Economic feasibility of an accelerated lambing operation in Central Iowa

by

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ABSTRACT

A dairy farmer in Central Iowa has recently decided to close down the dairy parlor after his family has had the business for one hundred years so that he can retire. In order to maintain some cash flow, he is offering to rent out the barn facilities for a flat price. As an individual with years of experience working, handling, and maintaining sheep, these facilities would work great to run sheep on dry ground. With three of the four children wishing to come back to the family farm, this research seeks to determine the economic feasibility of an accelerated lambing program on a dry lot in Central Iowa.

There are two types of accelerated lambing operation: Standard Accelerated Lambing, where ewes lamb three times within a two-year period; and STAR method, where ewes lamb five times within a two-year period. This research focuses on a standard accelerating program of three lambing crops within two years. The business strategy envisions starting with twenty ewes and building the flow to five hundred ewes over 10 years.

The feasibility analysis undertaken in this thesis focuses on three main factors for profit. They are production rate, death rate for lambs, and conception rate. It was found that production and conception rates had the most impact on the economic feasibility of an accelerated lambing operation. Future work would focus on the marketing side of the business, exploring opportunities for building strategic alliances with ethnic restaurants and grocery stores. It would also explore opportunities of providing the processing service by forming alliances with local abattoirs to service these restaurants and grocery stores.

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CHAPTER I: INTRODUCTION

1.1 Introduction

Spanish sheep were first brought to the United States by Christopher Columbus. Today, the sheep industry makes up less than 1% of the US livestock industry's total receipts. Sheep and lamb inventory is currently 5.17 million head strong. (USDA, 2023) While small, the sheep and lamb industry is a viable and growing industry as the demographics of the country changes. This creates an opportunity for building business in corn and soybean country, where there is also an abundance of pasture.

Sheep are multipurpose animals. They may be raised for meat, wool, and in rare cases for milk. Most producers focus on stock-sheep that graze open pastures producing young or feeder lambs that are typically sold at 60-80 pounds to be fattened and finished for slaughter at between 130 and 150 pounds. Black-face sheep, such as Suffolk and Hampshire, tend to be seen more on the feeder operations. White-face sheep, such as Rambouillet and Polypay, tend to be seen more on the stock-sheep operations.

Texas and California account for 25% of U.S. sheep population (Figure 1.1). This may be possibly because of their land being more suitable to hold animals on grazing operations. However, from Figure 1.2, it is observed that ewe numbers have been declining. In 2021, USDA/NASS reported ewe one year and older inventory at a total of 2.96 million, down 6 percent from ten years earlier. It would seem that sheep population has been negatively correlated with the population of the more traditionally American livestock – cattle, swine, chicken and turkey (Iowa Ag News – Sheep and Lambs, 2023) Additionally, the type of lamb meat consumed in the US has also changed. While mutton (lamb meat from animals over a year) was the main type in the period leading to and after

the Second World War, current consumers prefer lamb meat from animals under a year of age (Fogarty, 2019). This may not be unrelated to the demographics of the country. The typical lamb consumer is older with an ethnic background and preferring certain cuts like leg, loin, or rack. Lower quality cuts are sold into the pet-food market or exported.

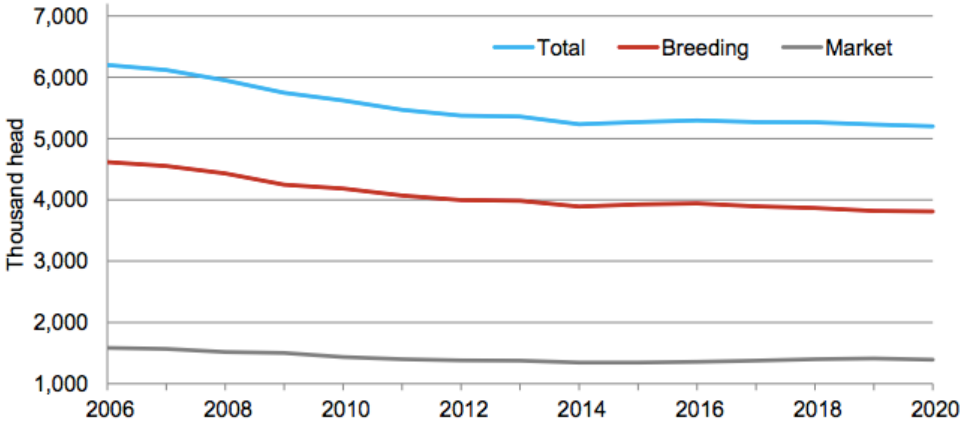
Figure 1.1: Number of Sheep per State

United States		5,210,000	
Rank	State	Head	% Of U.S.
1	Texas	740,000	14.20%
2	California	550,000	10.56%
3	Colorado	365,000	7.01%
4	Wyoming	355,000	6.81%
5	Utah	275,000	5.28%
6	South Dakota	270,000	5.18%
7	Idaho	250,000	4.80%
8	Montana	220,000	4.22%
9	Oregon	195,000	3.74%
10	Iowa	155,000	2.98%

The declining domestic production may be a result of international competition from Australia and New Zealand, the dominant sheep producers in the world. These two countries account for 75% and 24% of US lamb and mutton imports, respectively (Sector at a Glance, 2020). Most live imports and exports stay within North America. Mexico has a higher demand for mutton compared to the United States, presenting significant future opportunity for US sheep producers. The declining sheep population in the United States (U.S.) is attended by declining sheep producing farms. This decline has been attributed to the decreasing competitive advantage of sheep against other livestock or other agricultural products. Yet, the Census of Agriculture reports that between 2007 and 2017, the number of operations increased from about 83,000 to over 101,000. More interestingly, NASS data

used to estimate average price per head shows lamb prices increasing across the U.S. at an average rate of about 4.1% per year between 2000 and 2022.

Figure 1.2: Domestic Production Rate



Source: National Agricultural Statistics Service (quickstats.nass.usda.gov).

1.2 Research Problem

The US bovine dairy industry has been experiencing increasing competition from alternative non-dairy products, especially plant and nut-based milk. At the same time, the changing demographics that have fewer children, is causing a reduction in the traditional dairy customer base. This is exacerbated as alternative food products on the market now indicate that they have higher or same calcium content, a reason most adults consumed bovine milk. These conditions are causing dairy farmers to exit. This has created an opportunity to leverage the dairy facilities to produce sheep for the increasing ethnic markets within a day's drive of the facility's location. This research, therefore, examined the economic feasibility of using some of the production dairy cow facilities as sheep feedlots in Tama County, Iowa.

Tama County is 60 miles from Des Moines, IA, 266 miles from Minneapolis/St. Paul, and 289 miles from Chicago, IL. These three metropolitan centers have a total

population of 3.65 million, and 46.3% of it is ethnic (US Census, 2020). The ethnic composition of these metro markets is predominantly Muslim, and sheep are a very important meat and celebration product in this community. Therefore, the principal problem the research seeks to address is the exploration of the economic feasibility of sheep feedlot operations in abandoned dairy facilities.

1.3 Research Objectives

The overall objective of this research was to evaluate the economic feasibility of sheep production operation in abandoned dairy facility in Tama County, IA. The specific objectives are as follows:

1. Conduct an extensive review of the trends in sheep production in the US over the past decade;
2. Develop multiple scenarios to evaluate the conditions under which sheep feedlot operations in abandoned dairy operations can be economically feasible and assess the attractiveness of the minimum feasibility condition to potential investors.

