FEASIBILITY ANALYSIS OF SEED PRODUCTION FOR USE IN RE-SEEDING LAND BURNED IN WILFIRES IN THE GREAT BASIN REGION OF THE UNITED STATES.

by

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Native and introduced grass and shrub species are grown for seed production in the Great Basin region of the United States. The purpose of this research is to evaluate the profitability and risk associated with the production of five different species of grasses and shrubs which are used in rehabilitation following wildfires. Enterprise budgets are constructed for both the establishment and production years. Returns above operating costs are compared to other crops produced in the same region. Production and market risks are discussed. Returns and risks are evaluated using an expected value model which compares risk and return between species, as well as risk and return for seven different crop combinations on a simulated 400-acre farm. All five species evaluated are found to be more profitable than other crops grown in the region. However, there are many production and market factors which must be carefully considered prior to investment in grass and shrub seed production.

Declaration of Author's Rights

I declare that the dissertation embodies the results of my own research or advanced studies and that it has been composed by myself. Where appropriate, I have made acknowledgement to the work of others.

Signed,

Benjamin Jay Young
March 30, 2009

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Chapter 1 – Introduction

The Great Basin is North America's largest desert. When defined hydrographically, it stretches west from the Uintah Mountains to the Sierra Nevada Mountains. Its northern border is made up by the Snake River Plain, while the southern border is less distinct. The Great Basin includes most of the state of Nevada, about half of Utah, and significant portions of Idaho, Wyoming, Oregon, and California. Within these boundaries are 200,000 square miles of temperate desert (Pellant 2007). The climate is defined by hot, dry summers and snowy winters. The Great Basin contains many mountain ranges, which gives it a wide variety of vegetation due to the differences in elevation. However, a large portion of the area is dominated by sagebrush (Artemisia tridentate), with an understory of native grasses and forbs. This sagebrush steppe habitat is also very arid, with over half of the Great Basin receiving less than 12 inches of annual precipitation (Pellant 2007).

During the summer of 2007 more than 3,000 fires burned over 3.3 million acres of public and private land in the Great Basin (National Interagency Fire Center 2008). Two of these fires were of historic magnitude. The Milford Flat fire in Utah was the largest in the history of the state. It involved nearly 363,000 acres (Bureau of Land Management 2008a). The Murphy Complex fire on the Idaho/Nevada border was the largest in the history of the nation since 1910. It burned about 653,000 acres of federal, state, and private land (Bureau of Land Management 2008b). Between the two fires, there was much devastation, and losses were suffered by many. Smoke covering a major roadway in Utah resulted in several accidents, including the loss of two lives. Many structures and vehicles were burned in the blazes. Wildlife were seen fleeing in front of the racing flames. Wildlife and livestock unable to escape were consumed by the fires. Air quality deteriorated, as the fires filled the air with smoke and ash.

The fires not only had an immediate impact on the environment, but the burned areas will still suffer the effects of the fires for years to come. Soil erosion has become a concern in many areas where vegetation has been burned. Without plant roots to hold topsoil in place, rain and snow runoff scour the burned landscape. When precious topsoil and native seeds are washed away, it becomes extremely difficult for natural vegetation to return.

Another problem created by rangeland fires is the opportunity given to invasive species to spread into new areas. When native brush and grass species are burned, it leaves the ground barren, allowing other plants to take over. Invasive species such as cheatgrass *(Bromus tectorum)* spread rapidly across burned areas. Not only do cheatgrass and similar plants prevent the return of native species, but they are also poor forage sources for wildlife and livestock. Cheat grass also grows and dies rapidly, leaving abundant dry fuel for fires, thereby decreasing the time interval between naturally occurring fires. This creates a vicious cycle which occurs more frequently with each successive cycle (Pellant 1990).

In addition to the many negative impacts wildfires have on the environment in the Great Basin, the fires can also cause problems for livestock producers. For some ranchers in the Intermountain United States, public lands play an integral part in the production process. Lands managed by the Bureau of Land Management (BLM) and the Forest Service provide grazing to many livestock producers during several months during the year. Due to the hot dry climate that characterizes summers in the Great Basin, some of these grazing areas can become prone to wildfires. The negative effects of a rangeland fire can be felt by livestock producers for several years. Areas burned in wildfires are not returned to regular grazing schedules until the vegetation has returned sufficiently that in will not be damaged by grazing livestock. In some cases this process can take up to five years, or even longer in extreme circumstances.

Not only are burned areas often closed to livestock grazing, but they can also be closed to hunting, fishing, hiking, and other recreational activities that may disturb the fragile landscape. Many times, a temporary fence is erected around burned areas to keep anyone from accessing the area. Sometimes the areas are returned to full use within one year. Other times, the burned areas remain closed to public use for several years in order for vegetation to regenerate.

In order to minimize the negative effects of wildfires in the Great Basin, it is essential that desirable vegetative covers are restored as quickly as possible following a fire. It has been shown in some cases that plant regeneration times can be greatly decreased by reseeding the area at the appropriate time following the fire (Ratzlaff and Anderson 1995). However, one of the many problems that have occurred in the past is a lack of seeds that are suitable for reseeding. Some preliminary reports show that less than 10% of burned areas from the Murphy Complex fire can be reseeded due primarily to a lack of seeds (Bureau of Land Management 2008b). Lack of seeds was also a limiting factor in reseeding following the Milford Flat fire in Utah. A report to congress in April 2002 by the United States Department of Interior and the United States Department of Agriculture states the following: “Both increases in commercial field production and wildland seed collection are needed to meet public land needs” (United States Department of Interior 2002: 3). Although this is not the only limiting factor in reseeding, it is a problem for which there may be a solution. It is believed that the production of seed for rangeland reseeding can become a profitable business.

While grass and shrub seed production can be a profitable business, it must first be understood that this industry is saturated with risks. Price risk is an important factor to consider when evaluating grass and shrub seed production. Seed prices for most grass and shrub species have greater volatility than many traditional crops such as wheat and barley. Not only do these species have a broader range of possible prices, but producers could see both the extreme high and low prices in the same year.

Along with the high price volatility which characterizes grass and shrub seed markets, there are many aspects of production which impose high risks to producers’ profits. Many species can be difficult to establish due to poor seedling vigor. Establishment difficulties can also arise from weed management problems, improper irrigation, or poor weather at critical times during establishment.

In addition to the establishment difficulties of many grasses and shrubs, there is a significant capital investment required. Unlike most agricultural crops, grass and shrub seed production requires a large initial investment, with no return at the end of the first year. Instead, revenues are collected through annual seed harvests throughout the lifetime of the crop. Therefore, producers depend completely on the seed yields of years following the establishment year. Several unpredictable factors can significantly reduce seed yields, thereby reducing revenue, and the ability to recover establishment costs. The most threatening of these factors is the weather. Frost, extreme heat, wind, rain, and hail have the potential of reducing seed yields to zero. Because there is little one can do to predict or prevent the weather from affecting seed yields, great risk is imposed upon the producer.

Although grass and shrub seed production is risky, there are years when producers see both high yields and high prices. In such cases, grass and shrub seed production becomes extremely profitable. In fact, it will be discussed in chapter four how grass and shrub seed production can be much more profitable than typical crops such as grains. It is partly due to such years of high profits that producers are willing to take on the risks associated with grass and shrub seed production.

Farmers have many different options when it comes to deciding what to plant. Each crop carries with it an expected return and an associated risk. Each year, farmers weigh these risk/return combinations for each crop against each other, and make decisions based on their available resources. In doing so, one could say that alternative crops could be viewed as alternative assets. Therefore, the combination of crops that a farmer grows could be viewed as a portfolio of assets, or a combination of assets which each have their own expected returns and associated risks. There are limitless possibilities of crop portfolios for farmers to choose from. The idea that there exists an optimal portfolio is known as portfolio theory. The idea was first introduced by Harry Markowitz in his 1952 article *Portfolio Selection.* Markowitz developed what is known as the expected value- variance (E-V) model as a method of selecting an optimal portfolio (Markowitz 1952). Farmers can use a model such as Markowitz's E-V model to effectively select an optimal portfolio of crops which matches their return/risk preferences.

The purpose of this research is first, to evaluate the profitability of the production of native and introduced grass and shrub seeds for reseeding following a fire. Secondly, this research is to evaluate the production and market risks associated with the production of such seeds. Lastly, this research will look at alternative crop mixes on a typical Utah farm and evaluate these using an expected value-variance frontier approach.

To achieve the above objectives, the following methods and procedures will be used: Several grass and shrub species will be selected based upon a set of criteria and recommendations of industry professionals and government officials. Enterprise budgets will then be constructed for each species to estimate returns above operating costs. These returns will be compared to returns for more commonly grown crops such as wheat and barley. Production and market risks, as well as price and yield data will be obtained from experts within the industry. Using price and yield data, returns and risks for individual species will be compared through the use of an E-V model. Crop portfolios will then be created for a typical farm in Utah. These portfolios will contain different combinations of barley, alfalfa, and various grasses and shrubs. The returns and risks of these portfolios will be evaluated by using an E-V model. The results of the analysis will be outlined in detail in chapter four.

Chapter 2 – Literature Review

Ecological

Each summer there are numerous fires throughout the Great Basin. The following table shows the total number of fires and acres burned in wildfires on all land within the Great Basin that are managed by the following agencies of government: Bureau of Indian Affairs, BLM, Forest Service, US Fish and Wildlife Services, Nevada Department of Forestry, National Park Service, as well as state and private properties.

Table 1 - Total Number of Fires and Acres Burned by Wildfires in the Great Basin, 1994-2007

TOTAL for all agencies in the Great Basin		
Year	**Fires**	**Acres**
1994	4,076	1,119,017
1995	2,853	558,505
1996	3,919	2,078,988
1997	2,104	116,040
1998	2,468	273,792
1999	3,438	2,424,971
2000	4,384	2,275,345
2001	4,574	954,461
2002	3,021	424,232
2003	2,612	280,504
2004	3,230	128,985
2005	2,967	2,667,971
2006	6,796	3,547,495
2007	3,267	3,310,341

National Interagency Fire Center (2008)

There has been a significant decrease in the time between fires in the same area. A study on the role of fire in sagebrush communities has shown that historically, wildfires occurred at return intervals of 32-70 years in the sagebrush steppe of the Great Basin (Wright, Neuenschwander, and Britton 1979). However, a more recent study by Pellant (1990) shows that fire return intervals are decreasing dramatically. Pellant states that the main reason for this decrease in time is the invasion of cheatgrass.

Knick and Rotenberry (1997) indicated that repeat fires in the same area have led to a loss of shrub land. They attributed this pattern to the fact that fires burn the shrubs, and annual grasses move in before new sagebrush can become established. This also increases the distance between existing patches of shrubs, which also reduces the chance for natural reseeding by existing plants. This cycle, over time, has led to the spread of annual grasses, both native and introduced, and a decrease of natural sagebrush steppe habitat.

Keeley (2006) analyzed the impacts of different fire management practices on invasive plants in the western United States. Impacts from six different management practices are evaluated: fire suppression, fuel reduction in forests, prescription burning in shrub lands, fuel breaks, prescription burning to target noxious aliens, and post fire rehabilitation. These practices have had varied effects on the spread of invasive plants. Prescriptive burning of shrub lands in the Intermountain sagebrush steppe has been shown to favor cheatgrass expansion (Harnis and Murray 1973, Knapp 1996, and Young and Allen 1997). Therefore, Keeley (2006) suggests that there is need for a closer examination of prescriptive burning of dense areas of sagebrush steppe habitat in the Great Basin. Keeley’s study also shows that reseeding with introduced plants such as wheat and other cereal grains has actually increased the spread of invasive species and created even greater problems than previously existed.

A 1987 fire near Pocatello, Idaho became a study for effectiveness of post-fire rehabilitation by reseeding. In the study by Ratzlaff and Anderson (1995), some plots were left undisturbed following the fire, while others were reseeded with a mix of native and introduced species. The results showed better vegetative growth in the areas which were left undisturbed than in areas which were reseeded. The authors conclude that there must be an objective means of evaluating each individual area for post-fire rehabilitation.

Although the study by Ratzlaff and Anderson showed that reseeding following a fire could disrupt natural vegetative recovery, a more recent study by Jessop and Anderson (2007) shows just the opposite. Following a fire in Southeastern Utah, plots were reseeded and monitored to determine the effects of reseeding both native and introduced species to control cheatgrass invasion. Results showed that even in areas receiving less than 8 inches of annual precipitation, drilled plantings at the proper time can be effective in slowing and even stopping cheatgrass expansion following fires.

A similar study was conducted in by Thompson *et al.* (2006). However, this study was carried out in a region of the Great Basin receiving 10-12 inches of annual precipitation. The results were similar to those conducted by Jessop and Anderson in areas receiving less than 8 inches of annual precipitation. The study demonstrated once more that the reseeding of burned areas with desirable species at the proper time will create habitat that reduces density of invasive plant species. Such habitat is also less prone to fires in the future than if left unseeded.

