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The Impact of Robotic Milking Systems: The Case of the Rocky Mountain Region

Garret Nelson

Abstract

The increasing adoption of automatic milking systems (AMS) in the U.S. has caused interest in determining if they are truly beneficial to the farmers who install them. The focus in this study is to identify the monetary value of AMS for dairies in the Rocky Mountain region and the estimated value of the non-monetary benefits. Using a mixed methods approach to create a survey; information was gathered from farmers in the Rocky Mountain region who are using AMS. The results reveal that monetary benefits from production and labor savings are lacking in themselves to provide positive net present values (NPVs) for the farms that install AMS. It is concluded that labor flexibility, reduction of labor risk, animal welfare, and increased cow information contribute enough value to compensate the negative NPVs. It is difficult to determine actual numbers or ratios of these other benefits as it will differ between farmers. Yet it appears that results support the idea that farmers do put value in these areas based on the responses from the surveys.

Introduction

The adoption of automatic milking systems (AMS) has been on the increase in recent years in the Rocky Mountain region of the United States of America. The AMS technology was first developed in the mid-1990s and experienced early adoption in the European markets (Shortall, Shalloo, Foley, Sleator, & O'Brien, 2016). The interest in AMS has grown in the U.S. market due to dairy farms having more difficulty in finding people who are willing to milk cows. Labor difficulties have been the main reason for many of the farmers in the Rocky Mountain region to install AMS. It is clear that AMS helps resolve labor problems as it is automating the milking process, but it is still in debate if they are actually better economically for the farm.

Different studies have used a variety of parameters and assumptions which have resulted in both positive and negative results. Salfer, Minegishi, Lazarus, Berning, and Endres (2017) found a positive average net return by using a 30-year period of operation of AMS. They were factoring wage inflation and replacing the AMS after a useful life of 15 years. Despite the accuracy of the results it is not likely that a producer will invest in a technology that he will need to invest into twice before it becomes profitable. Two studies that were based off the grazing models of Europe had two different conclusion with one saying there were no monetary difference between AMS and conventional milking systems (CMS) (Oudshoorn, Kristensen, & de Boer, 2012) and the other finding a negative return, but saying that the other benefits added by AMS outweigh the negative return (Shortall, Shalloo, Foley, Sleator, & O'Brien, 2016). Schult and Tranel (2013) found that AMS could have a positive net income financially, but that cash flows would most likely be negative. One interesting aspect with Schult and Tranel's study is that they also added a factor to include the positive effect on the quality of life change of the farmer. The idea of other positive factors adding value can be an important aspect in the overall valuation of AMS.

The impact that AMS have on animal and human welfare has been positive for many dairy farms that have installed them. Tse, Barkema, DeVries, Rushen, and Pajor (2016) conducted a survey of what health benefits dairy farmers had seen from 217 Canadian dairies that had an operational AMS. They found that 80% of farmers found it easier to detect illness with AMS; lameness decreased for 42%, stayed the same for 38%, and increased for 20%; mastitis decreased for 49%, stayed the same for 38%, and increased for 13%; fertility increased for 63%, stayed the same for 31%, and decreased for 6%. They found no statistical differences in the proportions for

lameness and mastitis, but there was statistical significance found in the impact of AMS on fertility (Tse, Barkema, DeVries, Rushen, & Pajor, 2016). The large survey still revealed that the majority of farmers saw cow health and welfare improve or stay the same, with a minority seeing negative effects. However, it is still debatable how much of the perceived effects come from the robots and how much was a result of other factors that coincided with the introduction of the robots. In contrast of the Canadian study; Oudshoorn, Kristensen, and de Boer (2012) found no differences in animal health between AMS and CMS for organic grazing dairies.

Employee and owner welfare benefits is another area that AMS can add value. Farmers have reported improved lifestyle with both their physical and mental health improving after the adoption of AMS (Mathijs, 2004). Also with AMS the farmer is freed of his lower valued labor in order to put his time in areas that are of more importance; whether that is in other areas of the farm or personal time (Salfer, Minegishi, Lazarus, Berning, & Endres, 2017). The flexibility of time was found to be the biggest reason for the improve quality of life in almost all of the respondents in a Canadian survey (Tse, et al., 2018). It is also mentioned that reducing the physical and repetitive motions of milking which wear on employees' joints was a justification for adopting the new technology (Oudshoorn, Kristensen, & de Boer, 2012). Schult and Tranel's (2013) quality of life improvement factor that is included on their partial budget was an attempt to capture these benefits that occur with the freeing up of labor. How they determined the value is uncertain, but they mentioned that it can vary from farmer to farmer.

The research on AMS has shown that there are many positive benefits, but also that small changes can turn the tide of AMS being a positive investment into a negative. The lack of research done in the Rocky Mountain region gives need for an evaluation of whether AMS shows the same level of benefits that have been found in other areas. The purpose of this paper is to evaluate the economic value that farmers have experienced who have installed AMS in the Rocky Mountain region.

Method

Selection of Farms

The farms were selected for the study based on their physical location inside the states of Utah and Idaho. It was also a requirement that they had at least six months of operating their AMS in order to be included in the survey. Ten farms were identified that met the set criteria. All ten

farms were contacted by phone as their information was provided by the dealers. Six of the ten farms were willing to participate in the survey.

General Survey

A mixed methods approach was used in the formation of the survey questions as both quantitative questions targeting the costs and production numbers of the dairy and qualitative questions were used to gain insight into the perceptions that the farmers had gained about their AMS units. The questions were formed to obtain the desired information and then sent to both a dairy farmer and a AMS dealer for their input and revision. The revised questions were then organized for clarity and deemed ready for the survey. The results of the surveys were meant to identify the changes in levels of milk production, labor costs, maintenance costs, feed efficiencies, cow health changes, quality of life changes, and the top areas of value seen by the farmer. Many of the qualitative questions allow for more open ended answers to allow farmers to provide more insight. The survey questions are displayed in the appendix.

Analysis

There are three main areas of evaluation. The first area of evaluation is based on a simple statistical analysis of the current levels of change of milk production, maintenance costs, feed costs, and labor costs. The mean and the range will be identified on a per cow basis to provide easier comparison between the different size farms. The results of this analysis will be used in the third part of the overall analysis. The second stage of the analysis is of the qualitative responses relating to animal and worker health and welfare. The goal of this analysis will be to identify other beneficial factors and if there are any repeating themes between the multiple responses. The final part of the analysis will be evaluating the net present value (NPV) of the different farms using the values found in the first part of the analysis and using a few assumptions. A ten-year average using the years 2009-2018 was used to choose a base milk price which differed between the two states. \$17.10 was used for the Idaho farms and \$17.60 was used for the Utah farms. The averages were taken from the National Agricultural Statistics Service (NASS) website. Also the capital cost of the AMS were based on publication from Iowa State by Schult and Tranel (2013). This may not provide the most accurate scenario for every farm, but in order to maintain a higher response to the survey; it was determined not to ask such personal question regarding the financial situation of each farm. The last assumption is based on life expectancy of the AMS. It is still an unknown on

how long AMS are able to continue to operate at effective levels (Salfer, Minegishi, Lazarus, Berning, & Endres, 2017) (Schult & Tranel, 2013). As a result, multiple periods of 7, 10, 12, and 15 years will be done to see how different working life expectancies will affect the NPV for each farm. The financing assumptions were based off the current situations and came to be 5.5% interest rate with a 30% tax rate and using a straight line depreciation over seven years. The salvage value assigned after full depreciation to the robots will be \$40,000 per robot (Schult & Tranel, 2013). The last assumption was in relation to the effects of increasing costs of maintenance and income from increased savings. It is assumed that as the machines wear out that they will require more maintenance and thus a two percent inflation rate will be tied to the cost of repairs. Labor savings will also increase in the sense that there has been a trend over the last ten years of an annual three percent increase in the hourly wage in Idaho's farm worker's wage (NASS, 2019). This trend in increasing wages will be seen as increasing revenues, which includes added revenue and cost savings, for the farm in the net present value evaluations.

Figure 1 shows an example of how the NPV was put together on an excel spreadsheet for one of the scenarios. The appendix contains the figures for every scenario. The assumptions listed above were the same for every scenario with the initial investment changing to represent the size of the AMS. The starting gross return is the value of the annual increased milk production caused by the AMS based on the average milk price added to labor savings. Gross receipts grow at a two percent annual inflation rate which is the same rate applied to the maintenance cost. The two percent annual inflation rate on total revenue come close to the value that a three percent inflation rate of wages would have on the total revenue. The payment cost was calculated using the excel PMT formula and the established assumptions. There are only two areas of income for the AMS investment. The increased revenue from milk production and labor savings contributes every year while the second area of income is from the salvage value of the AMS and is added during the final year of the planning scenario. The cost portion takes a little more space to calculate the impact of taxable income. Taxable income was the sum of cash receipts minus maintenance expenses, depreciation, interest. Important to note that in the final year of the investment scenario the terminal value is not added to taxable income as it is still part of the initial cash outflow and was never depreciated. The taxable income is then used to calculate income taxes which then provides the needed information for adding up the annual cash flow. Net cash flow was the sum of the receipts and terminal value (only in the last year) minus the maintenance expense, interest,

principle, and income taxes. The resulting net cash flow values are what was used in establishing NPV for the investment of AMS.

Figure 1 Example of NPV calculation spreadsheet

Farm 3 AMS Investment											
Initial	\$800,000	Units per year	1								
Terminal	\$160,000	Starting gross return	\$124,527								
Loan payoff	\$0.00	Starting maintenance cost	\$48,000								
Growth		Payment	\$140,771.53								
Investment											
receipts	2.00%										
Expenses	2.00%										
Tax rate	30.00%	Net present value		(\$59,290.82)							
% financed	100.00%	IRR		0.47%							
Finance rate	5.50%	MIRR		2.78%							
Real cost of capital	7.00%										
Inflation rate	0.00%										
Nominal discount rate	7.00%	Depreciation schedule									
Nominal after tax rate	4.90%	1	2	3	4	5	6	7	8		
Yrs financed	7	0.333333	0.444444444	0.148148148	0.074074						
Planing horizon	10	0.142857	0.142857143	0.142857143	0.142857	0.142857	0.142857	0.142857			
Year >>	0	1	2	3	4	5	6	7	8	9	10
Receipts	124,527	127,017	129,558	132,149	134,792	137,487	140,237	143,042	145,903	148,821	
Terminal value											160,000
Cash inflow	0	124,527	127,017	129,558	132,149	134,792	137,487	140,237	143,042	145,903	308,821
Down	0										
Maintenance expenses	48,000	48,960	49,939	50,938	51,957	52,996	54,056	55,137	56,240	57,364	
Depreciation	91,429	91,429	91,429	91,429	91,429	91,429	91,429	0	0	0	
Interest	44,000	38,678	33,062	27,138	20,889	14,295	7,339	0	0	0	
Principal	96,772	102,094	107,709	113,633	119,883	126,477	133,433	0	0	0	
Taxable income	-58,902	-52,049	-44,873	-37,356	-29,482	-21,232	-12,586	87,905	89,663	91,456	
Income taxes	-17,671	-15,615	-13,462	-11,207	-8,845	-6,370	-3,776	26,372	26,899	27,437	
Loan Payoff										0	
Cash outflow	0	171,101	174,117	177,249	180,503	183,884	187,398	191,052	81,508	83,139	84,801
Net cash flow	0	-46,574	-47,100	-47,691	-48,354	-49,092	-49,910	-50,814	61,534	62,764	224,019
Accumulated Cash Flow	0	-46,574	-93,674	-141,365	-189,719	-238,811	-288,722	-339,536	-278,002	-215,238	8,781

