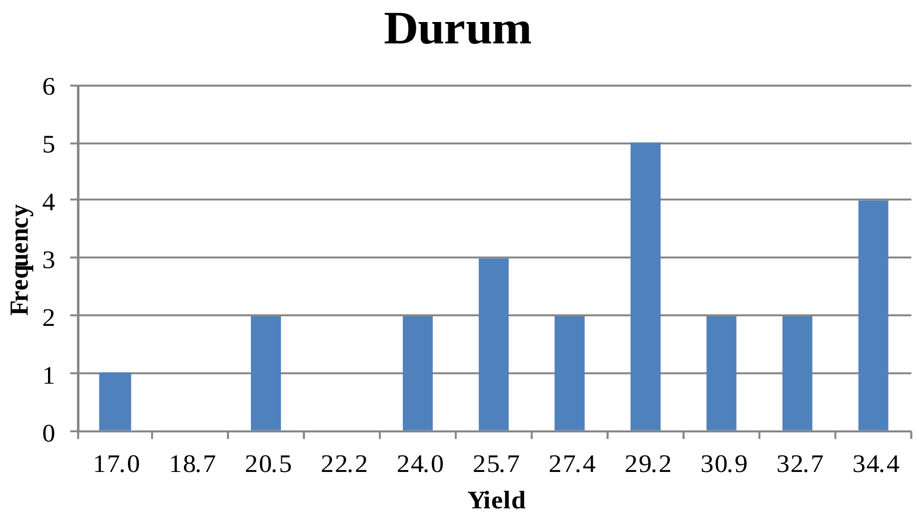
- Expense Calculations (per acre)
    - Seed Cost
    - Fertilizer Cost
    - Crop Protection Cost
- Income Calculations (per acre)
    - Expected Price Received
    - Expected Yield

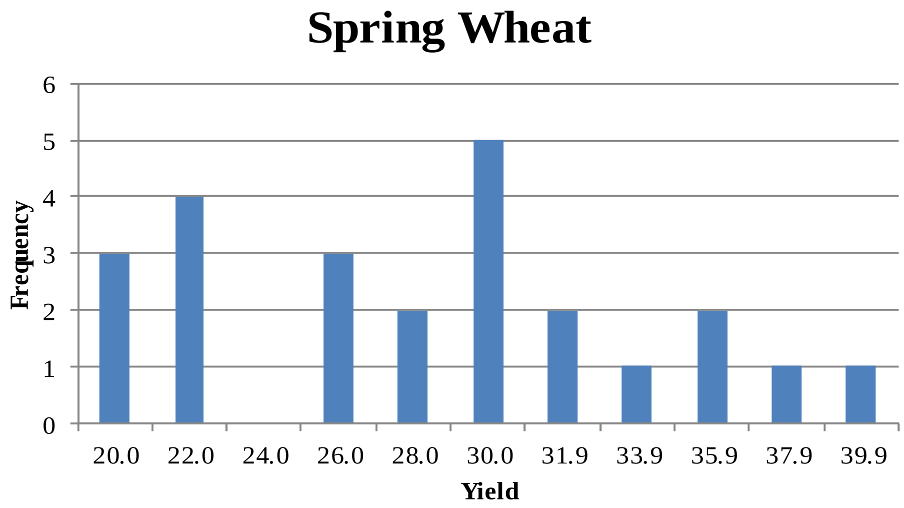
Simulation is useful in that it provides the opportunity to forecast future events using a wide range of input values. Specifically, in agriculture, it is readily apparent that yields and prices vary from year to year (or near-instantaneously, in the case of prices). If we refer to Table 4.2, the durum price received observed a high of $10.30/bushel and a low of $4.61/bushel. Clearly, these numbers offer vastly different profitability scenarios to the producer, exacerbated when yields cannot be predicted with certainty.

Fortunately, many software programs provide tools that allow us to randomly assign values given input parameters. In this model, we are using Excel’s randomization function to create an expected value of profit (or loss) per acre that we can then use in our net present value model. Since we observe that none of our variables exhibit pricing distributions that resemble the normal distribution (shown in Figure 5.1), instead of the traditional NORMINV function, we will use the following two randomization functions in Excel in the construction of our model:

1. =RAND
2. =RANDBETWEEN

Figure 5.1: Distributions For Crop Yield, Prices, and Fertilizer Prices


Durum


Spring Wheat

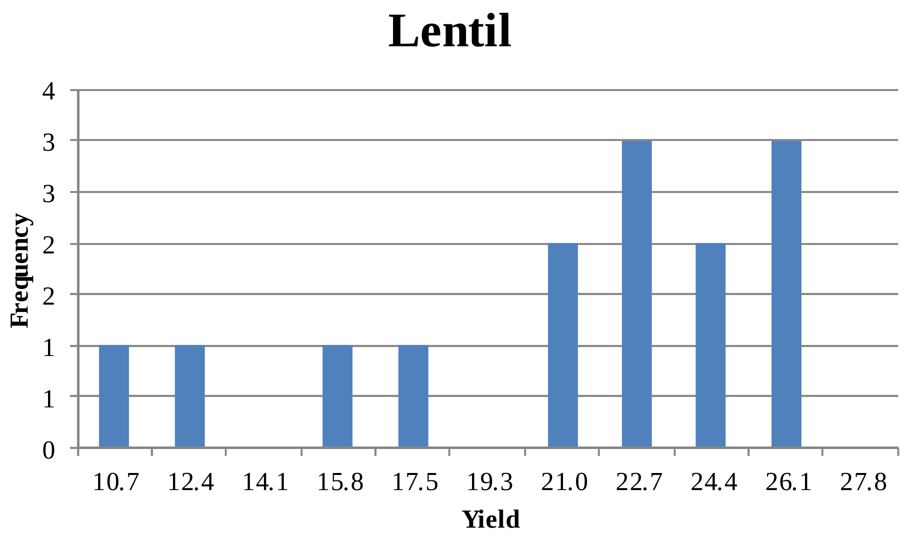
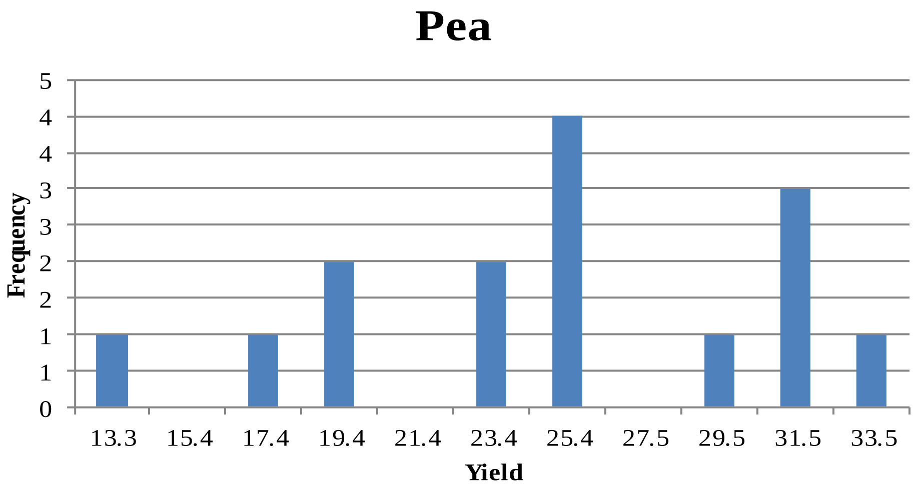
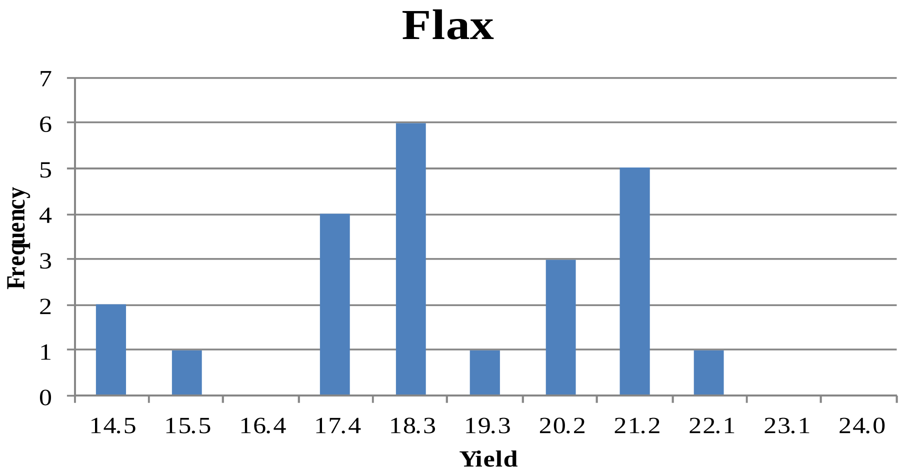

Lentil

Figure 5.1: Distributions For Crop Yield, Prices, and Fertilizer Prices (continued)





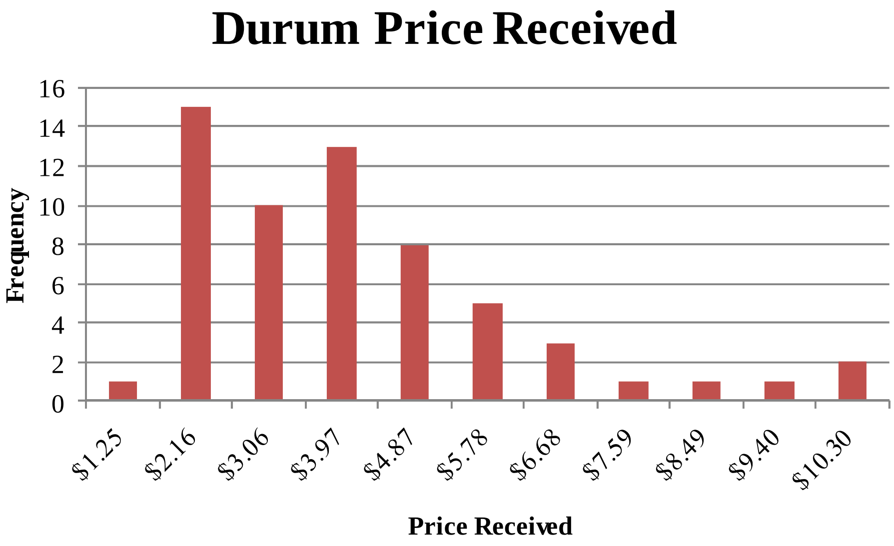
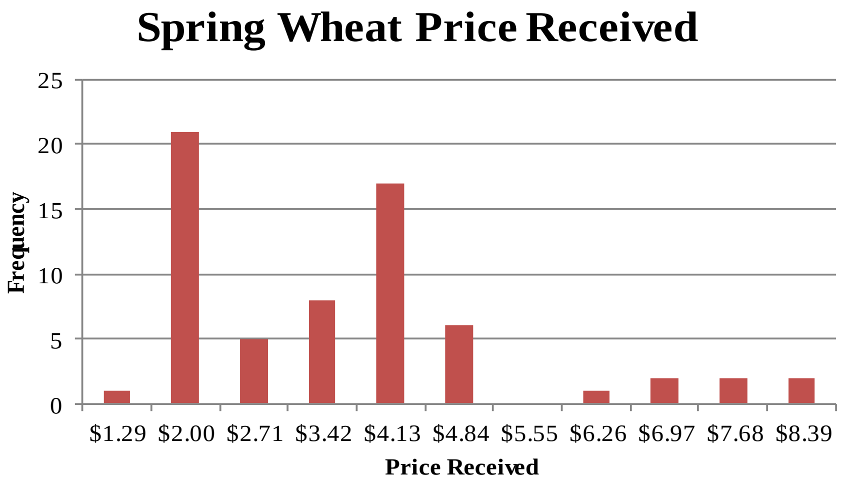
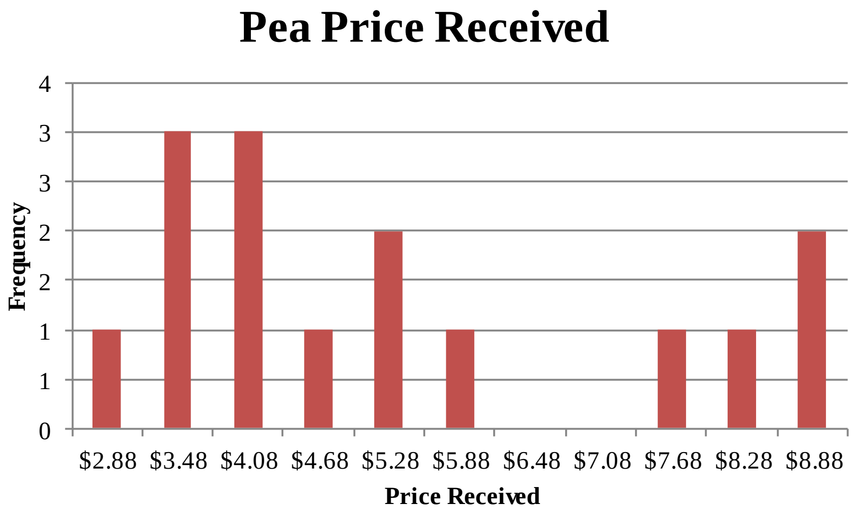