1.4 Outline of Thesis

This chapter presents the research background and the problem as well as the objectives the thesis seeks to address. In the next chapter, a review of the available and relevant literature will be presented. Chapter 3 will present the data and analytical model used and the results and conclusions will be presented in Chapter 4.

CHAPTER II: LITERATURE REVIEW

2.1 Reproduction

Sheep are polyestrous animals, which is majorly determined by photoperiod. Once sunlight in the day starts to get shorter this signals the animals hypothalamus to produce gonadotropin-releasing hormone (Inskeep, 2012). Breed, location, and temperature play significant roles in the length of estrus. In the United States, all sheep are most fertile during the fall. Sheep become fertile at six to seven months of age and it is encouraged to breed sheep earlier in their life to maximize their lambing potential. At five months of age, males and females should be separated to avoid possibility of unwanted pregnancies.

2.2 Synchronization

Modern medicine has been able to force sheep to go into estrus throughout the year instead of just during their peak season in the fall timeframe. Synchronization of ewes can improve farming management to help ensure lambing timeframes. A controlled internal drug release (CIDR's) can be vaginally inserted twenty days prior to the expected date of turning a ram out with the ewes. The CIDR releases progesterone to help induce an ewe into estrus. Twelve days after a CIDR is insert ewes can be administrator 2.5 mL of PG600 and 1 mL of estrumate. Eight days after injection is the ideal time to place ewes with a ram for breeding practices.

2.3 Vaccination

Proper farm management of sheep includes multiple rounds of vaccinations throughout the year as a precaution to maintain healthy animals. Lambs should receive 2 cc of CDT, 1 cc of dewormer along with doses of sore mouth medication within a month after birth. CDT protects against *Clostridium perfringens* types C and D (overeating disease) and *Clostridium tetani* (tetanus) (Larsen, 2021). Overeating disease is a common cause of death

in lambs where sore mouth and tetanus prevention can help lambs stay on a good production of weight gain. A booster shot of CDT should be given two weeks after the first dose. To maintain proper ewe health, these animals should be given 5 cc of dewormer and 5 cc of vitamin B to help with reproduction efforts and healthy lifestyle.

2.4 Nutrition

Sheep are ruminant animals and rely on five major categories for proper nutrition: (1) water; (2) energy; (3) protein; (4) vitamins; and (5) minerals (Umberger, 2009). Their needs vary by their life stage. According to research conducted at the Virginia Extension Service, winter lambs born from November through early February should have creep feed that contains 18 to 20 percent crude protein and be low in fiber (high in energy) (Umberger, 2009). Due to the rumen not being fully developed in lambs until around 2 months old, protein of lambs needs to be specialized to exclude urea as a feed source. Lambs should adjust to a growing diet by the time they are two months old and ready to be weaned around 40 to 70 pounds. Ground ear corn, silage, and urea should not be fed until lambs are weighing 65 pounds or up (Umberger, 2009).

Breeding ewe's nutrition can be broken down to three different periods 1) three weeks before breeding; 2) mid-gestation; and 3) weaning. Body condition scoring (BCS) should be on a scale of 0 to 5 while observing nutritional needs of ewes. Animals that are extremely thin will rate at a 0 while animals overly condition are at a scale of 5. Ewes should range from 2.5 at weaning to a 3.5 at lambing (Umberger, 2009). Ewes on either side of the spectrum should be placed together. Thin ewes should receive higher energy diet to improve their BCS while overly conditioned ewes should be feed less energy until they reach a more desirable BCS. Ewes prior to breeding should be placed on a high-quality pasture and given 0.75 to 1 pound whole shelled corn or barley. During their

gestation period ewes should be maintained with strong pasture ground. Any pasture ground over 50 percent clover or other legumes should be avoided to help with avoid reduction in conception rates. The last six weeks of the gestation cycle are critical to fetus development which means pregnant ewes need to be at the peak of their nutritional needs. Supplement to ewes should include 0.75 to 1 pound of corn or barley in addition to their normal diet starting at this time. To encourage manageable lambs for delivery producers should ensure not to over feed their ewes during this time. Once these ewes start lactation their energy requirement will increase by 30 to 50 percent. Ewes should be divided into pens based off of the type of rearing (single, twin, triplets, etc.) and fed 1 pound of grain for each lamb they are nursing. Once lambs are weaned, ewes should return to strong pasture or roughage for nutritional requirement.

2.5 Wool

Wool is a revenue source from sheep production. Sheep are shorn annually or twice a year depending on the farming operation. Depending on the breed of sheep, a producer can receive anywhere from 2 to 30 pounds of wool each year (Moyer, n.d.). California, Colorado, Wyoming, Utah, and Texas are the top five wool producing states in the United States. White face sheep, such as Merino sheep, produce more valuable wool, because it lends itself easily to processing and dyeing.

2.6 Meat

Like most livestock, sheep are produced essentially for their meat. Sheep meat tends to be broken into two categories. Mutton, which is meat from sheep that are over a year in age, and lamb, which is meat from a sheep under a year in age. Lamb is generally not the preferable sheep meat choice here in the United States. Countries such as China, India, Iran, and Australia offer the larger number of flocks for exports (*Sheep Meat Market*

Size, Share, Growth, Demand, Forecast 2023-2028, n.d.). While most consumers will not purchase an entire lamb directly from a producer, offerings like shoulder, rack, and loin are among the leaders in consumer choice.

2.7 Ethnic Market

An ethnic market is a group of consumers linked by culture, religion, race, and language and/or national origin (Schoenian, 2021). Demand for sheep meat often increases around religious holidays or celebrations. Easter (Christian) and Eid (Muslim) are two holidays that produce high demand for both feeder lambs and smaller lambs that come off of weaning mothers. Easter usually occurs in March or April and Eid frequently in May and July. However, that is not the only time we see ethnic groups change the markets. In 2020, it is believed that 280.6 million international migrants came to the United States (Batalova, 2022). Many of these immigrants prefer lamb over other meat sources as that is what they grew up eating and are accustomed too. Unlike American's who prefer the feeder lambs around 125 pounds, ethnic groups prefer lambs around 90 pounds. The prediction is that these immigrants coming into the United States are going to cause a shift in sheep meat demand. The concern is do we have enough lambs here in the United States to meet their needs or do we need to look at importing from countries like Australia and New Zealand. This situation supports the need for this study. If indeed, the competitive advantage in sheep production is non-existent, then the emerging market from the immigrants must be ceded to the Australians and New Zealanders. Contrarily, if there is a potential to leverage existing resources and reduce overhead costs to produce sheep products competitively priced against imports from Australia and New Zealand, then it is worth exploring that opportunity in U.S. agriculture.