Results

Production Value of AMS

All but one of the six farmers saw an increase in the milk production per cow after switching to AMS. The farm that saw a decrease was milking three times a day before the installation of AMS. The other farms which were milking twice a day saw a 10 to 14% increase of milk per cow after switching to AMS which equates to an additional \$405.70 to \$642.40 in gross annual income per cow. The average income of the five farms that saw increases in income was \$543.67 per cow. The dairy that was milking three times before switching saw a 19% decrease or

a loss of close to a thousand dollars per cow in milk income. It was assumed that with increased production that the cows would increase their consumption of feed. This was captured by evaluating if there was a change in the cost of feed needed to produce 100 pounds of milk. There appeared to be no significant changes in that cost in the farms that provided that information. It can be acknowledged that the price of feed varies widely and can skew the assumptions, but the tone of the farmers in their response supports the assumption that they saw no significant feed to milk efficiencies gained with AMS. More research will be needed to provide a conclusion on AMS feed to milk efficiencies. The cost of feed to produce the change in milk production was taken from each farms estimate of what their feed costs are to produce hundred pounds. This value was then added back into the milk revenues to show the revenues after feed costs. The profit of milk production after subtracting feed averaged \$321.59 per cow for the five farms that switched from two milking to AMS with a range of \$248.40-\$386.90 and the farm that was milking three times a day saw a reduction of income of \$619.04 per cow after adding back in feed savings due to a reduction in milk production.

Table 1. AMS impact on production and operational costs

Farm	1	2	3	4	5	6
Herd Size	230	110	200	120	120	240
Net change in milk yield per cow due to AMS	6.5	10	10	8	8	-16
Daily farm milk production change	1495	1100	2000	960	960	-3840
Added annual milk revenues	\$ 93,310.43	\$ 70,664.00	\$ 128,480.00	\$ 61,670.40	\$ 61,670.40	\$ (246,681.60)
Revenues after feed costs	\$ 57,132.17	\$ 42,559.00	\$ 77,380.00	\$ 35,951.04	\$ 34,339.20	\$ (148,569.60)
Milk revenues after feed costs per cow	\$ 248.40	\$ 386.90	\$ 386.90	\$ 299.59	\$ 286.16	\$ (619.04)
Annual repair and maintenance of AMS	\$ 57,600.00	\$ 26,400.00	\$ 48,000.00	\$ 21,000.00	\$ 26,400.00	\$ 52,800.00
Repair and maintenance of AMS per cow	\$ 250.43	\$ 240.00	\$ 240.00	\$ 175.00	\$ 220.00	\$ 220.00
Annual Labor Savings	\$ 65,292.00	\$ 23,766.00	\$ 37,764.43	\$ 21,660.00	\$ 31,500.00	\$ 44,640.00
Savings/Cow	\$ 283.88	\$ 216.05	\$ 188.82	\$ 180.50	\$ 262.50	\$ 186.00
Net change	\$ 64,824.17	\$ 39,925.00	\$ 67,144.43	\$ 36,611.04	\$ 39,439.20	\$ (156,729.60)
Net change per cow	\$ 281.84	\$ 362.95	\$ 335.72	\$ 305.09	\$ 328.66	\$ (653.04)

Labor Impacts

Labor savings made up the next biggest value of AMS after milk production. The annual labor savings ranged from \$180.50 to \$283.88 for the farms in the surveys with the average at \$225.79. Between the added income from milk production increases and labor savings AMS look pretty appealing, but they have some large costs. The monthly range of costs per robot repairs and maintenance provided in the survey was between \$1000-1200 or an annual cost of \$12,000 to \$14,400. The cost per cow ranged between \$175.00 to \$250.42 with the average at \$225.09. It was

interesting to see that the cost of maintaining and repairing the robots is in the same range as labor savings.

The AMS impact on the lifestyle for the six farms surveyed was positive for all, but one. Further inquiry revealed that although the farmers reported it as a positive change to their overall lifestyle there are definitely some pros and cons. It was commonly agreed that the AMS allowed for more labor flexibility and reduced the need for hired labor. However, it also created the need to have someone on call 24/7. Another negative impact is caused by positively viewed reduction of labor. Some of the farmers who were able to reduce the number of employees find themselves short-handed when they have problems on the farm or when they are wanting to take a vacation. This was the cause of the one farmer reporting a negative impact on his life style. He reduced his hired labor and now takes sole responsibility for the robots so that he is never off call. Overall he is still happy with the changes, but the personal time commitment was something he had underestimated. The interesting scenario with that farmer is that he was not the only employee on the farm, but for some reason he was the only one taking care of the robots. He mentioned that the other employees were quite happy with the change since they went from helping with the milking to having nothing to do with it. A few of the other farmers in the survey had a partner or another employee who would take turns being on call for the robots to allow the farmer to take time off. They said having that complete break from the robots helped reduce the monotony of being on call all the time.

Table 2. Farmers perceptions of AMS benefits.

Farm	1	2	3	4	5	6
Do you feel your general working knowledge of your herd has improved or decreased with the addition of robotic milking?	yes	yes	yes	Yes	yes	yes
milking been a positive change financially?	a slight yes	yes	yes	Yes	yes	yes
Has the change to robotic milking been a positive change to your life style?	yes	yes	yes	Yes	yes	no
What three things do you find most valuable to using robots?						
1	Cows are milked out better, low stress,	Labor	More milk	Knowledge per cow	More milk	Cow health
2	Not as reliant on hired help	Production	Cow comfort	Cow confort, consistency	Labor	Labor
3	Information	Cow health	Cows are more calm	Production	Information, consistency, cleanliness of cows, and cow comfort	

Animal Health and Welfare

The evaluation for animal health and welfare are based on the responses of the farmers as whether they perceived any changes. Five of the six farmers surveyed said they saw improvements in cow health after switching to AMS. The other farmer was neutral to any change. Farm number one perceived that he had fewer lame cows, lower stress on the cows, and that the cows were calmer in general. However, he noticed that he had a few more cows with mastitis. Farm number two reported that he also saw improvement to cow health in general, but did not provide any details. Farm number three stated that he saw improved cow comfort and that his cows were calmer. Farm number four saw a decrease in mastitis, fewer sick cows, and better cow comfort. Farm number five said he saw improvements on herd fertility, no lame cows, less mastitis and a lower vet bill. Farm number six did not notice a change in herd health, but saw cow comfort and cleanliness improve with the introduction of the AMS. Cow comfort was mentioned the most from the farmers as an improvement to animal welfare followed by reduction in lameness, improved fertility, and mastitis was mixed with some seeing increases while others saw decreases. It would appear based off these responses that there is some level of improvement to animal health and welfare with the introduction of AMS.

NPV Evaluation

There is valued gained in the human and animal health and welfare aspects with the adoption of AMS, but being able to put a value to it is a little more difficult. The case of AMS can give some insight on the minimal values placed on these benefits. All six farmers reported that AMS was a profitable investment, but looking at the numbers provided and estimated, it would appear that AMS would be a negative cash investment. By using NPV it can be assumed that if the cash values are negative then it would mean that the difference between that value and zero could be attributed to the minimal value of the other benefits gained.

Table 3 shows the different NPVs of the different farms in reference of the expected life of the AMS unit. The actual useful life of the AMS is still uncertain as many of the units have only been in operation for a few years. The range of useful life is reported to be between 7-15 years (Schult & Tranel, 2013) (Salfer, Minegishi, Lazarus, Berning, & Endres, 2017). Year seven shows the greatest loss for most of the farms as it is the last year of the payments. The reason why it is negative is due to the inability of AMS to generate enough cash flow to cover the payment in a

seven-year payment window. This would be a worst case scenario and it is unlikely that the dairymen made their decision based on that scenario. A ten-year expectancy would be a conservative expectation while fifteen years would be optimistic. All six farms see a negative NPV in every scenario until year twelve where farm two and five see a positive NPV. In year fifteen all but farm six see a positive NPV. Farm six had the largest losses as they were the only farm that was milking three times a day and saw a decrease in milk production after switching to AMS. They are also the only farm that the total NPV continues to decrease after the AMS is paid off due to the loss revenue in milk sales. Farm six NPV for the fifteen-year scenario was close to a negative \$1.6 million or an annual loss of about \$110,000. Yet farm six still said that the installation of AMS was a profitable investment for the farm which that an important detail was missed for that farm or they put a lot of value in the benefits of AMS. The other five farms showed more favorable results to support their responses that the adoption of AMS was a good investment. Farm two, three, and five all saw similar annual profit of about \$4,000-\$5,200 for the fifteen-year scenario. These same farms reported a ten-pound increase per cow in milk production while farm four only saw an eight-pound increase and as a result saw a lower value of \$2,492.13 annual NPV profit. Farm one has seen only a six-and-a-half-pound increase and as a result they are forecasted to have a gain of \$345.01 in annual NPV. Both farm one and four both were larger dairies compared to farm two, three, and five. These results are for the most optimistic scenario of fifteen years. The twelve-year scenario is more likely to be the conservative scenario used by the dairymen and it shows average annual NPV range between a loss of \$6,078 to a positive gain of \$1,278. The ten-year scenario had a range of annual NPV losses between \$1,983 -\$12,834. The chances for negative NVP seem likely in the different scenarios with the small rewards seen in the fifteen-year scenario which leads to the idea that there must be some value in the benefits to offset the risk of negative NVP.

Table 3. NPV of the six farms from the surveys

Farm		Expected working life of AMS				
		7	10	12	15	
1	NPV	(\$216,773.10)	(\$128,349.50)	(\$72,937.33)	\$5,175.08	
	Annual NPV	(\$30,967.59)	(\$12,834.95)	(\$6,078.11)	\$345.01	
2	NPV	(\$76,072.93)	(\$19,839.50)	\$15,337.31	\$64,842.81	
	Annual NPV	(\$10,867.56)	(\$1,983.95)	\$1,278.11	\$4,322.85	
3	NPV	(\$166,439.89)	(\$59,290.82)	(\$19,277.46)	\$78,725.63	
	Annual NPV	(\$23,777.13)	(\$5,929.08)	(\$1,606.46)	\$5,248.38	
4	NPV	(\$90,326.53)	(\$39,395.85)	(\$7,514.40)	\$37,381.90	
	Annual NPV	(\$12,903.79)	(\$3,939.59)	(\$626.20)	\$2,492.13	
5	NPV	(\$78,162.40)	(\$22,706.30)	\$11,987.43	\$60,817.26	
	Annual NPV	(\$11,166.06)	(\$2,270.63)	\$998.95	\$4,054.48	
6	NPV	(\$1,129,121.79)	(\$1,354,697.89)	(\$1,487,097.42)	(\$1,661,926.76)	
	Annual NPV	(\$161,303.11)	(\$135,469.79)	(\$123,924.79)	(\$110,795.12)	

Discussion

Economic theory based off of the results would classify the investments in AMS as most likely unprofitable with a chance of it being profitable for some in the optimal scenario. Yet despite these numbers every one of the farmers claim that it has been a positive move financially for their farms. All the farmers in the survey have had their AMS less than four years which means they are all similarly exposed to the same risk of not knowing how long the units will last. This leads to a plausible conclusion that the farmers in the surveys are seeing enough side value to compensate the risk of a shorter life span of the AMS unit and the negative NPV associated with that scenario.