In a study by Dewey, Jenkins, and Tonioli (1995), wildfire suppression is compared to noxious weed management. In addition to the many similarities discussed between management practices for controlling wildfires and invasive plant species, the authors emphasize the importance of augmentation or reintroduction of desirable, competitive plant species to effectively control noxious weeds following both wildfires and noxious weed treatments. If left unchecked in either situation, invasive species would return, inhibiting growth of native species.

Economic

The main research question of this study is to determine whether or not it can be profitable and feasible to produce native and non-native seeds for use in reseeding land burned in wildfires in the Great Basin. Reilly and Millikin (1996) discuss the basic elements of an economic feasibility analysis. Among other components, they emphasize the importance of market analysis and financial feasibility as important pieces of any economic feasibility analysis.

Because the objectives of this study require one to perform a financial feasibility analysis, it is necessary to consider some recent literature that discuss methods of analysis. In an article discussing the use of enterprise budgets in decision making, Iowa State University extension farm management field specialist Craig Chase (2006) gives the following definition: “An enterprise budget is an estimate of the costs and returns to produce a product (enterprise)." He goes on to further explain that an agricultural enterprise budget for crops should have five sections: revenue or sales, pre-harvest variable expenses, harvest expenses, ownership costs, and a returns summary. This is typical of most crops. However, some budgets have line items that do not fit within theses categorical descriptions. For this reason, it has been found necessary to modify this approach slightly by combining all variable expenses together in one category. This allows one to record all costs as either operating (variable) or ownership (fixed) costs.

Another important piece of literature outlines the basic procedure for decision making on range improvements. In his 1977 research bulletin, Nelsen provides ranchers with a tool for economic decision making with regards to range improvement. The handbook outlines in a plain and simple manner how to decide if range improvements can help ranchers increase the size of their operation, increase income. Financial tools such as internal rate of return, cost analysis, and enterprise budgets are explained with specific application to cattle ranching. The costs for each specific improvement are weighed against the possible increase in herd size, which increases revenue. Each calculation is shown so as to create an easy to follow guide for ranchers. Reseeding for rangeland improvement is covered extensively in this bulletin. However, like all other literature found on the subject, Nielsen's work does not touch on the possibility of producing seed for use in rangeland improvement, or the associated costs of doing so.

No published studies were found that evaluated the feasibility of producing native or introduced grass seed. Not only is there no literature analyzing costs or returns for producing native seeds for use in rehabilitating lands that have been burned , but there are also no published studies on many other important aspects of the industry such as marketing and industry organization. As a result, this the first study that provides a detailed feasibility analysis of seed production for several widely-used species of grasses and shrubs. Not only does this study provide a feasibility analysis of seed production, but also offers insights into the many risks producers face when producing grass and shrub seeds for use in post-fire rehabilitation.

Because this study uses expected value-variance models to analyze returns and risks for different enterprises as well as for different crop portfolios, it is necessary to review some recent literature on this topic. Portfolio theory was first introduced by Markowitz (1952). This paper introduced the idea of a set of optimal portfolios. Such portfolios optimally balance risk and returns. Markowitz's paper demonstrated that all portfolios could be evaluated using their expected returns, and variance through the use of an expected value-variance model. Using such a model, the optimal portfolios can be found on the efficient frontier. Anything inside the efficient frontier either has increased risk for the same return, or decreased returns for the same level of risk.

Many have added to Markowitz's work on portfolio theory. Currently, researchers are using portfolio theory in agriculture to evaluate possible crop combinations.   Barkley and Peterson (2008) used portfolio theory to evaluate winter wheat varieties as well as combinations of these varieties. Using the average yield and standard deviations of the average yield, they constructed an E-V model. The efficient frontier from the model clearly shows which varieties and combination of varieties optimally balance the returns and risks of Kansas winter wheat production.

Teegerstrom *et al*. (1997) use decision theory and portfolio analysis to evaluate possible options for cattle grazing contracts in West Virginia. Three contract types were analyzed using four decision rules: maximin, maximax, minimum regret value, and expected monetary value. There were nine possible price/production scenarios for each contract type, resulting in a different net return for each scenario. Following the analysis using the four decision rules, the alternatives were analyzed using an expected value-variance approach. The results show that the optimal portfolio would include a mix of at least two of the three grazing contract options. The study also noted that when decision rules are used, there is no information obtained about the tradeoffs of returns and risks between the possible portfolios. Portfolio analysis, however, provides such information, thereby allowing producers to make more educated decisions.

Chapter 3 –Procedures and Methodology

Species Selection

In the Guidebook to the Seeds of Native and Non-Native Grasses, Forbs and Shrubs of the Great Basin, Lambert (2005) identifies 67 species of grasses, 117 forbs, and 43 shrub species which have been used to reseed BLM land burned in wildfires. There are also new species currently being developed by the USDA, universities, and private companies. An evaluation of the feasibility of producing all species is not possible for several reasons. These reasons include limitations on time, resources, and information. As a result, it is necessary to identify a subset of species that can be evaluated. Several criteria were used to narrow the list of species of be evaluated. The first criterion was that the plants to be considered had to be currently in production as certified seed. This was necessary because government agencies only purchase certified seed. It also provided contact with producers who had knowledge of current issues pertaining to the species. Secondly, there had to be producers willing to share the production practices, as well as difficulties and risks in producing the species. Both of these criteria were critical to the creation of the financial feasibility analysis. The next criteria were of a biological nature. Over half of the area in the Great Basin receives less than 12 inches of annual precipitation. Therefore, the species must be able to grow well in less than 12 inches of annual precipitation. Higher elevations receive deep accumulations of winter snow. This snow typically does not melt until late spring to mid-summer. The delayed melting keeps the moisture in mountain soils high and allows plants to stay green longer than at low elevations, thereby reducing the risk of fires at high elevations. This aspect of the Great Basin's climate further restricts the selection to species to be evaluated to those typically found at lower elevations where fires are more likely. The final criterion was that there must be a mix of both native and introduced species. This is an important factor in marketing the seeds. After speaking with Orson Boyce, Scott Lambert, Bill Hopkins, and others in the industry, the following five plants were chosen: Bluebunch wheatgrass (Anatone), Crested wheatgrass (Hycrest), Basin wildrye (Trailhead), Russian wildrye (Bozoisky), and Forage kochia. Bluebuch wheatgrass and Basin wildrye are both native to some areas of the Great Basin, while the other three plants are introduced species.

The above guidelines eliminated many species which are widely used in reseeding efforts. Some of these species, such as sagebrush and bitterbrush, are commonly not grown or harvested on private lands using common production practices. Some are currently collected from federal lands through hand harvesting techniques. This was the main reason sagebrush and bitterbrush were not selected for evaluation. Siberian wildrye (Vavilov) is another species that is widely used in reseeding in the Great Basin due to its extreme drought tolerance. However, due to the recent introduction of the species in 1994, there are some aspects of production which remain to be proven over longer periods of time. There are other species as well which should be evaluated for their production potential. However, it was necessary to limit the scope of the study in order to perform a thorough evaluation of the selected species.

Species Profitability

The literature review in the previous chapter indicated that there were no published studies that have evaluated the economic potential of commercially producing seed for use on rangelands in the Great Basin. This does not mean however, that information and methods are not available that can be used to guide the research that is needed to meet the objectives of this study. For example, enterprise budgets have been developed by researchers for numerous crop and animal enterprises (Ellis et al. 2008, Chase 2006, and Smathers 2005). The methods suggested for the development of enterprise budgets have been outlined by several authors, and a typical enterprise budget for oats grown in Box Elder County, Utah is shown in Table 2. The key questions that have to be addressed in the development of a budget for a rangeland grass/forage/shrub enterprise involve obtaining answers to the following general questions.

1. What production practices are used to produce the plants?
2. What production yields can be expected?
3. What prices might be obtained?
4. What costs are incurred (establishment and production)?

It is expected that the information needed to answer these questions will be obtained in the following manner: First, species will be selected following a set of biological and economic criteria. The species selection will also involve the opinions of several industry professionals from different sectors of the industry. Secondly, common production practices for each of the selected species will be obtained from producers. Producers will be located through the

Table 2 – Estimated Costs and Returns for Oats – Box Elder County, Utah

Utah **S**tate **U**niversity
Extension **E**conomics

Modify Colored Columns

Costs and Returns per acre from growing oats, 2005
Box Elder County

Receipts	Quantity per acre	Unit	Price/cost per unit	Value/cost per acre	Base Value
Oats	100.0	bushels	$2.13	$213.33	$213.33
Straw	0.60	tons	$43.00	$25.80	$25.80
Subtotal				$239.13	$239.13
Operating costs					
Land preparation					
Plowing (every 3rd year)	1/3	acre	$5.88	$1.96	$1.96
Discing w/ packer	1	acre	$3.73	$3.73	$3.73
Land plane	2	acre	$3.34	$6.69	$6.69
Planting	1	acre	$2.96	$2.96	$2.96
Seed	70	pounds	$0.17	$11.90	$11.90
Fertilization					
Nitrogen (34-0-0)	205	pounds	$0.18	$36.59	$36.59
Phosphate (11-52-0)	48	pounds	$0.18	$8.57	$8.57
Custom application	1	acre	$7.82	$7.82	$7.82
Pesticides/herbicides					
2-4-D	1.25	pints	$2.75	$3.44	$3.44
Custom application	1	acre	$7.82	$7.82	$7.82
Irrigation (siphon)	3	irrigations			
Labor	1.00	hours	$10.00	$10.00	$10.00
Water assessment	1	share	$10.00	$10.00	$10.00
Repairs/maintenance	1	acre	$2.30	$2.30	$2.30
Pumping	-	acre inch	$0.00	$0.00	$0.00
Harvesting					
Custom combine	1	acre	$26.00	$26.00	$26.00
Haul grain (custom)	100.0	bushel	$0.06	$6.00	$6.00
Baling	0.60	tons	$4.79	$2.87	$2.87
Haul/stack straw	0.60	tons	$3.63	$2.18	$2.18
Crop insurance (75% Yield, 100% Price)	1	acre	$4.84	$4.84	$4.84
Interest on operating capital			7.61%	$3.37	$3.37
Subtotal				$159.05	$159.53
Ownership costs (excludes cost of land)				$60.87	$60.87
Farm insurance	1	acre	$2.00	$2.00	$2.00
Machinery ownership costs	1	acre	$50.62	$50.62	$50.62
Irrigation equipment costs	1	acre	$8.25	$8.25	$8.25
Total costs				$219.92	$220.40
Net returns to owner for unpiad labor, management, equity and risk					
Above operating costs				$80.09	$79.60
Above total listed costs				$19.21	$18.73

Utah State University (2007c)

certified seed directory published by the Utah Crop Improvement Association. Then, production yield, price, and cost data will be obtained from producers who are able and willing to provide needed information. Price data will also be collected from federal government agencies.

The methods noted above outline the anticipated methods that will be used to evaluate the profitability that an individual producer might expect if he or she decided to produce one or more of the species selected for evaluation. This information will be presented in the form of enterprise budgets for each species. The returns above operating costs estimated using these enterprise budgets will then be compared to returns above operating cost for barley and wheat. These two crops require the same basic machinery for production and are both grown in the Great Basin.

Production and Market Risk

In addition to the profitability analysis to be performed, it is necessary to consider the risks, and evaluate these risks with respect to their associated returns. Castle, Becker, and Nelson (1987) identify seven sources of risk in agriculture: production, market, financial, obsolescence, casualty, legal, and human. Production risk is due to the variability in production caused by unpredictable factors. Therefore, the variations in seed yields can be used as a measure of production risk. Market risk involves the variability and unpredictability of prices producers receive for their seed and pay for their production inputs. Changes in input prices have a relatively small impact on returns when compared to the impact on returns caused by a change in the price per pound received by producers for their seed. Therefore, variation and unpredictability in the price per pound received by producers for grass and shrub seed is identified as the greatest factor of market risk. Other factors of risk are minimal relative to production and market risks. Therefore, for the purpose of this study, any other risks will be ignored beyond the recognition of their existence.

Having identified variation in seed yield, and the price per pound received by producers for seed as the major sources of risk for seed production, one can begin to evaluate these risks in a quantitative manner. As has been shown in literature reviewed in the previous chapter, an expected value – variance model can be an effective tool in evaluating the risks and returns for different crops and crop portfolios.

Harry Markowitz first introduced the notion of portfolio selection in 1952. His ideas were based on the general assumption that investors dislike risk, and if given the option between two portfolios with equal expected returns, the investor would choose that portfolio which has the lowest level of risk. From this assumption, Markowitz explained that when selecting an investment portfolio from the limitless possibilities, there are some which balance risk and return more efficiently than others. The most efficient of these portfolios lie on what Markowitz called the efficient frontier. Portfolios are measured using the expected return, and the variance, or standard deviation of those expected returns. Returns are measured on one axis, and variance is measured on the other axis. Therefore, by calculating the expected return and the standard deviation of the expected return, crops and crop portfolios can be evaluated with an E-V model.