CHAPTER III: THEORY, METHODS, AND DATA

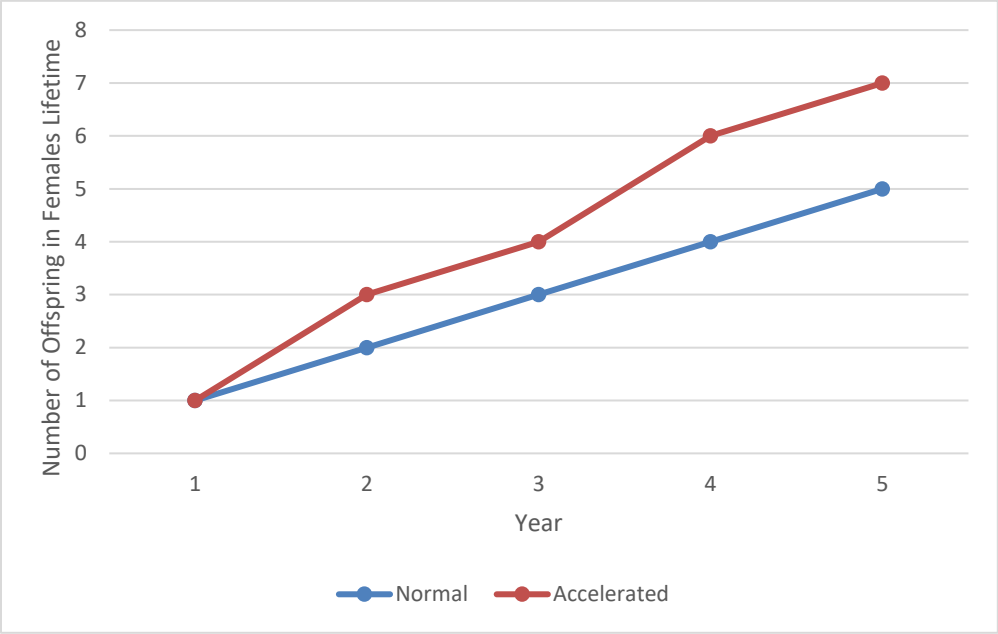
In Chapter 3, the theory, methods, and data used to explore the feasibility study are presented. First, the theory of an accelerated lambing program is explored. This information includes feed cost, market conditions, vaccinations, and scale constraints. Next, the primary analytical tools for conducting the feasibility analysis, net present value and internal rate of return, are presented and discussed. The alternative scenarios under which the analyses are conducted are presented to provide a framework for evaluating the confidence the results present. Additionally, the scenario analysis enables the exploration of the critical bottlenecks to economic feasibility.

3.1 Theory

3.1.1 Accelerated Lambing Program

Accelerated lambing program is defined by sheep producing more than once per year. Typically, these programs aim to have three lambing crops every two years instead of the typical model of one a year. In Figure 3.1, a comparison of the Accelerated Lambing Program and Traditional Program is conducted. The production difference between a ewe on an accelerated program and one that is on the typical system. This model is based on the factor that each female only has one offspring per year. The typical program would account for one lambing per year or a 100% production rate. The accelerated program would consist of females having 1.5 lambing per year or a production rate of 150%. If an ewe were to not get bred during the accelerated track, they would then be culled from the herd to minimize cost. Figure 3.1 shows that over the five-year period, the accelerated lambing produced a total of 21 lambs compared to 15 for the traditional, a 40% higher output.

Figure 3.1: Accelerated Lambing Program versus Typical Program



The accelerated lambing program also utilizes certain breeds that are known for their prolific nature. Dorset and Finnsheep are the most heavily used breeds as they are known to produce twins or triplets and sometimes even quadruplets for lambs. Polypay sheep were created in Idaho as a cross between Dorest, Rambouillet, Finnsheep, and Targhee to utilizes both their maternal qualities as well as their wool qualities. By selecting these top breeds producers shoot for no less than two lambs per year or a 200% production rate as an entire flock.

Beyond the intended purpose of creating a higher production rate and ultimately higher net returns, there are additional benefits to farmers using the accelerated lambing program. For example, farmers that breed all year round can put ewe on pasture during the warmer months, thereby saving cost on grains or other proteins during the winter weather. This is a great benefit to those farmers who are further north and must supplement their animals during a non-growing season. Producers have also noted saving cost on facilities and being able to increase their management attention during critical lambing and early

lactation periods. Since not every female in the facility is lambing at once they can focus efforts on those who need the assistance.

Suppliers have also seen a benefit to this program with a more uniform supply of lambs throughout the year. In the United States, lambing normally takes place from January to March. This would hit the Easter market when the best quality and quantity of lamb meat was available. Producers that use the accelerated lambing program can now supply these suppliers with uniform meat at any point of the year. This is beneficial to the customers that prefer lamb over other meats to be able to receive it not just in the spring season.

3.1.2 STAR Method

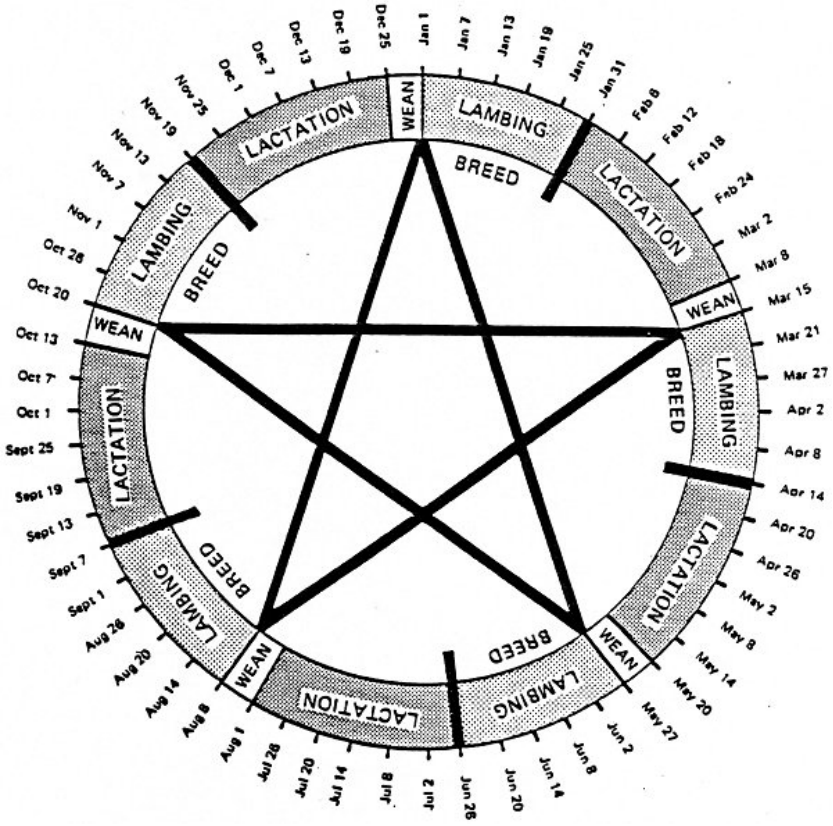
The STAR method was developed at Cornell University in the late 1980s to provide a management system that ensured year-round lamb supply. The STAR method breaks sheep into three categories: 1) breeding and pregnant ewes and the rams, 2) Lambing and/or lactating ewes and their lambs, 3) Growing lambs.

The breeding and pregnant ewes and rams includes all males and females at any age that will eventually produce more offspring. It is key that the genetics of this group allows for out of season breeders so they can easily be manipulated to breed quickly. This group is relatively low maintenance and requirements. They can easily be raised on pasture and require little housing.