Labor is a reoccurring theme in the discussions of AMS due to the fact that AMS are reducing the need for milking labor. There are two types of labor being replaced by the AMS. Hired labor is one and owner labor is the other with there being different benefits that come with reducing one or the other. Reducing hired labor reduces the amount of management time needed, reduces the risk of employee turnover, and the strains of training new employees. Also the current labor market is quite competitive as it is becoming harder to find employees and as a result wages are increasing. This leads to the idea of AMS providing a source of risk security against a labor shortage. Risk security is important to farmers as they generally tend to be more risk adverse in factors that affect their production income (Menapace, Colson, & Raffaelli, 2013). Labor is often overlooked as an input that is vulnerable to risk. As mentioned before dairymen in the Rocky Mountain region are finding it ever more difficult to find enough people to milk cows. Thus the

solution to this issue would provide value to the farm owner. In the scenario with AMS there is the actual money savings from reduced labor and also the non-monetary value due to the reduction of labor shortage risk; which would have different levels of value depending on the farmer. It could be assumed that farmers who experience a high level of employee turnover would place more value in reducing the labor shortage risk as it is more pressing on their minds; compared to a farm that has had the same employees for a large number of years. The reduction of labor shortage risk premium value of AMS is unknown, but is a real value as farms may be willing to risk small levels of financial loss to solve the problem.

The benefits from reducing owner milking labor is based on the labor-leisure tradeoff theory. It is not that the farmers are trading all their time freed up from milking to leisure activities. Many may be shifting their time to other areas of the farm which may be the cause for some of the animal health and welfare improvements. The labor-leisure tradeoff theory states that people may forego increased financial gain if they are able to gain more personal time away from work via more vacation days, longer weekends, or shorter workdays (Best, 1978). The fact that the farmer is on call 24/7 if there are robot problems would rule out the idea that the farmer is gaining more vacation days or longer weekends. However, it was mentioned by a few of the farmers that they enjoyed the improved flexibility of time. The flexibility of time would be that the farmer is no longer stuck in the rigid structure of starting milking early morning and starting the next milking twelve hours after that. The farmer may still be tied to the farm, but he is now able to start his day a little later or have the flexibility to leave the farm to attend a family or personal event. So farmers are not necessarily experiencing more vacation day, longer weekend, or even a shorter workday that were the areas of focus for Best's study (1978); yet flexibility of the work schedule allows the farmer to feel a little leisure from the monotony of milking cows.

Another area of benefit that was valued by the farmers in the survey was cow comfort and health. Cow comfort has been connected to more productive cows (Wang, et al., 2016). Thus the connection of cow comfort to production would make it appear that the dairymen are interested in the higher production aspect, but many of the farmers mentioned both milk production and cow comfort as valuable benefits of AMS. It would be redundant to mention both milk production and cow comfort if they were implying that the value of cow comfort was more milk. Thus it seems likely that the farmers who mention cow comfort as a valuable aspect of AMS are valuing the

condition that they are able to provide for their animals. In other words, the farmers may be willing to take a small loss if they perceive that their cows are doing better. It was also observed by some farmers that their herds experienced a reduction in number of lame cows. It was not identified how many fewer cases they were seeing, but based off of research by Cha, Hertl, Bar, and Grohn (2010) each reduced case of lameness could have a value of \$120-216 based on the type of lameness avoided. Thus a reduction of two to four cases could make an annual income difference for the farm by \$240-864. Fertility was another area mentioned to have improved by a few farms and also in by Tse, et al. (2016). The value to place on improved fertility can be difficult, but using a value suggested by De Vries (2006) of \$278 per new pregnancy, a value can be assumed for improve fertility. An improved fertility of the dairy herd of 1-2% would equate to a gain of \$333.60-667.20 for the 120 cow farms and \$667.20-1334.40 for the 240 cow farms. The effect that AMS had on mastitis for the different farms was mixed which makes it difficult to conclude if there is a direct correlation with AMS and mastitis. However, the value of a mastitis case can be between \$100-200 (Cha, et al., 2011).

Another factor that may explain why the farmers are saying that the investment into AMS is profitable is that they are in denial. The cost of installing AMS is a large investment and one that farmers would hope to be profitable. There is a chance that farmers may be overlooking the negative economic outcome of the AMS, because they are still hoping that the investment works out. This is a possibility, but it would seem unlikely that 100% of the respondents would fall into this category. Thus there has to be some value gained from the benefits to outweigh risk of negative return.

The last area mentioned in the responses as having value is the information gained on the individual cows from the AMS technology. The AMS records an immense amount of data for each cow. Milk production data is kept on every cow as well as keeping track of the activity of the cows to know when they are in heat. The information gained can be of great value as it helps the farmer to make better decisions in culling cows and identifying illness. The value of the information may vary from farm to farm depending on how much they were tracking information before and how much they are utilizing the information from the AMS now.

The different areas that add value will be different for each farmer, but the total effect of the areas of benefit should hold a value that is equal or greater than the negative NPV over the

range of the ten to twelve-year scenario. The equation below shows how that calculation could appear.

$$NPV + LaborRiskPremium + LaborFlexibility + AnimalWelfare + Information \geq 0$$

Table 4. NPVs to be compensated by added benefits of AMS

Farm	AMS working life					
			10		12	
	#cows		Farm Total	Per cow	Farm Total	Per cow
1	230	Annual NPV	(\$12,834.95)	(\$55.80)	(\$6,078.11)	(\$26.43)
2	110	Annual NPV	(\$1,983.95)	(\$18.04)	\$1,278.11	\$11.62
3	200	Annual NPV	(\$5,929.08)	(\$29.65)	(\$1,606.46)	(\$8.03)
4	120	Annual NPV	(\$3,939.59)	(\$32.83)	(\$626.20)	(\$5.22)
5	120	Annual NPV	(\$2,270.63)	(\$18.92)	\$998.95	\$8.32
6	240	Annual NPV	(\$135,469.79)	(\$564.46)	(\$123,924.79)	(\$516.35)

Farm six shows the greatest value put on the added benefits, but it is also likely that there are some details missing as their negative NPV is far greater than any other farm. The other five farms fall fairly close in the NPV values. The three smaller farms have a range of \$3,939.59 to \$0 (the value of zero is due to the fact that the NPV were positive in year twelve for two of the small farms) of necessary value added from the benefits in order to claim that the investment is positive for the farm based on the ten and twelve year scenarios. The other two larger farms have a range of \$12,834.95 to \$1,606.46 which means that the larger farms need to see greater benefit than is what is seen by the smaller farms in order to be deemed a positive investment for the farm. The value of labor flexibility and satisfaction in animal comfort should not be affected by the size of the farm. However, larger farms have need of more labor and thus the labor risk premium should be greater for these farms. The information benefit value should also increase with the larger farms. It can be assumed that a good portion of difference between the values of the small and large farms is due to the labor risk premium and added information. Thus the difference in range of \$8,895.36 to \$1,606.46 can be greatly attributed to benefit of the added information and the removal of labor shortage risk. Animal health economic value shown in table 5 below illustrates how benefits of different areas of health can add significant amount of value. Yet it is important to remember that not every farm sees benefits in all three of the areas and some actually see negative impacts. Thus not every farmer will view the benefits in the same way, but it would seem that the larger farmers

are willing to pay some level of labor risk premium in order to prevent milking labor shortage problems.

Table 5. Possible values of impacts on animal health

# cases/ percentage change	Lameness per case	1% change in fertility		Mastitis per case
		120 cow farm	240 cow farm	
1	\$120-216	\$333.60	\$667.20	\$100-200
2	\$240-432	\$667.20	\$1,334.40	\$200-400
3	\$360-648	\$1,000.80	\$2,001.60	\$300-600
4	\$480-864	\$1,334.40	\$2,668.80	\$400-800

Conclusion

AMS have a lot of potential as a new technology as it provides many benefits, but they also increase costs to the business. It is clear that AMS have difficulty in generating enough cash flow to cover the payments over a typical seven-year payment period, but they also increase production and add benefits which can compensate and even surpass the early losses depending on the productive life of the AMS unit. It was discovered that added milk production and labor savings were lacking in their ability to compensate the cost of AMS in all the different operating life scenarios until the twelve-year life span. There was still one farm that was lacking a breakeven NPV even in that fifteen-year life span. As a result, it is necessary that farmers must see value in the other added benefits in order for the farmers to justify their answers that the adoption of AMS into their business has been a positive financial change.

The noncash generating benefits that were valued include labor flexibility, reduction of labor risk, animal welfare, and increased cow information. The true value of these benefits are still difficult to determine, but minimal values can be established by determining what would be needed to have a breakeven NPV. An assumption that value of animal welfare and labor flexibility would be the same for both the small and larger farmers led to the conclusion that the difference in NPV between the two size farms would be attributed to value in the reduction of labor risk and increased cow information. As a result of that assumption those two areas have the greatest minimal values.

It is acknowledged that the results of this study may not truly reflect reality due to a few blanket assumption and the fact that farmers will have different values on the benefits of AMS depending on the challenges they were facing before and after the adoption of the new technology.

Further study will be needed to establish a better range of the true value that the noncash benefits of AMS add to the farm. Another survey to determine how much each farmer would be willing to pay annually for each benefit would further the results of this study. Despite these shortcomings it can be concluded that AMS have the possibility to provide enough benefits to justify the costs of investment and that the value of those benefits will vary from farm to farm.

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Appendix

Survey Questions

How long have you been milking with robots?

What brand of robotic milking system did you install?

What was your herd average milk production before switching to robots?

What is your herd average milk production after switching to robots?

In the transition, did milk production go down and if so for how long?

How many days were involved in the initial intense training and start up?

How many times did you milk per day prior to robots?

How many times on average are cows now milked per day with robots?

What is your average box time? (Amount of time from cow entry to exit with successful milking)

Did you make any other structural or operational changes when you switched to robots?

Have you made any changes to your feed or feeding process with the switch to robotic milkers?

Do you think these other changes had any effect on your milk production? How much?

What was your feed cost to produce 100 pounds of milk prior to robotic milking?

What is your feed cost to produce 100 pounds of milk with the milking robots?

Did you need to cull any cows to accommodate robotic milking, and if so how many?

Has your culling rate for springers changed since you put the robots in?

How much are your operating cost to run your robotic system?

What were your barn operating costs before?

What is your cost of labor per hour, including wages, taxes, benefits, and housing?

How many hours of milking labor were you paying per month in your conventional parlor? (Just for the milking process, not including feeding, breeding, treating etc.)

How many hours of labor are you spending per month doing the daily robot maintenance, fetching?

Have the robots affected herd health?

What was your herd average Somatic Cell Count prior to the robotic change?

What is your herd average Somatic Cell Count following the change to robotics?

Are you using the robotic system to monitor activity (heat detection) and rumination of your herd?