Figure 1 – Example of Expected Value – Variance Model

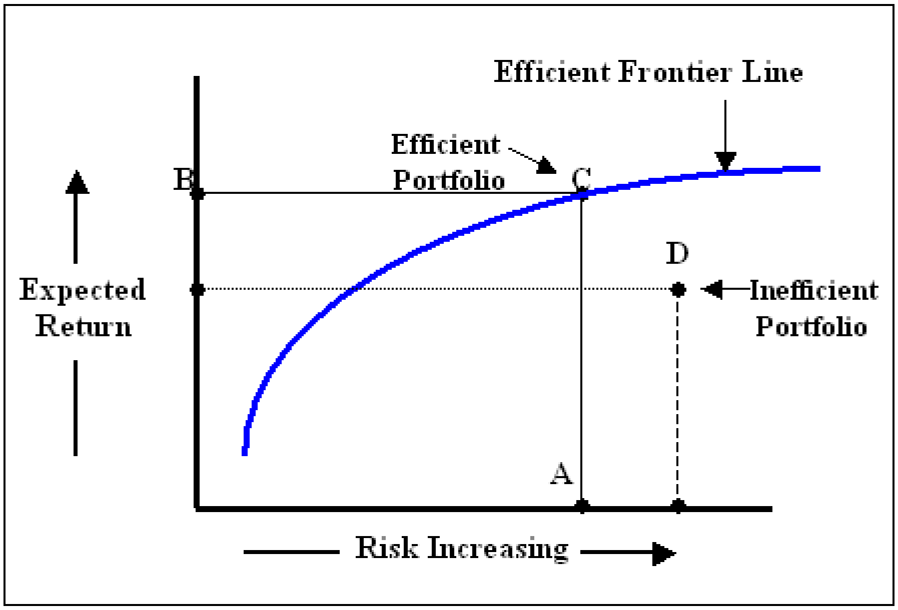


Figure 1 shows an example of an expected value – variance model. The X axis measures risk. Risk is zero at the origin, and increases away from the origin. Along the Y axis is measured the expected return. Returns are also zero at the origin, and increase as they move up the Y axis. The area of the chart beneath the blue line represents all of the possible portfolios available to investors. The blue line is known as the efficient frontier. Portfolios located on this line are considered to be more efficient than any portfolio beneath this line. For example, portfolio C lies on the efficient frontier, while portfolio D does not. Portfolio C is more efficient because it offers a higher expected return at a lower level of risk. The expected return for portfolio C is shown at point B. The expected return for portfolio D is less than B. The risk of portfolio C is shown by point A on the X axis. Portfolio D shows a level of risk greater than that at point A. Therefore, portfolio D is less efficient than portfolio C.

This basic model will be used in two different ways to analyze the risk and returns of grass and shrub seed production. First, individual grass and shrub species will be compared against each other using an E-V model. Previously, seed yield and price were identified as the two main sources of risk. By creating break-even tables with varying yield and price, net returns above operating cost can be calculated for each possible yield/price combination. A detailed explanation of the creation of the break-even tables is included in the following chapter. The result of the break even table is 25 possible outcomes for returns above operating costs. These 25 possibilities are assigned equal likelihood due to a lack of required data to accurately assign probability distribution to the sample. Therefore, the expected value is simply the average of the 25 possible returns above operating cost. Risk is measured by the standard deviation of the 25 returns from the expected value. After the expected return and standard deviation are calculated for each species, the species is plotted on the E-V model. Once all five species have been plotted on the graph, an efficient frontier is drawn through the two most efficient points on the graph. The relationship between risk and returns for each species can then be easily seen and conclusions will be made.

Following the evaluation of individual species using an E-V model, seven alternative crop portfolios will be created. This will allow one to evaluate the effects of including individual grass and shrub species in a portfolio of traditional crops grown in the Great Basin. The grass and shrub species to be included in the portfolios will be from those that lie on the efficient frontier of the individual species E-V model. A 400 acre farm will be used to create the portfolios. It is assumed that the farm already has the machinery needed for grass and shrub seed production. It is also assumed that the farm is currently producing barley and alfalfa. Both of these crops are commonly grown in the Great Basin.

To obtain the expected value and variance for each of the seven alternative crop portfolios, a simulation analysis is performed. SIMETAR (Richardson, Schumann and Feldman) is an add in to Excel that allows one to conduct monte carlo simulation analysis. The enterprise budgets developed for crested wheat grass seed and for kochia grass seed are used as well as enterprise budgets for Alfalfa and barley published by Utah State University to obtain expected returns for each of the crops. The farm return for each different portfolio of crops grown is just the summation of the return per acre for each crop multiplied by the number of acres. Price and yield for each of the four crops is treated as a stochastic variable.

Due to lack of price and yield data on the seed crops and yield data on alfalfa and barley that could be used to estimate a distribution for each of these variables, a modified triangle distribution is used. The GRK distribution in SIMETAR is similar to a two piece normal distribution where the minimum, middle and maximum values are chosen. The simulation generates values based on these parameters and about two percent of the time there are extreme values that fall outside of the range. Yield values for each crop were based on Utah State University budgets and Smith and Smith, 1997 and prices were based on observed values over the last 10 years, Table 3.

Table 3 – Price and Yield Values Used to Perform the Simulation Analysis for the GRK distribution.

	Minimum	Middle	Maximum
Alfalfa Yield tons/acre	3.5	5.0	6.5
Alfalfa Price $/ton	80.00	120.00	180.00
Barley Yield bushel/acre	80	95	110
Barley Price $/bushel	1.50	3.50	6.00
Crested Yield lbs./acre	50	733	1000
Crested Price $/lb.	0.80	1.67	2.50
Kochia Yield lbs./acre	50	533	800
Kochia Price $/lb.	0.50	8.76	17.00

There are 500 iterations of the simulation that is based on the price and yield data in table 3. From this simulation analysis, an expected value and a standard deviation for each of the seven crop portfolios are determined. These expected values and standard deviations for each crop portfolio are then plotted in an E-V framework and an E-V frontier is determined. Conclusions about the effects on returns and risks of including one or more grass species in a crop portfolio are then discussed.

Chapter 4 – Results and Findings

Budget Background

Given the limitations of this study, it was not possible to contact every producer, or to create budgets reflecting every method of production. Therefore, using the Certified Seed Directory published by the Utah Crop Improvement Association (2007), producers who have the largest number of certified acres were identified. They were then contacted to obtain production practices. Some producers were unable to be contacted. Others have gone out of business since the 2007 directory was published. Through the course of the study, it became clear that there were not sufficient producers producing the selected species to provide an accurate and fair representation of typical production practices. However, the Native Grass Seed Production Manual (Smith and Smith, 1997) outlines production techniques for all four grass species being evaluated. Industry professional Jensen (2008) stated that the Native Grass Seed Production Manual is heavily used by most producers in Utah, and is a reliable source for general production practices. Therefore, from the information contained in this manual, enterprise budgets were constructed for each species.

Following the selection of species and having obtained basic production practices, enterprise budgets were constructed for each of the above listed species. Each budget consists of an establishment year, which varies from 12-17 months depending upon species, and a production year, which is the calendar year in which seeds are harvested. Seeds are usually not harvested during the establishment year.

Crested Wheatgrass

A commonly used plant in restoration and rehabilitation efforts is crested wheatgrass. Crested wheatgrass is an introduced species to the Great Basin and has been used in seedings for more than 50 years. Due to the abundance of seed, and the wide range of conditions in which the plant thrives, seed prices are typically lower than most grass species. In the past 2 years, producers have received between $0.80 and $2.50 per pound for crested wheatgrass seed (Boyce 2008). Residual stems left following harvest can be swathed, baled, and sold as straw for additional revenue. Generally, no residual cleanup is needed if straw is cut and baled. Crested wheatgrass heads usually hold seeds well, allowing producers to combine the crop without dropping seed on the ground.

Budget Details

The enterprise budgets for crested wheatgrass will be explained line by line in detail. Budgets for other species vary slightly, and such variations will be clearly stated. As previously explained, there is an establishment budget, shown as table 3, as well as a production budget, shown as table 4.

Land preparation only occurs prior to seeding in the establishment year. It is suggested by Smith and Smith,1997 that the seedbed be firmly packed. It is assumed that seedbed preparation consist of one pass with a plow, one with a disk, followed by two passes with a roller harrow or similar seed bed packer.

Operating costs consist of repair, fuel, lubrication, and labor. Repair costs are given as a percentage of purchase prices in the Iowa State Extension bulletin by Edwards (2005:5). Repair costs for a four wheel drive tractor with 2,000 accumulated hours of use were listed at 1% of the purchase price. Moldboard plows, tandem disks, and a harrow with 400 accumulated hours of use are listed at 6%, 4%, and 7% of purchase prices respectively.

Fuel costs for the various pieces of machinery have been given in Iowa State University Extension publication PM 709 by Hanna (2001a). They are listed in gallons of diesel used per acre for various activities. These figures were then multiplied by the current per gallon price of diesel to obtain a total fuel cost for each machine. Diesel price of $3.38/gallon was quoted by Kellerstrass Oil of Ogden, Utah on October 20, 2008. Lubrication costs, in accordance with Edwards (2005), are calculated at 15% of fuel costs.

The most recent report issued by the National Agricultural Statistics Service (2008) reports that the average wage rate for field workers in the US was $9.66. Using this wage rate, labor costs were calculated using the field capacity rates for each piece of equipment used. A field capacity rate is simply the number of acres a certain piece of machinery can cover in one hour. The field capacity rates were obtained from Iowa State University Extension publication PM 696 written by Hanna (2001a). The wage rate of $9.66/hour was divided by the effective field capacity rates for each piece of equipment to obtain labor costs. For example, the field capacity rate of a four-bottom plow is 5.5 acre/hour. Using the average wage rate of $9.66/hour, the resulting labor cost per hour = $9.66/hour ÷ 5.5 acres/hour = $1.76/acre. The repairs, fuel, lubrication, and labor costs were then combined to create the total operating cost. A detailed table of machinery operating costs is included as appendix A.

Once the machinery operating costs per acre were calculated, they were placed in the budget as a line item. For example, operating costs for plowing with a four bottom plow were calculated at $9.64 per acre. This is listed under the Price/cost per unit column heading. Figures in this column are then multiplied by their corresponding Quantity per acre column figure. For plowing, this figure is one, and so the Value/cost per acre equals $9.64 X 1 = $9.64. All machinery operating costs are listed in the budgets in the same manner.

Planting is done using a 13 foot grain drill pulled behind the 160 PTO horsepower tractor. The operating cost per acre for the seed drill is $3.18. Seed prices were obtained from Wheatland West Seed LLC in Clearfield, UT. The price paid for certified crested wheatgrass seed in August 2008 was $2.00 per pound. According to Smith and Smith, crested wheatgrass should be seeded at a rate of 3.2 pounds per acre. Therefore, the total seed cost per acre = $2.00 per pound X 3.2 pounds per acre = $6.40 per acre.

Fertilization costs occur twice during the establishment year, and once during production years. Smith and Smith suggest that phosphorus (11-52-0) be applied at a rate of 55 pounds per acre at the time of planting. Phosphorus (11-52-0) was priced at $0.60 per pound at IFA in Lewiston, Utah in June 2008. Following seedling establishment, Smith and Smith recommend the application of 70 pounds of nitrogen per acre. It is assumed that urea (46-0-0) is currently the most cost effective method of achieving this. Therefore, 152 pounds of urea

(46-0-0) are applied spring and fall to achieve the 70 pounds of nitrogen per application. Urea was priced at $0.40 per pound at IFA in Lewiston, Utah in June 2008. Custom application rates vary depending upon location. Those used in the budgets were provided by IFA in Lewiston, Utah in October 2008. A rate of $4.50 per acre for dry fertilizer application has been used. Therefore, total custom application costs for fertilizer = $4.50 per acre X 2 applications (spring and fall) = $9.00.

Smith and Smith state that when possible, seeds should be planted in field where weeds have been controlled by summer fallow or a broad spectrum herbicide. A broad spectrum herbicide is commonly used prior to planting to clean the field of any vegetation. It is applied at a rate of 2 quarts per acre. The cost of broad spectrum herbicide per quart in June 2008 at IFA in Lewiston, Utah was $18.50. Few chemicals are labeled for the treatment of broadleaf weeds in grasses. Those used are typically applied in both the establishment and production years. Common broadleaf herbicide was $11.30 per quart in June 2008. The product was applied at a rate of 1 quart per acre. Liquid chemical custom application rates as quoted by IFA in October 2008 were $6.00 per acre. Both broad spectrum and broadleaf herbicides are used in the establishment year, while only broadleaf treatment is needed in the production years. Therefore, custom application costs in the establishment year are $12.00 per acre, while only $6.00 per acre in the production years. It should be noted that label restrictions vary between products and location. This study only attempts to estimate costs for herbicide application. It does not endorse any specific brand, label, or application of herbicides.

