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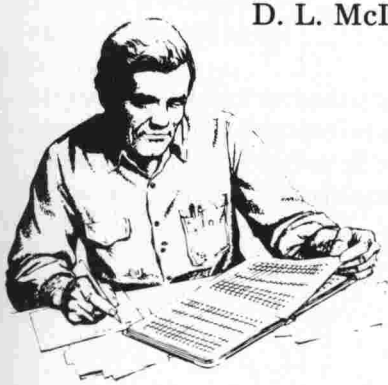

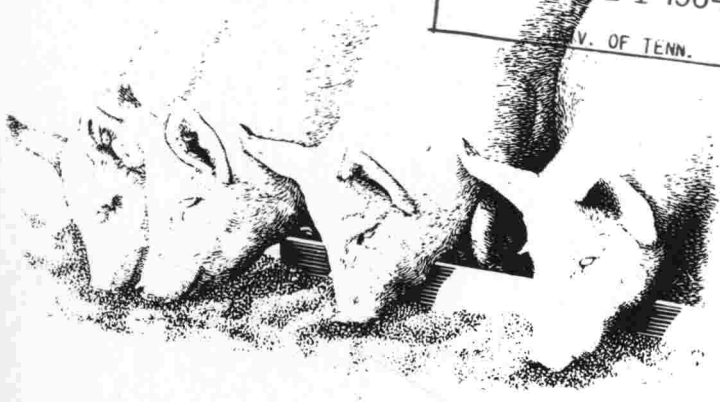

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INTRODUCTION

Corn is a major input in slaughter hog production accounting for approximately 30 percent of total production cost [4]. Since corn prices vary during the season, the timing of corn purchases is an important management consideration for slaughter hog producers. In addition to deciding when to purchase grain, the producer must also decide what amounts to purchase. This implies decisions about grain storage since the timing and size of grain purchases can be flexible only where storage capacity is available.

The market for corn futures provides an alternative to traditional cash purchases in that grain may be priced in advance of actual purchase through hedging. Hedging allows flexibility in the timing of pricing and relieves producers of the need to actually store the grain. In effect, the producer who hedges grain for future delivery is actually paying someone else to store the grain. That payment is a part of the price of the grain.

In making decisions about the purchase and storage of corn, the producer's objective is to minimize the total cost of providing the grain input. Savings obtained by buying large quantities of grain during periods of low prices must be compared to the cost of storing the grain until it is actually used. Also, savings achieved by hedging corn during periods of low futures prices must be compared to the costs of hedging (commission fees and margin requirements).

Thus, the hog producer is faced with several alternatives with respect to buying and storing grain. He must choose a purchase method and, if he does not already have storage facilities, he must decide whether to build facilities and what capacity to build. If he already has storage facilities, he is faced with decisions regarding the construction of additional storage capacity.

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Little research has been done which deals specifically with various grain storage alternatives and purchase strategies for hog producers. However, related studies have been undertaken which analyzed the price forecasting ability of futures markets [2, 7, 8] and the application of long hedging[1] by livestock feeders [9].

The purpose of the research reported here was to determine the least-cost combination of grain purchasing strategy and grain storage capacity for the Tennessee market hog operation with fixed grain requirements during the 1971-80 period. Information about the performance of purchase-storage alternatives in the recent past should help producers choose an alternative for the present and future.

METHODS

Analysis of the various purchasing strategies and storage capacities was accomplished using simulation routines to compare purchase price plus storage cost per bushel among the alternatives for the 1971-80 period. Simulation is a research technique which uses mathematical representations of actual systems to make comparisons among the systems. The simulations were incorporated into computer routines which represented each purchase and storage alternative. Data on actual corn prices, storage costs, and hedging costs during the nine years were utilized. The data were divided into years which ran from October 15 of one year to October 14 of the next year in order to conform to the seasonality of harvests. The period studied was from October 15, 1971 to October 14, 1980.