What was your herd pregnancy rate prior to robotic milking?

What is your current herd pregnancy rate?

Do you feel your general working knowledge of your herd has improved or decreased with the addition of robotic milking?

Has the change to robotic milking been a positive change financially?

Has the change to robotic milking been a positive change to your life style?

What three things do you find most valuable to using robots?

If you had known prior to the change what you know now, would you have still made the change?

Farm #	1	2	3	4	5	6
Herd Size	230	110	200	120	120	240
How long have you milked with robots? (in years)	1.5	1.25	2.5	3	1	3.5
What brand of robotic milking system did you install?	Delaval	Lely	Lely	Lely	Lely	Lely
What was your herd average milk production before switching to robots? (lbs)	67.5	70	55	72	71	84
What was your herd average milk production after switching to robots? (lbs)	74	80	65	86	85	68
In the transition, did milk production go down?	no	no	no	no	no	no
How many days were involved in the initial intense training and start up?	1 week	1.5 months	2 weeks	1 Month	2-3 weeks	1 week
How many times did you milk per day prior to robots?	2	2	2	2	2	3
How many times on average are the cows milked per day with robots?	2.6	3	3.1	3	2.8	2.85
What is your average box time? (minutes)	7	7	5.5	8	6.4	6.42
Did you make any other structural or operational changes when you switched to robots?	Feeding grain in robots, routine cow handling, guided flow	no	no	yes new shed	yes	no
Have you made any changes to your feed or feeding process with the switch to robotic milkers?	no	no	Reduced grain in TMR	no	no	yes
Do you think these other changes had any affect on your milk production?	no	no	no	yes	yes	?
How much do you think these changed made on your daily milk production per cow?				8lb from robot, 5lb from comfort, 2 from feed pellets	2-4 lbs	?

What was your feed cost to produce 100 pounds of milk prior to robotic milking?	5.98	?	?	7.14	7.8	?
What is your feed cost to produce 100 pounds of milk with the milking robots?	6.63	?	?	7.34	little less	?
Did you need to cull any cows to accommodate robotic milking?	yes	yes	yes	no	no	yes
How many?	5%	6 cows	2%	0	0	2%
How much are you monthly operating costs to run your robotic system?	\$4,800	?	\$900	\$2,000	?	\$3600 per robot
What were your barn operating costs before?	?	?	850	?	?	?
What is your cost of labor per hour, including wages, taxes, benefits, and housing?	\$9	?	?	?	\$12	\$ 17.50
How many hours of milking labor were you paying per month in your conventional parlor?	\$6,000	\$2000 month	?	\$2,000	\$ 3,600	\$ 5,150
How many hours of labor are you spending per month doing the daily robot maintenance and fetching?	43	1.5	360	15	75	110

Have the robots affected herd health?	yes, cows are calmer and there are fewer lame cows, but more mastitis	yes, SCC has gone down	yes	yes, less mastitis and sickness	neutral	yes, improved reproduction, no lame cows, less mastitis, and lower vet bills
What was your herd SCC prior to the robotic change?	150-180	180	180	220-240	90-110	no change
What is your herd SCC following the change to robots?	200-220	140	200	130	90-110	no change
Are you using the robotic system to monitor activity (heat detection) and rumination of your herd?	yes	no	yes	yes	yes	yes
What was your herd pregnancy rate prior to robotic milking?	?	?	?	?	14-15	22-24
What is your current herd pregnancy rate?	?	?	?	27%	18-20	33.5

Do you feel your general working knowledge of your herd has improved or decreased with the addition of robotic milking?	yes	yes	yes	Yes	yes	yes
Has the change to robotic milking been a positive change financially?	a slight yes	yes	yes	Yes	yes	yes
Has the change to robotic milking been a positive change to your life style?	yes	yes	yes	Yes	yes	no
What three things do you find most valuable to using robots?						
1	cows are milked out better, low stress, consistent	Labor	More milk	Knowledge per cow	More milk	Cow health
2	not as reliant on hired help	Production	Cow comfort	Cow comfort, consistency	Labor	Labor
3	information	Cow health	Cows are more calm	Production	Information, consistency, cleanliness of cows, and cow comfort	
If you had known prior to the change what you know now, would you have still made the change?	yes	yes	yes	yes	yes	yes

Farm 1 AMS Investment									
Initial	\$800,000	Units per year	1						
Terminal	\$160,000	\$/unit - return	\$122,424			Depreciable Assets			
Loan payoff	\$0.00	\$/unit - cost	\$57,600			Buildings	7 year		
Growth		Payment	\$140,771.53			Equipment	640,000 7 year		
Investment						Livestock	3 year		
receipts	2.00%								
Expenses	2.00%								
Tax rate	30.00%	Net present value	(\$216,773.10)						
% financed	100.00%	IRR	#NUM!						
Finance rate	5.50%	MIRR	-13.80%						
Real cost of capital	7.00%								
Inflation rate	0.00%								
Nominal discount rate	7.00%	Depreciation schedule							
Nominal after tax rate	4.90%	1	2	3	4	5	6	7	
Yrs financed	7	0.3333333	0.4444444	0.148148148	0.074074				
Planning horizon	7.00	0.1428571	0.1428571	0.142857143	0.142857	0.1428571	0.142857	0.142857	
Year>>	0	1	2	3	4	5	6	7	
Receipts									
Terminal value		122,424	124,873	127,370	129,918	132,516	135,166	137,869	
Cash inflow	0	122,424	124,873	127,370	129,918	132,516	135,166	297,869	
Down	0								
Maintenance expenses		57,600	58,752	59,927	61,126	62,348	63,595	64,867	
Depreciation		91,429	91,429	91,429	91,429	91,429	91,429	91,429	
Interest		44,000	38,678	33,062	27,138	20,889	14,295	7,339	
Principal		96,772	102,094	107,709	113,633	119,883	126,477	133,433	
Taxable income		-70,604	-63,985	-57,048	-49,775	-42,149	-34,152	-25,765	
Income taxes		-21,181	-19,196	-17,114	-14,933	-12,645	-10,246	-7,729	
Loan Payoff								0	
Cash outflow	0	177,190	180,328	183,584	186,965	190,475	194,121	197,909	
Net cash flow	0	-54,766	-55,455	-56,214	-57,047	-57,959	-58,955	99,960	
Accumulated Cash Flow	0	-54,766	-110,221	-166,435	-223,482	-281,441	-340,396	-240,436	

Farm 1 AMS Investment											
Initial	\$800,000	Units per year	1								
Terminal	\$160,000	\$/unit - return	\$122,424		Buildings		7 year				
Loan payoff	\$0.00	\$/unit - cost	\$57,600		Equipment		640,000 7 year				
Growth		Payment	\$140,771.53		Livestock		3 year				
Investment receipts	2.00%										
Expenses	2.00%										
Tax rate	30.00%	Net present value	(\$128,349.50)								
% financed	100.00%	IRR	-4.11%								
Finance rate	5.50%	MIRR	0.21%								
Real cost of capital	7.00%										
Inflation rate	0.00%										
Nominal discount rate	7.00%	Depreciation schedule									
Nominal after tax rate	4.90%	1	2	3	4	5	6	7	8		
Yrs financed	7	0.3333333	0.4444444	0.148148148	0.074074						
Planning horizon	10.00	0.1428571	0.1428571	0.142857143	0.142857	0.1428571	0.142857	0.142857			
Year>>	0	1	2	3	4	5	6	7	8	9	10
Receipts	122,424	124,873	127,370	129,918	132,516	135,166	137,869	140,627	143,439	146,308	
Terminal value										160,000	
Cash inflow	0	122,424	124,873	127,370	129,918	132,516	135,166	137,869	140,627	143,439	306,308
Down	0										
Maintenance expenses	57,600	58,752	59,927	61,126	62,348	63,595	64,867	66,164	67,488	68,837	
Depreciation	91,429	91,429	91,429	91,429	91,429	91,429	91,429	0	0	0	
Interest	44,000	38,678	33,062	27,138	20,889	14,295	7,339	0	0	0	
Principal	96,772	102,094	107,709	113,633	119,883	126,477	133,433	0	0	0	
Taxable income	-70,604	-63,985	-57,048	-49,775	-42,149	-34,152	-25,765	74,463	75,952	77,471	
Income taxes	-21,181	-19,196	-17,114	-14,933	-12,645	-10,246	-7,729	22,339	22,786	23,241	
Loan Payoff										0	
Cash outflow	0	177,190	180,328	183,584	186,965	190,475	194,121	197,909	88,503	90,273	92,079
Net cash flow	0	-54,766	-55,455	-56,214	-57,047	-57,959	-58,955	-60,040	52,124	53,166	214,230
Accumulated Cash Flow	0	-54,766	-110,221	-166,435	-223,482	-281,441	-340,396	-400,436	-348,312	-295,146	-80,916

Farm 1 AMS Investment													
Initial	\$800,000	Units per year			1	Depreciable Assets							
Terminal	\$160,000	\$/unit - return			\$122,424	Buildings		7 year					
Loan payoff	\$0.00	\$/unit - cost			\$57,600	Equipment	640,000	7 year					
Growth		Payment			\$140,771.53	Livestock		3 year					
Investment													
receipts	2.00%												
Expenses	2.00%												
Tax rate	30.00%	Net present value			(\$72,937.33)								
% financed	100.00%	IRR			1.11%								
Finance rate	5.50%	MIRR			3.17%								
Real cost of capital	7.00%												
Inflation rate	0.00%												
Nominal discount rate	7.00%	Depreciation schedule											
Nominal after tax rate	4.90%	1	2	3	4	5	6	7	8				
Yrs financed	7	0.3333333	0.4444444	0.148148148	0.074074								
Planning horizon	12.00	0.1428571	0.1428571	0.142857143	0.142857	0.1428571	0.142857	0.142857					
Year>>	0	1	2	3	4	5	6	7	8	9	10	11	12
Receipts													
Terminal value													160,000
Cash inflow	0	122,424	124,873	127,370	129,918	132,516	135,166	137,869	140,627	143,439	146,308	149,234	312,219
Down	0												
Maintenance expenses		57,600	58,752	59,927	61,126	62,348	63,595	64,867	66,164	67,488	68,837	70,214	71,618
Depreciation		91,429	91,429	91,429	91,429	91,429	91,429	91,429	0	0	0	0	0
Interest		44,000	38,678	33,062	27,138	20,889	14,295	7,339	0	0	0	0	0
Principal		96,772	102,094	107,709	113,633	119,883	126,477	133,433	0	0	0	0	0
Taxable income		-70,604	-63,985	-57,048	-49,775	-42,149	-34,152	-25,765	74,463	75,952	77,471	79,020	80,601
Income taxes		-21,181	-19,196	-17,114	-14,933	-12,645	-10,246	-7,729	22,339	22,786	23,241	23,706	24,180
Loan Payoff													0
Cash outflow	0	177,190	180,328	183,584	186,965	190,475	194,121	197,909	88,503	90,273	92,079	93,920	95,799
Net cash flow	0	-54,766	-55,455	-56,214	-57,047	-57,959	-58,955	-60,040	52,124	53,166	54,230	55,314	216,420
Accumulated Cash Flow	0	-54,766	-110,221	-166,435	-223,482	-281,441	-340,396	-400,436	-348,312	-295,146	-240,916	-185,602	30,819