The lambing and/or lactating ewes and their lambs are quite the opposite. This is the highest management group. Requiring high levels of feed and care. Not only does the producer have to look out for the ewes but also those young. Ewes tend to need a higher diet of protein during this time and lambs tend to have creep feed available to the at all times about two weeks prior to weaning. This all normally occurs in a barn facility where they can be closely monitored.

Growing lambs is a medium coverage of care and maintenance. Most growing lambs require a feeding twice a day and are normally kept in an outside open facing barn or type facility. Depending on the breed of these animals can affect when they go to market. There are three market phases in the United States. These include suckling or hothouse lambs from 35-40 pounds live weight, to market/finish lambs or the ethic population choice of 80-100 pounds, and there is the freezer or base market lamb weighing around 125 pounds.

Figure 3.2: STAR Lambing Schedule



Source: Cornell STAR Accelerated Lambing System (https://blogs.cornell.edu/newsheep/management/reproduction/star-management/).

3.2 Methods

The principal method used for this thesis is discounted cash flow analysis and scenario analysis. The purpose was to identify the variable to which the cash flow results were more sensitive. This provides management with a focus on which of the many variables influencing performance need to be actively managed.

3.3 Data

3.3.1 Excel Data

The first step for the business to produce lambs using the abandoned dairy facility and employing the accelerated lambing program is purchasing 100 ewes. The ewe would be bred in September for a lambing date in January the following year. We start with the assumption that 90% of those females get breed in the first year. This would give us 90 females lambing in the following January. All bred ewes are assumed to give birth to twins, giving us a projected (lamb) production rate of 200%. Lambs will be weaned two months after birth. It also assumed a 1.5% death loss will occur with each lambed crop and 20% of ewes from each production will be kept to reach 500 ewes. It is also assumed that ewes given birth to singles will be culled, and this is assumed at 20% of each breeding crop. The limit of the housing capacity is 500 ewes, and it sets the scale limit on production.

Price is from live sheep is set at standard prices according to today's market. Cull ewes are assumed to run $200 per ewe and market lambs are assumed to run $225 per lamb. The final revenue piece, while the least amount, but still important is wool revenue that is set at $1.89 per pound of wool. This is sourced from NASS/USDA.

The biggest expenses to be looked at in this study are feed cost, synchronization, vaccinations, transportation, and rental cost. Feed, synchronization, and vaccinations variable cost dependent upon number of sheep on the facility and what stage of their

lifecycle they are in. Transportation and rental cost are considered fixed cost in this study. Any time an animal is taken to market or culled it is a $100 fee to drive to the sale barn and return back to the farm. Negotiated facilities' rent is $800 a month for use of a barn and utilities. These facilities will be used only for lambing and lactating females. Breeding and dry ewes along with rams will be placed on pasture that is already available from the family operation.

Feed cost is obtained from various sources and from livestock farmers in the county. Feed is structured around sheep lifecycle: Lactating ewes; Dry ewes; Suckling lambs; Feeding lambs; Replacement ewes; and Rams. Lactating ewes are generally on alfalfa/grass hay, corn silage, soybean meal, and mineral for a total of sixty days at an average cost of $0.55 per animal. Dry ewes are being fed alfalfa/grass hay, corn silage, and mineral for two hundred days costing $0.23 per animal. Suckling lambs are only provided creep feed as they are still getting nutrients from their mother. This creep feed cost $0.23 per lamb. Lambs are feed for 60 days after weaning from their mothers. They are on a corn and protein pellet feed that cost $0.44 per lamb. Replacement ewes are those young lambs just entering the breeding program. They require a higher protein diet to grow and prepare to carry young. Their diets include alfalfa/grass hay, corn silage, soybean meal, and mineral that cost $0.52 a day. The final group is the rams that are breeding the females. Their feeds consist of alfalfa/grass hay, corn silage, and mineral and cost $0.48 per ram. The costs are summarized in Figure 3.1.

Figure 3.3: Summary of Unit Production Costs

Ewe Lactation Diet		
Feedstuff	#/Head	$/Head
Alfalfa/Grass Hay	3	$0.23
Corn Silage	8.3	$0.23
Soybean Meal	0.3	$0.07
Mineral	0.1	$0.03
Total	11.7	$0.55

Dry Ewe Diet		
Feedstuff	#/Head	$/Head
Alfalfa/Grass Hay	2.5	$0.19
Corn Silage	6	$0.17
Mineral	0.1	$0.03
Total	8.6	$0.38

Rams		
Feedstuff	#/Head	$/Head
Alfalfa/Grass Hay	3	$0.23
Corn Silage	8	$0.22
Mineral	0.1	$0.03
Total	11.1	$0.48

Suckling Lambs		
Feedstuff	#/Head	$/Head
Creep Feed	1.5	$0.23
Total	1.5	$0.23

Feeding Lambs		
Feedstuff	#/Head	$/Head
Corn	2	$0.20
Protein Pellet	0.75	$0.24
Total	2.75	$0.44

Replacement Ewes		
Feedstuff	#/Head	$/Head
Alfalfa/Grass Hay	3	$0.23
Corn Silage	8	$0.22
Soybean Meal	0.2	$0.05
Mineral	0.1	$0.03
Total	11.3	$0.52

Almost all synchronization and vaccinations will be completed by the farmer and will not need vet assistance. Synchronization will be utilized to ensure females are bred at a certain time to improve conception rates. This will occur with all dry ewes prior to turning a ram out to them. Between CIDR and estrumate, it will cost $6.20 per ewe per breeding season. Vaccinations will include CDT, sore mouth, dewormer, and Vitamin B. Ewes will need to be treated annually with dewormer, costing $0.36 annually per ewe, and vitamin B, costing $0.50 annually per ewe. Feeder lambs need two vaccinations prior to going to market. The first round consists of CDT, sore mouth, and dewormer, which is assumed to cost $1.15. Two weeks later lambs will need another round of CDT to add on $0.50 for a total vaccination of $1.65 per feeder lambs.

3.3.2 Net Present Value

Net Present Value (NPV) is the present value of future cash flows at the given discount rate. It brings the future value of money into the present. The biggest challenge in using NPV is determining the appropriate discount rate. Net present value is determined by the initial investment that is made (*I)* the cash flow in each period (C_t), the discount rate (*r),* and the discount salvage value of the investment in the terminal period (T). The formula reads as follows:

$$NPV = -I_0 + \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} + S_T \tag{3.1}$$

In this case, since the business is expected to be in operation at the end of the analysis period, T, no salvage value is assumed. That is, S_T is equal to zero.

3.3.3 Internal Rate of Return

Internal Rate of Return (IRR) is closely related to NPV. It provides a measure of how much financial risk management room is available to the business given its cash flow and initial investment. The higher the IRR compared to the discount rate, the more risk the business can bear. IRR is the discount rate that will a zero NPV. That is:

$$NPV = -I_0 + \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} + S_T = 0 \tag{3.2}$$

CHAPTER IV: RESULTS

Chapter 4 presents the results of our data analysis. There are six sections in this chapter. Section 4.1 discusses the overall model with the six different scenarios listed. Section 4.2 reviews the results of change in the lambing production. Section 4.3 reviews the results of change in the death loss. Section 4.4 reviews the results from change in conception rate. Section 4.5 is the conclusion found based off the different NPV and IRR calculations given in each scenario.