Figure 5.1: Distributions For Crop Yield, Prices, and Fertilizer Prices (continued)





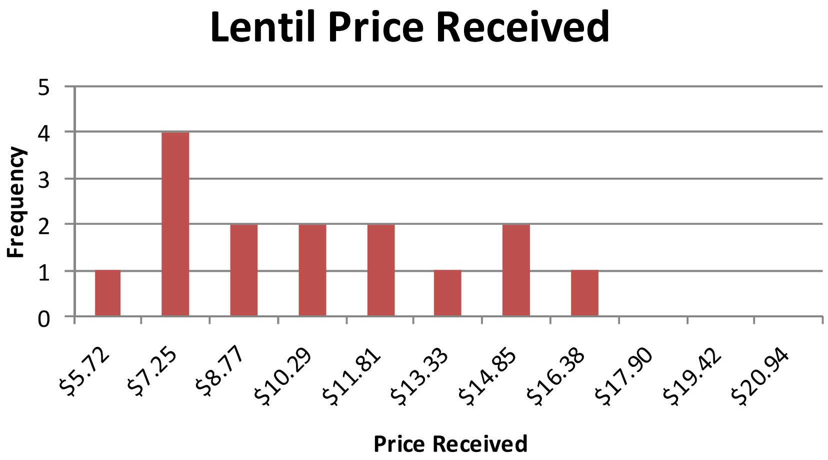
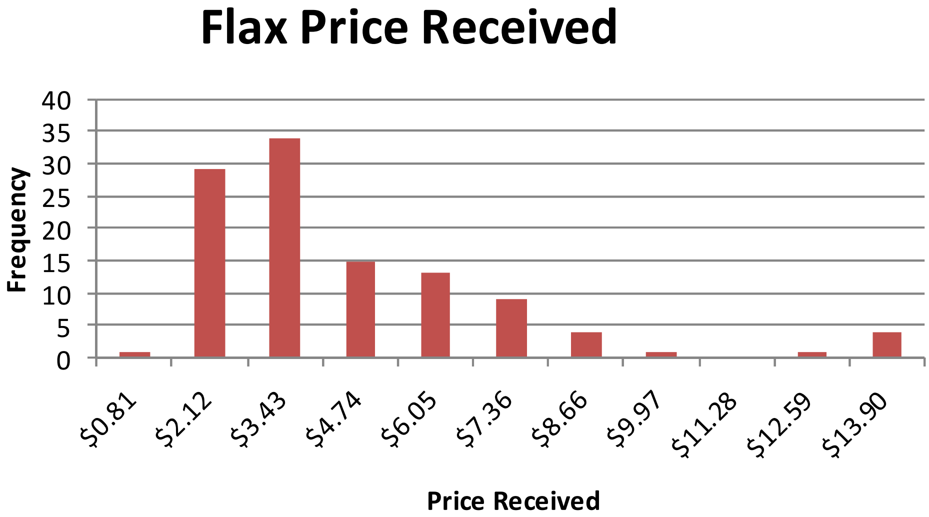


Figure 5.1: Distributions For Crop Yield, Prices, and Fertilizer Prices (continued)



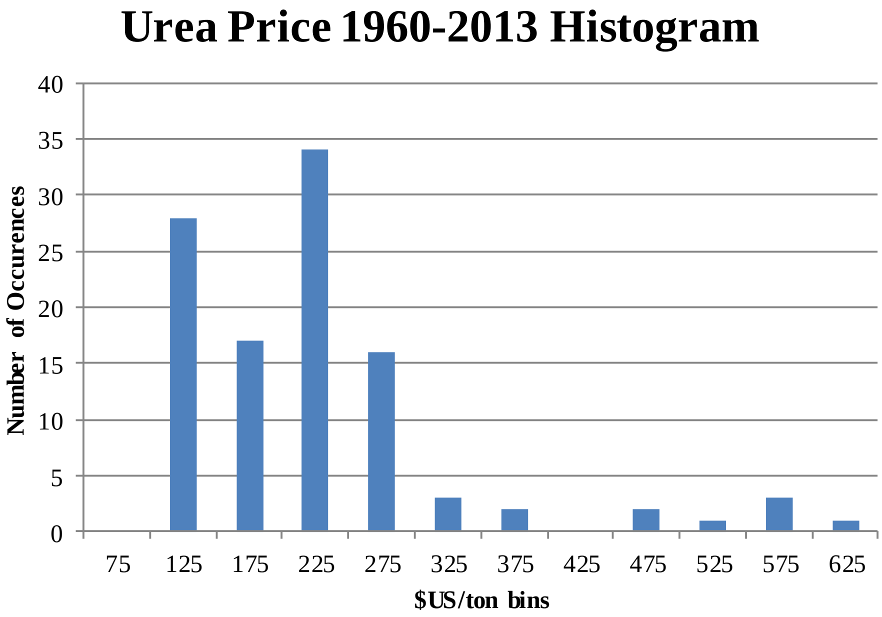
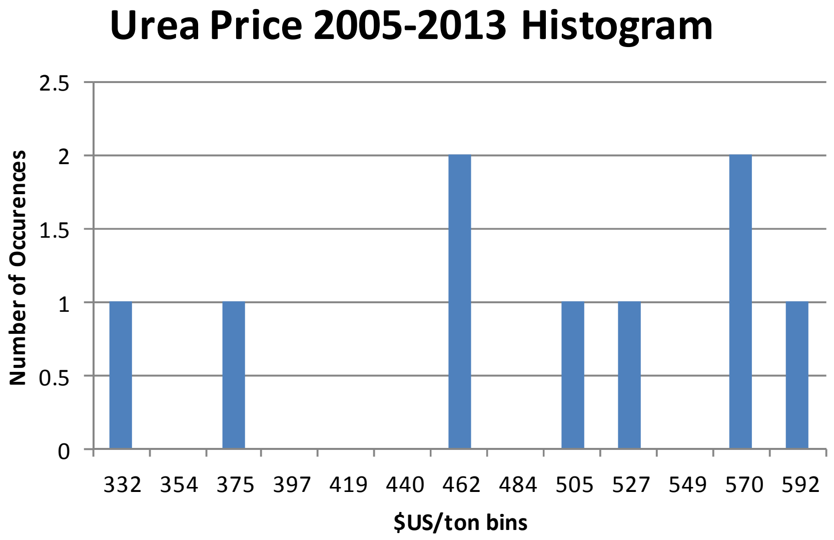