Farm 1 AMS Investment																
Initial	\$800,000	Units per year	1			Depreciable Assets										
Terminal	\$160,000	\$/unit - return	\$122,424			Buildings			7 year							
Loan payoff	\$0.00	\$/unit - cost	\$57,600			Equipment			640,000	7 year						
Growth		Payment	\$140,771.53			Livestock			3 year							
Investment																
receipts	2.00%															
Expenses	2.00%															
Tax rate	30.00%	Net present value	\$5,175.08													
% financed	100.00%	IRR	5.10%													
Finance rate	5.50%	MIRR	5.56%													
Real cost of capital	7.00%															
Inflation rate	0.00%															
Nominal discount rate	7.00%	Depreciation schedule														
Nominal after tax rate	4.90%	1	2	3	4	5	6	7	8							
Yrs financed	7	0.3333333	0.4444444	0.148148148	0.074074											
Planning horizon	15.00	0.1428571	0.1428571	0.142857143	0.142857	0.1428571	0.142857	0.142857								
Year>>	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Receipts		122,424	124,873	127,370	129,918	132,516	135,166	137,869	140,627	143,439	146,308	149,234	152,219	155,263	158,369	161,536
Terminal value																160,000
Cash inflow	0	122,424	124,873	127,370	129,918	132,516	135,166	137,869	140,627	143,439	146,308	149,234	152,219	155,263	158,369	321,536
Down	0															
Maintenance expenses		57,600	58,752	59,927	61,126	62,348	63,595	64,867	66,164	67,488	68,837	70,214	71,618	73,051	74,512	76,002
Depreciation		91,429	91,429	91,429	91,429	91,429	91,429	91,429	0	0	0	0	0	0	0	0
Interest		44,000	38,678	33,062	27,138	20,889	14,295	7,339	0	0	0	0	0	0	0	0
Principal		96,772	102,094	107,709	113,633	119,883	126,477	133,433	0	0	0	0	0	0	0	0
Taxable income		-70,604	-63,985	-57,048	-49,775	-42,149	-34,152	-25,765	74,463	75,952	77,471	79,020	80,601	82,213	83,857	85,534
Income taxes		-21,181	-19,196	-17,114	-14,933	-12,645	-10,246	-7,729	22,339	22,786	23,241	23,706	24,180	24,664	25,157	25,660
Loan Payoff																0
Cash outflow	0	177,190	180,328	183,584	186,965	190,475	194,121	197,909	88,503	90,273	92,079	93,920	95,799	97,715	99,669	101,662
Net cash flow	0	-54,766	-55,455	-56,214	-57,047	-57,959	-58,955	-60,040	52,124	53,166	54,230	55,314	56,420	57,549	58,700	219,874
Accumulated Cash Flow	0	-54,766	-110,221	-166,435	-223,482	-281,441	-340,396	-400,436	-348,312	-295,146	-240,916	-185,602	-129,181	-71,632	-12,932	206,941

Farm 2 AMS Investment									
Initial	\$400,000	Units per year		1		Depreciable Assets			
Terminal	\$80,000	\$/unit - return		\$66,325		Buildings		7 year	
Loan payoff	\$0.00	\$/unit - cost		\$26,400		Equipment		320,000 7 year	
Growth		Payment		\$70,385.77		Livestock		3 year	
Investment									
receipts	2.00%								
Expenses	2.00%	Net present value		(\$76,072.93)					
Tax rate	30.00%	IRR		-25.52%					
% financed	100.00%	MIRR		-9.66%					
Finance rate	5.50%								
Real cost of capital	7.00%								
Inflation rate	0.00%	Depreciation schedule							
Nominal discount rate	7.00%	1	2	3	4	5	6	7	
Nominal after tax rate	4.90%	0.333333	0.444444	0.148148148	0.074074				
Yrs financed	7	0.142857	0.142857	0.142857143	0.142857	0.1428571	0.142857	0.142857	
Planning horizon	7.00								
Year >>	0	1	2	3	4	5	6	7	
Receipts		66,325	67,652	69,005	70,385	71,792	73,228	74,693	
Terminal value								80,000	
Cash inflow	0	66,325	67,652	69,005	70,385	71,792	73,228	154,693	
Down	0								
Maintenance expenses		26,400	26,928	27,467	28,016	28,576	29,148	29,731	
Depreciation		45,714	45,714	45,714	45,714	45,714	45,714	45,714	
Interest		22,000	19,339	16,531	13,569	10,444	7,148	3,669	
Principal		48,386	51,047	53,855	56,817	59,941	63,238	66,716	
Taxable income		-27,789	-24,330	-20,708	-16,915	-12,942	-8,781	-4,422	
Income taxes		-8,337	-7,299	-6,212	-5,074	-3,883	-2,634	-1,326	
Loan Payoff								0	
Cash outflow	0	88,449	90,015	91,640	93,327	95,079	96,899	98,790	
Net cash flow	0	-22,124	-22,363	-22,636	-22,943	-23,287	-23,671	55,903	
Accumulated Cash Flow	0	-22,124	-44,487	-67,123	-90,066	-113,352	-137,023	-81,121	

Farm 2 AMIS Investment											
Initial	\$400,000	Units per year		1							
Terminal	\$80,000	\$/unit - return		\$66,325		Buildings	7 year				
Loan payoff	\$0.00	\$/unit - cost		\$26,400		Equipment	320,000 7 year				
Growth		Payment		\$70,385.77		Livestock	3 year				
Investment											
receipts	2.00%										
Expenses	2.00%	Net present value		\$15,337.31							
Tax rate	30.00%	IRR		6.61%							
% financed	100.00%	MIRR		6.31%							
Finance rate	5.50%										
Real cost of capital	7.00%										
Inflation rate	0.00%	Depreciation schedule									
Nominal discount rate	7.00%	1	2	3	4	5	6	7	8		
Nominal after tax rate	4.90%	0.333333	0.444444	0.148148148	0.074074						
Yrs financed	7	0.142857	0.142857	0.142857143	0.142857	0.1428571	0.142857	0.142857			
Planning horizon	12.00										
Year>>	0	1	2	3	4	5	6	7	8	9	10 11 12
Receipts		66,325	67,652	69,005	70,385	71,792	73,228	74,693	76,187	77,710	79,265 80,850 82,467
Terminal value											80,000
Cash inflow	0	66,325	67,652	69,005	70,385	71,792	73,228	74,693	76,187	77,710	79,265 80,850 162,467
Down	0										
Maintenance expenses		26,400	26,928	27,467	28,016	28,576	29,148	29,731	30,325	30,932	31,550 32,181 32,825
Depreciation		45,714	45,714	45,714	45,714	45,714	45,714	45,714	0	0	0 0 0
Interest		22,000	19,339	16,531	13,569	10,444	7,148	3,669	0	0	0 0 0
Principal		48,386	51,047	53,855	56,817	59,941	63,238	66,716	0	0	0 0 0
Taxable income		-27,789	-24,330	-20,708	-16,915	-12,942	-8,781	-4,422	45,861	46,779	47,714 48,668 49,642
Income taxes		-8,337	-7,299	-6,212	-5,074	-3,883	-2,634	-1,326	13,758	14,034	14,314 14,601 14,893
Loan Payoff											0
Cash outflow	0	88,449	90,015	91,640	93,327	95,079	96,899	98,790	44,084	44,965	45,865 46,782 47,718
Net cash flow	0	-22,124	-22,363	-22,636	-22,943	-23,287	-23,671	-24,097	32,103	32,745	33,400 34,068 114,749
Accumulated Cash Flow	0	-22,124	-44,487	-67,123	-90,066	-113,352	-137,023	-161,121	-129,018	-96,273	-62,873 -28,805 85,944

Farm 2 AMS Investment																
Initial	\$400,000	Units per year	1			Depreciable Assets										
Terminal	\$80,000	\$/unit - return				Buildings		7 year								
Loan payoff	\$0.00	\$/unit - cost				Equipment	320,000	7 year								
Growth		Payment				Livestock		3 year								
Investment																
receipts	2.00%															
Expenses	2.00%	Net present value		\$64,842.81												
Tax rate	30.00%	IRR		10.13%												
% financed	100.00%	MIRR		8.29%												
Finance rate	5.50%															
Real cost of capital	7.00%															
Inflation rate	0.00%	Depreciation schedule														
Nominal discount rate	7.00%	1	2	3	4	5	6	7	8							
Nominal after tax rate	4.90%	0.333333	0.444444	0.148148148	0.074074											
Yrs financed	7	0.142857	0.142857	0.142857143	0.142857	0.1428571	0.142857	0.142857								
Planning horizon	15.00															
Year>>	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Receipts		66,325	67,652	69,005	70,385	71,792	73,228	74,693	76,187	77,710	79,265	80,850	82,467	84,116	85,798	87,514
Terminal value																80,000
Cash inflow	0	66,325	67,652	69,005	70,385	71,792	73,228	74,693	76,187	77,710	79,265	80,850	82,467	84,116	85,798	167,514
Down	0															
Maintenance expenses		26,400	26,928	27,467	28,016	28,576	29,148	29,731	30,325	30,932	31,550	32,181	32,825	33,482	34,151	34,834
Depreciation		45,714	45,714	45,714	45,714	45,714	45,714	45,714	0	0	0	0	0	0	0	0
Interest		22,000	19,339	16,531	13,569	10,444	7,148	3,669	0	0	0	0	0	0	0	0
Principal		48,386	51,047	53,855	56,817	59,941	63,238	66,716	0	0	0	0	0	0	0	0
Taxable income		-27,789	-24,330	-20,708	-16,915	-12,942	-8,781	-4,422	45,861	46,779	47,714	48,668	49,642	50,635	51,647	52,680
Income taxes		-8,337	-7,299	-6,212	-5,074	-3,883	-2,634	-1,326	13,758	14,034	14,314	14,601	14,893	15,190	15,494	15,804
Loan Payoff																0
Cash outflow	0	88,449	90,015	91,640	93,327	95,079	96,899	98,790	44,084	44,965	45,865	46,782	47,718	48,672	49,645	50,638
Net cash flow	0	-22,124	-22,363	-22,636	-22,943	-23,287	-23,671	-24,097	32,103	32,745	33,400	34,068	34,749	35,444	36,153	116,876
Accumulated Cash Flow	0	-22,124	-44,487	-67,123	-90,066	-113,352	-137,023	-161,121	-129,018	-96,273	-62,873	-28,805	5,944	41,388	77,541	194,418