4.1 Summary Statistics

There are many factors that determine a profitable lambing operation. Many producers would identify feed prices and sheep prices. While these are important, this study assumed them constant throughout the analyses because they are outside the control of the farmer. It was assumed that market prices and feed prices will have the same effect on all farmers and probably leave the net results the same due to market conditions. That is, if feed prices increased, because all farmers will face the same feed price increase, they will adjust their sheep price accordingly. Therefore, the study focused attention only on variables directly under the control of the farmer: lambing rate, mortality rate, herd size, and conception rate.

The analysis started with 100 lambs and then builds up to 500 lambs within a ten-year period. The base operational assumptions on the three crucial variables of interest are as follows: A 90% ewe conception rate; 200% projected lambing rate; and 1.5% death loss rate. The production profile over the first 10 years of the project is presented in Figure 4.1. It shows the one hundred ewes we start with will produce 141 market lambs that reach market in year one. By year nine, the farms have reached its maximum number of ewes of 500, and produces 1,416 market lambs reach market each year thereafter.

Figure 4.1 Production Size of Breeding Ewes vs Market Lambs

Feed cost in the model is based on local feed prices. Feed was the biggest cost of revenue as shown in Figure 4.2 Feed Cost Over Ten Years, which shows the change in feed cost from operating 100 ewes in year one to 500 ewes in year 10. Ewes and lambs were broken down into five different categories lactating ewes, dry ewes, suckling lambs, feeding lambs, and replacement ewes. Figure 4.3 Feed Cost Comparison for Different Stages of Sheep Lifecycle shows year 1 feed cost versus year 5 and then year 10 of the different lifecycle of sheep. It is worth mentioning that dry ewes have the most feed cost as these animals are being kept in a barn so they do not have the option to graze and feed must be provided to them. Suckling lambs cost the least as they still rely mostly on their mother's milk for their source of nutrients. It is easy to see that as female and market lamb numbers grow, feed cost will change with it.

Figure 4.2: Feed Cost Over Ten Years

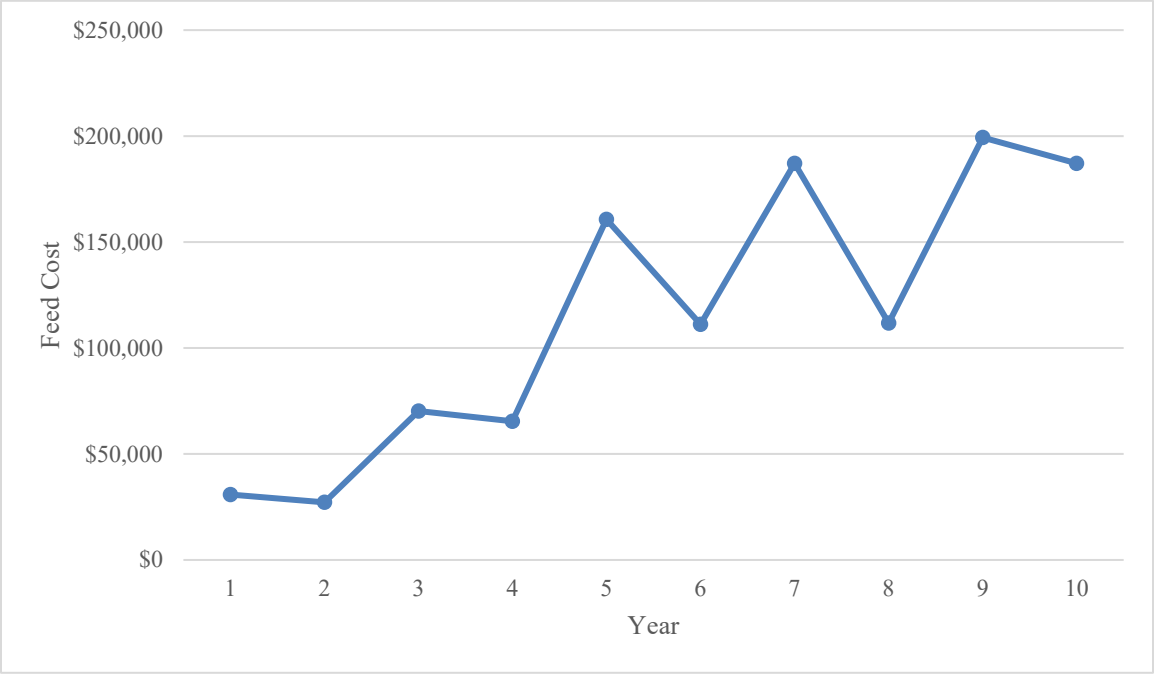
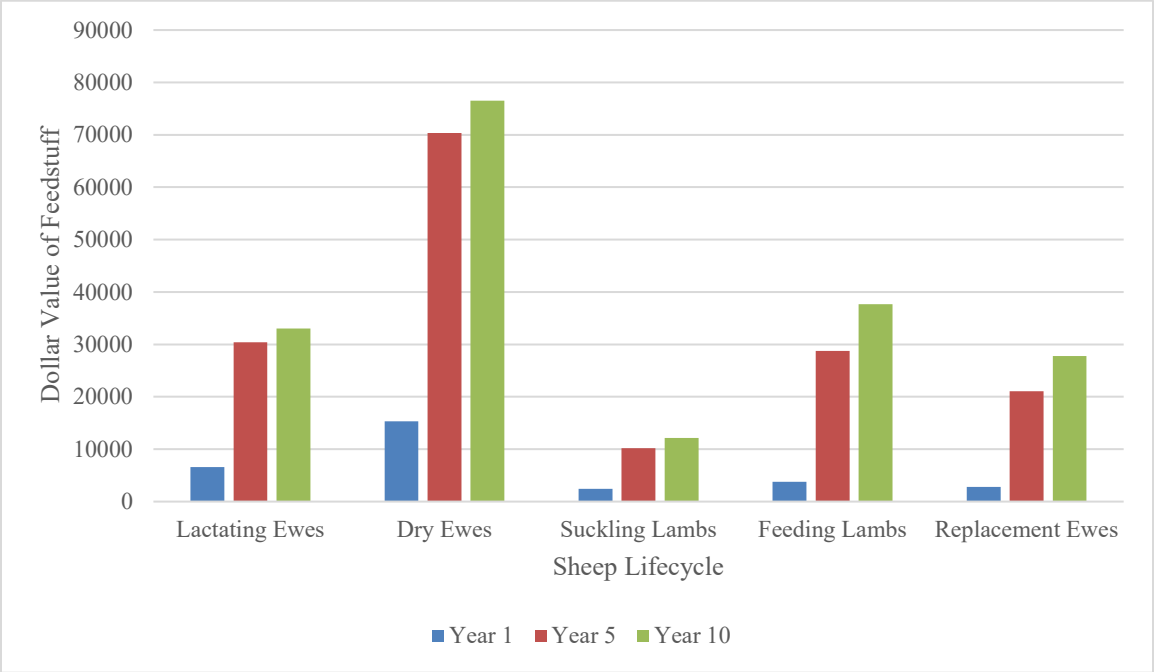