Figure 5.1: Distributions For Crop Yield, Prices, and Fertilizer Prices (continued)



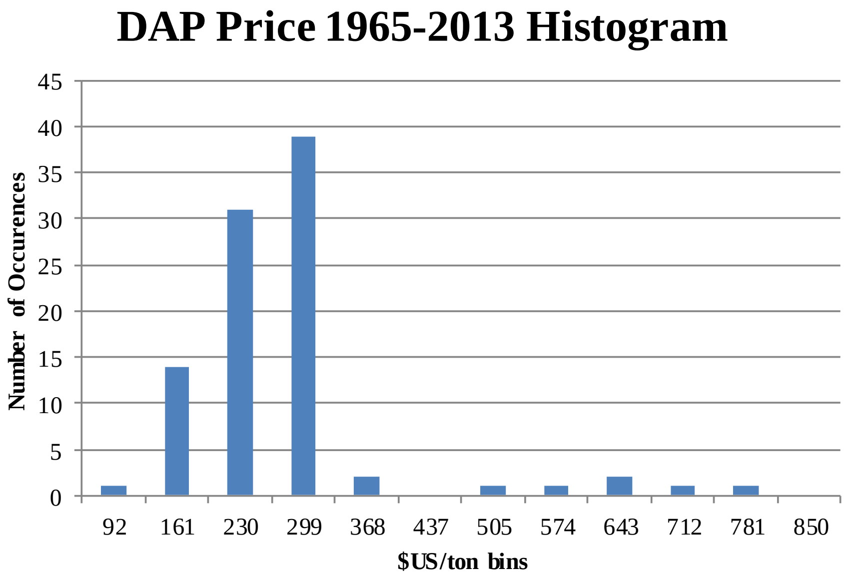
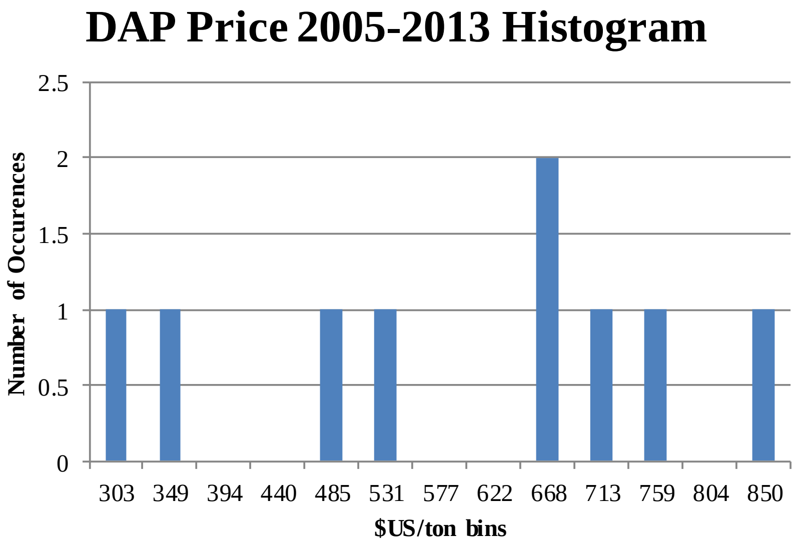


Figure 5.1: Distributions For Crop Yield, Prices, and Fertilizer Prices (continued)



To calculate anticipated crop protection costs, we use the following RAND formula:

$$= RAND(\quad) * (Max - Min) + Min$$

where *Max* is the maximum anticipated amount spent in a given year, and *Min* is the minimum anticipated amount spent in a given year. Each time we use these function in Excel, it generates a random number between the minimum and the maximum, with an equal probability of any number occurring. For the other variables, we use the formula:

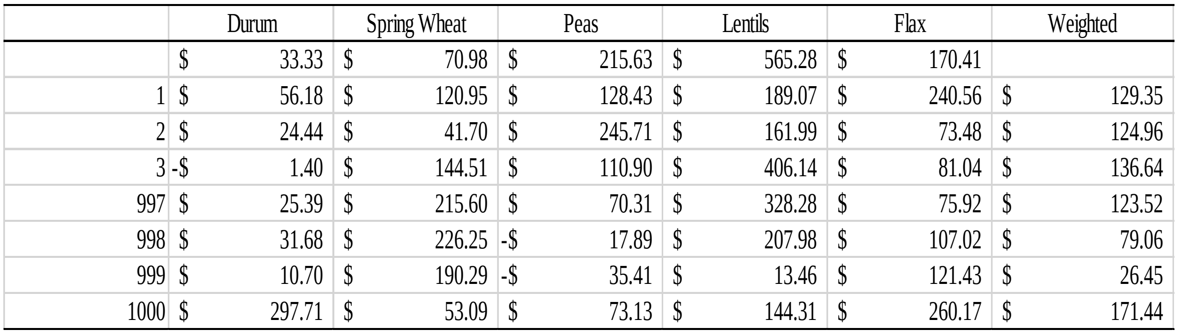
$$= RANDBETWEEN(N_1, N_2)$$

where N_1 is the lower limit and N_2 is the upper limit with which we wish to constrain the variable. As with the RAND function, Excel generates a random number between these two constraints every time the function is used, however, this function does not generate a number with an equal probability of all values occurring.

This individual number resulting from the randomization functions is referred to as an “iteration”, and we then run many of these (in this model: 1,000) to create a sample of cash flows from that we can draw an expected value for each year in our NPV calculation.

Excel's data table feature is used to create this set of iterations for our simulation. This is accomplished by first determining the number of iterations used, then making a column of numbers, starting with 1, and adding one to the preceding number until we get to our desired total. We then copy the cell to simulate (in this case, the gross profit figure for each crop type). By making the reference cell a blank cell, the spreadsheet recalculates the random numbers, and thus the profit figure, each time it calculates iterations in the data table. Table 5.5 exhibits a portion of the data table used in the model.