Farm 3 AMS Investment									
Initial	\$800,000	Units per year		1					
Terminal	\$160,000	Starting gross return		\$124,527		Buildings		7 year	
Loan payoff	\$0.00	Starting maintenance cost		\$48,000		Equipment	640,000	7 year	
Growth		Payment		\$140,771.53		Livestock		3 year	
Investment									
receipts	2.00%								
Expenses	2.00%								
Tax rate	30.00%	Net present value		(\$166,439.89)					
% financed	100.00%	IRR		-27.65%					
Finance rate	5.50%	MIRR		-10.63%					
Real cost of capital	7.00%								
Inflation rate	0.00%								
Nominal discount rate	7.00%	Depreciation schedule							
Nominal after tax rate	4.90%	1	2	3	4	5	6	7	
Yrs financed	7	0.333333	0.444444444	0.148148148	0.074074				
Planning horizon	7	0.142857	0.142857143	0.142857143	0.142857	0.142857	0.142857	0.142857	
Year >>	0	1	2	3	4	5	6	7	
Receipts		124,527	127,017	129,558	132,149	134,792	137,487	140,237	
Terminal value								160,000	
Cash inflow	0	124,527	127,017	129,558	132,149	134,792	137,487	300,237	
Down	0								
Maintenance expenses		48,000	48,960	49,939	50,938	51,957	52,996	54,056	
Depreciation		91,429	91,429	91,429	91,429	91,429	91,429	91,429	
Interest		44,000	38,678	33,062	27,138	20,889	14,295	7,339	
Principal		96,772	102,094	107,709	113,633	119,883	126,477	133,433	
Taxable income		-58,902	-52,049	-44,873	-37,356	-29,482	-21,232	-12,586	
Income taxes		-17,671	-15,615	-13,462	-11,207	-8,845	-6,370	-3,776	
Loan Payoff								0	
Cash outflow	0	171,101	174,117	177,249	180,503	183,884	187,398	191,052	
Net cash flow	0	-46,574	-47,100	-47,691	-48,354	-49,092	-49,910	109,186	
Accumulated Cash Flow	0	-46,574	-93,674	-141,365	-189,719	-238,811	-288,722	-179,536	

Farm 3 AMS Investment													
Initial	\$800,000	Units per year											
Terminal	\$160,000	Starting gross return		1									
Loan payoff	\$0.00	Starting maintenance cost		\$124,527									
Growth		Payment		\$48,000									
Investment				\$140,771.53									
receipts	2.00%												
Expenses	2.00%												
Tax rate	30.00%	Net present value		(\$19,277.40)									
% financed	100.00%	IRR		3.77%									
Finance rate	5.50%	MIRR		4.75%									
Real cost of capital	7.00%												
Inflation rate	0.00%												
Nominal discount rate	7.00%	Depreciation schedule											
Nominal after tax rate	4.90%	1	2	3	4	5	6	7	8	9	10	11	12
Yrs financed	7	0.333333	0.44444444	0.148148148	0.074074								
Planning horizon	12	0.142857	0.142857143	0.142857143	0.142857	0.142857	0.142857	0.142857					
Year>>	0	1	2	3	4	5	6	7	8	9	10	11	12
Receipts		124,527	127,017	129,558	132,149	134,792	137,487	140,237	143,042	145,903	148,821	151,797	154,833
Terminal value													160,000
Cash inflow	0	124,527	127,017	129,558	132,149	134,792	137,487	140,237	143,042	145,903	148,821	151,797	314,833
Down	0												
Maintenance expenses		48,000	48,960	49,939	50,938	51,957	52,996	54,056	55,137	56,240	57,364	58,512	59,682
Depreciation		91,429	91,429	91,429	91,429	91,429	91,429	91,429	0	0	0	0	0
Interest		44,000	38,678	33,062	27,138	20,889	14,295	7,339	0	0	0	0	0
Principal		96,772	102,094	107,709	113,633	119,883	126,477	133,433	0	0	0	0	0
Taxable income		-58,902	-52,049	-44,873	-37,356	-29,482	-21,232	-12,586	87,905	89,663	91,456	93,286	255,151
Income taxes		-17,671	-15,615	-13,462	-11,207	-8,845	-6,370	-3,776	26,372	26,899	27,437	27,986	76,545
Loan Payoff													0
Cash outflow	0	171,101	174,117	177,249	180,503	183,884	187,398	191,052	81,508	83,139	84,801	86,497	136,227
Net cash flow	0	-46,574	-47,100	-47,691	-48,354	-49,092	-49,910	-50,814	61,534	62,764	64,019	65,300	178,606
Accumulated Cash Flow	0	-46,574	-93,674	-141,365	-189,719	-238,811	-288,722	-339,536	-278,002	-215,238	-151,219	-85,919	92,687

Farm 3 AMS Investment																
Initial	\$800,000	Units per year		1												
Terminal	\$160,000	Starting gross return		\$124,527												
Loan Payoff	\$0.00	Starting maintenance cost		\$48,000												
Growth		Payment		\$140,771.53												
Investment																
receipts	2.00%															
Expenses	2.00%															
Tax rate	30.00%	Net present value		\$78,725.63												
% financed	100.00%	IRR		8.19%												
Finance rate	5.50%	MIRR		7.24%												
Real cost of capital	7.00%															
Inflation rate	0.00%															
Nominal discount rate	7.00%	Depreciation schedule														
Nominal after tax rate	4.90%	1	2	3	4	5	6	7	8							
Yrs financed	7	0.333333	0.444444444	0.148148148	0.074074											
Planning horizon	15	0.142857	0.142857143	0.142857143	0.142857	0.142857	0.142857	0.142857								
Year >>	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Receipts		124,527	127,017	129,558	132,149	134,792	137,487	140,237	143,042	145,903	148,821	151,797	154,833	157,930	161,088	164,310
Terminal value																160,000
Cash inflow	0	124,527	127,017	129,558	132,149	134,792	137,487	140,237	143,042	145,903	148,821	151,797	154,833	157,930	161,088	324,310
Down	0															
Maintenance expenses		48,000	48,960	49,939	50,938	51,957	52,996	54,056	55,137	56,240	57,364	58,512	59,682	60,876	62,093	63,335
Depreciation		91,429	91,429	91,429	91,429	91,429	91,429	91,429	0	0	0	0	0	0	0	0
Interest		44,000	38,678	33,062	27,138	20,889	14,295	7,339	0	0	0	0	0	0	0	0
Principal		96,772	102,094	107,709	113,633	119,883	126,477	133,433	0	0	0	0	0	0	0	0
Taxable income		-58,902	-52,049	-44,873	-37,356	-29,482	-21,232	-12,586	87,905	89,663	91,456	93,286	95,151	97,054	98,995	260,975
Income taxes		-17,671	-15,615	-13,462	-11,207	-8,845	-6,370	-3,776	26,372	26,899	27,437	27,986	28,545	29,116	29,699	78,293
Loan Payoff																0
Cash outflow	0	171,101	174,117	177,249	180,503	183,884	187,398	191,052	81,508	83,139	84,801	86,497	88,227	89,992	91,792	141,628
Net cash flow	0	-46,574	-47,100	-47,691	-48,354	-49,092	-49,910	-50,814	61,534	62,764	64,019	65,300	66,606	67,938	69,297	182,683
Accumulated Cash Flow	0	-46,574	-93,674	-141,365	-189,719	-238,811	-288,722	-339,536	-278,002	-215,238	-151,219	-85,919	-19,313	48,625	117,922	300,604

Farm 4 AMS Investment									
Initial	\$400,000	Units per year		1					
Terminal	\$80,000	\$/unit - return		\$57,611		Buildings		7 year	
Loan payoff	\$0.00	\$/unit - cost		\$21,000		Equipment	320,000	7 year	
Growth		Payment		\$70,385.77		Livestock		3 year	
Investment									
receipts	2.00%								
Expenses	2.00%	Net present value		(\$90,326.53)					
Tax rate	30.00%	IRR		#NUM!					
% financed	100.00%	MIRR		-11.57%					
Finance rate	5.50%								
Real cost of capital	7.00%								
Inflation rate	0.00%	Depreciation schedule							
Nominal discount rate	7.00%	1	2	3	4	5	6	7	
Nominal after tax rate	4.90%	0.3333333	0.4444444	0.148148148	0.074074				
Yrs financed	7	0.1428571	0.1428571	0.142857143	0.142857	0.1428571	0.142857	0.142857	
Planning horizon	7.00								
Year>>	0	1	2	3	4	5	6	7	
Receipts									
Terminal value									
Cash inflow	0	57,611	58,763	59,939	61,137	62,360	63,607	144,879	
Down	0								
Maintenance expenses									
Depreciation									
Interest									
Principal									
Taxable income									
Income taxes									
Loan Payoff									
Cash outflow	0	82,055	83,493	84,988	86,542	88,158	89,839	91,589	
Net cash flow	0	-24,444	-24,730	-25,049	-25,404	-25,798	-26,232	53,290	
Accumulated Cash Flow	0	-24,444	-49,173	-74,222	-99,627	-125,425	-151,657	-98,366	

Farm 4 AMS Investment												
Initial	\$400,000	Units per year		1								
Terminal	\$80,000	\$/unit - return		\$57,611		Buildings	7 year					
Loan payoff	\$0.00	\$/unit - cost		\$21,000		Equipment	320,000 7 year					
Growth		Payment		\$70,385.77		Livestock	3 year					
Investment												
receipts	2.00%											
Expenses	2.00%	Net present value		(\$39,395.85)								
Tax rate	30.00%	IRR		-0.88%								
% financed	100.00%	MIRR		2.03%								
Finance rate	5.50%											
Real cost of capital	7.00%											
Inflation rate	0.00%	Depreciation schedule										
Nominal discount rate	7.00%	1	2	3	4	5	6	7	8			
Nominal after tax rate	4.90%	0.3333333	0.4444444	0.148148148	0.074074							
Yrs financed	7	0.1428571	0.1428571	0.142857143	0.142857	0.1428571	0.142857	0.142857				
Planning horizon	10.00											
Year >>	0	1	2	3	4	5	6	7	8	9	10	
Receipts												
		57,611	58,763	59,939	61,137	62,360	63,607	64,879	66,177	67,501	68,851	
Terminal value											80,000	
Cash inflow	0	57,611	58,763	59,939	61,137	62,360	63,607	64,879	66,177	67,501	148,851	
Down	0											
Maintenance expenses		21,000	21,420	21,848	22,285	22,731	23,186	23,649	24,122	24,605	25,097	
Depreciation		45,714	45,714	45,714	45,714	45,714	45,714	45,714	0	0	0	
Interest		22,000	19,339	16,531	13,569	10,444	7,148	3,669	0	0	0	
Principal		48,386	51,047	53,855	56,817	59,941	63,238	66,716	0	0	0	
Taxable income		-31,103	-27,710	-24,155	-20,432	-16,530	-12,440	-8,154	42,055	42,896	43,754	
Income taxes		-9,331	-8,313	-7,247	-6,129	-4,959	-3,732	-2,446	12,616	12,869	13,126	
Loan Payoff											0	
Cash outflow	0	82,055	83,493	84,988	86,542	88,158	89,839	91,589	36,739	37,474	38,223	
Net cash flow	0	-24,444	-24,730	-25,049	-25,404	-25,798	-26,232	-26,710	29,438	30,027	110,628	
Accumulated Cash Flow	0	-24,444	-49,173	-74,222	-99,627	-125,425	-151,657	-178,366	-148,928	-118,901	-8,274	