Figure 4.3: Feed Cost Comparison for Different Stages of Sheep Lifecycle

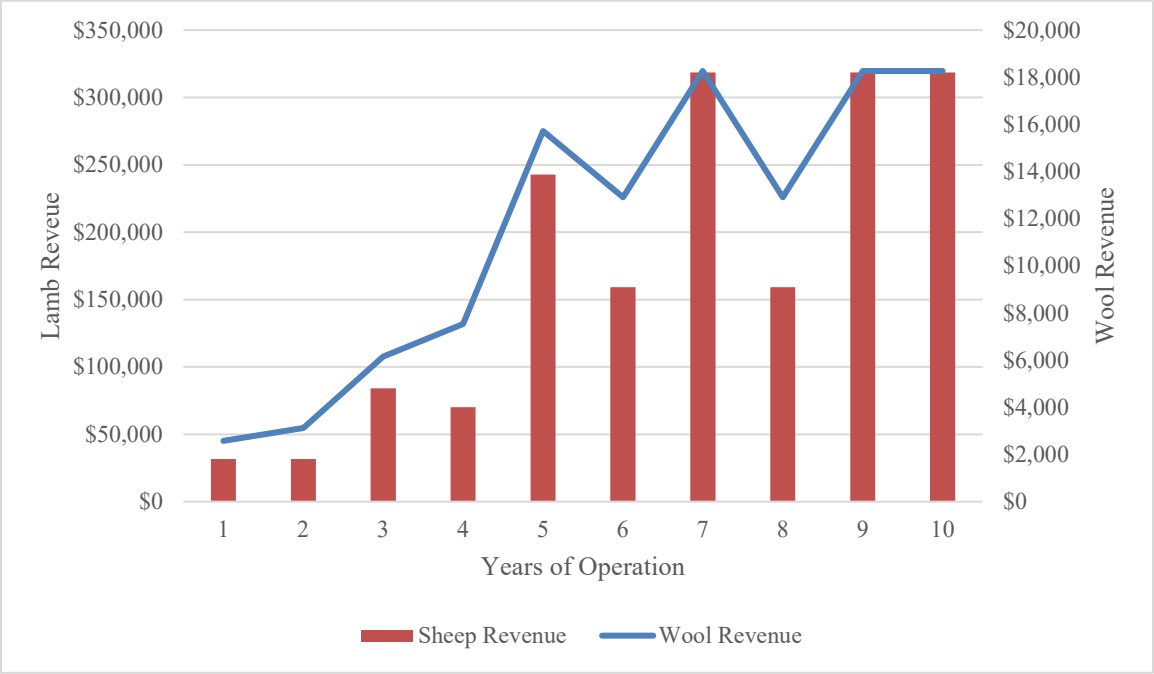


Revenue has two different sources. The model's primary source is from selling sheep off the operation. These sheep can be cull ewes or market lambs. Cull ewes were set

at a base price of $200 per ewe. In year 1 it is assumed that the producer sells only 20 females to accommodate the 20% cull rate. Once the model has a total of 500 ewes in operation there would be a cull of 100 ewes per year. Market lambs fluctuate with number of ewes on property determined by the production rate of 200%. In year 1, it is assumed only 141 market lamb will be on the property. Once the operation is at full capacity of 500 ewes in year 10, it is predicted to have 1416 market lambs to sell. The gross revenue in year 1 is $4,000 from cull ewes and $31,725 dollars from market lambs. In comparison, year ten has a gross revenue of $20,000 from cull ewes and $318,600 from market lambs.

Wool is the additional benefit to raising sheep since they are a dual-purpose animal, it provides additional revenue for the producer. While the model shows only $2,577.96 for the first year of wool sales by year 10 it accounts for $18,264.96. This is a great help in the first few years to boost revenue, but as more market lambs are available the percentage of wool revenue to sheep revenue has an inverse relationship. Figure 4.4 summarizes the trend in wool and meat revenue over the first 10 years of operating the farm. Year 4 provides the highest benefit from wool sales at 11% in comparison to meat sales. By year 10 wool only has a 6% comparison to meat sales.

Figure 4.4: Trends in Lamb and Wool Revenue Comparison



This model analyzed seven different scenarios, including the base scenario. The financial analyses results for all the scenarios are presented in Table 4.1. As indicated, the base scenario assumed a lambing rate of 200%, a death rate of 1.5%, and a conception rate of 90% over the 10 years. The other six scenarios varied these three variables. The scenarios and their assumptions are presented in Table 4.1.

Table 4.1: Description of Alternative Scenarios

Scenarios	Project Lamb Rates	Death Loss	Conception Rate
Base Scenario	200%	1.50%	90%
Scenario 1A	150%	1.50%	90%
Scenario 1B	175%	1.50%	90%
Scenario 2A	200%	3.00%	90%
Scenario 2B	200%	4.50%	90%
Scenario 3A	200%	1.50%	75%
Scenario 3B	200%	1.50%	80%

The base assumption results show the ten-year span NPV at 6.5% with a discount rate of $128,782.63 and an IRR of 19.8%. This base assumption produced the best possible

outcome for the operation. Scenario 1 changes production rates or determining how many lambs a female breeding ewe will have each lambing period. Scenario 2 changes death loss to determine how feasibility will change once lambs are born if some die. Scenario 3 is considering conception rate of females. This number is based solely on the female getting breed within the timeframe not number of lambs being born. Table 4.1: NPV and IRR results Under Alternative Scenarios, shows all scenarios with their projected NPV and IRR.

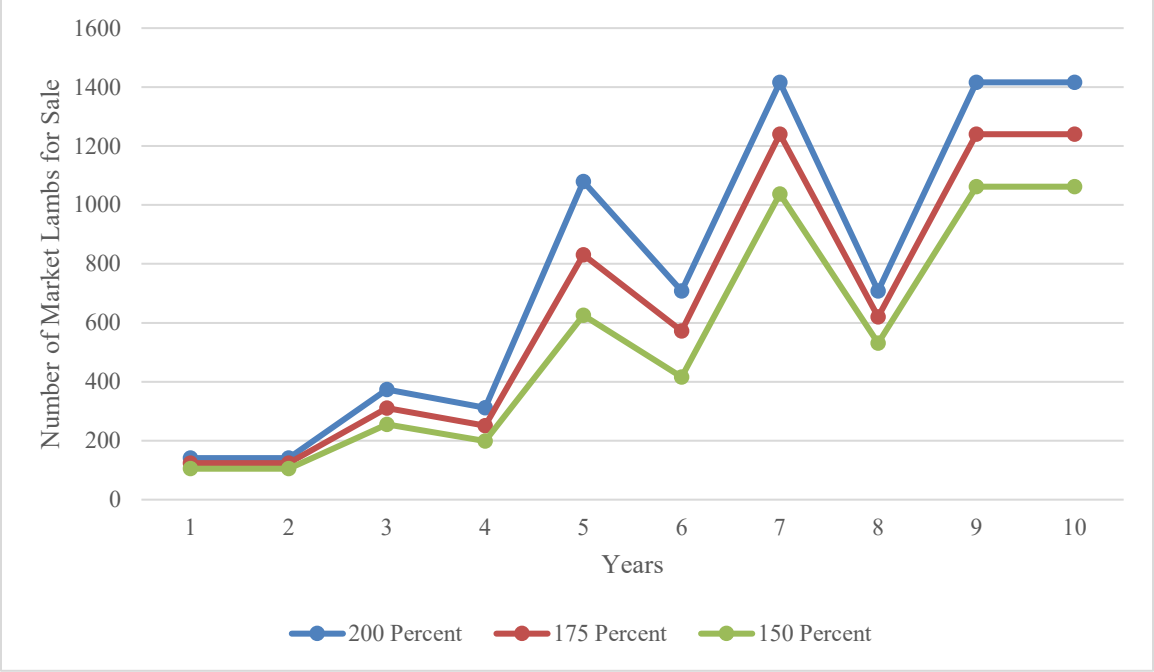
Table 4.2: NPV and IRR Results Under Alternative Scenarios