Table 1 provides an overview of the combinations of storage capacity and purchase strategy which were evaluated in the study. Combinations selected for evaluation are indicated by an X in Table 1. The strategies which were not evaluated (blanks in Table 1) were judged inappropriate. The storage and purchase alternatives are explained in the following sections.

HOG OPERATION AND STORAGE FACILITIES

The comparisons were based upon a purchased feeder pig — market hog operation with a 1440-head one-time capacity. This particular size enterprise was chosen because its grain requirement was large enough to enable use of the futures market as a hedging tool. Specifications for the enterprise were based upon budgets in the Tennessee *Farm Planning Manual* [10]. In most hog operations, grain usage will vary throughout the year according to size distribution of hogs. However, for this study a constant distribution of hog

[1]Long hedging refers to the purchase of a futures contract for a commodity which will subsequently be purchased on the cash market. When the cash market purchase is made a futures contract is sold to close the hedge.

Table 1. Combinations of Storage Capacity and Purchase Strategy Evaluated in the Study[a]

Storage Capacity	Purchase Strategy					
	Cash Buy	Quarterly Hedging	Semi-Annual Hedging	Annual Hedging	Futures Forecast	Optimum
Weekly (736 bu.)	X					
Monthly (3,190 bu.)	X	X	X	X		
Quarterly (9,569 bu.)	X		X	X	X	X
Semi-Annual (19,138 bu.)	X			X	X	X
Annual (38,276 bu.)	X				X	X

[a] Combinations which were evaluated are indicated by an X.

sizes was assumed to keep the grain usage rate constant. It was assumed that 9.7 bushels of No. 2 yellow corn were required to finish each hog. Total annual corn requirements for the operation were 38, 276 bushels.[2]

Since the grain usage rate was assumed constant through the year, the requirement for any particular future period could be determined. Semi-annual requirement was 19,138 bushels, quarterly requirement was 9569 bushels, monthly requirement was 3190 bushels, and weekly requirement was 736 bushels.

Storage capacity options were analyzed which approximated grain requirements for a week, month, quarter, half-year, and year in advance. Total grain storage capacities were rounded upward to a multiple of the number of bushels in a truckload. It was assumed that 850 bushels was the maximum amount of grain that could be hauled in a single truckload. Therefore, storage facilities were designed to handle multiples of 850-bushels.

The weekly storage capacity option approximated hand-to-mouth buying in which the producers must make weekly grain purchases. In this option no storage capacity existed except for the handling facility.

[2] The hog finishing process was assumed to require 133 days from the time one pig was started until another pig was started in his place. Thus, the facility would be filled the equivalent of 2.74 times each year.

PURCHASING STRATEGIES

The alternative methods of grain purchasing included the typical cash buy, long hedging, and grain purchases based upon expected prices. The strategies were compared against an optimum pattern of purchases. This optimum pattern of grain purchases was the pattern which would have resulted in the lowest total cost over the period.

Cash-Buy Strategy

The purchasing strategy in which the producer routinely bought grain on the cash market in amounts equal to storage capacity was approximated by the cash-buy strategy. Beginning in October the producer was assumed to have purchased grain in amounts sufficient to fill storage capacity. When the storage facility was empty it was refilled by another purchase. This process was continued through the period of the study. All five of the storage capacity options were simulated in combination with this purchasing strategy.

Hedging Strategies

Another pricing strategy available to hog producers who purchase grain is long hedging of future grain requirements. Long hedging consists of purchasing a corn futures contract in advance of the time when the grain will actually be needed. The approximate net price which will be paid for the grain is thus established prior to actual cash purchase. At the time the grain is needed, a cash purchase is made and a corn futures contract is sold to close the hedge.

Hedging strategies were simulated in combination with monthly, quarterly, and semi-annual storage capacity options. Hedging for delivery of corn on a weekly basis is probably impractical for most hog producers, and it was not included in the study. The hedging strategies analyzed in the study consisted of hedging for quarterly, semi-annual, and annual periods. The hedging periods differed with respect to the time over which the hedges were maintained. The quarterly hedging period consisted of placing hedges once every three months for grain requirements three months in advance. For the semi-annual hedging period, hedges were placed once every six months for grain requirements six months in advance. For the annual hedging period, hedges were placed once a year for grain requirements one year in advance.

