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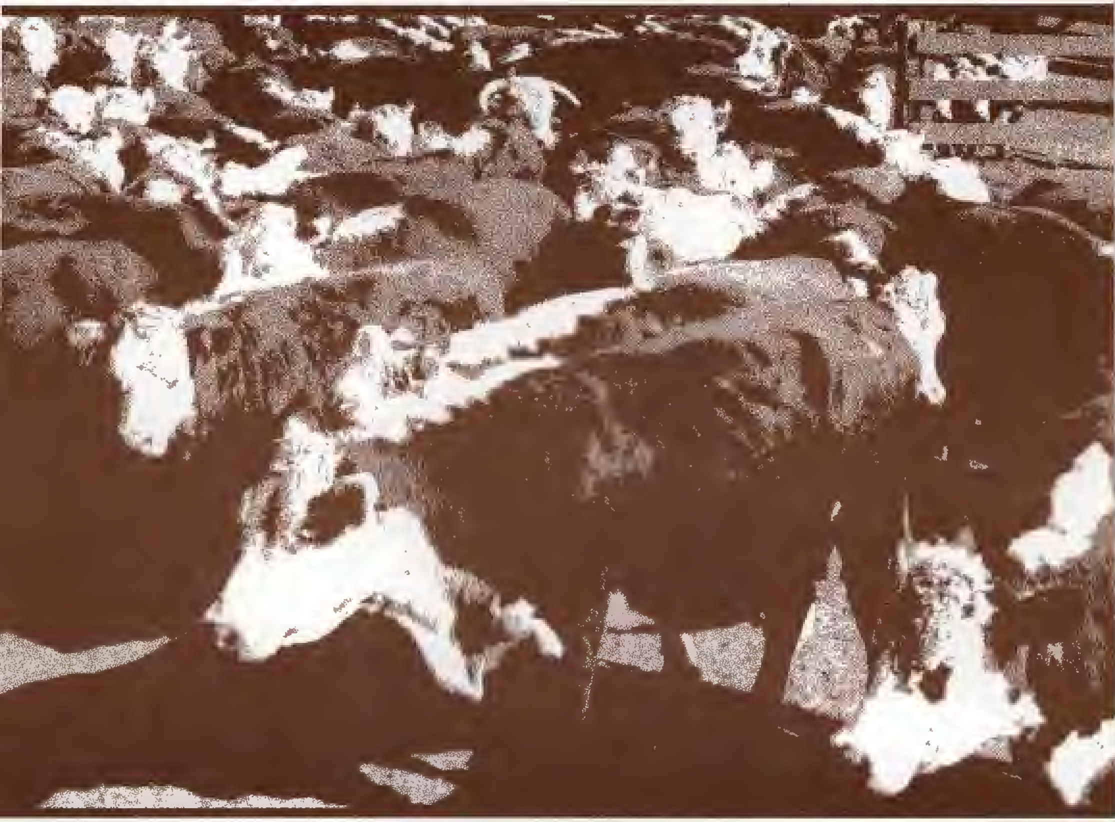

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ECONOMIC ANALYSIS OF IMPACTS ON LENDER RISK OF SELECTED HEDGING STRATEGIES USED BY CATTLE FEEDERS

Melvin Davis and John Franzmann*

Introduction

Profits would be nonexistent in a competitive capitalistic economic environment without the presence of risk. In a world of certainty, all prices would equal costs. This is true for all economic activities, including cattle feeding. But, since we do not live in a world of certainty both profits and losses exist. Therefore, risk must be managed in order to accomplish the primary objective of cattle feeding, that of generating profits.

In the business of cattle feeding, two basic types of risk have been identified. The first is production risk, which is concerned with such items as feed efficiency, death loss, adverse weather, rate of gain, etc. The second type of risk is market or price risk, which is concerned with the purchase price of inputs and the selling price of the final product. Together these two basic types of risk combine to make up the total risk faced by the cattle feeder.

An increasing amount of attention has been focused on price risk during the last ten years. It is a matter of concern not only to the cattle feeder, but also to agricultural lenders who make funds available for investment in cattle feeding enterprises. Lenders can no longer evaluate a potential borrower on production abilities alone. Lenders must also take into consideration the borrower's marketing abilities.

Figure 1 illustrates the volatility in weekly average prices of Good-Choice slaughter steers at Guymon, Oklahoma during 1976-1980. Many factors affect the final selling price for a pen of fat cattle, including the availability of competitive products and the economic environment. But, volatile prices are not solely responsible for the creation of profits, losses, or risk. Inability to predict the future creates risk and, therefore, the potential for profit or loss.

Uncertainty in the cattle feeding business is evident in the wide range of net returns experienced by Guymon area cattle feeders during 1976-1980. Profit margins ranged from an estimated average loss of $194.57 per head to an estimated average profit of $189.26 per head. The wide fluctuation in net returns created "boom or bust" situations for many cattle feeders and had serious implications for agricultural lenders financing those feeders.

Of course not all cattle feeders experienced the estimated wide range of net returns. Some, whether by their skillful analysis of the

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market or just plain luck, timed their purchases of inputs and their sales of output to take advantage of fluctuating prices. However, others were devastated by the effects of adverse unexpected price changes and suffered even worse losses than indicated above.

The practice of hedging by cattle feeders is becoming increasingly important as a method of managing price risk more effectively. Agricultural lenders view the use of hedging by their clients differently based on past experience and their own analysis. Lenders are aware of the argument that hedging assures a producer a set price for a product (neglecting basis risk), and thus a producer who hedges properly should be considered as a better risk by lenders. But, lenders are also aware of cases where hedging magnified losses or restricted profits over what would have otherwise occurred. It should be pointed out that hedging always reduces the exposure to price risk even when it results in less favorable returns, provided the cash and futures prices of the product hedged are highly correlated.

Most cattle feeders borrow money to finance their operations either to provide financial leverage or to make the investment possible. When the investment in cattle feeding is financed in part by borrowing, the lender indirectly faces the same kind of risks incurred by the borrower because the realized outcome of the feeding operation is a determinant of the ability of the borrower to repay the loan. Often, when repayment problems occur, currently maturing debt obligations are refinanced, especially when the problem is deemed temporary in nature. However, this reaction to the problem is not a permanent solution and a run of "temporary" bad luck combined with increasing debt obligations may result in serious financial problems for both the cattle feeder and the lender. Thus, any course of action the feeder might take to reduce risk should be welcomed and encouraged by the lender.

The Problem

The uncertain profitability of feeding cattle is a problem not only for the cattle feeder, but also for the agricultural lender who provides the necessary funds for many individuals and firms to operate. Because profit margins in the cattle feeding business are highly variable, lenders typically view loans for this purpose as risky and, therefore, require a risk premium. This risk premium is a combination of the interest charged above that of the total economic cost of funds and the equity margin requirement placed on the borrower to obtain the loan.

Hicks (1946) suggests that decision makers act differently under risk situations than under no-risk situations. He states,

> ...when risk is present, people will generally act, not upon the price which they expect as most probable, but as if the price had been shifted a little in a direction unfavorable to them.

Accepting this logic it is easy to see why lenders require a risk premium on their loans to cattle feeders. The lender is faced with the problem of uncertainty and as a result charges a higher interest rate and/or will not lend the full expected value of assets offered as security.

Past studies have indicated that the price risk component in cattle feeding may be reduced through the proper use of hedging. If this is true then it would follow that lenders should be willing to lower the risk premium on loans where hedging is utilized, i.e. lenders should be willing to lower either the interest rate, the equity margin requirement, or both.

Many lenders perceive a reduction in risk when their customers hedge and some translate the perceived risk reduction into reduced equity requirements. No effort was made to determine whether any credit institution presently compensates for the perceived reduction in risk by decreasing the cost of funds to their customers who hedge. However, it is possible to fully compensate a borrower for the reduction in risk by decreasing only the margin requirement in most cases. Lenders seem willing to do this because of the additional security provided by hedging.

Some lenders presently have policies that specifically deal with customers who use hedging to manage price risk. These policies generally specify guidelines concerning percent equity requirements for borrowers when they hedge versus when they do not hedge. The difference in equity requirements demanded of the same borrower in these lending policies represent the perceived risk differentiation due solely to the use of hedging by the cattle feeder.

Since lenders do not generally participate directly in any gain or loss derived from the use of borrowed funds, the repayment ability of their borrower is the critical factor in determining lender risk. A procedure for determining the existence and magnitude of any impact on lender risk due solely to the use of alternative hedging strategies by cattle feeders is needed to provide information for use in the development of lending policies that properly reflect any difference present in lender risk as a result of hedging performed by a borrower. This procedure would not only provide information that would be useful for lenders, but would also benefit cattle feeders as well because it would help to identify the best marketing strategy for a particular feeder, given the cattle feeder's own attitude toward and ability to bear risk.

Objectives

The overall objective of this study was to contribute to the continuous effort by agricultural economists of providing better information on which those involved in agriculture may base decisions.

The specific objectives of this study were to:

(1.) Analyze the impact of selected hedging strategies used by cattle feeders on lender risk.