Scenarios	Project Lamb Rates	Death Loss	Conception Rate	NPV (Discount Rate = 6.5%)	IRR
Base Scenario	200%	1.50%	90%	$47,236	11.1%
Scenario 1A	**150%**	1.50%	90%	($187,186)	-17.9%
Scenario 1B	**175%**	1.50%	90%	($70,835)	-1.1%
Scenario 2A	200%	**3.00%**	90%	$31,697	9.6%
Scenario 2B	200%	**4.50%**	90%	$16,713	8.2%
Scenario 3A	200%	1.50%	**75%**	($109,858)	-5.9%
Scenario 3B	200%	1.50%	**80%**	($57,304)	0.4%

4.2 Change of Lambing Production

Scenario 1A and 1B changed the project lambing rates. A successful accelerated lambing program giving birth to twins or better triple, even quadruplets. These scenarios provided insight into if our production rate dropped below 200% or below two lambs per ewe, what would happen to our NPV or IRR. Table 4.2 shows looking at scenario 1A and 1B produces the worst outcome for both NPV and IRR. A 25% decrease in the lambing rate while holding all other things constant produced a project that was not financially feasible. This means that it is critical that managers keep an eye on the lambing rates and aggressively cull all ewes that do not produce a minimum of twins. The effect of this 25% drop in lambing rate from 200% to 150% on the number of lambs available for sale is summarized in Figure 4.5.

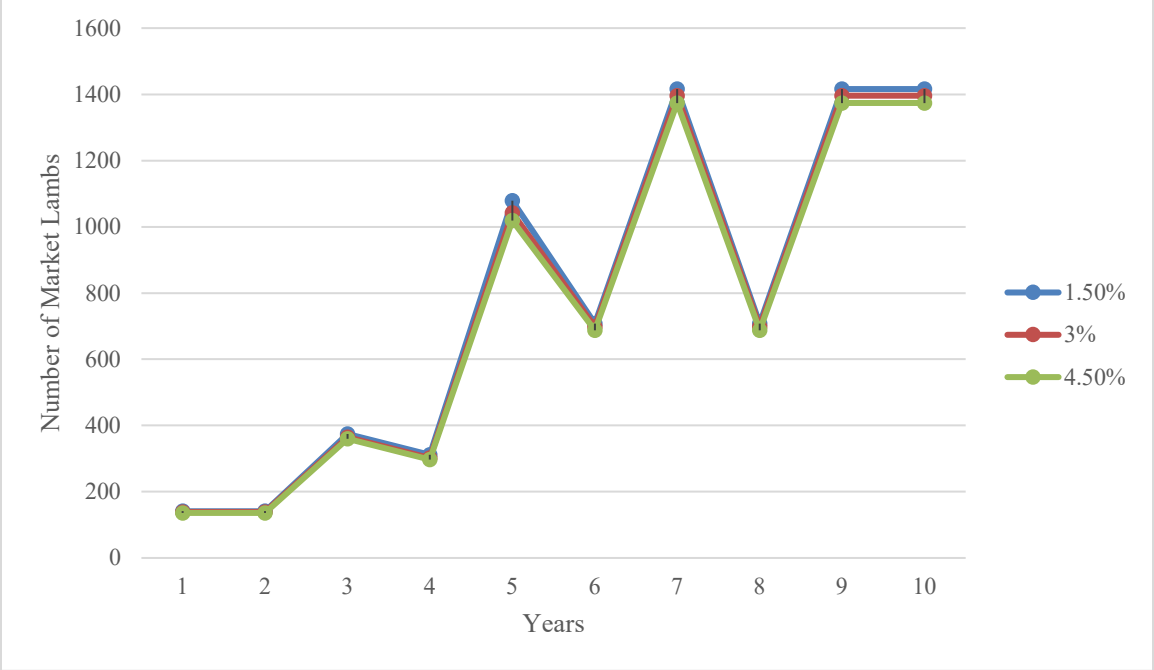
Figure 4.5: Number of Market Lambs in Comparison to Different Production Rates



4.3 Change of Death Loss

Scenario 2 doubled death loss of lambs. This scenario did not adversely affect the financial feasibility of the project. From Table 4.2, doubling and tripling death loss produced positive NPV. Indeed, tripling death loss only decreased IRR from the base scenario value of 11.1% to 8.2%, which was about 1.7% above the discount rate. In the period of very stable interest rates, this suggests that death loss' effect on financial feasibility is non-threatening. The effect of the increases in death loss on lambs marketed is summarized in Figure 4.6.

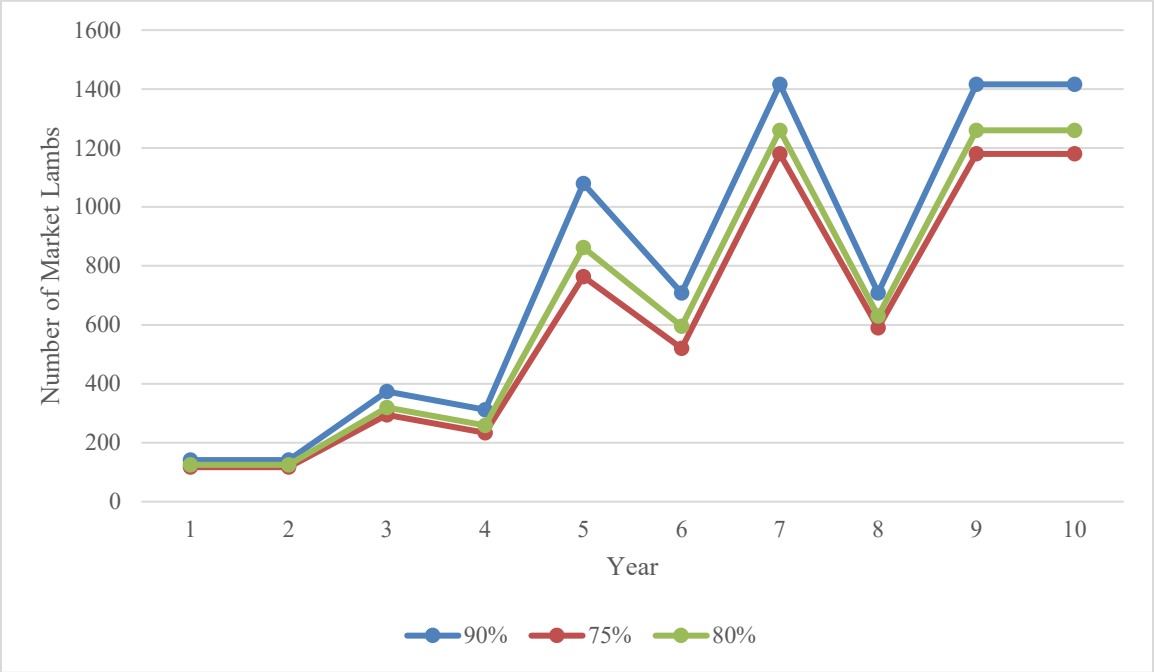
Figure 4.6: Number of Market Lambs in Comparison to Different Death Loss



4.4 Change of Conception Rate

Scenario 3 changes the conception rate of females. In the base assumption, it is the goal for 90% of females to get bred. In scenario 3A, conception rate is changed to 75%, producing an NPV of ($109,856) and an IRR of -5.9%. These fertility rates can be ensured with the help of hormone drugs and CIDR's to ensure conception rate along with semen checking on the rams that will be used. In scenario 3B, conception rate is changed to 80% which produced NPV of ($57,304) and an IRR of 0.4%. Figure 4.7 summarizes the effect of the changed conception rate on the number of lambs available for sale in each year.