Simulated trades were executed on the Mid-America Commodity Exchange. The Mid-America Exchange provides an opportunity for trading in small units (1000 bushels) which may be more accommodating to the average Tennessee hog producer than the 5000 bushel contracts traded on the Chicago Board of Trade. Execution of the hedging strategies involved cash purchases of grain in amounts equal to storage capacity on the 15th of October. Concurrently, a hedge was placed for the remainder of the hedging period's requirements. If there was not a contract for the month in which the grain was required, the grain was hedged in the closest subsequent month. Hedges were lifted as the grain was purchased on the cash market.

In comparing the hedging strategies, an average purchase price and storage cost was calculated for each year and for the entire period as in the other purchasing strategies. However, the farm delivered purchase price included the gain or loss on the futures market transaction. The gain or loss on the futures market included any profit or loss on the futures trade, a commission charge, and an interest charge for the margin requirement.

Monthly Storage Capacity. Quarterly, semi-annual, and annual hedging periods were examined under the monthly storage capacity option. At the beginning of each hedging period, a month's supply of corn was bought on the cash market and an amount of corn equal to the remainder of the hedging period's requirement was bought on the futures market. On the 15th of each month, the hedges were lifted for the coming month by selling three contracts (3,000 bu.) in the nearest future and buying corn on the local cash market.

Quarterly Storage Capacity. With quarterly storage capacity, a quarterly supply of corn was bought on the cash market at the beginning of hedging period and an amount equal to the remainder of the hedging period's requirement was bought on the futures market. Semi-annual and annual hedging periods were considered. The hedges were lifted on the 15th of October, January, April, and July by buying corn on the cash market in an amount required to fill quarterly storage capacity and selling an equivalent amount in the nearest futures contract.

Semi-Annual Storage Capacity. With the semi-annual storage capacity option, only the annual hedging period was considered. A six-month supply of grain was bought on the cash market on October 15. At the same time, the remaining amount required for the year (six-month supply) was hedged on the futures market. The hedge was lifted and a cash purchase made for another six-month supply on April 15.

Futures Forecast Strategy

Grain purchases timed to minimize total cost based upon expectations of future grain prices were also simulated. Corn futures market price quotations for contract months were used as forecasts of future corn prices. Based upon a futures market prediction of corn prices, an estimate of basis, and an estimate of future handling and transportation costs, farm-delivered corn prices for future periods could be forecasted. These forecasts were used in making decisions with respect to timing purchases and storing grain so that the total cost of purchase and storage would be minimized.

Decisions regarding planned purchase and storage of grain were made four times per year: October 15, January 15, April 15, and July 15. For purposes of discussion, these dates are referred to as "reevaluation points." At each of these reevaluation points, future grain prices were forecasted for one year in advance from the futures price information available on that date. For example, on October 15, future farm-delivered corn prices were forecasted, based upon evaluations of futures market quotations for corn, basis estimates, and expectations of future handling and transportation

costs. Based upon this information subsequent grain purchases were planned for one year in advance in such a way as to minimize combined costs of purchasing and storage. Three months later, the purchasing strategy planned on October 15 was reevaluated. The reevaluation took into account the producer's current storage situation and new information concerning forecasted future farm-delivered corn prices and storage costs. Based upon this new information, grain purchases were replanned for one year in advance. The replanning of grain purchases one year in advance and subsequent reevaluations of planned purchases every three months were simulated through the nine-year period of the study. Simulations for purchases based upon future price expectations were conducted for the quarterly, semi-annual, and annual storage options.

Development of Futures Market Price Indicators. At each reevaluation point the futures market quotations for the coming year served as expected prices for corn delivered to Chicago. For months in which there was no contract the price was estimated by interpolating between the nearest contracts. For example, if March futures was $3.40 and May futures was $3.50 then April price was estimated at $3.45.