Farm 4 AMS Investment													
Initial	\$400,000	Units per year		1		Depreciable Assets							
Terminal	\$80,000	\$/unit - return		\$57,611		Buildings	7 year						
Loan payoff	\$0.00	\$/unit - cost		\$21,000		Equipment	320,000 7 year						
Growth		Payment		\$70,385.77		Livestock	3 year						
Investment													
receipts	2.00%												
Expenses	2.00%	Net present value		(\$7,514.40)									
Tax rate	30.00%	IRR		4.09%									
% financed	100.00%	MIRR		4.88%									
Finance rate	5.50%												
Real cost of capital	7.00%												
Inflation rate	0.00%	Depreciation schedule											
Nominal discount rate	7.00%	1	2	3	4	5	6	7	8				
Nominal after tax rate	4.90%	0.3333333	0.4444444	0.148148148	0.074074								
Yrs financed	7	0.1428571	0.1428571	0.142857143	0.142857	0.1428571	0.142857	0.142857					
Planning horizon	12.00												
Year >>	0	1	2	3	4	5	6	7	8	9	10	11	12
Receipts		57,611	58,763	59,939	61,137	62,360	63,607	64,879	66,177	67,501	68,851	70,228	71,632
Terminal value													80,000
Cash inflow	0	57,611	58,763	59,939	61,137	62,360	63,607	64,879	66,177	67,501	68,851	70,228	151,632
Down	0												
Maintenance expenses		21,000	21,420	21,848	22,285	22,731	23,186	23,649	24,122	24,605	25,097	25,599	26,111
Depreciation		45,714	45,714	45,714	45,714	45,714	45,714	45,714	0	0	0	0	0
Interest		22,000	19,339	16,531	13,569	10,444	7,148	3,669	0	0	0	0	0
Principal		48,386	51,047	53,855	56,817	59,941	63,238	66,716	0	0	0	0	0
Taxable income		-31,103	-27,710	-24,155	-20,432	-16,530	-12,440	-8,154	42,055	42,896	43,754	44,629	45,521
Income taxes		-9,331	-8,313	-7,247	-6,129	-4,959	-3,732	-2,446	12,616	12,869	13,126	13,389	13,656
Loan Payoff													0
Cash outflow	0	82,055	83,493	84,988	86,542	88,158	89,839	91,589	36,739	37,474	38,223	38,987	39,767
Net cash flow	0	-24,444	-24,730	-25,049	-25,404	-25,798	-26,232	-26,710	29,438	30,027	30,628	31,240	111,865
Accumulated Cash Flow	0	-24,444	-49,173	-74,222	-99,627	-125,425	-151,657	-178,366	-148,928	-118,901	-88,274	-57,034	54,831

Farm 4 AMS Investment																
Initial	\$400,000	Units per year	1													
Terminal	\$80,000	\$unit - return														
Loan payoff	\$0.00	\$unit - cost	\$21,000													
Growth		Payment	\$70,385.77													
Investment																
receipts	2.00%															
Expenses	2.00%	Net present value	\$37,381.90													
Tax rate	30.00%	IRR	7.82%													
% financed	100.00%	MIRR	7.06%													
Finance rate	5.50%															
Real cost of capital	7.00%															
Inflation rate	0.00%	Depreciation schedule														
Normal discount rate	7.00%	1	2	3	4	5	6	7	8							
Normal after tax rate	4.90%	0.3333333	0.4444444	0.148148148	0.074074											
Yrs financed	7	0.1428571	0.1428571	0.142857143	0.142857	0.1428571	0.142857	0.142857								
Planning horizon	15.00															
Year >>	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Receipts		57,611	58,763	59,939	61,137	62,360	63,607	64,879	66,177	67,501	68,851	70,228	71,632	73,065	74,526	76,017
Terminal value																80,000
Cash inflow	0	57,611	58,763	59,939	61,137	62,360	63,607	64,879	66,177	67,501	68,851	70,228	71,632	73,065	74,526	156,017
Down	0															
Maintenance expenses		21,000	21,420	21,848	22,285	22,731	23,186	23,649	24,122	24,605	25,097	25,599	26,111	26,633	27,166	27,709
Depreciation		45,714	45,714	45,714	45,714	45,714	45,714	45,714	0	0	0	0	0	0	0	0
Interest		22,000	19,339	16,531	13,569	10,444	7,148	3,669	0	0	0	0	0	0	0	0
Principal		48,366	51,047	53,855	56,817	59,941	63,238	66,716	0	0	0	0	0	0	0	0
Taxable income		-31,103	-27,710	-24,155	-20,432	-16,530	-12,440	-8,154	42,055	42,896	43,754	44,629	45,521	46,432	47,360	48,307
Income taxes		-9,331	-8,313	-7,247	-6,129	-4,959	-3,732	-2,446	12,616	12,869	13,126	13,389	13,656	13,929	14,208	14,492
Loan Payoff																0
Cash outflow	0	82,055	83,493	84,988	86,542	88,158	89,839	91,589	36,739	37,474	38,223	38,987	39,767	40,563	41,374	42,201
Net cash flow	0	-24,444	-24,730	-25,049	-25,404	-25,798	-26,232	-26,710	29,438	30,027	30,628	31,240	31,865	32,502	33,152	113,815
Accumulated Cash Flow	0	-24,444	-49,173	-74,222	-99,627	-125,425	-151,657	-178,366	-148,928	-118,901	-88,274	-57,034	-25,169	7,333	40,485	154,301

Farm 5 AMS Investment									
Initial	\$400,000	Units per year		1					
Terminal	\$80,000	\$/unit - return		\$65,839		Buildings	7 year		
Loan payoff	\$0.00	\$/unit - cost		\$26,400		Equipment	320,000 7 year		
Growth		Payment		\$70,385.77		Livestock	3 year		
Investment receipts	2.00%								
Expenses	2.00%	Net present value		(\$78,162.40)					
Tax rate	30.00%	IRR		-26.15%					
% financed	100.00%	MIRR		-9.95%					
Finance rate	5.50%								
Real cost of capital	7.00%								
Inflation rate	0.00%	Depreciation schedule							
Nominal discount rate	7.00%	1	2	3	4	5	6	7	
Nominal after tax rate	4.90%	0.333333	0.444444	0.148148148	0.074074				
Yrs financed	7	0.142857	0.142857	0.142857143	0.142857	0.142857	0.142857	0.142857	
Planning horizon	7.00								
Year>>	0	1	2	3	4	5	6	7	
Receipts									
Terminal value									
Cash inflow	0	65,839	67,156	68,499	69,869	71,266	72,692	74,146	
								80,000	
Down	0								
Maintenance expenses		26,400	26,928	27,467	28,016	28,576	29,148	29,731	
Depreciation		45,714	45,714	45,714	45,714	45,714	45,714	45,714	
Interest		22,000	19,339	16,531	13,569	10,444	7,148	3,669	
Principal		48,386	51,047	53,855	56,817	59,941	63,238	66,716	
Taxable income		-28,275	-24,825	-21,213	-17,430	-13,468	-9,318	-4,969	
Income taxes		-8,483	-7,448	-6,364	-5,229	-4,040	-2,795	-1,491	
Loan Payoff								0	
Cash outflow	0	88,303	89,866	91,488	93,173	94,921	96,738	98,626	
Net cash flow	0	-22,464	-22,710	-22,989	-23,303	-23,655	-24,046	-55,520	
Accumulated Cash Flow	0	-22,464	-45,174	-68,164	-91,467	-115,122	-139,169	-83,649	

Farm 5 AMS Investment												
Initial	\$400,000	Units per year			1							
Terminal	\$80,000	\$unit - return			\$65,839							
Loan payoff	\$0.00	\$unit - cost			\$26,400							
Growth		Payment			\$70,385.77							
Investment												
receipts	2.00%											
Expenses	2.00%	Net present value			(\$22,706.30)							
Tax rate	30.00%	IRR			1.46%							
% financed	100.00%	MIRR			3.34%							
Finance rate	5.50%											
Real cost of capital	7.00%											
Inflation rate	0.00%	Depreciation schedule										
Nominal discount rate	7.00%	1	2	3	4	5	6	7	8			
Nominal after tax rate	4.90%	0.333333	0.444444	0.148148148	0.074074							
Yrs financed	7	0.142857	0.142857	0.142857143	0.142857	0.142857	0.142857	0.142857				
Planning horizon	10.00											
Year>>	0	1	2	3	4	5	6	7	8	9	10	
Receipts		65,839	67,156	68,499		69,869	71,266	72,692	74,146	75,629	77,141	78,684
Terminal value												80,000
Cash inflow	0	65,839	67,156	68,499		69,869	71,266	72,692	74,146	75,629	77,141	158,684
Down	0											
Maintenance expenses		26,400	26,928	27,467		28,016	28,576	29,148	29,731	30,325	30,932	31,550
Depreciation		45,714	45,714	45,714		45,714	45,714	45,714	45,714	0	0	0
Interest		22,000	19,339	16,531		13,569	10,444	7,148	3,669	0	0	0
Principal		48,386	51,047	53,855		56,817	59,941	63,238	66,716	0	0	0
Taxable income		-28,275	-24,825	-21,213		-17,430	-13,468	-9,318	-4,969	45,303	46,209	47,133
Income taxes		-8,483	-7,448	-6,364		-5,229	-4,040	-2,795	-1,491	13,591	13,863	14,140
Loan Payoff												0
Cash outflow	0	88,303	89,866	91,488		93,173	94,921	96,738	98,626	43,916	44,795	45,690
Net cash flow	0	-22,464	-22,710	-22,989		-23,303	-23,655	-24,046	-24,480	31,712	32,347	112,993
Accumulated Cash Flow	0	-22,464	-45,174	-68,164		-91,467	-115,122	-139,169	-163,649	-131,936	-99,590	13,404

Farm 5 AMS Investment													
Initial	\$400,000	Units per year		1		Depreciable Assets							
Terminal	\$80,000	\$/unit - return		\$65,839		Buildings	7 year						
Loan payoff	\$0.00	\$/unit - cost		\$26,400		Equipment	320,000 7 year						
Growth		Payment		\$70,385.77		Livestock	3 year						
Investment													
receipts	2.00%												
Expenses	2.00%	Net present value		\$11,987.43									
Tax rate	30.00%	IRR		6.23%									
% financed	100.00%	MIRR		6.09%									
Finance rate	5.50%												
Real cost of capital	7.00%												
Inflation rate	0.00%	Depreciation schedule											
Normal discount rate	7.00%	1	2	3	4	5	6	7	8				
Normal after tax rate	4.90%	0.333333	0.444444	0.148148148	0.074074								
Yrs financed	7	0.142857	0.142857	0.142857143	0.142857	0.142857	0.142857	0.142857					
Planning horizon	12.00												
Year >>	0	1	2	3	4	5	6	7	8	9	10	11	12
Receipts		65,839	67,156	68,499	69,869	71,266	72,692	74,146	75,629	77,141	78,684	80,258	81,863
Terminal value													80,000
Cash inflow	0	65,839	67,156	68,499	69,869	71,266	72,692	74,146	75,629	77,141	78,684	80,258	161,863
Down	0												
Maintenance expenses		26,400	26,928	27,467	28,016	28,576	29,148	29,731	30,325	30,932	31,550	32,181	32,825
Depreciation		45,714	45,714	45,714	45,714	45,714	45,714	45,714	0	0	0	0	0
Interest		22,000	19,339	16,531	13,569	10,444	7,148	3,669	0	0	0	0	0
Principal		48,386	51,047	53,855	56,817	59,941	63,238	66,716	0	0	0	0	0
Taxable income		-28,275	-24,825	-21,213	-17,430	-13,468	-9,318	-4,969	45,303	46,209	47,133	48,076	49,038
Income taxes		-8,483	-7,448	-6,364	-5,229	-4,040	-2,795	-1,491	13,591	13,863	14,140	14,423	14,711
Loan Payoff													0
Cash outflow	0	88,303	89,866	91,488	93,173	94,921	96,738	98,626	43,916	44,795	45,690	46,604	47,536
Net cash flow	0	-22,464	-22,710	-22,989	-23,303	-23,655	-24,046	-24,480	31,712	32,347	32,993	33,653	114,326
Accumulated Cash Flow	0	-22,464	-45,174	-68,164	-91,467	-115,122	-139,169	-163,649	-131,936	-99,590	-66,596	-32,943	81,383