(2.) Develop a method to quantitatively measure any risk differential that may exist among loans due solely to the use of hedging.

EXAMINATION OF SELECTED HEDGING STRATEGIES

Procedure and Assumptions

To analyze the impacts of hedging by cattle feeders on lender risk, a computerized simulation model was developed to provide estimates of net returns per head of cattle fed under selected marketing strategies. The simulation model utilized in this study was designed to be as typical as possible of actual custom feeding operations in Northwestern Oklahoma. However, only hedging strategies using the live cattle futures contract were included. No hedging strategies were considered that included the use of hedged inputs.

The simulation period covered 239 feeding periods of 150 days each beginning the first Monday in January, 1976 and ending in December, 1980. Cattle were assumed to be placed on feed at the beginning of each week beginning in January, 1976 and concluding with a final feeding period of July 8, 1980 to December 25, 1980. If markets were closed on the day a feeding period was to begin, the next day the market opened was used in the simulation. If the markets were closed on the final day of a feeding period, the nearest previous trading day was utilized.

Even though the finished steers were assumed to meet contract specifications, no deliveries against any futures contracts were considered.

Hedging decisions were made according to signals specified under each strategy examined. The closest futures delivery month after the expected marketing date of the finished cattle was the month in which hedges were placed.

Production assumptions for the simulation are shown in Table 1. The marketing weight of 1,070 pounds was the pay weight assumed given a 4 percent shrink. A one percent death loss was assumed for the cattle placed on feed during the 150 day feeding period.

Actual price data were used in the simulation. Futures market prices used were daily settlement prices for the live cattle contract traded on the Chicago Mercantile Exchange. Cash prices used for Choice 600-700 pound feeder steers in Oklahoma City, Oklahoma and for Good-Choice 1,000-1,100 pound slaughter steers in Guymon, Oklahoma were weekly averages calculated from the Weekly Livestock Report, Oklahoma City, Oklahoma.

Calculation of Costs and Net Returns

The single major cost in cattle feeding is the cost of the feeder steer. It was assumed that feeder steers were purchased at a weight of 650 pounds in Oklahoma City and then shipped to the Guymon, Oklahoma area. Total feeder cattle cost is simply the placement weight times the purchase price per pound. A death loss of one percent was assumed and the death loss charge per head was calculated as 1.5 percent of the cost of the feeder steer.

TABLE I
PRODUCTION ASSUMPTIONS FOR SIMULATION

Placement Weight	650 lbs.
Marketing Weight	1070 lbs.
Time on Feed	150 days
Total Gain	420 lbs.
Average Daily Gain	2.8 lbs.
Feed Conversion Rate	9.4

The second major cost in cattle feeding is the cost of the feed. Feed costs in this simulation were adjusted from average cost information provided by Livestock Business Advisory Services, Inc., on a weekly basis.

A yardage and handling cost used in the simulation was also obtained through Livestock Business Advisory Services, Inc. This cost, calculated per head for each feeding period, included charges for transportation of the feeder steer to the feedlot, commissions, feed handling and management, vet medicine and sick pen charges.

Commissions charged for futures transactions were calculated at $60.00 per round turn for the live cattle contract traded on the Chicago Mercantile Exchange. On a per head basis, the commission cost was charged at $1.61 per round turn.

Interest charges on feeding capital were computed on a per head basis for the 150 day feeding period using annual interest rates reported by the U.S.D.A. in their Great Plains Custom cattle feeding estimates of expenses and net margins. Interest charges were calculated by multiplying the current interest rate by the cost of the feeder steer and one half of the feed cost per head.

Margins were assumed to be $1250 per contract. The interest charges on margin funds for hedging were computed on a daily basis on the outstanding balance of borrowed funds during each feeding period and for each different hedging strategy.

Net returns per head generated by the cattle feeding activity in the simulation were calculated in the following manner:

$$NR = 10.7\ PLC_t - (6.5\ PFC_{t-k} + CF + YH + DL + IFC) - CE \quad MI \quad FPLH$$

where:

NR = net returns per head;

PLC_t = price finished cattle are marketed at per hundredweight on date t;

t = date fat cattle are marketed;

PFC_{t-k} = price of feeder cattle per hundredweight first day of feeding period;

k = length of feeding period (150 days);

CF = cost of feed per head during feeding period;

YH = yardage and handling cost during feeding period per head;

DL = death loss charge per head;

ICF = interest on feeding capital per head during feeder period;

CE = commission expense per head if hedging is executed;

MI = interest on margin funds if hedging is executed;

FPLH = futures profit or loss per head if hedging is executed.

Selected Hedging Strategies: Description and Simulation Results

Two basic types of hedging strategies have been identified, forward pricing and multiple hedging. Under a forward pricing strategy cattle are hedged only once during the feeding period and the hedge, once in place, is not lifted until the cattle are marketed. Multiple hedging strategies on the other hand involve placing and lifting hedges as often as required on the same cattle during the feeding period. Under either strategy only short positions are taken on live cattle futures contracts and the number of contracts shorted must never exceed the number of contracts necessary to cover the number of cattle presently on feed or marketing intentions.

Twenty-eight different strategies were examined in the simulation. Some strategies vary only slightly from each other or are distinct only because of the assumptions made about whether the cattle feeder is a continuous feeder or a selective feeder.

For the purpose of this study a continuous feeder was defined as a feeder who places cattle on feed on each of the 239 feeding periods examined regardless of whether it appears to be a profitable investment or not. A selective feeder was defined as a feeder who places cattle on feed only when it is believed to be profitable based on criteria to be explained later.

As a basis for comparison, a "no hedge" strategy was simulated under both the continuous feeding assumption and the selective feeding assumption.

A description of each strategy examined under the two different assumptions follows. Then, the results under both assumptions are summarized.

Continuous Feeding

Under the continuous feeding assumption, it was assumed that the cattle feeder places cattle on feed in each of the 239 feeding periods examined. This type of strategy might be followed particularly by a feeder who owns feedlot facilities and finds it to his advantage to continue feeding even when total costs are not covered, but at least some contribution is made to fixed costs. However, in this simulation it is assumed that no feedlot facilities are owned. In the case of a feeder who does not own his own feeding facilities all costs are variable and it would make little sense to place cattle on feed at the start of each period unless a positive return is expected. Therefore, under this asumption it was assumed that a positive return was expected each time.

Strategy I - No Hedge (NH). In the simulation, no hedging was performed under the first strategy. It was designed to allow complete exposure to price risk. Cattle are assumed to have been sold at the end of each feeding period at prevailing cash prices. The results of this strategy were used as a basis of comparison for the other strategies and as an illustration of the effects of complete exposure to price risk.

Strategy IA - Hedge with Stop Loss Provision (NH-SL). This strategy is identical to the previous strategy described with one addition. Some lenders who make adjustments for hedging in their loan requirements also place stipulations upon their clients hedging activities. One such stipulation presently in use is that should a feeder lose a specified percent of equity during the feeding period, the feeder must hedge the cattle at once and usually leave them hedged until they are marketed. This, in effect, is a stop loss on the cattle being fed. The idea is to protect the lender by not allowing the borrower to lose more than his equity, i.e. never lose any of the borrowed funds. Conceptually, this type of stipulation placed on the borrower will decrease the lender's risk of repayment problems or default.

In this simulation, one variation of the stop loss programs was combined with each strategy to analyze the effects of this stop loss strategy on risk faced by both the lender and the cattle feeder. Stop loss orders were assumed to be resting in the futures market in the proper amount whenever the feeder was unhedged at 10 percent under the estimated breakeven price, plus $1.25 per hundredweight. The $1.25 per hundredweight was the basis estimate used in this simulation for Guymon, Oklahoma and was derived from a study of historical basis relationships. No loans were made and no cattle were placed on feed if on the day cattle were to be placed the stop loss price was above the relevant futures price. This occurred in 27 out of 239 instances.

Strategy II - Hedge and Hold (H&H). Under this strategy hedges were placed the first day of each feeding period and not lifted until the cattle were marketed. Hedging was performed regardless of price or profit expectations.

Strategy IIA - Hedge and Hold with Stop Loss Provision (H&H-SL). This strategy included the addition of the stop loss provision to Strategy II. Therefore, the only difference in the results generated under Strategy II versus Strategy IIA occurred when the cattle were not placed on feed because the stop loss price was already greater than the relevant futures price.

Strategy III - Hedge and Hold Using Entry Rules Based on Moving Averages (H&H-MA). This strategy utilized a moving average technique to identify the proper time to place a forward price hedge. Hedging was performed only once during a feeding period or not at all. The moving averages used in this strategy (and in all other strategies presented in this simulation using moving averages) were optimized for the live cattle futures contract by Shields (1980). Those averages were a 1-3-5 day combination with the 5 day average being linearly weighted. A .09 cent penetration was also required. This strategy specified that cattle be hedged the first day of the feeding period if the last signal generated by the moving average technique was to sell, rather than waiting for the next sell signal.