Cultivation is another method of weed control which has been effective. For cost estimation purposes, it is assumed that cultivation is performed with a 16 foot rigid cultivator. The total operating cost is $2.86 per acre.

Irrigation costs have been calculated using Utah State University Extension Pumping Cost Estimator (www.extension.usu.edu/irrestimator/). The following criteria were used in the estimation: Richmond, Cache County, 50 acres of spring grain, Utah Power as the power provider, 14.77 inches of water spread through the months of April, May, June, July, and August. It is assumed that water was pumped from a depth of 100 feet at 50 pounds per square inch, with a flow of 356 gallons per minute. The resulting cost per acre is $49.34.

Field certification, application, and tagging fees for certified seeds were obtained from the Utah Crop Improvement Association (2007). These fees consist of a $10 fee per field/crop/class combination each year. Supposing that the farm were planted with only one field, and this field contained only one species, this $10 fee would be divided by the acreage of that specific field. It is assumed that the field is 50 acres, thereby making the fee $0.20 per acre. There is also a $2.00 per acre fee for field inspection. Therefore, in the establishment year, certification fees total $2.20 per acre. During production years, there is an additional tagging and bulk certification fee of $1.00/cwt for production exceeding 250 lbs/acre, and $2.00/cwt for production less than 250 lbs/acre. This fee is multiplied by the cwt yield for the species. For crested wheatgrass, where yields are typically 500 pounds per acre, the tagging and bulk certification fee would be $1.00/cwt X 5cwt/acre = $5.00. Therefore, the total certification fees for production years = $5.00 + $2.20 = $7.20.

Overhead costs are highly variable depending upon methods of calculation, what is included in those calculations, and other operational variables. It is assumed that three hours of labor are allocated as overhead costs at the average farm labor rate of $9.66. Therefore, overhead costs are assumed to be $28.98 per acre. These three hours could be used for any number of tasks including picking rock, manual weeding, or general farm maintenance and upkeep. Interest on operating capital is assumed to be incurred at a real annual interest rate of 5%.

As was mentioned above, seeds are not typically harvested during the establishment year. Therefore, operating costs for the establishment year have been amortized over the remaining lifetime of the crop. Castle, Becker, and Nelson (1987:155-6) explain how to calculate equal payments toward a loan over a period of time. The following equation is used if one is to pay or receive a series of equal value payments (*pmt*) for a number of periods (*n*) with fixed interest rate (*i*) and a known present value (*pv*):

$pmt = pv([i(1+i)]^{n} / ([(1+i)]^{n} - 1)$ PV is equal to the total operating costs for the establishment year, or $294.62 in the example of crested wheatgrass. The interest rate (*i*) is assumed to be 5%. The number of periods (*n*) is equal to the number of production years, or the stand lifetime minus 1.Crested wheatgrass has a stand lifetime of 7 years, which means there are 6 production years, therefore, *n*=6. Following this formula, the establishment cost to be paid each year for crested wheatgrass is $58.04/acre. These figures are included in the production year budget as the last line item under operating costs.

Many of the costs in the production years are the same as those in the establishment year. Therefore, only those costs which are new, or calculated in a different manner than those explained previously will be outlined. Revenue consists of seed sales. Smith and Smith give a range of seed yields which are possible under the production practices described. The yield used in the budget is the median yield from the range given for each species. The seed prices were obtained from Wheatland West Seed LLC (Boyce 2008). The prices reflect the median price in a range of certified seed prices received by producers during the past 24 months. However, seed prices fluctuate wildly from year to year, and are dependent upon several factors which will be discussed later in the chapter.

Harvesting crested wheat consists of swathing the field of grass, allowing it to dry for several days, and then harvesting the seed with a combine. Once the seed has been harvested, it must be hauled to an approved cleaning facility. Swather and combine operating costs have been calculated the same as previously explained for other equipment. There were only 9 approved conditioning plants for seeds in Utah in 2007 (Utah Crop Improvement Association 2007). These 9 plants were located in 2 places in the state of Utah; Brigham City/Tremonton, which is in the northern part of the state, and Manti/Ephriam, which is in central Utah. For producers not located in these regions, this means there may be high transportation costs to the seed cleaning facilities. Due to the high variability in transportation costs due to differences in geographic location and transportation equipment, the transportation costs are assumed to be $0.00 for the purpose of this budget. However individual producers must take seed transportation costs into account when evaluating the possible returns for each enterprise.

Interest on operating capital has been calculated at a real annual interest rate of 5%. Therefore, per acre operating costs for the year have been multiplied by 5% to obtain the figure of $9.19/acre.

Following the calculation of total ownership costs/acre, net returns to the owner above operating costs for unpaid labor, management, equity, and risk are calculated. To calculate returns above operating costs, the total operating costs are subtracted from total sales. Net return above operating costs for production of crested wheatgrass was estimated at $974.00/acre. This number can be compared to other crops that could be produced in the same region to determine which enterprise is more profitable. Net returns above operating costs for soft white wheat in Cache County, Utah in 2007 were estimated at $224.19/acre (Utah State University 2008a). Net returns above operating costs for barley for the same area were estimated at $57.65/acre (Utah State University 2008b).

Following the establishment and production year budgets, break-even tables have been created. Table 5 shows the returns above operating cost with varying price and yield combinations for crested wheatgrass. The tables contain price data provided by Boyce (2008) which reflects the wide variation in prices received by producers over the past 24 months. The top of each of five columns contains a price figure. These five figures were derived from the range of prices given my Boyce. The high and low of the range were set as the far left and right columns. Between these two prices, the other three were spread evenly, with the middle price being the mean of the range. Yield data were given by Smith and Smith, and are shown in the far left column of each table. The top row in the yield column of each table is zero because there is always a possibility that seed production could completely fail in any given year due to a number of production risks such as frost or extreme heat. The remaining four yield figures represent and equal distribution of a yield range given by Smith and Smith. The table is populated by multiplying the per acre yield in the far left column by the per pound selling price on the corresponding cell in the top row, and then subtracting the total operating costs, which are $256.19 for crested wheatgrass. The break-even tables provide returns above operating costs for the best and worst case scenarios, as well as a wider range of possibilities which lie in between. Later in the chapter, the break-even tables will be used to create expected values for returns, as well as an expected value frontier, which is used to compare risk/return combinations for different enterprises.

Table 4 – Establishment Costs per Acre from Producing Crested Wheatgrass (Hycrest) Seed in Great Basin, 2008

Establishment Year (16 months)				
Operating Costs	**Quantity per acre**	**Unit**	**Price/cost per unit**	**Value/cost per acre**
Land Preparation				
Plowing	1	acres	$ 9.72	$ 9.72
Discing	1	acres	$ 3.88	$ 3.88
Seed Bed Packer	2	acres	$ 3.24	$ 6.48
Planting	1	acres	$ 2.99	$ 2.99
Seed	3.2	pounds	$ 2.00	$ 6.40
Fertilization				
Phosphorus(11-52-0)	55	pounds	$ 0.60	$ 33.00
Urea(46-0-0)	152	pounds	$ 0.40	$ 60.80
Custom Application	2	acre	$ 4.50	$ 9.00
Herbicides				
Broad Spectrum Herbicide	2	quarts	$ 18.50	$ 37.00
Broadleaf Treatment	1	quart	$ 11.30	$ 11.30
Custom Application	2	acre	$ 6.00	$ 12.00
Cultivation	1	acre	$ 2.67	$ 2.67
Irrigation	1	acre	$ 49.34	$ 49.34
Field certification and application fees[1]	1	acre	$ 2.20	$ 2.20
Overhead	1	acre	$ 28.98	$ 28.98
Interest on Operating Capital	1	acre	5%	$ 13.79
Total Operating Costs/acre				$ 289.55
Capitalize establishment year costs over 6 production years				$57.05

[1] Field certification, seed certification, and tagging fees are listed for the state of Utah. Fees for other states may be different.

Table 5 – Production Costs and Returns per Acre from Producing Crested Wheatgrass (Hycrest) Seed in Great Basin, 2008

Production Year				
Receipts	**Quantity per acre**	**Unit**	**Price/cost per unit**	**Value/cost per acre**
Seed	733	pounds	$ 1.67	$ 1,224.11
Subtotal Sales				$ 1,224.11
Operating Costs				
Fertilization				
Urea(46-0-0)	152	pounds	$ 0.40	$ 60.80
Custom Application	1	acre	$ 4.50	$ 4.50
Broadleaf herbicides	1	acre	$ 11.30	$ 11.30
Custom Application	1	acre	$ 6.00	$ 6.00
Cultivation	1	acre	$ 3.90	$ 3.90
Irrigation	1	acre	$ 49.34	$ 49.34
Field Certification and inspection Fees[1]	1	acre	$ 2.20	$ 2.20
Overhead	1	acre	$ 28.98	$ 28.98
Harvesting				
Swathing	1	acre	$ 3.35	$ 3.35
Combine	1	acre	$ 8.50	$ 8.50
Haul to cleaners	1	acre	$ -	$ -
Seed certification and tagging fees[1]	1	acre	$ 5.00	$ 5.00
Interest on operating capital	1	acre	5%	$ 9.19
Capitalized Investment Costs (7 year lifetime)	1	acre	$ 57.05	$ 57.05
Subtotal Operating Costs				$ 250.11
Net returns to owner for unpaid labor, management, equity, and risk				
Above operating costs				$ 974.00

[1] Field certification, seed certification, and tagging fees are listed for the state of Utah. Fees for other states may be different.

Table 6 – Estimated Returns Above Operating Costs With Varying Prices and Yields for Crested Wheatgrass (Hycrest) Seed in Great Basin, 2008

Net returns per acre above operating costs (7 year lifetime)					
	Selling Price ($/lb bulk seed)				
Yield (lbs/acre)	$ 0.80	$ 1.23	$ 1.67	$ 2.08	$ 2.50
0	$(250.11)	$ (250.11)	$ (250.11)	$ (250.11)	$ (250.11)
600	$ 229.89	$ 487.89	$ 751.89	$ 997.89	$ 1,249.89
733	$ 336.29	$ 651.48	$ 974.00	$ 1,274.53	$ 1,582.39
867	$ 443.49	$ 816.30	$ 1,197.78	$ 1,553.25	$ 1,917.39
1000	$ 549.89	$ 979.89	$ 1,419.89	$ 1,829.89	$ 2,249.89

Bluebunch Wheatgrass

Bluebunch wheatgrass was one of the two native plants for which costs and returns of seed production were evaluated. The budgets for bluebunch wheatgrass are similar to those of crested wheatgrass. Producers have received between $1.50 and $7.50 per pound (Boyce 2008). The median price of this range, which was used in the budget, is $4.50 per pound. Yields for irrigated seed production range from 200 to 500 pounds per acre. A yield of 300 pounds per acre was used in the budget. Net returns above operating cost were estimated at $1,039.16 per acre. The previously mentioned returns above operating costs for soft white wheat and barley grown in Cache County, Utah in 2007 were $224.19 and $57.65 per acre respectively. When compared to these two alternative enterprises, bluebunch appears to be much more profitable.

Table 7 – Establishment Costs per Acre from Producing Bluebunch Wheatgrass (Anatone) Seed in Great Basin, 2008

Establishment Year (16 months)				
Operating Costs	**Quantity per acre**	**Unit**	**Price/cost per unit**	**Value/cost per acre**
Land Preparation				
Plowing	1	acres	$ 9.72	$ 9.72
Discing	1	acres	$ 3.88	$ 3.88
Seed Bed Packer	2	acres	$ 3.24	$ 6.48
Planting	1	acres	$ 2.99	$ 2.99
Seed	4.6	pounds	$ 8.50	$ 39.10
Fertilization				
Phosphorus(11-52-0)	50	pounds	$ 0.60	$ 30.00
Urea(46-0-0)	152	pounds	$ 0.40	$ 60.80
Custom Application	2	acre	$ 4.50	$ 9.00
Pesticides/herbicides				
Broad Spectrum Herbicide	2	quarts	$ 18.50	$ 37.00
Broadleaf Treatment	1	quart	$ 11.30	$ 11.30
Custom Application	2	acre	$ 6.00	$ 12.00
Cultivation	1	acre	$ 2.67	$ 2.67
Irrigation	1	acre	$ 49.34	$ 49.34
Field certification and application fees[1]	1	acre	$ 2.20	$ 2.20
Overhead	1	acre	$ 28.98	$ 28.98
Interest on Operating Capital	1	acre	5%	$ 15.27
Total Operating Costs/acre				$ 320.73
Capitalize establishment year over 3 production years				$117.78

[1] Field certification, seed certification, and tagging fees are listed for the state of Utah. Fees for other states may be different.