Figure 4.7: Number of Market Lambs in Comparison to Different Conception Rates



CHAPTER V: SUMMARY AND CONCLUSIONS

This thesis determines if it is economically feasible to have an accelerated lambing program ran out of an old dairy barn facility. Prior knowledge of the industry from Gray's Farm is helpful in determining sheep management including timeline for females to be breeding, lambing, lactating, and dry. Other data such as input cost that go with vaccinations, feed, and synchronization are valuable to determine feasibility during the ten-year study.

Production rate of females showed to be the number one priority with this operation. Decreasing production rate of females will decrease the NPV and IRR significantly compared to the other two factors. Females in this program will have to produce a minimum of twins every lambing program. It is crucial to cull females that do not produce twins every birthing cycle since twins are a genetic characteristic and passed on to future generations. It is also important that the females kept for replacement ewes are twins themselves even if their twin did not survive or was count at a death loss. Female that are born twins are more likely to produce twins when they are bred. The rams selected for breeding should also be from twins to ensure best odds from all sides.

Conception rate came in as the number two priority. Conception rates need to be at 90% in order to meet a feasible profitability. All females should receive a CIDR twelve days prior to being turned out with a ram. Right before ewes and rams are placed in the same pen females should have CIDRs pulled and be given their shot of estrumate. This will ensure that all females are cycling while being placed with males. Males sure also be semen tested thirty to sixty days prior to breeding to make sure they are viable for breeding. After thirty days of being together males and females should be separated to ensure a

certain time period for females to give birth. A producer should give females forty-five days after being separated and ultrasound females. At this stage it will be obvious if a female is bred and able to determine the number of offspring present. Any female not bred should immediately be culled to save the producer expense on feed cost.

The financial model proved that death loss even as great as 4.5% would still result in a feasible NPV and IRR. Though no producer would like to see their profit disappear after an animal is born it is important to make sure that lambs are closely monitored forty-eight hours after birth to ensure they are claimed by their mother and nursing is going well. This should be done in a smaller pen size. If the bond seems to be strong and mother is milking fine a producer could turn them out to a bigger more open pen to accommodate for other females. Vaccinations and care will be the greatest asset to help keep death loss to a minimum. Prevention is key to reducing death loss. This thesis is feasible if lambing rate and conception rate remain above 200% and 90%.

5.1 Future Study

This thesis begins to explore whether it is financially feasible to have an accelerated lambing program ran out of an old dairy barn. There are two additional studies that could be explored. This would include pasture lambing ewes during the warmer months and completing the STAR method with the sheep operation.

Iowa winters can become extremely frigid and thus most lambing should be done inside during this time. The dairy barn would be largely used during the colder months, but the barn only has a holding capacity of 500 ewes. If the financials were to allow for dry ewes to be raised on pasture, this would open up space for females that are lambing. Females could also lamb outside during the warmer seasons if there is an adequate enough fencing system to keep them protected from natural predators like coyotes or wild dogs.

The STAR method would allow farmers to have two additional lambing crops within the same time period as the model that was given. In this method, females would only be culled if they missed conception twice in a row. This would allow producers to potentially have more lambs during that time frame given. There are a few studies with this that females' life expectancy is rapidly decreased as more stress is put on them to produce, but given the right breeds (e.g., Dorset and Polypay), it is possible to maintain a decent life expectancy without undue stress.

WORK CITED

Batalova, J. (2022, July 21). *Article: Top Statistics on Global Migration.* Migration Policy Institute. Retrieved March 5, 2023, from https://www.migrationpolicy.org/article/top-statistics-global-migration-migrants

Fogarty, L. (2019, November 26). *After WWII, Mutton Fell Out Of Favor In The U.S. Can It Make A Comeback?* NPR. Retrieved March 5, 2023, from https://www.npr.org/sections/thesalt/2019/11/26/781652195/after-wwii-mutton-fell-out-of-favor-in-the-u-s-can-it-make-a-comeback

Inskeep, K. (2012, August 14). *29 EXPERIENCES WITH SHEEP CIDRS TO INDUCE FALL LAMBING Historically strong market prices during the winter and early spring*. Animal and Poultry Sciences. Retrieved January 2, 2022, from https://www.apsc.vt.edu/content/dam/apsc_vt_edu/extension/sheep/programs/shepherds-symposium/2012/12_symposium_greiner_cidrs.pdf

Iowa Ag News – Sheep and Lambs. (2023, January 31). USDA National Agricultural Statistics Service. Retrieved March 5, 2023, from https://www.nass.usda.gov/Statistics_by_State/Iowa/Publications/Livestock_Report/2023/IA-Sheep-01-23.pdf

Larsen, J. W. (2021, May). *Reproductive Physiology of Sheep - Management and Nutrition*. Merck Veterinary Manual. Retrieved January 2, 2021, from https://www.merckvetmanual.com/management-and-nutrition/management-of-reproduction-sheep/reproductive-physiology-of-sheep

Metzger, M. (2016, August 2). *CDT Vaccinations for Sheep and Goats*. CDT Vaccinations for sheep and goats - MSU Extension. Retrieved January 2, 2022, from https://www.canr.msu.edu/news/cdt_vaccinations_for_sheep_and_goats

Moyer, K. (n.d.). *A Sheep Produces 2-30 lbs. of Wool a Year*. AgHires Blog. Retrieved January 2, 2022, from https://blog.aghires.com/sheep-facts/

Pugh, D. G. (2020, August). *Nutritional Requirements of Sheep - Management and Nutrition*. Merck Veterinary Manual. Retrieved January 2, 2022, from https://www.merckvetmanual.com/management-and-nutrition/nutrition-sheep/nutritional-requirements-of-sheep

Schoenian, S. (2021, October 1). *Ethnic markets drive sheep/goat industry (Shepherd's Notebook)*. American Farm Publications. Retrieved March 5, 2023, from https://americanfarmpublications.com/ethnic-markets-drive-sheep-goat-industry-shepherds-notebook/

Sector at a Glance. (2020, June 24). USDA ERS. Retrieved March 5, 2023, from https://www.ers.usda.gov/topics/animal-products/sheep-lamb-mutton/sector-at-a-glance/

Sheep Meat Market Size, Share, Growth, Demand, Forecast 2023-2028. (n.d.). Expert Market Research. Retrieved March 5, 2023, from https://www.expertmarketresearch.com/reports/sheep-meat-market

Umberger, S. H. (2009). *Feeding Sheep*. Feeding Sheep. Retrieved March 5, 2023, from https://extension.unl.edu/statewide/lincolnmcpherson/410-853_pdf.pdf