Strategy IIIA - Hedge and Hold Using Entry Rules Based on Moving Averages With Stop Loss Provision (H&H-MA-SL). This strategy was identical to the previous strategy presented with one exception, the addition of the stop loss provision. A difference in the results between this strategy and Strategy III occurred when the stop loss price was reached prior to the time a sell signal was generated by the moving average technique or when no cattle were placed on feed because at the beginning of the feeding period the stop loss price was greater than the relevant futures price.

Strategy IV - Hedge and Hold at Breakeven or Better (H&H-BE). Under this strategy cattle remained unhedged unless the futures market offered the opportunity to hedge the cattle on feed at breakeven or better. It was assumed that if on the first day of the feeding period breakeven or better could be hedged, the cattle were hedged. However, if the cattle could not be hedged at a breakeven price or better on the first day, then an open order to sell at the estimated breakeven price was placed and the moment that price was achieved, the cattle were hedged. Of course, there was the possibility that the breakeven price would never be obtained during the feeding period. In that case, the cattle were simply sold at prevailing cash market prices at the end of the feeding period.

The breakeven price used in this simulation was calculated as follows:

$$BFP = ETPC + CE + EIM + BE$$

where,

BFP = the breakeven futures price;

ETPC = estimated total production cost per pound;

CE = commission expense per pound ($60.00/40,000);

EIM = estimated interest expense on margin funds per pound ($1,250.00 x current interest rate for 90 days/40,000);

BE = basis estimate ($0.0125).

Under this strategy, hedges were placed 216 times out of 329, i.e. about 90 percent of the time. Of those hedges placed, 137 were placed in the first month of the feeding period and 74 were placed on the first day.

Strategy IVA - Hedge and Hold at Breakeven or Better with Stop Loss Provision (H&H-BE-SL). This strategy adds the stop loss provision to Strategy IV. The results under this strategy versus Strategy IV differed whenever the stop loss provision was enforced prior to a breakeven price being reached or whenever the stop loss provision was enforced and no breakeven hedge could have been placed during the feeding period. In addition, the results differed when no cattle were placed on feed because the stop loss price was above the relevant futures price on the day the cattle were to be placed.

Strategy V - Hedge and Hold at $2.00/cwt. Profit or Better (H&H-$2). This strategy was identical to Strategy IV except that instead of attempting to hedge in a breakeven price, hedges were placed only if a breakeven price plus $2.00 per hundredweight could be obtained. If that amount of profit could not be hedged then the cattle were sold at the end of the feeding period at prevailing cash prices.

Under this strategy hedges were placed 173 times out of 239, i.e. about 72 percent of the time. Of those hedges placed, 90 were placed in the first month of the feeding period and 39 were placed on the first day.

Strategy VA - Hedge and Hold at $2.00/cwt. Profit or Better with Stop Loss Provision (H&H-$2-SL). Strategy VA was the same as the previous strategy with one exception, the addition of the stop loss provision. The results from this strategy differed from Strategy V whenever the stop loss was executed prior to a breakeven price plus $2.00 per hundredweight being reached or whenever the stop loss was executed and no hedge at a breakeven price plus $2.00 per hundredweight could have been placed during the feeding period. Also, the results differed when no cattle were placed on feed because the stop loss price was above the relevant futures price on the day the cattle were to be placed.

Strategy VI - Multiple Hedging Based on Moving Average Technique Honoring Previous Signals (MH-MA-PS). This strategy used the moving average technique described in Strategy III to produce objective buy and sell signals for multiple hedging. Hedges were placed and lifted according to signals generated by the moving average program during the entire feeding period. No hedges were placed or one or more hedges were placed on the same cattle during a feeding period. If a hedge was in place when the cattle were marketed, the futures position was offset at that time. Under this strategy it was assumed that hedges were placed the first day cattle were placed if the last previous signal given by the moving average technique was to sell. All commission charges and interest on margin funds were accounted for in this strategy as well as the others included in this simulation.

Strategy VIA Multiple Hedging Based on Moving Average Technique Honoring Previous Signals with Stop Loss Provision (MH-MA-PS-SL). This strategy added the stop loss provision to Strategy VI. When using a multiple hedging strategy, stop loss prices must be refigured every time a hedge is lifted. If profits as a result of the recently lifted hedge are taken in the futures market then a new lower stop loss price must be set that allows only the preset percent of equity to be lost. If losses are taken in the futures market, then a new higher stop loss price must be set to prevent total losses from being greater than desired. Results under strategy VIA differed from the results of Strategy VI whenever the stop loss provision was enforced.

In this simulation the stop loss prices were calculated and recalculated in the following manner:

$$SLFP = ETPC - .10\,(ETPC) + BE - FP + FL$$

where,

SLFP = the stop loss futures price;

ETPC = estimated total production cost per pound;

BE = basis estimate ($0.0125);

FP = futures profit per pound accounting for interest on margin funds and commissions;

FL = futures loss per pound accounting for interest on margin funds and commissions.

Strategy VII - Multiple Hedging Based on Moving Average Technique Honoring Only New Signals (MH-MA-NS). This strategy was exactly the same as Strategy VI except that when cattle were placed on feed, hedges were not placed the first day even if the last signal generated by the moving average technique was to sell unless that sell signal was generated the previous day, which would dictate that a short position in the market be taken on the following day.

Strategy VIIA - Multiple Hedging Based on Moving Average Technique Honoring only New Signals with Stop Loss Provision (MH-MA-NS-SL). This was identical to the previous strategy described with one exception which was the addition of the stop loss provision. Results under this strategy differed from the results of Strategy VII whenever the stop loss provision was executed.

Selective Feeding

Under the selective feeding assumption it was assumed that cattle were placed on feed only when profits were expected to be realized. Most studies that have examined hedging strategies for cattle feeding have assumed that cattle were fed on a regular basis regardless of the expected outcome. Of course, it is realized that some individuals are eternal optimists. However, it is doubtful that any experienced cattle feeder would expect to make a profit on every lot of cattle if they were mechanically placed on feed every Monday of the year.

In order for cattle feeders to make a reasonable estimate of whether or not a pen of cattle placed on feed will make money, the cost of the feeders and the feeding expenses need to be known or projected.

Then, they must make an estimate or forecast of what they believe their finished cattle will sell for to determine if it might be profitable to place cattle or not.

Forecasting of cattle prices several months in advance is not an easy task. Outlook information is readily available from many sources to assist a feeder in his forecasting. But, which forecast is to be used?

Just and Rausser (1981) compared the accuracy of four major commercial price forecasters and the U.S.D.A. against the price-forecasts developed from futures prices. They found that futures prices perform relatively better on average although not universally so. In the case of live cattle, the use of futures prices ranked fifth out of six. The U.S.D.A. forecast for cattle ranked sixth.

Even though futures prices are not forecasts, they are readily available on a daily basis at a low cost and they represent actual bids for cattle to be delivered at a future date. Of course, assumptions must be made concerning quality differences, location, basis, etc to estimate a localized price for a given cattle feeder. However, these adjustments may be readily made based on historical relationships for a specific area.

In this simulation, futures market prices, adjusted for the local basis, were used as the cattle feeder's price expectation. On the first day of each 239 feeding periods examined a projected net return was calculated using the relevant adjusted futures settlement price for that day. Expected total costs were calculated per head assuming no hedging was performed and then subtracted from the basis adjusted futures value per head to obtain a projected net return. All production assumptions and cost calculations presented earlier are identical to those used in obtaining the projections of net returns.

The net return projections are shown graphically in Figure 2. The average of the projected returns was a negative $18.25 per head and the standard deviation of the projections about the mean was equal to $34.84. The number of projected profitable feeding periods was 80 of 239 which is about 33 percent compared to 103 actual profitable feeding periods as simulated in this study under the "No Hedge" strategy, i.e. Strategy I under the continuous feeding assumption. Of the 80 projected profitable feeding periods, 32 actually turned out to be profitable on the basis of the results of Strategy I-(NH) under the continuous feeding assumption. Of the 80 projected profitable feeding periods, 32 actually turned out to be profitable on the basis of the results of Strategy I-(NH) under the continuous feeding assumption. The average projected return of the 80 projected profitable feeding periods was $21.79 per head. The standard deviation of the projected profitable returns about the mean was $12.66 and the range was from $0.19 to $49.58 per head.

All of the strategies examined under the selective feeding assumption were identical to the strategies examined under the continuous feeding assumption. The difference in overall results occur because cattle under the selective feeding assumption were placed on feed only when it appeared profitable based on the projected return. Since the projected return predicted profits on only 80 out of the 239 feeding periods, cattle were assumed to be placed only 80 times over the testing period.

In order to avoid repetition, the strategies will not be described again in this section, but will be numbered in the same manner as under the continuous feeding assumption for ease of comparison.

SUMMARY OF THE SIMULATION RESULTS

A summary of the results from each selected marketing strategy under both the continuous and selective feeding assumptions is presented in Tables II and III, respectively. The strategy yielding the highest average net return under over the time period examined was Strategy V-(H&H-$2) under the selective feeding assumption. Strategy V under the selective feeding assumption produced an average net return of $22.42 per head. Under Strategy V, hedges were placed only if a $2.00/cwt. profit or better could be obtained. Once the hedge was placed it was not lifted until the cattle were sold.