Farm 6 AMS Investment									
Initial	\$800,000	Units per year		1					
Terminal	\$160,000	\$/unit - return		\$44,640		Buildings		7 year	
Loan payoff	\$0.00	\$/unit - cost		\$52,800		Equipment		640,000	7 year
Growth		Payment		\$140,771.53		Livestock		3 year	
Investment									
receipts	3.00%								
Expenses	2.00%	Net present value		(\$1,129,121.79)					
Tax rate	30.00%	IRR		#NUM!					
% financed	100.00%	MIRR		-100.00%					
Finance rate	5.50%								
Real cost of capital	7.00%								
Inflation rate	0.00%	Depreciation schedule							
Nominal discount rate	7.00%	1	2	3	4	5	6	7	
Nominal after tax rate	4.90%	0.333333	0.444444	0.148148148	0.074074				
Yrs financed	7	0.142857	0.142857	0.142857143	0.142857	0.142857	0.142857	0.142857	
Planning horizon	7.00								
Year >>	0	1	2	3	4	5	6	7	
	-148570	-148570	-148570	-148569.6	-148569.6	-148569.6	-148569.6	53,302	
Receipts		44,640	45,979	47,359	48,779	50,243	51,750	53,302	
Terminal value								160,000	
Cash inflow	0	-103,930	-102,590	-101,211	-99,790	-98,327	-96,820	64,733	
Down	0								
Maintenance expenses		52,800	53,856	54,933	56,032	57,152	58,295	59,461	
Depreciation		91,429	91,429	91,429	91,429	91,429	91,429	91,429	
Interest		44,000	38,678	33,062	27,138	20,889	14,295	7,339	
Principal		96,772	102,094	107,709	113,633	119,883	126,477	133,433	
Taxable income		-292,158	-286,553	-280,635	-274,389	-267,796	-260,839	-253,496	
Income taxes		-87,647	-85,966	-84,191	-82,317	-80,339	-78,252	-76,049	
Loan Payoff								0	
Cash outflow	0	105,924	108,662	111,514	114,487	117,585	120,815	124,184	
Net cash flow	0	-209,854	-211,252	-212,725	-214,277	-215,912	-217,635	-59,451	
Accumulated Cash Flow	0	-209,854	-421,106	-633,831	-848,108	-1,064,020	-1,281,655	-1,341,106	

Farm 6 AMS Investment									
Initial	\$800,000	Units per year	1						
Terminal	\$160,000	\$/unit - return	\$44,640						
Loan payoff	\$0.00	\$/unit - cost	\$52,800						
Growth		Payment	\$140,771.53						
Investment receipts	3.00%								
Expenses	2.00%	Net present value	(\$1,354,697.89)						
Tax rate	30.00%	IRR			#NUM!				
% financed	100.00%	MIRR			-27.73%				
Finance rate	5.50%								
Real cost of capital	7.00%								
Inflation rate	0.00%	Depreciation schedule							
Nominal discount rate	7.00%	1	2	3	4	5	6	7	8
Nominal after tax rate	4.90%	0.333333	0.444444	0.148148148	0.074074				
Yrs financed	7	0.142857	0.142857	0.142857143	0.142857	0.142857	0.142857	0.142857	
Planning horizon	10.00								
Year>>	0	1	2	3	4	5	6	7	8
Receipts		-148570	-148570	-148570	-148569.6	-148569.6	-148569.6	-148569.6	-148569.6
Terminal value		44,640	45,979	47,359	48,779	50,243	51,750	53,302	54,902
Cash inflow	0	-103,930	-102,590	-101,211	-99,790	-98,327	-96,820	-95,267	-93,668
Down	0								
Maintenance expenses		52,800	53,856	54,933	56,032	57,152	58,295	59,461	60,651
Depreciation		91,429	91,429	91,429	91,429	91,429	91,429	91,429	0
Interest		44,000	38,678	33,062	27,138	20,889	14,295	7,339	0
Principal		96,772	102,094	107,709	113,633	119,883	126,477	133,433	0
Taxable income		-292,158	-286,553	-280,635	-274,389	-267,796	-260,839	-253,496	-154,319
Income taxes		-87,647	-85,966	-84,191	-82,317	-80,339	-78,252	-76,049	-46,296
Loan Payoff									0
Cash outflow	0	105,924	108,662	111,514	114,487	117,585	120,815	124,184	14,355
Net cash flow	0	-209,854	-211,252	-212,725	-214,277	-215,912	-217,635	-219,451	-108,023
Accumulated Cash Flow	0	-209,854	-421,106	-633,831	-848,108	-1,064,020	-1,281,655	-1,501,106	-1,609,129

Farm 6 AMS Investment													
Initial	\$800,000	Units per year	1										
Terminal	\$160,000	\$/unit - return	\$44,640										
Loan payoff	\$0.00	\$/unit - cost	\$52,800										
Growth		Payment	\$140,771.53										
Investment													
receipts	3.00%												
Expenses	2.00%	Net present value	(\$1,487,097.42)										
Tax rate	30.00%	IRR	#NUM!										
% financed	100.00%	MIRR	-24.18%										
Finance rate	5.50%												
Real cost of capital	7.00%												
Inflation rate	0.00%	Depreciation schedule											
Nominal discount rate	7.00%	1	2	3	4	5	6	7	8				
Nominal after tax rate	4.90%	0.333333	0.444444	0.148148148	0.074074								
Yrs financed	7	0.142857	0.142857	0.142857143	0.142857	0.142857	0.142857	0.142857					
Planning horizon	12.00												
Year >>	0	1	2	3	4	5	6	7	8	9	10	11	12
		-148570	-148570	-148570	-148569.6	-148569.6	-148569.6	-148569.6	-148569.6	-148569.6	-148569.6	-148569.6	-148569.6
Receipts		44,640	45,979	47,359	48,779	50,243	51,750	53,302	54,902	56,549	58,245	59,992	61,792
Terminal value													160,000
Cash inflow	0	-103,930	-102,590	-101,211	-99,790	-98,327	-96,820	-95,267	-93,668	-92,021	-90,325	-88,577	73,223
Down	0												
Maintenance expenses		52,800	53,856	54,933	56,032	57,152	58,295	59,461	60,651	61,864	63,101	64,363	65,650
Depreciation		91,429	91,429	91,429	91,429	91,429	91,429	91,429	0	0	0	0	0
Interest		44,000	38,678	33,062	27,138	20,889	14,295	7,339	0	0	0	0	0
Principal		96,772	102,094	107,709	113,633	119,883	126,477	133,433	0	0	0	0	0
Taxable income		-292,158	-286,553	-280,635	-274,389	-267,796	-260,839	-253,496	-154,319	-153,885	-153,425	-152,940	-152,428
Income taxes		-87,647	-85,966	-84,191	-82,317	-80,339	-78,252	-76,049	-46,296	-46,165	-46,028	-45,882	-45,728
Loan Payoff													0
Cash outflow	0	105,924	108,662	111,514	114,487	117,585	120,815	124,184	14,355	15,698	17,073	18,481	19,922
Net cash flow	0	-209,854	-211,252	-212,725	-214,277	-215,912	-217,635	-219,451	-108,023	-107,719	-107,398	-107,058	53,301
Accumulated Cash Flow	0	-209,854	-421,106	-633,831	-848,108	-1,064,020	-1,281,655	-1,501,106	-1,609,129	-1,716,848	-1,824,246	-1,931,304	-1,878,003

Farm 6 AMS Investment																
Initial	\$800,000	Units per year		1	Depreciable Assets											
Terminal	\$160,000	\$/unit - return		\$44,640	Buildings	7 year										
Loan payoff	\$0.00	\$/unit - cost		\$52,800	Equipment	640,000 7 year										
Growth		Payment		\$140,771.53	Livestock	3 year										
Investment																
receipts	3.00%															
Expenses	2.00%	Net present value		(\$1,661,926.76)												
Tax rate	30.00%	IRR		#NUM!												
% financed	100.00%	MIRR		-20.29%												
Finance rate	5.50%															
Real cost of capital	7.00%															
Inflation rate	0.00%	Depreciation schedule														
Nominal discount rate	7.00%	1	2	3	4	5	6	7	8							
Nominal after tax rate	4.90%	0.333333	0.444444	0.148148148	0.074074											
Yrs financed	7	0.142857	0.142857	0.142857143	0.142857	0.142857	0.142857	0.142857								
Planning horizon	15.00															
Year >>	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		-148570	-148570	-148570	-148569.6	-148569.6	-148569.6	-148569.6	-148569.6	-148569.6	-148569.6	-148569.6	-148569.6	-148569.6	-148569.6	-148569.6
Receipts		44,640	45,979	47,359	48,779	50,243	51,750	53,302	54,902	56,549	58,245	59,992	61,792	63,646	65,555	67,522
Terminal value																160,000
Cash inflow	0	-103,930	-102,590	-101,211	-99,790	-98,327	-96,820	-95,267	-93,668	-92,021	-90,325	-88,577	-86,777	-84,924	-83,014	78,952
Down	0															
Maintenance expenses		52,800	53,856	54,933	56,032	57,152	58,295	59,461	60,651	61,864	63,101	64,363	65,650	66,963	68,302	69,668
Depreciation		91,429	91,429	91,429	91,429	91,429	91,429	91,429	0	0	0	0	0	0	0	0
Interest		44,000	38,678	33,062	27,138	20,889	14,295	7,339	0	0	0	0	0	0	0	0
Principal		96,772	102,094	107,709	113,633	119,883	126,477	133,433	0	0	0	0	0	0	0	0
Taxable income		-292,158	-286,553	-280,635	-274,389	-267,796	-260,839	-253,496	-154,319	-153,885	-153,425	-152,940	-152,428	-151,887	-151,317	-150,716
Income taxes		-87,647	-85,966	-84,191	-82,317	-80,339	-78,252	-76,049	-46,296	-46,165	-46,028	-45,882	-45,728	-45,566	-45,395	-45,215
Loan Payoff																0
Cash outflow	0	105,924	108,662	111,514	114,487	117,585	120,815	124,184	14,355	15,698	17,073	18,481	19,922	21,397	22,907	24,454
Net cash flow	0	-209,854	-211,252	-212,725	-214,277	-215,912	-217,635	-219,451	-108,023	-107,719	-107,398	-107,058	-106,699	-106,321	-105,922	54,499
Accumulated Cash Flow	0	-209,854	-421,106	-633,831	-848,108	-1,064,020	-1,281,655	-1,501,106	-1,609,129	-1,716,848	-1,824,246	-1,931,304	-2,038,003	-2,144,324	-2,250,246	-2,195,747