Table 8 – Production Costs and Returns per Acre from Producing Bluebunch Wheatgrass (Anatone) Seed in Great Basin, 2008

Production Year				
Receipts	**Quantity per acre**	**Unit**	**Price/cost per unit**	**Value/cost per acre**
Seed	300	pounds	$ 4.50	$ 1,350.00
Subtotal Sales				$ 1,350.00
Operating Costs				
Fertilization				
Urea(46-0-0)	152	pounds	$ 0.40	$ 60.80
Custom Application	1	acre	$ 4.50	$ 4.50
Broadleaf herbicides	1	acre	$ 11.30	$ 11.30
Custom Application	1	acre	$ 6.00	$ 6.00
Cultivation	1	acre	$ 3.90	$ 3.90
Irrigation	1	acre	$ 49.34	$ 49.34
Field Certification Fees[1]	1	acre	$ 2.20	$ 2.20
Overhead	1	acre	$ 28.98	$ 28.98
Harvesting				
Swathing	1	acre	$ 3.35	$ 3.35
Combine	1	acre	$ 8.50	$ 8.50
Haul Seed to Cleaners	1	acre	$ -	$ -
Seed certification and tagging fees[1]	1	acre	$ 5.00	$ 5.00
Interest on operating capital	1	acre	5%	$ 9.19
Capitalized Investment Costs (4 year lifetime)	1	acre	$ 117.78	$ 117.78
Subtotal Operating Costs				$ 310.84
Net returns to owner for unpaid labor, management, equity, and risk				
Above operating costs				$ 1,039.16

[1] Field certification, seed certification, and tagging fees are listed for the state of Utah. Fees for other states may be different

Table 9 – Estimated Returns Above Operating Costs With Varying Prices and Yields for Bluebunch Wheatgrass (Anatone) Seed in Great Basin, 2008

Net returns per acre above operating costs (6 year stand lifetime)					
	Selling Price ($/lb bulk seed)				
Yield (lbs/acre)	$ 1.50	$ 3.00	$ 4.50	$ 6.00	$ 7.50
0	$(310.84)	$ (310.84)	$ (310.84)	$ (310.84)	$ (310.84)
200	$ (10.84)	$ 289.16	$ 589.16	$ 889.16	$ 1,189.16
300	$ 139.16	$ 589.16	$ 1,039.16	$ 1,489.16	$ 1,939.16
400	$ 289.16	$ 889.16	$ 1,489.16	$ 2,089.16	$ 2,689.16
500	$ 439.16	$1,189.16	$ 1,939.16	$ 2,689.16	$ 3,439.16

Russian Wildrye (Bozoisky)

Russian wildrye is another introduced species grown by producers in the Great Basin. Production practices are similar to those of crested and bluebunch wheatgrass. Seed yields typically range from 300 to 700 pounds per acre (Smith and Smith). A yield of 433 pounds is used in the production budget. Prices received by producers in 2007 and 2008 have ranged from $2.00 to $7.00 per pound (Boyce 2008). The median price of this range, $4.50, is also used to calculate receipts for the production budget. Returns above operating costs are estimated at $1,670.61 per acre. These estimated returns show that Russian wildrye can be much more profitable than wheat or barley grown in the same area. Returns for wheat and barley are estimated at $224.19 and $57.65 per acre respectively.

Table 10 – Establishment Costs per Acre from Producing Russian Wildrye (Bozoisky) Seed in Great Basin, 2008

Establishment Year (16 months)						
Operating Costs	**Quantity per acre**	**Unit**		**Price/cost per unit**		**Value/cost per acre**
Land Preparation						
Plowing	1	acres	$	9.72	$	9.72
Discing	1	acres	$	3.88	$	3.88
Seed Bed Packer	2	acres	$	3.24	$	6.48
Planting	1	acres	$	2.99	$	2.99
Seed	2.85	pounds	$	6.00	$	17.10
Fertilization						
Phosphorus(11-52-0)	55	pounds	$	0.60	$	33.00
Urea(46-0-0)	152	pounds	$	0.40	$	60.80
Custom Application	2	acre	$	4.50	$	9.00
Pesticides/herbicides						
Non-selective Herbicide	2	quarts	$	18.50	$	37.00
Broadleaf Treatment	1	quart	$	11.30	$	11.30
Custom Application	2	acre	$	6.00	$	12.00
Cultivation	1	acre	$	2.67	$	2.67
Irrigation	1	acre	$	49.34	$	49.34
Field certification and application fees[1]	1	acre	$	2.20	$	2.20
Overhead	1	acre	$	28.98	$	28.98
Interest on Operating Capital	1	acre		5%	$	14.32
Total Operating Costs/acre					$	300.78
Capitalize establishment year over 4 production years						$84.82

[1] Field certification, seed certification, and tagging fees are listed for the state of Utah. Fees for other states may be different.

Table 11 – Production Costs and Returns per Acre from Producing Russian Wildrye (Bozoisky) Seed in Great Basin, 2008

Production Year				
Receipts	**Quantity per acre**	**Unit**	**Price/cost per unit**	**Value/cost per acre**
Seed	433	pounds	$ 4.50	$ 1,948.50
Subtotal Sales				$ 1,948.50
Operating Costs				
Fertilization				
Urea(46-0-0)	152	pounds	$ 0.40	$ 60.80
Custom Application	1	acre	$ 4.50	$ 4.50
Broadleaf herbicides	1	quart	$ 11.30	$ 11.30
Custom Application	1	acre	$ 6.00	$ 6.00
Cultivation	1	acre	$ 3.90	$ 3.90
Irrigation	1	acre	$ 49.34	$ 49.34
Field Certification Fees[1]	1	acre	$ 2.20	$ 2.20
Overhead	1	acre	$ 28.98	$ 28.98
Harvesting				
Swathing	1	acre	$ 3.35	$ 3.35
Combine	1	acre	$ 8.50	$ 8.50
Haul to cleaners	1	acre	$ -	$ -
Seed certification and tagging fees[1]	1	acre	$ 5.00	$ 5.00
Interest on operating capital	1	acre	5%	$ 9.19
Capitalized Investment Costs (5 year lifetime)	1	acre	$84.82	$ 84.82
Subtotal Operating Costs				$ 277.89
Net returns to owner for unpaid labor, management, equity, and risk				
Above operating costs				$ 1,670.61

[1] Field certification, seed certification, and tagging fees are listed for the state of Utah. Fees for other states may be different.

Table 12 – Estimated Returns Above Operating Costs With Varying Prices and Yields for Russian Wildrye (Bozoisky) Seed in Great Basin, 2008

Net returns per acre above operating costs (6 year stand lifetime)					
	Selling Price ($/lb bulk seed)				
Yield (lbs/acre)	$ 2.00	$ 3.25	$ 4.50	$ 5.75	$ 7.00
0	$ (277.89)	$ (277.89)	$ (277.89)	$ (277.89)	$ (277.89)
300	$ 322.11	$ 697.11	$1,072.11	$ 1,447.11	$ 1,822.11
433	$ 588.11	$ 1,129.36	$1,670.61	$ 2,211.86	$ 2,753.11
567	$ 856.11	$ 1,564.86	$2,273.61	$ 2,982.36	$ 3,691.11
700	$1,122.11	$ 1,997.11	$2,872.11	$ 3,747.11	$ 4,622.11

Great Basin Wildrye

Basin wildrye is native to the Great Basin. A major difference in the production practices of basin wildrye from those of other grass species is in the establishment period. Generally, basin wildrye does not produce sufficient seeds for harvesting until year three (Jensen 2008). Therefore establishment costs must include the first two years, rather than just the first year as is the case with other grasses evaluated. These increased establishment costs were budgeted in the following manner: When calculating the amortization of the establishment costs to be paid through the production years, a different figure was used for the present value (*pv*) term in the equation. The subtotal of operating costs from the production year less the capitalized establishment costs was added to the subtotal operating costs from the establishment year. This essentially means that all costs incurred from planting through the second year of the stand lifetime, including interest, are amortized over the remaining 4 production years.

Producers have been receiving between $0.85 and $5.25 per pound of seed (Boyce 2008). The median price of $3.05 per pound has been used in the production budget. Yields generally range from 200 to 350 pounds per acre. A yield of 250 pounds was used for budgeting purposes. Returns above operating cost for basin wildrye were estimated to be $655.84 per acre. While lower than other grass species previously evaluated, returns above operating cost for basin wildrye are substantially greater than those of wheat and barley, which are $224.19 and $57.65 per acre respectively.

Table 13 – Establishment Costs per Acre from Producing Basin Wildrye (Trailhead) Seed in Great Basin, 2008

Establishment Year (16 months)				
Operating Costs	**Quantity per acre**	**Unit**	**Price/cost per unit**	**Value/cost per acre**
Land Preparation				
Plowing	1	acres	$ 9.72	$ 9.72
Discing	1	acres	$ 3.88	$ 3.88
Seed Bed Packer	2	acres	$ 3.24	$ 6.48
Planting	1	acres	$ 2.99	$ 2.99
Seed	4	pounds	$ 5.50	$ 22.00
Fertilization				
Phosphorus(11-52-0)	50	pounds	$ 0.60	$ 30.00
Urea(46-0-0)	152	pounds	$ 0.40	$ 60.80
Custom Application	2	acre	$ 4.50	$ 9.00
Pesticides/herbicides				
Non-selective Herbicide	2	quarts	$ 18.50	$ 37.00
Broadleaf Treatment	1	quart	$ 11.30	$ 11.30
Custom Application	2	acre	$ 6.00	$ 12.00
Cultivation	1	acre	$ 2.67	$ 2.67
Irrigation	1	acre	$ 49.34	$ 49.34
Field certification and application fees[1]	1	acre	$ 2.20	$ 2.20
Overhead	1	acre	$ 28.98	$ 28.98
Interest on Operating Capital	1	acre	5%	$ 14.42
Total Operating Costs/acre (year 1)				$ 302.78
Year 2 Production Costs (no seed harvest in year 2)				$ 197.61
Capitalize establishment year and year 2 over 4 remaining production years				$141.12

[1] Field certification, seed certification, and tagging fees are listed for the state of Utah. Fees for other states may be different.

Table 14 – Production Costs and Returns per Acre from Producing Basin Wildrye (Trailhead) Seed in Great Basin, 2008

Production Year				
Receipts	**Quantity per acre**	**Unit**	**Price/cost per unit**	**Value/cost per acre**
Seed	250	pounds	$ 3.05	$ 762.50
Subtotal Sales				$ 762.50
Operating Costs				
Fertilization				
Urea(46-0-0)	152	pounds	$ 0.40	$ 60.80
Custom Application	1	acre	$ 4.50	$ 4.50
Broadleaf herbicides	1	quart	$ 11.30	$ 11.30
Custom Application	1	acre	$ 6.00	$ 6.00
Cultivation	1	acre	$ 3.90	$ 3.90
Irrigation	1	acre	$ 49.34	$ 49.34
Field Certification Fees[1]	1	acre	$ 2.20	$ 2.20
Overhead	1	acre	$ 28.98	$ 28.98
Harvesting				
Combine	1	acre	$ 8.50	$ 8.50
Haul to cleaners	1	acre	$ -	$ -
Seed certification and tagging fees[1]	1	acre	$ 5.00	$ 5.00
Swathing	1	acre	$ 3.35	$ 3.35
Baling	1	acre	$ 4.33	$ 4.33
Interest on operating capital	1	acre	5%	$ 9.41
Capitalized Establishment Costs (yrs 1&2)	1	acre	$141.12	$ 141.12
Subtotal Operating Costs				$ 338.73
Net returns to owner for unpaid labor, management, equity, and risk				
Above operating costs				$ 423.77

[1] Field certification, seed certification, and tagging fees are listed for the state of Utah. Fees for other states may be different.