The strategy producing the highest average net return under the continuous feeding assumption was Strategy VII-(MH-MA-NS) with an average net return of $5.08 per head. Strategy VII involved the placing and lifting of hedges relative to signals generated by a moving average technique honoring only new signals versus a trading signal previously generated prior to the day before cattle were placed on feed. In all cases, the average net return produced by each strategy under the selective feeding assumption was higher than the average net return produced by the same strategy under the continuous feeding assumption.

The lowest net return of -$194.57 per head was experienced under the continuous feeding assumption. This compares with the lowest net return experienced under the selective feeding assumption of -$101.33 per head. Both of the lowest net returns under each feeding assumption were produced by both Strategy I-(NH) and Strategy V-(H&H-$2). The highest net return under both the continuous and selective feeding assumptions was $189.26 and was produced under both assumptions by both Strategy I-(NH) and Strategy IA-(NH-SL). Strategy I involved no hedging while Strategy IA involved no hedging unless projected losses at some point during the feeding period were equal to or greater than 10% of breakeven. Strategy I under the continuous feeding assumption was the only strategy to produce both the lowest and highest net return. In all cases, the lowest net return produced by each strategy was higher under the selective feeding assumption than the lowest net return produced by the same strategy under the continuous feeding assumption. At the same time, the highest net return produced by each strategy under the continuous feeding assumption was higher than the highest return produced by the same strategy under the selective feeding assumption with the exception of Strategies I-(NH), IA-(NH-SL), II-(H&H), and IIA-(H&H-SL).

The worst average net return of -$21.62 per head was produced by Strategy II-(H&H) under the continuous feeding assumption. Strategy II involved the placing of a hedge at the beginning of each feeding period and the lifting of that hedge as the cattle were marketed. This same strategy under the selective feeding assumption produced an average net return of $20.10 per head. The worst average net return of -$8.34 per head under the selective feeding assumption was produced by Strategy IA-(NH-SL).

The stop loss provision, when utilized, improved average net returns from the identical strategy without the stop loss provision in only two out of fourteen cases considering the seven basic strategies under both the continuous and selective feeding assumptions. In three cases the average net returns were identical while in the other nine cases the average net returns were worse. The stop loss provision limited the lowest net return experienced in nine of the cases while not limiting the highest net return experienced in any of the cases. The lowest net return produced by strategies with the stop loss provision was the same in three cases as the lowest net return produced by the same strategy without the stop loss provision while in the remaining two cases the lowest net return produced by strategies with the stop loss provision was worse than that produced by the same strategy without the stop loss provision.

The strategy producing a distribution of returns about the average return for that strategy resulting in the largest standard deviation of net returns for any strategy under both the continuous and selective feeding assumptions was Strategy IA-(NH-SL). The strategies with the lowest standard deviation of net returns were Strategy IV-(H&H-BE) under the continuous feeding assumption and Strategy IV and Strategy IVA-(H&H-BE-SL) under the selective feeding assumption. In all cases, the standard deviation of net returns for a strategy under the selective feeding assumption was less than the standard deviation for the same strategy under the continuous feeding assumption. The stop loss provision reduced the standard deviation of net returns for identical strategies without the stop loss provision in only two out of fourteen cases considering both the continuous and selective feeding assumptions. In three cases the stop loss provision did not alter the standard deviation of net returns while in the remaining nine cases the stop loss provision resulted in a higher standard deviation of net returns.

Concerning the number of profitable feeding periods in relation to the number of feeding periods, Strategy V-(H&H-$2), had the highest percent of profitable feeding periods of all strategies under both the continuous and selective feeding assumptions. Under the continuous feeding assumption, Strategy V was profitable 67% of the time while under the selective feeding assumption, Strategy V was profitable 87% of the time. Strategy IA-(NH-SL), under both the continuous and selective feeding assumptions, produced the smallest percentage of profitable feeding periods at 30% under the continuous feeding assumption, and 35% under the selective feeding assumption. In all cases, with the exception of Strategy I-(NH), the percent of profitable feeding periods was higher for each respective strategy under the selective feeding assumption versus the continuous feeding assumption.

The stop loss provision resulted in no change in the percent of profitable feeding periods in five cases out of fourteen considering the seven basic strategies under both the continuous and selective feeding assumptions. In six cases, the stop loss provision resulted in a lower percent of profitable feeding periods for the same strategy without the stop loss provision while in the remaining three cases the stop loss provision improved the percent of profitable feeding periods.

Considering only those strategies without the stop loss provision and under the continuous feeding assumption, Strategy I-(NH) produced a better average net return than both Strategy II-(H&H) and Strategy III-(H&H-MA). However, all of the other hedging strategies without the stop loss provision under the continuous feeding assumption produced a better average net return than Strategy I. Under the selective feeding assumption, Strategy I produced the worst and only negative average net return of the strategies without the stop loss provision. Under both the continuous and selective feeding assumptions, Strategy I produced the highest net return for a single feeding period, produced the highest standard deviation of net returns, and tied with Strategy V-(H&H-$2) for the lowest net return generated for a single feeding period considering only those strategies without the stop loss provision.

COMPARATIVE RISK ANALYSIS OF SELECTED MARKETING STRATEGIES

The concept of risk has been defined and measured in numerous ways over time. Risk, like many other words, often means something different to one person than it does to another. Various types of risk exist, and so there should be differences in definitions as well as measurements among the various types of risk. However, much of the controversy on how to measure risk is usually due to a difference in interpretation of the concept.

A general definition of risk intuitively should include the possibility of a loss. If there is no chance of losing something then there is certainly no risk. Considering risk and the cattle feeding business, the feeder and the lender are concerned about the risk of losing money. Therefore, one might consider the definition of risk as "exposure to loss". However; the study of economics tells us that investors should not only be concerned about losing money, but also about not making as much money as could have been made with the same investment in the next best alternative. Therefore, in this study, the general definition of risk will be "exposure to an economic loss". In the simulation, feeding periods were considered unprofitable when accounting profits were less than what could have been made if the next best alternative investment would have yielded an amount equal to the prevailing interest rate being charged the feeder.

Regardless of the definition of risk used in different studies, many authors have utilized the mean-variance approach in measuring the riskiness of an activity. This approach measures the variability of outcomes about the expected or average outcome. If two investments have the same average return, but one of the investments has returns that are more variable than the other, then it is considered to be more risky. This line of reasoning implies that "variability" is synonymous with "risk". If this were the case, then this study could have ended with the results presented above. Standard deviations for each marketing strategy could have been compared and relative measurements of risk determined.

However, measurements of variability do not directly consider the chance of experiencing a loss. Probability distributions can be obtained using these measurements and the chance of a loss under each strategy compared, but to do so, one must assume that all of the distributions are normally distributed or at least symmetrical. This is not a satisfactory assumption.

Several hedging strategies by their design skew the distribution of returns. For example, most multiple hedging strategies produce a positively skewed distribution when working properly. Net returns in the simulation from eight of the fourteen marketing strategies under the continuous feeding assumption were found to be skewed at the .05 significance level.

Another major fault of the mean-variance approach is that the calculations required treat all extreme returns equally. If the average return of a series of returns is equal to $2.00, a return of $100.00 has the same impact as a return of negative $96.00 in the mean-variance approach. A reduction in either the $100.00 profit or the $96.00 loss will reduce the variability of returns and implicitly the risk.

Since the commonly used measurements of variance and standard deviation do not consider skewness and because equally extreme profits and losses are treated with the same disrespect another measurement of risk was used in this study; semi-variance.

The Semi-Variance Method of Risk Measurement

In his book on portfolio selection, Markowitz (1959) describes the use of semi-variance to measure risk. He compares the use of the semi-variance method to the variance method on the basis of cost, convenience, familiarity, and desirability, then states, "Variance is superior with respect to cost, convenience, and familiarity." Markowitz found that the semi-variance approach however tended to produce better portfolios than those based on the variance approach. Analyses based on variance seek to eliminate all extremes while analyses based on semi-variance of the mean concentrate on reducing losses.

For the readers convenience the following is an excerpt from Markowitz's book explaining semi-variance:

By definition,

$$\bar{r}^- = \begin{cases} r & \text{if } r \text{ is equal to or less than zero,} \\ o & \text{if } r \text{ is greater than zero.} \end{cases}$$

For example,

if r equals,	then r^- equals:
0.1	0
0.5	0
-0.4	-0.4
0	0
0.1	-0.1

S_0 is defined to be the mean value of $(r^-)^2$. If r is a random variable or a future event subject to probability beliefs, then

$$S_0 = \text{expt } (r^-)^2.$$

If r is the past return on a portfolio, S_0 is the average $(r^-)^2$. If r takes on the values .1, .5, -.4, 0, and -.1, as in the above example,

$$S_0 = \frac{(-.4)^2 + (-.1)^2}{5} = \frac{.17}{5} = .034.$$

By definition,

$$(r-b)^- = \begin{cases} (r-b) & \text{if } (r-b) \text{ is less than or equal to zero;} \\ 0 & \text{if } (r-b) \text{ is greater than zero.} \end{cases}$$

For example, with b = .2,

if r equals:	then $(r - .2)^-$ equals
0.1	-0.1
0.5	0
-0.4	0.6
0	-0.2
-0.1	-0.3

S_b is the mean value of $(r - b)^{-2}$. If r takes on the values of the above example, then

$$S_b = \frac{(-.1)^2 + (-.6)^2 + (-.2)^2 + (-.3)^2}{5} = \frac{.50}{5} = .10$$

If b = 0, S_b is the same as S_0 defined previously.