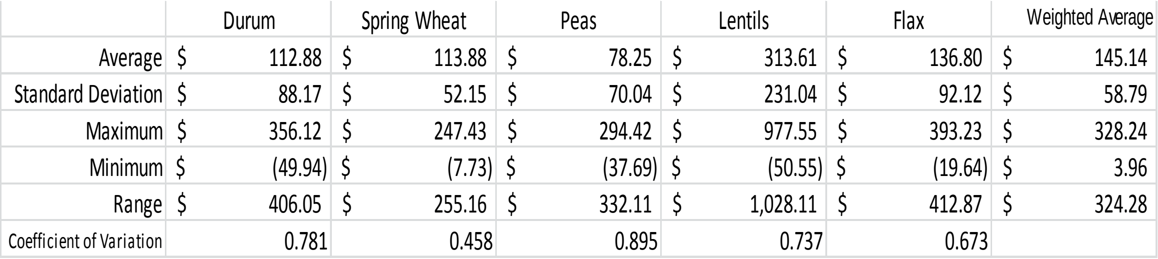
Table 5.5: Partial View of Gross Profit Simulation Data Table in Excel



	Durum	Spring Wheat	Peas	Lentils	Flax	Weighted
	$ 33.33	$ 70.98	$ 215.63	$ 565.28	$ 170.41	
1	$ 56.18	$ 120.95	$ 128.43	$ 189.07	$ 240.56	$ 129.35
2	$ 24.44	$ 41.70	$ 245.71	$ 161.99	$ 73.48	$ 124.96
3	-$ 1.40	$ 144.51	$ 110.90	$ 406.14	$ 81.04	$ 136.64
997	$ 25.39	$ 215.60	$ 70.31	$ 328.28	$ 75.92	$ 123.52
998	$ 31.68	$ 226.25	-$ 17.89	$ 207.98	$ 107.02	$ 79.06
999	$ 10.70	$ 190.29	-$ 35.41	$ 13.46	$ 121.43	$ 26.45
1000	$ 297.71	$ 53.09	$ 73.13	$ 144.31	$ 260.17	$ 171.44

Table 5.6 illustrates data table summary statistics for our simulation model of gross profit using these variables and their corresponding functions.

Table 5.6: Summary Statistics of Simulated Gross Profit ($US/acre)



	Durum	Spring Wheat	Peas	Lentils	Flax	Weighted Average
Average	$ 112.88	$ 113.88	$ 78.25	$ 313.61	$ 136.80	$ 145.14
Standard Deviation	$ 88.17	$ 52.15	$ 70.04	$ 231.04	$ 92.12	$ 58.79
Maximum	$ 356.12	$ 247.43	$ 294.42	$ 977.55	$ 393.23	$ 328.24
Minimum	$ (49.94)	$ (7.73)	$ (37.69)	$ (50.55)	$ (19.64)	$ 3.96
Range	$ 406.05	$ 255.16	$ 332.11	$ 1,028.11	$ 412.87	$ 324.28
Coefficient of Variation	0.781	0.458	0.895	0.737	0.673	

Crop rotation is an integral part of production agriculture in Montana, and since the exact rotation to be used is not known, past data is used to determine the likelihood of a particular crop being planted in a given year. In this case, Table 5.7 displays the weightings used for each crop type.

Table 5.7: Crop Rotation Weightings for Selected Crops in Calculating Average Expected Gross Profit Per Acre

	Durum	Spring Wheat	Peas	Lentils	Flax
Planting Probability	30%	10%	30%	20%	10%

These percentages are arrived at based upon current production practices. Using a ten year timeframe, usually half the time there are peas or lentils seeded (since they are legumes that fix their own nitrogen and thus require substantially less fertilizer, as well as other agronomic and financial considerations); and four out of five years, wheat is the alternating crop, typically durum, but sometimes spring wheat. Flax is occasionally planted when circumstances are favorable, roughly one in ten years. By multiplying each crop's average gross profit times its probability of being planting, we can sum the resulting numbers to get an expected annual gross profit. Table 5.8 illustrates the calculations for average expected gross profit.

Table 5.8: Calculation of Expected Gross Profit ($US/acre)

	Durum	Spring Wheat	Peas	Lentils	Flax
Planting Probability:	30%	10%	30%	20%	10%
Average Gross Profit:	$108.87	$113.24	$70.01	$275.17	$115.49
Expected Gross Profit:	$32.66	$11.32	$21.00	$55.03	$11.55
Total Expected Gross Profit:	$131.57				

Using the results of our 1,000 iterations, we can create a cumulative probability distribution that allows us to visualize the range of values we can expect to see with a level of certainty, given this data set. Figure 5.2 illustrates this cumulative probability on a per crop basis, while Figure 5.3 accounts for the probability of planting illustrated in Table 5.8 and shows the weighted cumulative probability of expected gross profit on a given year.

Figure 5.2: Cumulative Probability Distribution of Expected Gross Profit, by Crop