Table 15 – Estimated Returns Above Operating Costs With Varying Prices and Yields for Basin Wildrye (Trailhead) Seed in Great Basin, 2008

Net returns per acre above operating costs (6 year stand lifetime)					
	Selling Price ($/lb bulk seed)				
Yield (lbs/acre)	$ 0.85	$ 1.95	$ 3.05	$ 4.15	$ 5.25
0	$ (338.73)	$ (338.73)	$ (338.73)	$ (338.73)	$ (338.73)
200	$ (168.73)	$ 51.27	$ 271.27	$ 491.27	$ 711.27
250	$ (126.23)	$ 148.77	$ 423.77	$ 698.77	$ 973.77
300	$ (83.73)	$ 246.27	$ 576.27	$ 906.27	$ 1,236.27
350	$ (41.23)	$ 343.77	$ 728.77	$ 1,113.77	$ 1,498.77

Forage Kochia

One of the few shrub species which is currently produced for seeds is forage kochia. Forage kochia is an introduced perennial shrub which thrives in desert conditions. The plant is extremely drought tolerant, and grows well in poor soils. There are several major differences in the production methods for forage kochia from those of the grass species evaluated. Forage kochia germinates best when seeded very shallow on disturbed soils. Reed (2008) suggests that seedbed preparation consist of disturbing the soil by passage with a disc or cultivator in late fall. Planting should follow in January when there is snow on the ground. For optimal germination, seed should be drilled directly into the snow, but not into the soil. This should be done at a rate of 3 pounds of seed per acre with 36 inch row spacing to allow for cultivation. There are no herbicides labeled for use on forage kochia. However, a broad spectrum herbicide can be used during the summer prior to planting to clean the field of any weeds. Cultivation also works well to control weeds, and the cultivation costs are the same as those applied in the grass seed budgets. It is not recommended that any fertilizer be applied during the establishment year. Young (2008) recommends that irrigation of forage kochia be limited to a maximum of four inches annually. A maximum of two inches are needed in mid summer, and two more inches in late August or September to maximize seed production. Irrigation of forage kochia requires significantly less water than the four grass species evaluated. Therefore, irrigation costs are assumed to be 50% of those of the grass species, which equals $24.67. During production years it is recommended that 100 units of nitrogen be applied. If urea (46-0-0) were to be used, this would require 220 pounds. Harvest methods are different than those of the grass species. Forage kochia is best harvested through direct combining. This typically occurs in the end of November or the first part of December. Kochia seeds are harvested at a moisture content which is too high for seed storage. If stored directly after harvest, the viability of the seeds would be drastically reduced within a short period of time. Therefore, seeds must be dried to 7% moisture or lower prior to storage. The most common method of drying is to spread the seeds out on a large concrete surface and turn them daily with shovels. This is labor intensive, and requires large amounts of clean floor space. Drying costs were calculated based on an assumed 15 minutes of labor per 150 pounds of seed each day. That allocates 15 minutes each day per acre of seed. It is estimated that the seed will require 10 days of drying to reach the desired moisture level. Therefore, drying costs = 0.25 hours X $9.66/hour (avg. wage rate) X 10 days = $24.15 per acre.

Producers have received between $0.50 and $17.00 per pound for forage kochia seed (Boyce 2008). A median price of this range, $8.76 has been used in the production budget. According to Reed (2008) yields for irrigated production of forage kochia seed range from 400 to 800 pounds per acre. A yield of 533 pounds per acre was used in the budget. Net returns above operating costs for forage kochia have been estimated at $1,091.79 per acre. When compared to the returns above operating costs for production of soft white wheat and barley, which are $224.19 and $57.65 per acre respectively, returns for forage kochia seed production are much more profitable.

Table 16 – Establishment Costs per Acre from Producing Forage Kochia (Immigrant) Seed in Great Basin, 2008

Establishment Year (12 months)				
Operating Costs	**Quantity per acre**	**Unit**	**Price/cost per unit**	**Value/cost per acre**
Land Preparation				
Discing	1	acres	$ 5.11	$ 5.11
Planting	1	acres	$ 2.99	$ 2.99
Seed	3	pounds	$ 8.50	$ 25.50
Herbicides				
Roundup	2	quarts	$ 18.50	$ 37.00
Custom Application	1	acre	$ 6.00	$ 6.00
Cultivation	1	acre	$ 2.67	$ 2.67
Field certification and application fees[1]	1	acre	$ 2.20	$ 2.20
Overhead	1	acre	$ 28.98	$ 28.98
Interest on Operating Capital	1	acre	5%	$ 5.52
Total Operating Costs/acre				$ 115.97
Capitalize establishment year (operating costs only) over 5 production years				$26.79

[1] Field certification, seed certification, and tagging fees are listed for the state of Utah. Fees for other states may be different.

Table 17 – Production Costs and Returns per Acre from Producing Forage Kochia (Immigrant) Seed in Great Basin, 2008

Production Year				
Receipts	**Quantity per acre**	**Unit**	**Price/cost per unit**	**Value/cost per acre**
Seed	533	pounds	$ 8.76	$ 4,669.08
Subtotal Sales				$ 4,669.08
Operating Costs				
Cultivation	1	acre	$ 3.90	
Fertilization				
Urea(46-0-0)	220	pounds	$ 0.40	$ 88.00
Custom Application	1	acre	$ 4.50	$ 4.50
Irrigation	1	acre	$ 24.67	$ 24.67
Field Certification Fees[1]	1	acre	$ 2.20	$ 2.20
Overhead	1	acre	$ 28.98	$ 28.98
Harvesting				
Combine	1	acre	$ 8.50	$ 8.50
Drying Seed	1	acre	$ 24.15	$ 24.15
Haul to cleaners	1	acre	$ -	$ -
Seed certification and tagging fees[1]	1	acre	$ 5.00	$ 5.00
Interest on operating capital	1	acre	5%	$ 3.44
Capitalized Investment Costs (6 year lifetime)	1	acre	$ 32.77	$ 32.77
Subtotal Operating Costs				$ 222.21
Net returns to owner for unpaid labor, management, equity, and risk				
Above operating costs (6 year stand lifetime)			$ 4,446.87	$ 4,446.87

[1] Field certification, seed certification, and tagging fees are listed for the state of Utah. Fees from other states may be different.

Table 18 – Estimated Returns Above Operating Costs With Varying Prices and Yields for Forage Kochia (Immigrant) Seed in Great Basin, 2008

Net returns per acre above operating costs (6 year stand lifetime)					
	Selling Price ($/lb bulk seed)				
Yield (lbs/acre)	$ 0.50	$ 4.63	$ 8.76	$ 12.89	$ 17.00
0	$ (222.21)	$ (222.21)	$ (222.21)	$ (222.21)	$ (222.21)
400	$ (22.21)	$ 1,629.79	$ 3,281.79	$ 4,933.79	$ 6,577.79
533	$ 44.29	$ 2,245.58	$ 4,446.87	$ 6,648.16	$ 8,838.79
667	$ 111.29	$ 2,866.00	$ 5,620.71	$ 8,375.42	$ 11,116.79
800	$ 177.79	$ 3,481.79	$ 6,785.79	$ 10,089.79	$ 13,377.79

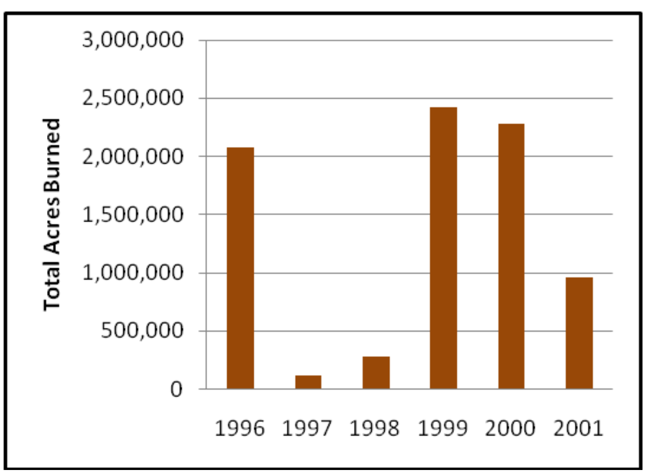
Production and Market Risk

Following the estimation of returns for each species, it is necessary to understand the production and market risks faced by grass and shrub seed producers in the Great Basin. Weather is a highly influential factor on the yields of grass and shrub seed species. Frost occurring late in the spring after several weeks of warm weather, or extremely hot weather during flowering can essentially reduce seed yields to zero (Jensen 2008). The potential for seed heads to shatter prior to or during harvest also has an impact upon seed yields. Weather factors such as wind, rain, and hail can dislodge ripe seeds from seed heads prior to harvest, resulting in a complete loss of seed crops for the production year. The effects of these factors and others are represented by the high variability in seed yields displayed in the break-even tables.

Another factor which can dramatically affect seed yields is machinery difficulty during harvest. Grass seed has proven difficult to harvest for many individuals. Combines used to harvest seed are the most expensive piece of machinery needed for grass seed production. In an effort to avoid the large expense of purchasing a combine, some producers have paid between $40 and $60 per acre to have a custom operator combine their crops for them. This works well with small grains such as wheat and barley. Grass seed, however, is an entirely different size of seed. Combines must be set up specifically for such grasses. Air flow, cylinder speed, and cylinder spacing must all be adjusted to accommodate the light seed weights. Many custom operators are not experienced in combining grasses. They also do not want to spend the time making the necessary adjustments and alterations to their machinery for what are typically small acreage fields. Therefore, it has been the case in the past that a custom harvester has simply combined a field of grass seed without adjusting his combine and has blown all of the seed right out the back of the combine onto the ground (Meek 2008). Not only does this result in a loss for the producer, but in most cases the custom operator is not willing to combine grass seed in the future, making it even more difficult for grass seed producers to find custom operators. Therefore, in order to successfully harvest grass seeds, one must have access to a combine, as well as the knowledge to make the necessary adjustments for proper harvesting of grass seed.

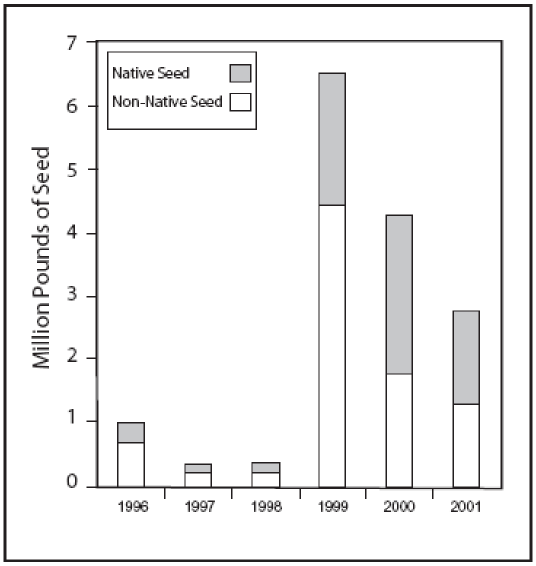
Figure 2 shows the number of acres burned in wildfires in the Great Basin from 1996-2001. Figure 3 shows the high variation in the pounds of seed purchased by the BLM for the same period. There was not sufficient data available to perform any statistical analysis to determine to what extent the number of acres burned influences price. This would have added an important aspect to the study. However, the graphs clearly show the enormous variation in both the number of acres burned and the amount of seed purchased by the BLM. Fluctuating demand causes

Figure 2 – Total Acres Burned by Wildfires in the Great Basin 1996-2001



(National Interagency Fire Center 2008)

Figure 3 – Total Pounds of Seed Purchased by BLM 1996-2001



(United States Department of the Interior 2002)

changes in the price of seeds. Such changes can pose high risks to producers, and therefore must be taken into consideration.

Another aspect of market risk which causes variations in price is the market organization. In the state of Utah, there were slightly over 500 total acres of certified grass and shrub seed in 2007 (Utah Crop Improvement Association 2007). When compared to more traditional crops such as corn and wheat, certified grass and shrub seed is an incredibly small market. In the same year, there were less than fifteen producers that registered certified fields in the state of Utah (Utah Crop Improvement Association 2007). In such a small market, a single producer's decisions can have an influence on the overall market price for seeds. Such was the case nearly six to eight years ago. A central Utah producer made a decision to plant nearly 1,000 acres of certified grass and shrub seed. This decision increased the supply of seed in the market. This, combined with the effects of decreased demand due to low numbers of acres burned, caused prices to drop dramatically. Some producers were unable to find buyers for seed and were forced to store them for several years until the excess supply was purchased (Meek 2008). This is one example of how a single producer's decision affected the entire market.

In addition to the number of acres burned in wildfires and the industry organization, there is another important factor which can cause variations in price. Top executives in federal agencies have power to determine what mix of native and introduced species will be purchased. Each group that is interested in the reseeding of public lands may have different motives in species selection. Livestock producers want the most forage for their animals at the right times during the year. In an effort to maximize livestock forage, livestock producers may choose to seed only a single species. The main priority may not be in restoring the environment to its natural state. Wildlife management officials are concerned with reseeding species which will create diverse habitat in an effort to sustain a wide range of animals. Environmentalists may have completely different desires for reseeding burn areas than those of livestock producers and wildlife management officials. Managers of public lands must take each of these groups', and others' desires into consideration when evaluating a burn site for reseeding. Thus, depending on what types of landscapes burn during the year, different seeds may be needed each year from producers. This causes the demand for specific seeds to fluctuate wildly from year to year.