S_E is the mean value of $(r - E)^{-2}$, where E is the mean value of r.

In the example above, E = .02; hence

$$S_E = S_{.02} = \frac{(-.42)^2 + (-.12)^2}{5} = \frac{.1908}{5} = .038$$

As can be seen from the above excerpt, semi-variance can be measured from any specified point. If one wished to compare two investments on the basis of the risk of loss, S_0 would be used. If one wished to compare two investments with equal average returns on the risk that the actual return will be something less than average, one would use S_E. And, if one wished to compare the relative risk between two investments of experiencing a return less than some level "b", one would use S_b.

In the examples given by Markowitz, "r" is the past return on a portfolio. In this study "r" will be a past return from cattle feeding. "b" is simply any specified point from which one might wish to measure risk. If "b" equals zero, then S_b is the same as S_o. If "b" equals the mean value of "r", then S_b equals S_E. By being able to specify the point from which risk will be measured, the risk of receiving returns lower than some level "b" may be derived without having to worry about the shape of the distribution of returns. Therefore, as one's willingness and ability to bear risk changes, the level of "b" from which risk is measured may be altered.

The semi-variance method is not just the probability of an outcome being less than a specified point. If the probability of an outcome being less than a specified point is desired, then a distribution of returns derived from past observations could be assembled and, assuming this distribution to be representative of the particular activity, one could simply count the number of observations below the specified point and divide by the total observations to obtain the probability of an outcome below the specified point. Semi-variance does consider the frequency of an event by dividing by the total number of observations rather than just the observations below a specified point, however; semi-variance also weights extreme values below the specified point heavier than those values closer to the specified point by the squaring operation performed during the calculations. Whether this particular weighting is appropriate or not is debatable. However, it seems logical that some type of weighting should be used because a small loss is preferred to a large loss.

Any measurement of risk should take into consideration both the frequency and the magnitude of potential losses. The semi-variance approach of measuring risk fulfills the above requirement.

The Semi-Variance Approach Applied to the Selected Marketing Strategies

Risk of loan loss is a function of many factors including the purpose of a loan, collateral secured, borrowers financial position, managerial ability, and moral responsibility of the borrower to repay. However, it would be difficult, if not impossible to quantitatively identify all of the dimensions involved with respect to a particular loan. Therefore, this study will not attempt to determine what interest rate or margin requirements should be placed on different loans. What is attempted is to provide lenders with an idea of the risk differentiation among loans when their borrowers hedge versus when they do not hedge. This will be done by identifying the difference in margin requirements necessary to equalize lender risk given each of the selected marketing strategies.

It is assumed that margin requirements or the amount of equity a borrower is required to invest is a function of the total risk faced by the cattle feeder as perceived by the lender. Production risk and marketing risk were described earlier as the two types of risk that make up a feeder's total risk. If both of these risks were not present, the outcome of a feeding operation would be known in advance and therefore no margin would need to be required as a stipulation for making a loan. It is possible that interest rates for this type of investment would also fall. However, that assumption is not made here. Therefore, complete adjustment to differences in lender risk can be made with adjustments in margin requirements.

The semi-variance method "S_b" of measuring relative risk has been applied to the results generated in the simulation model for each marketing strategy at various levels of "b". Instead of "b" representing a single number, as in the example given earlier, "b" is equal to a given negative percent of total expected costs for each feeding period. The results of these calculations render the relative risk of receiving a loss greater than the specified percentage level.

Since the returns generated by the simulation model only reflect differences in returns due to price risk the semi-variance method was applied under two assumptions. The first is where price risk and production risk are equal. The second is where production risk is one half price risk, i.e. total risk is two-thirds price risk and one-third production risk. The square root of the results of these calculations or semi-standard deviations are shown in Tables IV-VII. Where no numbers are shown, the relative risk was too small to be measured. In all of the strategies examined over the stated time period no measurements of relative risk were produced by the semi-variance method beyond 24 percent.

When a lender specifies the margin requirements for a loan, the amount of risk on that loan has been determined. Of course, the risk a lender is actually bearing is not always equalized between borrowers by adjusting margin requirements, but for the moment let us assume this is the case and that should losses amount to more than the equity requirement, loan loss due either to repayment problems or default on all or part of the loan occurs.

By making the above assumptions, comparisons can be made of the measurements of relative risk provided by the semi-variance method at various levels of equity requirements. Once the decision on equity requirement has been made for a cattle feeder, assuming no hedging will be performed, one can compare the numerical value generated by the semi-variance method at the required level of equity to the numerical values generated from results using alternative marketing strategies, the risk differential in terms of equity requirements can be determined. Since the tables only show the amount of relative risk at one percent intervals, equal values may not be found in the tables. In that case one simply determines the percent levels of the marketing strategy to be compared between which the numerical value of relative risk for the required equity margin falls and accept the higher percent level. This would assure that no more risk than is desired will be accepted. For example, utilizing Table IV, if the margin requirement determined for a particular borrower following the "no hedge" strategy (Strategy I) under the continuous feeding assumption was determined to be 20 percent, and price risk was assumed equal to production risk, then if the borrower was to follow Strategy III-(H&H-MA) under the continuous feeding assumption instead, lender risk would be no greater than originally desired percent level of equity was required. This allows the lender to loan more money without more risk, all other things equal.

In the above example, the risk differential between the two strategies examined was not substantial, which indicates that with the assumed margin requirement, and a feeder following that particular hedging strategy, lender risk is not significantly reduced. However, other hedging strategies do significantly reduce lender risk. If in the above example the initial equity requirement had been set at 25 percent, at which there was no measurable risk, and the feeder followed Strategy IIIA-(H&H-MA-SL) under the continuous feeding assumption, equity requirements could be reduced to 15 percent without increasing lender risk, all other things equal.

Implications of Results for Lenders

The decision of how much equity should be required in an investment financed by a lender must be left up to the person who bears the responsibility for the decision. It was not the purpose of this study, to make any decisions, but to provide information for decision makers.

Presently some lenders are differentiating equity requirements solely on the basis of whether a borrower hedges or not. For example, a lending policy may state that if a cattle feeder hedges, a 15 percent equity margin is required. The difference in equity requirements represent the lender's perceived difference in risk due to hedging.

It is doubtful whether any lending policy would be quite as simple as the one in the above example, but it serves the purpose of illustration. Certain requirements such as the stop loss provision mention earlier, might be made of a borrower who hedges as a condition for granting a lower equity loan. Also, certain types of hedging might not qualify for lower equity loans or equity requirements might be lowered, but not as much. This is probably a good idea because as the results show, not all hedging strategies are created equal.

While the relative risk to the lender among marketing strategies employed by a borrower varies depending on the level of equity requirements, some general conclusions regarding the difference in lender risk among the selected marketing strategies examined may be made. For example, the no hedge strategy was typically found to be the most risky of all for the lender. At the same time, some of the hedging strategies reduce lender risk so slightly at some levels that no reduction in equity requirement is warranted. A lender needs to be aware of those strategies. Even if the average return under one of the strategies looks especially appealing, the risk of loss to the lender may be the same as when the borrower performs no hedging at all.

When equity requirements can be lowered due to a reduction in risk, a lender is able to increase the size of a loan with no additional risk relative to the previous acceptable level of risk, all other things equal. All other things equal in this case refers to the same financial ability and moral responsibility to repay a larger loan as compared to a smaller loan. It could be possible that if an individual had $25,000 to invest and the initial equity requirement was set at 25 percent, any reduction in lender risk due to hedging might be offset by other considerations if the size of loan is increased. Suppose the borrower indicates that he/she will follow a hedging strategy that reduces lender risk due to hedging enough to warrant a reduction in equity requirements to 15 percent. Then, the borrower wants to use the $25,000 to acquire a loan of $140,000 instead of $75,000. If all other things are equal, the borrower is able to use more financial leverage and the lender has no more risk while making a larger loan. However, some cases probably exist where the borrower is worth a $75,000 loan, but isn't worth a $140,000 loan because other things are not equal. This type of increase in loan size must be examined closely. If the loan was to be increased from $75,000 to $85,000 and the original size investment maintained, it is highly probable an increase in loan size of this amount could be made without additional risk.