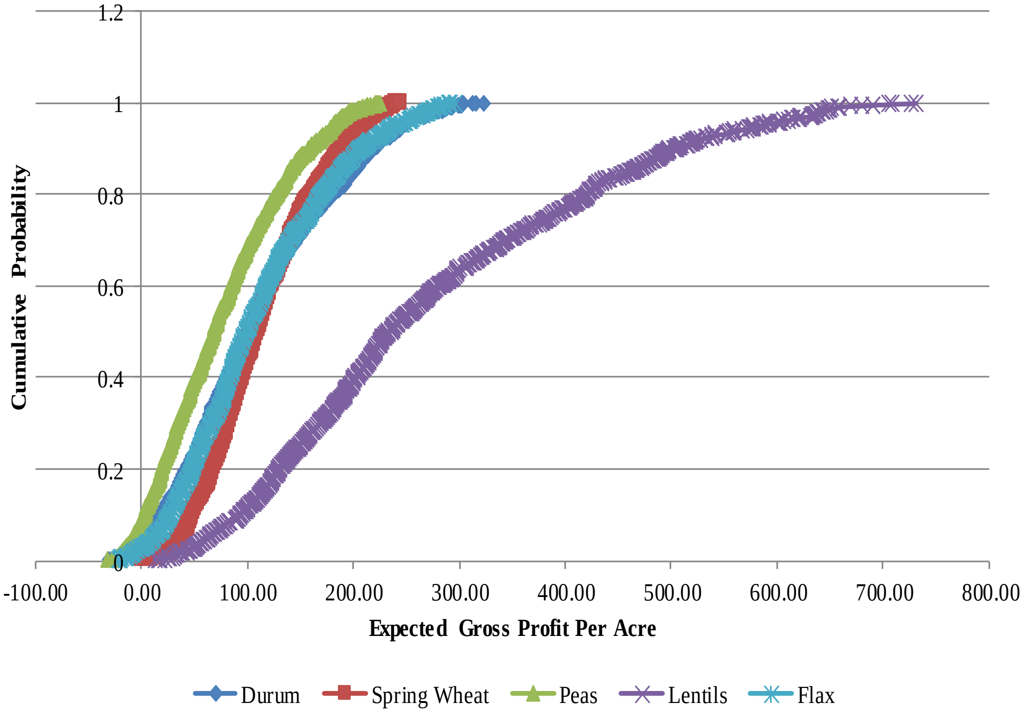


Figure 5.3: Cumulative Probability Distribution of Expected Gross Profit, Weighted by Cropping Pattern

Again using Excel's random number generator, twenty random weighted expected gross profit amounts are drawn from the data table of 1,000 iterations and inserted into each of the twenty years in our discounted cash flow model to be used in determining the net present value of the investment.

5.3 Net Present Value

Net Present Value is a fundamental concept in finance that states that the value of an asset is its benefit minus its cost; adjusted for the time value of money (that is, a dollar today is worth more than a dollar in the future). Mathematically, the present value formula is expressed as:

$$PV = \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \frac{C_3}{(1+r)^3} + \cdots + \frac{C_T}{(1+r)^T}$$

Where: PV is the Present Value of the sum of cash flows through time period T, C_t is the cash flow in period t, r is a constant discount rate, and t is current time period t.

To arrive at the Net Present Value figure, we add in the initial cash flow, and rewrite the equation as:

$$NPV = C_0 + PV = C_0 + \sum_{t=1}^{T} \frac{C_t}{(1+r)^t}$$

In most instances, the initial outflow at time C_0 is negative; and the resulting cash flows are positive. These cash flows, C, are presented as nominal numbers and are then discounted to present value by the use of an appropriate discount rate r. Typically, this discount rate is that which could be earned on an investment of approximately the same riskiness in the financial markets. The value of future cash flows decreases the further into the future they are, so cash flows in more distant periods do not have as much impact as those in earlier periods; even though they may be greater in nominal terms

(Brealey, Myers and Allen 2011).

Using the data and techniques we have assembled thus far, we can construct a spreadsheet model to calculate the net present value of an investment in farmland. Our spreadsheet model uses a timeframe that is too long to display, so the simple four year investment example in Table 5.9 illustrates the concept; with an initial outflow of $100,000 and the four $35,000 inflows. This example assumes no salvage value at the end of year 4.

Table 5.9: Simple Example of Net Present Value Calculation Using Excel

		Cash Flow Per Time Period				
	Net Present Value	0	1	2	3	4
12% discount rate	$ 6,307.23	(100,000.00)	31,250.00	27,901.79	24,912.31	22,243.13

As can be seen above, using a 12% discount rate, our four cash inflows have a net present value of $6,307.23. This is substantially less than the nominal (unadjusted) sum of all cash flows; which is $40,000 (-100,000+35,000+35,000+35,000+35,000). As previously stated, this is a much simplified version of the cash flow model used in the analysis.

For certain investments, it is difficult to accurately forecast precise cash flows, and consequently the net present value, with any reasonable amount of certainty. This is why we calculated an expected value using simulation. We use a randomly drawn Weighted Expected Gross Profit number from Table 5.5 as the expected cash flow for each year starting in year 1. In year 0, we spend the money to acquire the land (the initial outflow); the value of which can be randomly chosen to create an initial NPV value for our entire investment.

5.4 Sensitivity Analysis

Sensitivity analysis is an analytic technique where the parameters of the financial model are manipulated to see how the alterations affect the final result. Typically this is done with one input at a time so as to isolate the effects of changing one variable.

Table 5.10 illustrates this concept; again using the standard NPV formula. Here, we evaluate the effect on NPV of three different discount rates: 6%, 12%, and 16%. Below is an example of this simple sensitivity analysis, the only modification to the formula is changing the discount rate. A discount rate of 0% is provided for comparison.

Table 5.10: Example of Sensitivity Analysis Using Discount Rates and Net Present Values

		Cash Flow Per Time Period				
	Net Present Value	0	1	2	3	4
0% discount rate	$ 20,731.76	(100,000.00)	30,182.94	30,182.94	30,182.94	30,182.94
6% discount rate	$ 4,587.07	(100,000.00)	28,474.47	26,862.71	25,342.18	23,907.72
12% discount rate	$ (8,323.87)	(100,000.00)	26,949.05	24,061.65	21,483.62	19,181.80
16% discount rate	$ (15,542.68)	(100,000.00)	26,019.78	22,430.84	19,336.93	16,669.77

As illustrated in Table 5.10's example of sensitivity analysis, the choice of discount rate can greatly affect the final net present value calculation. For this particular project, it only provides a positive NPV at the 6% discount rate or less, and is substantially negative at the 12% and 16% discount rates. Sensitivity analysis gives the user the ability to see the effects of modifying one variable at a time in their model and thus evaluate potential alternative outcomes if they are in error in their initial assumption for one of the inputs. In the model we have constructed throughout the preceding sections, there are ample opportunities to utilize this technique. To examine changes on our ultimate valuation, the variables we will change are:

- The discount rate used to compute net present value, and

- The interest rate on the mortgage

The results of changing these variables are discussed in the following chapter.

5.5 Tax Deductibility of Interest Payments

Through the U.S. tax code, interest payments on debt financing are tax deductible. Therefore, to determine cash flow per acre we should add the “shield” to that cash provided by the tax deductibility of interest. This cash would otherwise be spent in income taxes, but is instead used to finance the debt portion of the purchase (Brealey, Myers and Allen 2011). In this model, we have assumed a tax rate of 25%. For example, the value of the tax shield on a $100 interest payment would be $25.