Highly fluctuating demand for seeds poses a major problem for producers. The time interval from planting to the first harvest for most grass and shrub species is approximately twenty four months. During this establishment period, the producer incurs costs, but no revenue. In order to recover these establishment costs, the crop must be harvested for several years. However, if seed buyers for federal lands suddenly change their opinions as to which seeds will be purchased for reseeding, then the producers are forced to bear all of the costs and risk associated with not being able to sell their seed, or having to sell seed at a lower price. Producers may also encounter similar difficulties when federal employees with influential power in which seeds are to be used for reseeding change positions. When someone retires, for example, a replacement must be hired to fill the position. When this replacement has a different opinion or agenda, then the demand for certain species may increase or decrease drastically (Meek 2008).

Another risk that all producers face is with regards to seed quality. The BLM is the largest buyer of certified grass and shrub seed in the United States (Lambert 2008b). The BLM and other federal government agencies use only the highest quality of seeds in their restoration projects. Table 18 shows the minimum purity and germination rates for the five selected species. When these two numbers are multiplied together, the resulting figure is the minimum percentage of pure live seed (PLS). Pure live seed is simply the percentage of a bulk quantity of seed which contains live, viable seeds of the desired species. By setting minimum PLS requirements for all seed purchases, the BLM ensures that the seed they are buying is actually high quality seed which will grow if properly planted.

Table 19 – BLM Minimum Purity and Germination Rates of Selected Species

Common Name	Scientific Name	Native or Introduced	BLM Minimum Purity	BLM Minimum Germination	BLM Pure Live Seed Requirement
Bluebunch Wheatgrass	*Pseudoroegneria spicata* ssp. *Spicatta*	Native	90%	85%	76.5%
Crested Wheatgrass	*Agropyron cristatum*	Introduced	95%	85%	80.8%
Basin Wildrye	*Leymus cinereus*	Native	90%	85%	76.5%
Russian Wildrye	*Psathrostachys juncea*	Introduced	90%	85%	76.5%
Forage Kochia	*Kochia prostrata*	Introduced	90%	60%	54.0%

(Lambert 2008a)

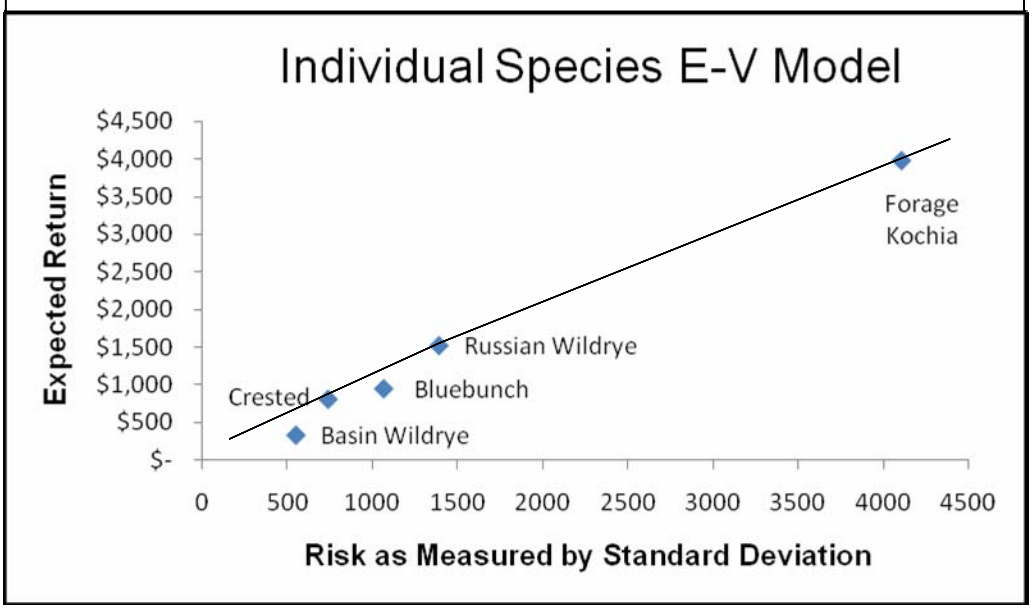
Every lot of seed that is purchased by the BLM is sampled to verify the percentage of PLS in the bulk seed. The BLM also uses certified seed whenever possible. In the event that there is not enough certified seed for their needs, they will use non-certified seed that still meets the minimum PLS percentages.

If a producer's seeds do not meet requirements for certification, options for selling seeds are limited. Producers in this situation are usually forced to sell their seeds to private buyers, typically ranchers, who use the seeds for range improvements for livestock grazing. Producers in this situation receive a significantly lower price for their seed than those who are able to sell certified seed to government agencies. In some cases, they are unable to sell their seeds, and receive no revenue for the production year.

Expected Value – Variance Model

From the break-even tables created, there are twenty five different possibilities for returns above operating costs for each species. These twenty five possibilities have been assigned equal likelihood of occurrence. Then, the expected value of returns was calculated by taking the average of the twenty five possibilities. The standard deviation from the expected value was also calculated for each species. Each species was then plotted on the E-V model with the expected value on the Y axis and the standard deviation on the X axis. The results of the E-V model of the five individual species are shown in figure 4 seen below. Forage kochia, Russian wildrye, and crested wheatgrass all lay on the efficient frontier. Of the three, forage kochia shows the greatest expected return and the greatest risk. Crested wheatgrass has the lowest expected return of the three, as well as the lowest risk. Russian wildrye lies between the two, with greater risk and return than crested wheatgrass, but lower risk and return than forage kochia. Bluebunch wheatgrass and basin wildrye are not as efficient as the other three, as they lay inside the efficient frontier.

Figure 4 – Expected Value – Variance Model of Individual Species



Based on the results of the E-V model of individual species, forage kochia and crested wheatgrass have been chosen to be included in the various crop portfolios for a typical farm in northern Utah. The two species are included in different crop/acreage combinations in order to show the effect that each and both can have when added to a typical farm portfolio in the place of more commonly grown crops. Seven crop portfolios have been created as explained in the previous chapter, each totaling 400 acres. The seven farm scenarios are listed as A thru G in table 3 below. Also provided in the table is the acreage of

Table 20 – Crop Acreages Contained in Each Farm Secenario

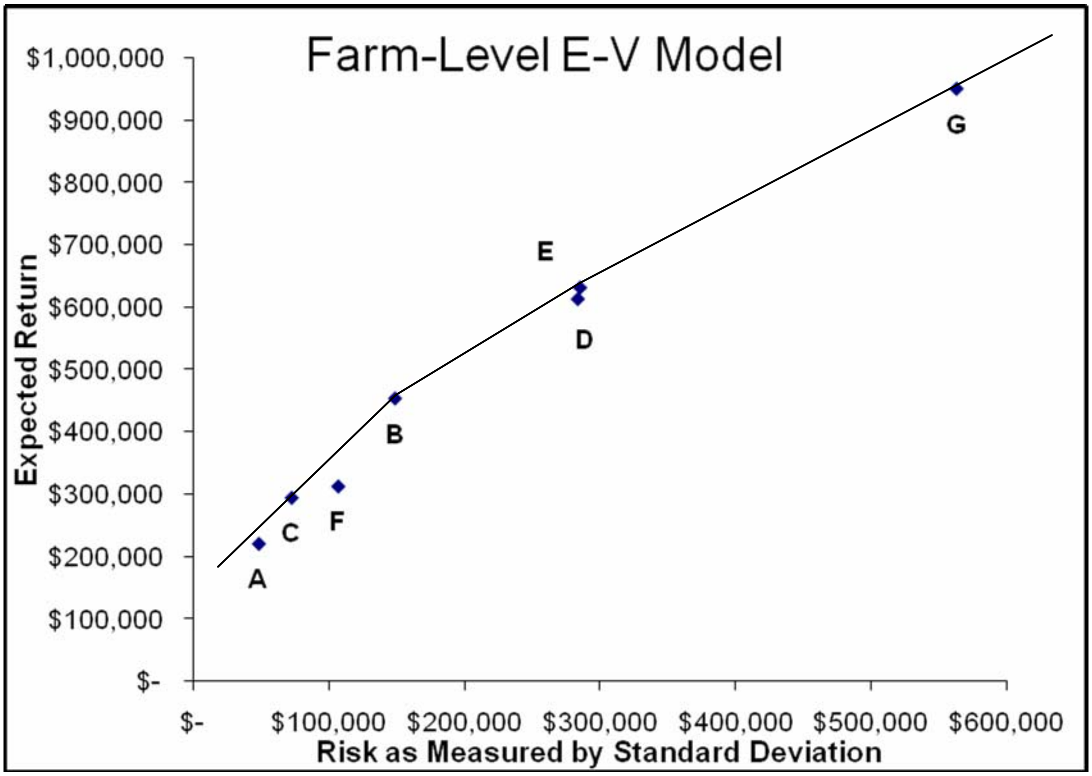
Scenario	Alfalfa	Barley	Crested	Kochia
A	300	100	0	0
B	300	0	50	50
C	300	0	100	0
D	300	0	0	100
E	100	100	100	100
F	100	100	200	0
G	100	100	0	200

each crop for all seven farm scenarios.

The expected returns and standard deviations were used to plot the seven scenarios on an E-V model. The results are seen in figure 5 below. Scenarios C, B, E, and G all lie on the the efficient frontier. Due to the high percentage of forage kochia in scenario G, this scenario has much higher expected returns and risks than the other farm scenarios. Scenario C, a combination of alfalfa and crested wheatgrass, has the lowest expected return and lowest associated risk of those that lie on the efficient frontier.

Scenario G has an expected return of $950,039, and a standard deviation of $562,961. This means that two thirds of the time, returns for

Figure 5 – Expected Value – Variance Model of Farm Scenarios



scenario G will range between $387,388 and $1,513,309, or within one standard deviation of the expected value. Scenario B has an expected return of $453,383 and a standard deviation of $149,902. Therefore, two-thirds of the time scenario B will range between $304,448 and $602,285. In comparing the two scenarios, one can see that the low end of each scenario at one standard deviation is relatively close. However, it is also clear that if scenario G passes much below one standard deviation of the expected value, the return would likely be less than that of scenario B.

Farmers with different risk preferences would likely choose different crop portfolios. Risk seeking or risk neutral farmers would likely choose a portfolio similar to G, which is comprised largely of forage kochia. The possible returns are high, while there is potential for greater loss than other portfolios. Producers who are risk adverse would likely choose a portfolio which lies toward the bottom end of the efficient frontier, such as B or C. Although such portfolios do not provide the potential for returns as great as those of portfolio G, they are not as risky, and therefore do not have the potential losses which portfolio G posseses.

Chapter 5 – Conclusions

From the results outlined in the previous chapter, it is concluded that each of the five species evaluated can be profitable above operating costs. Not only do they produce positive returns above operating costs, but have been shown to produce significantly greater returns than soft white wheat or barley produced in the same area.

The market for grass and shrub seed to be used in post-wildfire rehabilitation is filled with production and market risks. Overall production risks include several different weather factors which could each significantly reduce seed yields, as well as the risk of losing seed through improper harvest techniques. Price risks are extreme due to the wide range of prices that can be encountered within a twelve month period. Variation in price is mainly brought about by the heavy influence of the number of acres burned on the pounds of seed purchased by government agencies. There is also risk due to the industry's small size and the ability of a single producer to negatively impact the market. Sudden changes in executive government employees can also swing the demand for seeds from more native species to introduced species or vice versa. This sudden change in demand creates risk for producers. Producers are unable to alter production in the short run due to establishment periods of approximately two years for most species.

It is therefore concluded that all five species evaluated can be produced profitably as well as feasibly. The extent to which species are profitable depends upon several factors: some of which are within the control of the individual producer, while others such as weather and wildfires are completely unpredictable. These factors impose large risks upon producers of native and introduced grass and shrub seed.

As was seen in the expected value model in figure 4, the expected returns for forage kochia greatly exceed any of the other four species evaluated. Risk as measured by the standard deviation of expected returns is also the greatest of the five species evaluated. Russian wildrye is the second most profitable, followed by bluebunch wheatgrass, then crested wheatgrass. Basin wildrye is the least profitable of the five species. Forage kochia, Russian wildrye, and crested wheatgrass were all found to be on the efficient frontier of the E-V model. Bluebunch wheatgrass and basin wildrye were not, and are therefore not optimal choices for seed production.

When added to a portfolio of alfalfa and barley, forage kochia and crested wheatgrass increase the expected return as well as the risk. Portfolios containing high acreages of forage kochia have the greatest expected value of returns, as well as the highest standard deviation of returns. Crested wheatgrass adds risk and increases potential returns as well, but not to the same extent as forage kochia.

Through this study, it has become evident that there is a need for further research in many areas. First, there are many species currently used in reseeding which were not evaluated in this study. There is much research to be done regarding the feasibility of producing shrub species which are currently only available through hand collection techniques. There are also recently created grass species, such as Siberian wheatgrass (Vavilov), for which feasibility analysis need to be performed. There is also a need for marketing research into methods of smoothing demand for grass and shrub seeds to provide more steady demand from year to year. This research should include a cost/benefit analysis of long term contracts (5-10 years) between producers and government agencies. Finally, more research is needed of specialized equipment for the production and harvesting of grass and shrub seed.