During this study it was assumed that loan loss occurs if an amount greater than the equity requirement was lost. This is not usually the case. Loan loss may not occur even if all of the cattle pledged as collateral are lost because of other financial resources a borrower may possess. Therefore, when an equity level is set, the true critical level where loan loss might occur is probably something else. It might be determined that if half the expected costs are not covered by revenues from the sale of cattle, repayment problems or default could occur. If this is the case, then the 50 percent level is where the measurement of risk for that loan should be made regardless of the equity level required.

Implications of Results for Cattle Feeders

The amount of risk a cattle feeder is willing to bear is related to the feeder's abilities and present financial condition. Therefore, the amount of risk one feeder is willing to bear is probably different from that of another feeder at the same point in time. Also, the amount of risk a feeder is willing to bear today may not be the same as that the same feeder is willing to bear at some point in the future.

The results presented in Tables IV - VII and the procedure utilized to obtain the results may be used by a cattle feeder in the determination of a proper marketing strategy to be followed, given his/her present financial condition, abilities, and attitude toward risk. Assuming that aversion to risk increases as one's financial condition worsens, a feeder may select strategies of equal or lower risk at lower percent levels. Critical percent levels may be determined by a cattle feeder below which if losses occur, financial problems will probably ensue. Then the risk at that percent level could be minimized. However, use of these results only, without consideration of expected returns, would be foolish. If a critical loss level were set at 10 percent of total expected costs (breakeven) and a particular strategy always returned a loss, but never below the critical level, the risk at that level would be nil; however, one would never make any money.

The results of this study indicate that a marketing strategy that might be best for a feeder may not be one that results in less lender risk. Therefore, a particular type of hedging strategy or stipulation on which a lender would be willing to lend more money may lead to less than favorable results for a cattle feeder. An example is the stop loss provision used in the simulation. In many cases this stipulation forces a feeder to lock in a loss that otherwise would not have occurred if the original marketing strategy had been allowed to run its full course. In the simulation, the stop loss provision increased average returns of only two basic strategies and decreased the average returns of nine basic strategies. Identical returns resulted in the other three basic strategies.

Should cattle feeders use the results shown in Tables IV - VII, it is recommended the results be used only in conjunction with other statistics, such as those presented earlier in Tables II and III, and the statistics presented next in Tables VIII and IX.

The semi-variance methods of "S_E" and "S_O" may also be used by cattle feeders (as well as their lenders). Results of these methods, calculated with the returns from the simulation model, are shown in Tables VIII and IX. The results shown consider price risk only and so are directly comparable to Tables II and III. When comparison is made, differences in results can be identified. For example, under the continuous feeding assumption, Strategy IV-(H&H-BE) has the lowest standard deviation while Strategy II-(H&H) has the lowest semi-standard deviation from average return. The semi-standard deviations from zero shown in Tables VIII and IX indicate the relative risk of each strategy to produce an economic loss. These measurements when utilized along with others previously presented provide additional information for decision analysis by the feeders and their lender.

TABLE II

SUMMARY OF SIMULATION RESULTS FOR EACH SELECTED STRATEGY UNDER THE CONTINUOUS FEEDING ASSUMPTION

Marketing Strategy	Average Net Return Per Head	Lowest Net Return Experienced	Highest Net Return Experienced	Standard Deviation Of Net Returns	Number of Feeding Periods	Percent Profitable Feeding Periods
I -(NH)	- 2.03	-194.57	189.26	63.47	239	43
IA -(NH-SL)	-18.21	-118.39	189.26	68.47	212	30
II -(H&H)	-21.62	-112.40	71.93	40.80	239	32
IIA -(H&H-SL)	-13.90	- 89.88	71.93	36.04	212	36
III -(H&H-MA)	-12.66	-135.14	157.85	50.23	239	41
IIIA-(H&H-MA-SL)	- 7.75	-112.89	157.85	45.83	212	43
IV -(H&H-BE)	- 0.51	-122.09	76.10	33.05	239	53
IVA -(H&H-BE-SL)	- 7.58	-112.89	76.10	40.63	212	52
V -(H&H-$2)	4.52	-194.57	97.98	43.13	239	67
VA -(H&H-$2-SL)	- 6.31	-118.39	97.98	49.06	212	51
VI -(MH-MA-PS)	4.34	-182.65	157.97	54.95	239	51
VIA -(MH-MA-PS-SL)	0.67	-117.92	157.97	59.74	212	52
VII -(MH-MA-NS-)	5.08	-182.65	157.97	54.33	239	51
VIIA-(MH-MA-NS-SL)	- 0.73	-117.92	157.97	59.68	212	49

TABLE III

SUMMARY OF SIMULATION RESULTS FOR EACH SELECTED STRATEGY UNDER THE SELECTIVE FEEDING ASSUMPTION

Marketing Strategy	Average Net Return Per Head	Lowest Net Return Experienced	Highest Net Return Experienced	Standard Deviation Of Net Returns	Number of Feeding Periods	Percent Profitable Feeding Periods
I -(NH)	- 0.43	-101.33	189.26	53.02	80	40
IA -(NH-SL)	- 8.34	- 78.62	189.26	55.76	80	35
II -(H&H)	20.10	- 41.61	71.93	23.45	80	81
IIA -(H&H-SL)	-13.90	- 41.61	71.93	23.45	80	81
III -(H&H-MA)	-12.66	- 50.64	75.56	24.81	80	78
IIIA-(H&H-MA-SL)	- 7.75	- 50.64	75.56	24.81	80	78
IV -(H&H-BE)	- 0.51	- 51.45	68.72	22.07	80	81
IVA -(H&H-BE-SL)	- 7.58	- 51.45	68.72	22.07	80	81
V -(H&H-$2)	4.52	-101.33	68.72	24.23	80	87
VA -(H&H-$2-SL)	- 6.31	- 70.39	68.72	25.77	80	85
VI -(MH-MA-PS)	4.34	- 71.10	133.22	39.19	80	68
VIA -(MH-MA-PS-SL)	0.67	- 94.84	133.22	41.50	80	68
VII -(MH-MA--NS-)	5.08	- 71.10	133.22	39.20	80	61
VIIA-(MH-MA-NS-SL)	- 0.73	- 94.84	133.22	41.39	80	61

TABLE IV

RESULTS OF THE SEMI-VARIANCE METHOD APPLIED TO THE SELECTED MARKETING STRATEGIES AT VARIOUS LEVELS OF MARGIN REQUIREMENTS, EXPRESSED AS A PERCENT OF TOTAL EXPECTED COSTS FOR EACH FEEDING PERIOD, UNDER THE CONTINUOUS FEEDING ASSUMPTION WHEN PRICE RISK EQUALS PRODUCTION RISK

Marketing Strategy	% Margin Requirement											
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%
I -(NH)	53.32	48.30	43.58	39.15	35.03	31.27	27.88	24.77	21.93	19.39	17.15	15.20
IA -(NH-SL)	57.94	52.30	46.88	41.67	36.72	32.06	27.74	23.75	20.12	16.96	14.28	12.06
II -(H&H)	53.85	48.45	43.47	38.60	34.17	30.13	26.49	23.18	20.18	17.48	15.08	12.96
IIA -(H&H-SL)	53.80	48.40	43.21	36.97	33.51	29.70	26.11	22.71	19.47	17.01	14.42	12.35
III -(H&H-MA)	53.76	48.47	43.47	38.77	34.39	30.38	26.76	23.51	20.56	17.89	15.49	13.37
IIIA-(H&H-MA-SL)	48.09	42.96	38.13	33.60	29.42	25.64	22.29	19.36	16.78	14.53	12.61	10.99
IV -(H&H-BE)	44.19	39.75	35.65	31.87	28.39	25.23	22.37	19.76	17.37	15.25	13.41	11.86
IVA -(H&H-BE-SL)	48.49	43.67	39.11	34.79	30.73	26.96	23.50	20.32	17.43	14.91	12.79	11.08
V -(H&H-$2)	48.97	44.57	40.42	36.51	32.88	29.54	26.49	23.68	21.09	18.76	16.68	14.85
VA -(H&H-$2-SL)	51.98	46.96	42.15	37.53	33.16	29.05	25.26	21.75	18.57	15.77	13.40	11.43
VI -(MH-MA-PS)	48.98	44.04	39.39	35.06	31.08	27.48	24.27	21.38	18.81	16.55	14.56	12.80
VIA -(MH-MA-PS-SL)	49.98	45.04	40.06	35.45	31.12	27.08	23.39	19.99	16.89	14.34	11.79	9.77
VII -(MH-MA-NS-)	48.35	43.46	38.88	34.61	30.70	27.17	24.01	21.18	18.66	16.46	14.52	12.79
VIIA-(MH-MA-NS-SL)	49.92	44.81	39.95	35.33	30.98	26.96	23.27	19.90	16.83	14.17	11.78	9.76

TABLE IV (continued)