5.6 Other Assumptions

We must make a few assumptions to run the model, which are as follows:

- Active management of the farm for 20 years, earning all profits or losses; cash lease for the subsequent 20 years; and then a sale of the property after the 40 year period
    - A 1.17% real growth rate in land values is assumed. The average nominal geometric growth rate of 3.55% in land values in Montana for the time period 1983-2014 is divided by the 2.35% average nominal geometric change in Producer Price Index for the same time period to calculate a real growth rate (Federal Reserve Bank of St. Louis 2015); in the following equation:

      $$G=\frac{1+g_L}{1+g_P}-1$$

      Where: G is the real growth rate in percentage terms, g_L is the nominal year over year change of non-irrigated cropland values in percentage terms, and g_P is the nominal year over year change in the Producer Price Index in percentage terms.

- A starting value to determine the terminal value of the land equivalent to the 2014 Montana statewide average for non-irrigated cropland: $800/acre
- A discount rate of 8%
- Constant custom farming rates in real terms
- A tax rate of 25%; and continued tax deductibility of interest payments
- A down payment of 20%

Other assumptions made in developing the model, include the choice of commodity trading ranges which in turn influence input costs, particularly fertilizer. Those assumptions result in the expected gross profit that is central to our NPV calculations.

CHAPTER VI: RESULTS

To answer the question, “What is this land worth?” many concepts fundamental to finance and business analysis are used.

6.1 Results

Using the assumptions discussed in Chapter V, they are entered in the input fields of the model as shown in Table 6.1. Recall that while inputs are on a per acre basis, the spreadsheet calculates NPV based on total acres under consideration.

Table 6.1: Initial Inputs into NPV Model Calculations

Total Acres	320
Purchase Price ($US/acre)	$700.00
Down Payment	20%
Years Financed	20
Mortgage Rate	5.50%
Terminal Value Growth Rate:	1.17%
Tax Rate	25%
Discount Rate	8.00%

Using $700 per acre as a starting point, the spreadsheet calculates a gross NPV for the 320 acres of $128,361.44. Clearly more than $700 per acre could be paid and still expect a return on our investment. Using Excel’s Goal Seek function, we use it to set the cell representing Net Present Value to $0 by changing the value of the Purchase Price per Acre.

Table 6.2 again shows the input section of the spreadsheet, but this time with the purchase price that equals $0 NPV.

Table 6.2: Results of Using Goal Seek to Set NPV of Project to $0

Total Acres	320
Purchase Price ($US/acre)	$909.14
Down Payment	20%
Years Financed	20
Mortgage Rate	5.50%
Terminal Value Growth Rate:	1.17%
Tax Rate	25%
Discount Rate	8.00%

For this hypothetical 320 acre farm, the zero NPV purchase price of $909.14 per acre results in a total cost of $290,925.42; significantly higher than the $224,000 that was the result of the initial input of the $700 per acre purchase price.

Since the spreadsheet model calculates cash flows for each period, the entire model is too lengthy to display. A truncated version of the cash flow section of the spreadsheet is shown in Table 6.3; representing the purchase price resulting in $0 NPV calculation.

Table 6.3: Truncated Spreadsheet Model Showing Cash Flows at Select Time Periods

	0	1	19	20	40	End of Year 40
Land Payment (Total)		($19,475.56)	($19,475.56)	($19,475.56)		
Principle (Total)		($6,674.84)	($17,497.86)	($18,460.24)		
Interest (Total)		$12,800.72	$1,977.70	$1,015.31		
Mortgage Payment ($US/acre)		($60.86)	($60.86)	($60.86)		
Expected Gross Cash Flow ($US/acre)		$119.80	$184.19	$134.28	$40.00	
Machinery Costs ($US/acre)		$58.56	$58.56	$58.56		
Expected Direct Cash Flow Available ($US/acre)		$61.24	$125.63	$75.72		
EBITDA (Total)		$19,598.05	$40,200.12	$24,230.05	$12,800.00	
Value of Tax Shield (Total)		$3,200.18	$494.42	$253.83		
Cash Flow (Total)	-$290,925.42	$22,798.23	$40,694.54	$24,483.88	$12,800.00	$408,065.82
Cash Flow ($US/acre)		$71.24	$127.17	$76.51	$40.00	$1,275.21
Discounted Cash Flow ($US/acre)		$65.97	$29.47	$16.42	$1.84	$58.70

6.2 Analysis and Model Limitations

Using the assumptions and input parameters as described above, the maximum purchase price of $909.14 per acre is substantially higher than the initial estimate of $700 per acre. By examining the spreadsheet, a few observations about the calculations are made. First, using the 1.17% terminal value growth rate, the $290,925.42 initial cash outflow grows to $408,065.82 by the end of the 40th year; and the land that was paid $909.12 per acre is worth $1,275.21 per acre (in 40 years), although since this cash inflow is so distant that the discounted present value is only $58.70 per acre.

The value of the tax shield from interest payments made to service the debt incurred during the purchase decreases over time. This would be expected, since the portion of land payment that is applied to principle increases as time moves forward, decreasing the principle balance and thus the amount of interest paid on the outstanding amount. There are myriad options to run a sensitivity analysis on these calculations, but two changes are examined in Table 6.4:

1. Increasing the interest rate on the debt portion of the purchase price to 6.5% from 5.5%; and
2. Increasing the discount rate used in the NPV calculation from 8% to 12%

Table 6.4: Sensitivity Analysis of Debt Financing Costs and Discount Rates on NPV

	Debt Financing Cost		Discount Rate	
	5.50%	6.50%	8.00%	12.00%
Purchase Price ($US/acre)	$909.14	$925.11	$909.14	$586.17

As illustrated in Table 6.4, the increase in the discount rate greatly reduced the final net present value, while the increase in the financing costs had the effect of increasing the purchase price, suggesting benefits from the tax advantages associated with debt financing. Sensitivity analysis can be applied to any input in this model, allowing the user the ability to see the effects of modifying one variable at a time and therefore evaluate alternatives if their initial estimation of one of the inputs is incorrect.

The $909.14 per acre purchase prices is also reasonably close to the statewide average of $978 per cropland acre reported in USDA's 2014 survey, and greater than the $800 per acre for non-irrigated cropland. This is somewhat surprising, considering that Sheridan County's location in the eastern part of the state would be expected to have lower than statewide average value due to lack of price pressures from commercial real estate and non-agricultural interests that are significant forces in other areas of the state, particularly in the western part of the state. In addition, a more arid climate reduces the productive capacity of the county in comparison to others in Montana.