Chapter 6 – Self Reflection

The experience of researching and writing this dissertation has been much different than anticipated. From speaking to those who had previously gone through the process, and those who were in the process at the time, I had created an idea of what to expect. As I began the process, it did not take long for me to realize that I had grossly underestimated the time and effort that would be required to write a quality paper. With the guidance of a patient advisor and committee members, I have learned what is required in a master's level dissertation.

The topic which I have chosen has also presented its own set of difficulties. Very little has been published on the economics of grass and shrub seed production. This made it difficult to know what to expect when doing my research. I encountered numerous problems finding data to use in the research. The industry I chose to analyze is drastically smaller than I had anticipated. This created even more problems in finding data and relevant literature. There are many industry professionals who are extremely knowledgeable about grass and shrub seed production. This allowed me to obtain the information required to perform the analysis.

Another difficulty that I encountered was when my major professor retired before my research was complete. We were both well aware of when he would be retiring. However, when the date came, and I was still not finished, one of my committee members helped me to complete the thesis. I have been grateful for this assistance, as I could not have finished on my own.

Despite the many difficulties encountered, and the hours of frustration in working through these difficulties, I am pleased with the results of the research and feel that it is of great worth. This study provides the first research on the economics and financial feasibility of grass and shrub seed production for use in reseeding land burned in wildfires in the Great Basin. Producers now have useful information regarding the risks and returns that can be expected for five of the major species used in reseeding. The results confirmed previous suspicions about the great risk producers face in this industry. However, profits were much greater than anticipated for some species. In all, the study went well, and I anticipate that it will be heavily used and valued by many in the industry in future years.

If I were to do this research over again, there are a few things that I would change in the way I carried out the research. First, I would do more initial research so that I could create objectives that I know are attainable. With my advisor, I would clearly set out how I am going to reach each objective. This would give direction and purpose to the research. Without doing this, I feel that a lot of time was wasted on research that could not be incorporated into the final report. Maybe all research evolves as is goes along much like this did. However, after the experience I have has in writing this dissertation, I would be much more objective driven in what I did.

References

Barkley, A., and Peterson, H. (2008) *Wheat variety selection: An application of portfolio theory to improve returns*. Proceedings of the NCCC-134 conference on applied commodity price analysis, forecasting, and market risk management [online] Available from: <http://www.farmdoc.uiuc.edu/nccc134>.

Boyce, O. (2008 September 4) Conversation about marketing grass and shrub seeds from the standpoint of Wheatland West Seeds, LLC with the author.

Bureau of Land Management (2008a) *Milford flat fire rehabilitation, stabilization, and restoration effort* [online] Available from: <http://www.blm.gov/ut/st/en/prog/fire/milford_flat_fire.html> [10/26/2008].

Bureau of Land Management (2008b) *Murphy complex emergency stabilization and rehabilitation (ES&R)* [online] Available from: <http://www.blm.gov/id/st/en/fo/jarbidge/murphy_complex_rehabilitation.1.html> [8/6/2008].

Castle, E., Becker, M., and Nelson, A. (1987) *Farm business management: The decision-making process*. Macmillan Publishing Company.

Chase, C. (2006) *Using enterprise budgets to make decisions* Iowa State University Extension – Ag Decision Maker [online] Available from: <https://www.extension.iastate.edu/agdm/crops/html/a1-19.html> [8/19/2008].

Dewey, S.A., Jenkins, M.J., and Tonioli, R.C. (1995) Wildfire suppression – a paradigm for noxious weed management. *Weed Technology*, 9(3): 621-627.

Edwards, W. (2005) *Machinery management: estimating farm machinery costs* Iowa State University Extension [online] Available from: <http://www.extension.iastate.edu/Publications/PM710.pdf > [10/23/2008].

Ellis, S…et al. (2008) *Livestock enterprise budgets for Iowa – 2008* Iowa State University Extension [online] Available from: <http://www.extension.iastate.edu/Publications/FM1815.pdf> [10/23/2008].

Hanna, M. (2001) *Estimating Field Capacity of Farm Machines* Iowa State University Extension [online] Available from: <http://www.extension.iastate.edu/Publications/PM696.pdf> [10/27/2008].

Hanna, M. (2001b) *Fuel required for field operations* Iowa State University Extension [online] Available from: <http://www.extension.iastate.edu/Publications/PM709.pdf> [10/30/2008].

Harnis, R.O. and Murray, R.B. (1973) 30 years of vegetal change following burning of sagebrush-grass range. *Journal of Range Management*, 26: 322-325

Jensen, K. (2008 November) Personal conversation with the author regarding grass seed production.

Jessop, B.D. and Anderson, V.J. (2007) Cheatgrass invasion in salt desert shrublands: Benefits of postfire reclamation. *Rangeland Ecology Management*, 60(3): 235-243.

Keeley, J.E. (2006) Fire management impacts on invasive plants in the western United States. *Conservation Biology*, 20(2): 375-384.

Kettle, R. and Davison, J. (1998) *Forage Kochia* [online] University of Nevada Cooperative Extension fact sheet 98-48. Available from: <http://www.unce.unr.edu/publications/files/nr/other/FS9848.pdf> [10/17/ 2008].

Knapp, P.A. (1996) Cheatgrass (*Bromus tectorum L.*) dominance in the Great Basin Desert. *Global Environmental Change*, 6(1): 37-52.

Knick, S.T. and Rotenberry, J.T. (1997) Landscape characteristics of disturbed shrubsteppe habitats in southwestern Idaho (U.S.A.). *Landscape Ecology*, 12(5): 287-297.

Kummerow, S., Cook, G., and Turner, B. (1995) *Enterprise budget: fine fescue seed production, eastern Oregon region.* University of Oregon [online] Available from: <http://agecon.uwyo.edu/WFMEC/> [10/23/2008].

Lambert, S. (2008a) Unpublished BLM data updated May 31, 2008. Received August 2008 via mail.

Lambert, S. (2008b July) Personal communication with the author regarding BLM seed purchasing in the Great Basin.

Lambert, S. (2005) *Guidebook to the seeds of native and non-native grasses, forbs and shrubs of the Great Basin*. Bureau of Land Management (Idaho BLM technical bulletin 2005-04).

Markowitz, H. (1952) Portfolio selection. *Journal of Finance,* 7(1): 77-91.

Meek, B. (2008 August 14) Conversation about production and marketing native and introduced seeds from the standpoint of a producer with the author.

National Agricultural Statistics Service (2008) *Farm Labor*. National Agricultural Statistics Service [online] Available from: <http://usda.mannlib.cornell.edu/usda/current/FarmLabo/FarmLabo-08-15-2008.pdf> [10/27/2008].

National Interagency Fire Center (2008) *[no title]* Unpublished data sent from Eastern and Western Great Basin Coordination Centers via email on August 7, 2008. Sent from: ksherve@fs.fed.us and gldingman@fs.fed.us.

Nielsen, D. (1977) *Economics of range improvements: a rancher's handbook to economic decision-making*. 1st rev. ed. Utah agricultural experiment station bulletin 466, Utah State University.

Pellant M. (1990) *The cheatgrass-wildfire cycle--are there any solutions?* In: McArthur *et al.*, compilers. Proceedings--symposium on cheatgrass invasion, shrub die-off, and other aspects of shrub biology and management; 1989 April 5-7; Las Vegas, NV. Gen. Tech. Rep. INT-276. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 11-17.

Pellant M. (2007) *Statement of Mike Pellant, Great Basin Restoration Initiative Coordinator, Bureau of Land Management, U.S. Department of the Interior Before the Senate Subcommittee on Public Lands and Forests Regarding the Great Basin Restoration Initiative* [online]. Available from: <http://www.blm.gov/wo/st/en/info/newsroom/congressional_testimonies/2007.html> [8/4/2008].

Ratzlaff, T.D. and Anderson, J.E. (1995) Vegetal recovery following wildfire in seeded and unseeded sagebrush steppe. *Journal of Range Management*, 48(5): 386-391.

Reed, R. (2008 December) Personal communication with the author regarding current production practices for forage kochia seed production.

Reilly, M. and Millikin, N. (1996) *Starting a small business: the feasibility analysis*. Montana State University Extension Service [online] Available from: <http://msuextension.org/publications/BusinessandCommunities/MT199510HR.pdf> [10/27/2008]

Richardson, J., Schumann, K., and Feldman, P. (2006) *SIMETAR simulation & econometrics to analyze risk*. Simetar, Inc., College Station, TX

Smathers, R. (2005) *2005 northern Idaho crop costs and returns estimate: bluegrass seed production: irrigated*. University of Idaho [online] Available from: <http://www.ag.uidaho.edu/aers/PDF/Crops/05/EBB1-BSI-05.pdf> [10/23/2008]

Smith, R. and S. Smith. (1997) *Native grass seed production manual*. University of Manitoba, Winnipeg.

Teegerstrom, T., D'Souza, G., Osborne, P., and Jones, K. (1997) To contract or not to contract? A decision theory and portfolio analysis of cattle contract grazing. *Agricultural and Resource Economics Review*, 26(2): 205-215.

Thompson, T.W., Roundy, B.A., McArthur, E.D., Jessop, B.W., Waldron, B., and Davis, J.N. (2006) Fire rehabilitation using native and introduced species: a landscape trial. *Rangeland Ecology Management*, 59(3): 237-248.

United States Department of the Interior (2002) *Report to the congress: interagency program to supply and manage native plant materials for restoration and rehabilitation on federal lands*. [online] Available from: <http://www.nps.gov/plants/npmd/Native%20Plant%20Materials%202002%20Report%20To%20Congress.pdf> [10/21/2008]

Utah Crop Improvement Association (2007) *Certified Seed Directory.* Received via email from secretary keren.williams@usu.edu on August 2, 2008.

Utah State University (2007a) *Costs and returns from growing soft white wheat, 2006*. Utah State University Extension Economics [online] Available at: <http://extension.usu.edu/agribusiness/files/uploads/agecon/Crops/pdf/Cache/Wheat.pdf> [12/09/2008].

Utah State University (2007b) *Costs and returns from growing barley, 2006*. Utah State University Extension Economics [online] Available at: <http://extension.usu.edu/agribusiness/files/uploads/agecon/Crops/pdf/Cache/Barley.pdf> [12/09/2008].

Utah State University (2007c) *Costs and returns from oats, 2005*. Utah State University Extension Economics [online] Available at: <http://extension.usu.edu/agribusiness/files/uploads/agecon/Crops/pdf/Box%20Elder/Oats.pdf> [1/15/2009].

Wright, H., Neuenschwander, L., and Britton, C. (1979) *The role and use of fire in sagebrush and pinyon juniper plant communities: a state-of-the-art review.* Gen. Tech. Rep. INT-58. Ogden UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 48.

Young, J.A. and Allen, F.L. (1997) Cheatgrass and range science: 1930-1950. *Journal of Range Management*, 50(5): 530-535.

Appendix A – Machinery Operating Costs

Machinery Operating Expenses per Acre								
Machine	**Repairs as % of purchase price**	**Total Repair Cost/acre**	**Fuel Usage gal./acre**	**Total Fuel Cost**	**Lubrication**	**Field Capacities acres/hour**	**Total Labor Costs**	**Total Operating Cost**
160 Hp Tractor (4-wheel drive)	1%	$ 1.23						$ 1.23
Loader Attachment	2%	$ 0.26	0.20	$ 0.68	$ 0.10	15	$ 0.64	$ 1.68
4-Bottom Plow	6%	$ 0.12	1.70	$ 5.75	$ 0.86	5.5	$ 1.76	$ 8.49
Tandem Disk (14 foot)	4%	$ 0.22	0.65	$ 2.20	$ 0.33	8.5	$ 1.14	$ 3.88
Roller Harrow (30 foot)	7%	$ 0.21	0.65	$ 2.20	$ 0.33	19	$ 0.51	$ 3.24
Grain Drill (13 foot)	1%	$ 0.31	0.30	$ 1.01	$ 0.15	6.4	$ 1.51	$ 2.99
Cultivator (16 foot rigid)	2%	$ 0.17	0.40	$ 1.35	$ 0.20	10.2	$ 0.95	$ 2.67
Swather-18 foot (non-self propelled)	3%	$ 0.36	0.55	$ 1.86	$ 0.28	11.3	$ 0.85	$ 3.35
Baler (large bales)	2%	$ 1.16	0.40	$ 1.35	$ 0.20	6	$ 1.61	$ 4.33
Combine (20 foot)	1%	$ 3.10	1.00	$ 3.38	$ 0.51	6.4	$ 1.51	$ 8.50

Fuel usage and lubrication for tractor are allocated to each piece of equipment that will be used with the tractor.