Marketing Strategy	% Margin Requirement											
	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%
I -(NH)	13.44	11.79	10.23	8.75	7.39	6.11	4.88	3.74	2.77	1.90	1.04	0.28
IA -(NH-SL)	10.20	8.64	7.33	6.22	5.23	.	.	.	.	.	.	.
II -(H&H)	11.08	9.36	7.83	6.46	5.29	4.32	.	.	.	.	.	.
IIA -(H&H-SL)	10.43	8.88	7.62	5.95	4.83	.	.	.	.	.	.	.
III -(H&H-MA)	11.46	9.76	8.21	6.82	5.57	4.50	3.51	2.65	.	.	.	.
IIIA-(H&H-MA-SL)	9.59	8.35	.	.	.	.	.	.	.	.	.	.
IV -(H&H-BE)	10.50	9.26	8.07	6.94	5.89	4.89	3.93	3.04	2.28	1.58	0.90	0.28
IVA -(H&H-BE-SL)	9.63	8.36	7.23	.	.	.	.	.	.	.	.	.
V -(H&H-$2)	13.17	11.61	10.10	8.67	7.34	6.08	4.87	3.74	2.77	1.90	1.04	0.28
VA -(H&H-$2-SL)	9.80	8.42	7.25	6.19	.	.	.	.	.	.	.	.
VI -(MH-MA-PS)	11.20	9.72	8.35	7.11	5.98	4.93	3.01	2.96	2.12	1.37	.	.
VIA -(MH-MA-PS-SL)	8.10	6.78	5.77	4.90	4.15	3.47	2.79	2.17	1.70	1.26	.	.
VII -(MH-MA-NS-)	11.20	9.72	8.35	7.11	5.98	4.93	3.91	2.96	2.12	1.37	.	.
VIIA-(MH-MA-NS-SL)	8.10	6.78	5.77	4.90	4.15	3.47	2.79	2.17	1.70	1.26	.	.

TABLE V

RESULTS OF THE SEMI-VARIANCE METHOD APPLIED TO THE SELECTED MARKETING STRATEGIES AT VARIOUS LEVELS OF MARGIN REQUIREMENTS, EXPRESSED AS A PERCENT OF TOTAL EXPECTED COSTS FOR EACH FEEDING PERIOD, UNDER THE SELECTIVE FEEDING ASSUMPTION WHEN PRICE RISK EQUALS PRODUCTION RISK

Marketing Strategy	% Margin Requirement											
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%
I -(NH)	22.04	19.52	17.17	15.00	13.05	11.34	9.91	8.65	7.57	6.69	5.95	5.29
IA -(NH-SL)	24.25	22.48	18.85	16.35	14.03	11.92	10.03	8.36	6.91	5.76	4.84	4.10
II -(H&H)	16.13	14.17	12.37	10.72	9.27	8.03	.	.	.	.	.	.
IIA -(H&H-SL)	16.13	14.17	12.37	10.72	9.27	8.03	.	.	.	.	.	.
III -(H&H-MA)	16.19	14.22	12.41	10.76	9.32	8.07	7.02	6.12	.	.	.	.
IIIA-(H&H-MA-SL)	16.19	14.22	12.41	10.76	9.32	8.04	7.02	6.12	.	.	.	.
IV -(H&H-BE)	16.08	14.16	12.39	10.77	9.33	8.07	7.02	6.12	.	.	.	.
IVA -(H&H-BE-SL)	16.08	14.16	12.39	10.77	9.33	8.07	7.02	6.12	.	.	.	.
V -(H&H-$2)	17.04	15.19	13.50	11.93	10.54	9.32	8.28	7.37	6.57	5.89	5.29	4.74
VA -(H&H-$2-SL)	17.04	15.06	13.20	11.46	9.89	8.49	7.29	6.25	5.39	4.74	.	.
VI -(MH-MA-PS)	17.97	15.77	13.73	11.88	10.26	8.90	7.78	6.80	5.94	5.20	4.56	3.98
VIA -(MH-MA-PS-SL)	19.15	16.93	14.86	12.94	11.21	9.68	8.38	7.23	6.22	5.36	4.63	4.00
VII -(MH-MA-NS-)	18.07	15.85	13.81	11.96	10.34	8.97	7.84	6.84	5.95	5.20	4.56	3.98
VIIA-(MH-MA-NS-SL)	19.24	16.99	14.91	12.99	11.26	9.73	8.43	7.27	6.23	5.37	4.63	4.00

TABLE V (continued)

Marketing Strategy	% Margin Requirement											
	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%
I -(NH)	4.68	4.08	3.38	2.89	2.30	1.71	1.15	0.65	0.22	.	.	.
IA -(NH-SL)	3.51	2.98	2.49	2.04	.	.	.	.	.	.	.	.
II -(H&H)	.	.	.	.	.	.	.	.	.	.	.	.
IIA -(H&H-SL)	.	.	.	.	.	.	.	.	.	.	.	.
III -(H&H-MA)	.	.	.	.	.	.	.	.	.	.	.	.
IIIA-(H&H-MA-SL)	.	.	.	.	.	.	.	.	.	.	.	.
IV -(H&H-BE)	.	.	.	.	.	.	.	.	.	.	.	.
IVA -(H&H-BE-SL)	.	.	.	.	.	.	.	.	.	.	.	.
V -(H&H-$2)	4.21	3.68	3.16	2.64	2.13	1.62	1.12	0.65	0.22	.	.	.
VA -(H&H-$2-SL)	.	.	.	.	.	.	.	.	.	.	.	.
VI -(MH-MA-PS)	3.44	2.94	2.48	.	.	.	.	.	.	.	.	.
VIA -(MH-MA-PS-SL)	3.44	2.94	2.48	.	.	.	.	.	.	.	.	.
VII -(MH-MA-NS-)	3.44	2.94	2.48	.	.	.	.	.	.	.	.	.
VIIA-(MH-MA-NS-SL)	3.44	2.94	2.48	.	.	.	.	.	.	.	.	.

TABLE VI

RESULTS OF THE SEMI-VARIANCE METHOD APPLIED TO THE SELECTED MARKETING STRATEGIES AT VARIOUS LEVELS OF MARGIN REQUIREMENTS, EXPRESSED AS A PERCENT OF TOTAL EXPECTED COSTS FOR EACH FEEDING PERIOD, UNDER THE CONTINUOUS FEEDING ASSUMPTION WHEN PRICE RISK EQUALS PRODUCTION RISK

Marketing Strategy	% Margin Requirement											
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%
I -(NH)	46.17	41.83	37.74	33.90	30.34	27.08	24.14	21.45	18.99	16.79	14.85	13.16
IA -(NH-SL)	51.45	46.40	41.51	36.78	32.27	28.00	23.98	20.26	16.87	13.91	11.41	9.36
II -(H&H)	46.79	42.01	37.50	33.27	29.34	25.76	22.52	19.60	16.94	14.54	12.41	10.50
IIA -(H&H-SL)	46.75	42.02	36.98	32.70	28.04	25.01	21.67	19.04	16.11	14.12	11.99	10.12
III -(H&H-MA)	46.69	42.03	37.62	33.47	29.60	26.04	22.84	19.98	17.40	15.04	12.91	11.00
IIIA-(H&H-MA-SL)	40.03	35.53	31.29	27.31	23.64	20.32	17.40	14.83	12.71	10.83	9.25	7.94
IV -(H&H-BE)	35.25	31.58	28.22	25.14	22.34	19.00	17.59	15.49	13.47	11.07	10.31	9.11
IVA -(H&H-BE-SL)	49.50	36.39	32.48	28.76	25.25	21.96	18.92	15.11	13.55	11.33	9.50	8.06
V -(H&H-$2)	41.08	37.46	34.04	30.82	27.82	25.00	22.53	20.18	18.02	16.06	14.31	12.75
VA -(H&H-$2-SL)	44.62	46.26	36.08	32.02	28.15	24.49	21.03	17.88	14.98	12.44	10.29	8.54
VI -(MH-MA-PS)	40.09	36.83	32.82	20.09	25.67	22.50	19.87	17.43	15.20	12.42	11.77	10.31
VIA -(MH-MA-PS-SL)	23.29	39.01	34.69	30.70	26.25	23.45	20.26	17.31	15.83	12.42	16.21	8.46
VII -(MH-MA-NS-)	40.34	36.13	32.20	28.54	25.21	22.21	19.55	17.18	15.10	13.30	11.72	10.29
VIIA-(MH-MA-NS-SL)	43.23	38.81	34.60	30.69	26.83	23.35	20.15	17.23	14.58	12.27	18.20	.