While the theory underlying this valuation model is based on proven principles, there are many assumptions inherent in this type of analysis that could greatly affect the NPV calculation. First is with the concept of NPV itself, since it based upon the *expected* cash flows and the cost of capital, both of which are, by necessity, forecasts and consequently may deviate substantially in reality from the predicted values (Brealey, Myers and Allen 2011).

Secondly, we used regression to establish relationships between the underlying variables, but it should also be noted that econometrics in general and regression analysis in particular only provide quantitative evidence of correlation, not causation. That is, while regression shows if there is a statistical relationship among variables; it does not show if one variable actually causes the other to change. Determining which independent variables to include and whether they actually cause changes in the dependent variable should come down to economic theory, a key component of a good econometric model (Studenmund 2011).

As referred to earlier, changes in commodity and input prices could also materially change the expected gross profit per acre that underlies the valuation of the particular farmland in question and could significantly impact the results of the calculation. Note that this model calculates NPV based upon direct costs only, that is, those necessary to produce a crop. Changes in farming methods over the timeframe of the model could also significantly alter the outcome. This model also explicitly ignores overhead, such as insurance and returns to management, which should be a component of a complete enterprise analysis.

CHAPTER VII: CONCLUSION

In this thesis we have discussed several topics to try and establish a value for a hypothetical farm that we are considering purchasing. We first examined trends in farmland valuation in the United States in general and Montana in particular, observing they have been increasing consistently since 1997, and at the same time representing an increasing share of the farm sector's total assets. Then, we reviewed past literature on the topic of farmland valuation; many of which are based upon the traditional Net Present Value concept in finance. Additional factors, such as the presence of real options available to farmland sellers and proximity to urban centers are also discussed; both of which also may affect farmland values not explained by cash flow alone.

Since the traditional NPV analysis requires many assumptions regarding cash flow and other inputs, we modified the typical analysis through the use of simulation, a modeling technique that uses historical data combined with statistical analysis. By examining historical price, yield, and input trends, we estimate cash flows per acre using simulation to derive an expected value given assumptions regarding historical commodity and input price trading ranges. After weighting by anticipated cropping patterns, we then use the resulting expected cash flow in the net present value model combined with the Goal Seek feature in Excel to calculate a purchase price per acre that sets the net present value of the farmland purchase to zero.

In this instance, the resulting value was close to the statewide average for cropland and higher than the average for non-irrigated cropland, a somewhat surprising result since the county data used for analysis represents one with limited non-agricultural development potential and an arid climate that is less favorable to crop production than other areas in the state. It should be noted that this value only accounts for expected gross profit per acre, and doesn’t deduct management costs. Likewise, no allowance is made for crop insurance or operating overhead costs, as these decisions are often independent of those required to actually produce a crop. These additional costs should be included, the purchase price that would result in a zero NPV would be lower, possibly significantly.

While information in this paper is not personal data, the “correct” value per acre depends greatly on the quality of the land in question, as well as the abilities of the particular producer with regards to management ability. As such, this paper doesn’t present a definitive answer to the valuation question; indeed, the appropriate purchase price will vary by locale and specific individual. However, this model provides a foundation with which further analysis can be performed to arrive at a purchase price suitable for a producer in particular circumstances.

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APPENDIX I: CROP YIELD CORRELATION MATRIX FOR SHERIDAN COUNTY, MONTANA

	Durum	Spring Wheat	Lentils	Peas	Flax
Durum	1.0000				
Spring Wheat	0.8523	1.0000			
Lentils	0.8385	0.6148	1.0000		
Peas	0.6729	0.6524	0.7123	1.0000	
Flax	0.7280	0.4521	0.8097	0.3934	1.0000

APPENDIX II: CROP YIELD HISTORY FOR SHERIDAN COUNTY, MONTANA 1990-2013 (BU/ACRE)

	Durum	Spring Wheat	Lentils	Peas	Flax
2013	34.4	39.9	25.2	30.0	20.0
2012	28.0	30.7	20.7	25.0	17.5
2011	28.0	28.0	20.0	25.0	16.5
2010	34.0	35.6	23.3	33.3	22.0
2009	31.0	27.0	26.0	22.2	24.0
2008	19.0	21.0	15.7	18.0	17.0
2007	24.0	21.0	21.2	28.3	17.5
2006	17.0	20.0	10.7	18.0	14.5
2005	28.0	30.0	24.0	30.0	21.0
2004	33.0	29.0	27.8	33.5	20.5
2003	23.0	20.0	17.3	24.2	18.0
2002	23.0	21.0	11.3	13.3	17.0
2001	24.0	21.0	21.3	25.2	20.0
2000	28.0	24.0	22.0	16.5	21.0
1999	27.0	25.0	25.0	23.3	21.0
1998	28.0	29.0		30.0	21.0
1997	26.0	27.0			16.5
1996	25.0	24.0			18.0
1995	30.0	34.0			15.0
1994	30.0	29.0			17.5
1993	31.0	36.0			18.5
1992	33.0	29.0			19.5
1991	33.0	33.0			18.0
1990	19.0	20.0			14.5

APPENDIX III: CORRELATION MATRIX FOR SELECTED CROP PRICES RECEIVED, SHERIDAN COUNTY, MONTANA 2006-2013

	Durum	Spring Wheat	Peas	Lentils	Flax
Durum	1.0000				
Spring Wheat	0.8624	1.0000			
Peas	0.8920	0.8870	1.0000		
Lentils	0.4778	0.3936	0.3940	1.0000	
Flax	0.7984	0.9135	0.8893	0.3512	1.0000

APPENDIX IV: CORRELATION MATRIX FOR SELECTED LAGGED CROP AND FERTILIZER PRICES

	Urea	DAP	Lagged Spring Wheat	Lagged Winter Wheat	Lagged Durum	Lagged National Corn	Lagged National Soybeans
Urea	1.0000						
DAP	0.9342	1.0000					
Lagged Spring Wheat	0.9251	0.9417	1.0000				
Lagged Winter Wheat	0.9107	0.9050	0.9834	1.0000			
Lagged Durum	0.7922	0.8767	0.9281	0.9031	1.0000		
Lagged National Corn	0.8640	0.8467	0.9505	0.9509	0.8358	1.0000	
Lagged National Soybeans	0.8806	0.8662	0.9608	0.9551	0.8362	0.9692	1.0000