TABLE VI (continued)

Marketing Strategy	% Margin Requirement											
	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%
I -(NH)	11.64	10.21	8.86	7.58	6.40	5.29	4.22	3.24	2.40	1.64	0.90	0.24
IA -(NH-SL)	7.68	6.32	5.26	4.41	3.70	.	.	.	.	.	.	.
II -(H&H)	8.79	7.27	5.93	4.75	3.78	3.06	.	.	.	.	.	.
IIA -(H&H-SL)	8.20	6.81	5.41	4.42	3.29	.	.	.	.	.	.	.
III -(H&H-MA)	9.28	7.78	6.43	5.23	4.18	3.30	2.53	1.88	.	.	.	.
IIIA-(H&H-MA-SL)	6.85	5.91	.	.	.	.	.	.	.	.	.	.
IV -(H&H-BE)	8.07	7.14	6.25	5.39	4.58	3.82	3.08	2.40	1.81	1.27	0.73	0.24
IVA -(H&H-BE-SL)	6.90	5.93	5.12	.	.	.	.	.	.	.	.	.
V -(H&H-$2)	11.33	10.00	8.71	7.49	6.34	5.26	4.21	3.24	2.40	1.64	0.90	0.24
VA -(H&H-$2-SL)	7.13	6.02	5.14	4.38	.	.	.	.	.	.	.	.
VI -(MH-MA-PS)	8.96	7.72	6.59	5.60	4.70	3.87	3.18	2.29	1.60	0.99	.	.
VIA -(MH-MA-PS-SL)	7.01	5.87	5.00	4.25	3.60	3.00	2.41	1.88	1.47	1.09	.	.
VII -(MH-MA-NS-)	8.96	7.72	6.59	5.60	4.70	3.87	3.18	2.29	1.60	0.99	.	.
VIIA-(MH-MA-NS-SL)	7.01	5.87	5.00	4.25	3.60	3.00	2.41	1.88	1.47	1.09	.	.

TABLE VII

RESULTS OF THE SEMI-VARIANCE METHOD APPLIED TO THE SELECTED MARKETING STRATEGIES AT VARIOUS LEVELS OF MARGIN REQUIREMENTS, EXPRESSED AS A PERCENT OF TOTAL EXPECTED COSTS FOR EACH FEEDING PERIOD, UNDER THE SELECTIVE FEEDING ASSUMPTION WHEN PRICE RISK EQUALS PRODUCTION RISK

Marketing Strategy	% Margin Requirement											
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%
I -(NH)	19.09	16.90	14.87	12.99	11.30	9.82	8.58	7.49	6.56	5.79	5.15	4.59
IA -(NH-SL)	21.60	19.14	16.78	14.53	12.42	10.48	8.72	7.15	5.78	4.68	3.82	3.13
II -(H&H)	11.78	10.27	8.90	7.66	6.58	5.68	.	.	.	.	.	.
IIA -(H&H-SL)	11.78	10.27	8.90	7.66	6.58	5.68	.	.	.	.	.	.
III -(H&H-MA)	11.86	10.34	8.96	7.72	6.65	5.74	4.98	4.33	.	.	.	.
IIIA-(H&H-MA-SL)	11.86	10.34	8.96	7.72	6.65	5.74	4.98	4.33	.	.	.	.
IV -(H&H-BE)	11.72	10.26	8.93	7.73	6.66	5.75	4.98	4.33	.	.	.	.
IVA -(H&H-BE-SL)	11.72	10.26	8.93	7.73	6.66	5.75	4.98	4.33	.	.	.	.
V -(H&H-$2)	12.99	11.65	10.41	9.28	8.28	7.39	6.64	5.97	5.37	4.85	4.37	3.93
VA -(H&H-$2-SL)	13.00	11.47	10.02	8.67	7.43	6.31	5.34	4.51	3.84	3.35	.	.
VI -(MH-MA-PS)	14.19	12.38	10.72	9.22	7.92	6.85	6.00	5.25	4.58	3.98	3.45	2.97
VIA -(MH-MA-PS-SL)	15.67	13.84	12.13	10.55	9.11	7.85	6.76	5.801	4.93	4.19	3.55	2.99
VII -(MH-MA-NS-)	14.33	12.49	10.82	9.32	8.03	6.95	6.07	5.30	4.59	3.99	3.45	2.97
VIIA-(MH-MA-NS-SL)	15.77	13.91	12.19	10.61	9.18	7.91	6.82	5.84	4.95	4.20	3.55	2.99

TABLE VII (continued)

Marketing Strategy	% Margin Requirement											
	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%
I -(NH)	4.05	3.53	3.02	2.50	1.99	1.48	0.99	0.57	0.19	.	.	.
IA -(NH-SL)	2.61	2.17	1.78	1.44	.	.	.	.	.	.	.	.
II -(H&H)	.	.	.	.	.	.	.	.	.	.	.	.
IIA -(H&H-SL)	.	.	.	.	.	.	.	.	.	.	.	.
III -(H&H-MA)	.	.	.	.	.	.	.	.	.	.	.	.
IIIA-(H&H-MA-SL)	.	.	.	.	.	.	.	.	.	.	.	.
IV -(H&H-BE)	.	.	.	.	.	.	.	.	.	.	.	.
IVA -(H&H-BE-SL)	.	.	.	.	.	.	.	.	.	.	.	.
V -(H&H-$2)	5.49	3.07	2.64	2.22	1.79	1.37	0.96	0.57	0.19	.	.	.
VA -(H&H-$2-SL)	.	.	.	.	.	.	.	.	.	.	.	.
VI -(MH-MA-PS)	2.53	2.12	1.76	.	.	.	.	.	.	.	.	.
VIA -(MH-MA-PS-SL)	2.53	2.12	1.76	.	.	.	.	.	.	.	.	.
VII -(MH-MA-NS-)	2.53	2.12	1.76	.	.	.	.	.	.	.	.	.
VIIA-(MH-MA-NS-SL)	2.53	2.12	1.76	.	.	.	.	.	.	.	.	.

TABLE VIII

RESULTS OF THE SEMI-VARIANCE METHOD APPLIED TO SELECTED MARKETING STRATEGIES UNDER THE CONTINUOUS FEEDING ASSUMPTION FOR PRICE RISK ONLY

Marketing Strategy	Semi-Standard Deviation From Average Return	Semi-Coefficient Of Variation From Average Return	Semi-Standard Deviation From Zero
Strategy I	52.99	-26.10	41.46
Strategy IA	54.58	- 3.00	48.48
Strategy II	21.55	- 1.00	42.74
Strategy IIA	22.02	- 1.62	42.51
Strategy III	26.61	- 2.10	42.44
Strategy IIIA	26.29	- 3.39	33.81
Strategy IV	26.75	-52.45	26.09
Strategy IVA	28.23	- 3.72	33.92
Strategy V	40.88	9.04	34.05
Strategy VA	41.02	- 6.05	39.40
Strategy VI	36.57	8.43	34.90
Strategy VIA	43.42	64.81	38.41
Strategy VII	36.81	7.25	33.86
Strategy VIIA	42.47	-58.18	38.36

TABLE IX

RESULTS OF THE SEMI-VARIANCE METHOD APPLIED TO SELECTED MARKETING STRATEGIES UNDER THE SELECTIVE FEEDING ASSUMPTION FOR PRICE RISK ONLY

Marketing Strategy	Semi-Standard Deviation From Average Return	Semi-Coefficient Of Variation From Average Return	Semi-Standard Deviation From Zero
Strategy I	39.08	-90.91	17.49
Strategy IA	39.63	- 4.75	20.75
Strategy II	26.42	1.31	5.22
Strategy IIA	26.42	1.31	5.22
Strategy III	24.84	1.40	5.49
Strategy IIIA	24.84	1.40	5.49
Strategy IV	24.38	1.32	4.95
Strategy IVA	24.38	1.32	4.95
Strategy V	30.44	1.36	7.51
Strategy VA	33.84	1.62	7.82
Strategy VI	35.99	2.32	10.36
Strategy VIA	40.84	2.85	12.54
Strategy VII	33.42	2.78	10.64
Strategy VIIA	37.89	3.49	12.74

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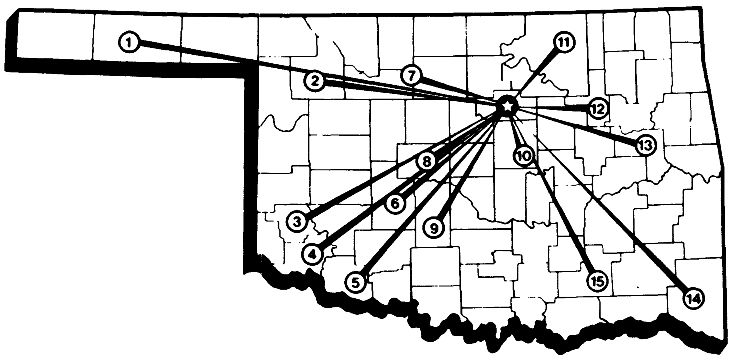

(★) Main Station—*Stillwater, Perkins and Lake Carl Blackwell*

1. Panhandle Research Station — *Goodwell*
2. Southern Great Plains Field Station — *Woodward*
3. Sandyland Research Station — *Mangum*
4. Irrigation Research Station — *Altus*
5. Southwest Agronomy Research Station — *Tipton*
6. Caddo Research Station — *Ft. Cobb*
7. North Central Research Station — *Lahoma*
8. Southwestern Livestock and Forage Research Station — *El Reno*
9. South Central Research Station — *Chickasha*
10. Pecan Research Station — *Sparks*
11. Pawhuska Research Station— *Pawhuska*
12. Vegetable Research Station — *Bixby*
13. Eastern Research Station — *Haskell*
14. Kiamichi Field Station — *Idabel*
15. Southeastern Oklahoma Agricultural Research and Extension Center — *Lane*