Development of Basis Estimates. In order to develop the forecasted Tennessee cash corn price from the predicted Chicago price, an estimate of basis was needed. Basis was defined as the difference between Chicago futures and local spot (cash) prices [5, p. 176]. Basis was calculated by subtracting the next nearest-maturing futures contract price from the current Tennessee cash corn price. The basis estimation procedure rests on the premise that there is a seasonal pattern in the basis which approximately repeats itself annually. Producers should be able to form expectations of basis from this seasonal pattern. The producer should be able to obtain an estimate of the corn basis from the corresponding time period one year ago with adjustments made for annual increases or decreases in the level of the overall basis pattern. The estimation of basis in this manner was accomplished using regression analysis.

Transportation and Handling Costs. In forecasting future farm delivered corn prices, the transportation and handling rates were assumed to be constant for the planning period. Hence, the transportation and handling charges on October 15 were used as indicators of charges for the next 12 months. At each reevaluation point the transportation and handling charges were revised and the updated charges were used in forecasting the next year's farm-delivered corn prices.

Development of Storage Costs. In order to make a decision with respect to minimizing the cost of procuring and storing corn, a producer should have knowledge of future storage costs. The weekly storage cost on October 15 was used as an indication of the storage cost for the next twelve months. Also, the weekly storage costs at the January 15, April 15, and July 15 reevaluation points were used as indicators of the next 12 month's storage cost.

Determination of the Purchase-Storage Pattern. A producer who has forecasts of future delivered grain prices and storage costs can mechanically formulate a grain buying pattern which will minimize total costs. However, in this study the minimum cost pattern of purchasing and storing corn based upon forecasted prices was determined using a linear programming model as a matter of convenience. The same results could be obtained by the individual producer with pencil, paper, and arithmetic.

Optimum Strategy

The least cost (optimum) pattern of purchasing and storing corn given perfect knowledge of prices over the entire period was also detemined. This pattern would have resulted in the minimum attainable cost over the period of study. While this optimum strategy is obviously not realistic, it provided a benchmark against which the other procurement strategies were compared. The actual farm delivered corn price on the 15th of each month was used for the purchase price. The linear programming method of determining the least cost purchasing and storage strategy was used here also.

DEVELOPMENT OF PRICE AND COST DATA

Farm Delivered Corn Price

The corn price used in the study represented the cost of corn delivered to the farm. This price included the Memphis cash corn price plus an elevator handling charge and a transportation charge. The handling charge represented an elevator's charge for moving grain into and out of the elevator. Differences between corn prices received in corn budgets and corn prices paid in hog budgets in the Tennessee *Farm Planning Manual* [10] were used as estimates of the handling charge. The differences between the prices were $.10 in 1970, $.15 in 1975, and $.25 in 1980. From these values a continuous increase was assumed between these years.

The transportation charge per bushel was based upon a haul of 100 miles with no back-haul. Rates for 1972-75 were based upon rates in hog feeding budgets in USDA *Livestock and Meat Situation* [13, p. 24]. Unfortunately, this source did not provide a data series for the entire period of the study. Rates for 1976-80 were based upon a straight line interpolation between the 1975 rate and current rates determined from a telephone survey of local truckers and firms which use trucks to haul grain.

Calculation of the transportation charge was based upon an 800-bushel load which was judged to reflect the average size trailer load. A producer utilizing the weekly storage capacity option would not be able to order in 800-bushel lots since his capacity is only 736 bushels. For the weekly storage option the transportation charge was based upon a 736-bushel haul. The transportation charge per bushel was determined by multiplying the rate per loaded mile by 100 miles and dividing this product by the number of bushels hauled (736 for weekly, 800 for other options). The handling charge per

bushel and transportation charge per bushel were added to the Memphis cash corn price to obtain a price for corn delivered to the farm.

Fixed Cost of Storage

The grain facilities consisted of a handling facility and, where indicated, a long-term grain storage facility. The handling facility consisted of a feed processing unit which included a small storage bin for 736 bushels to facilitate metering of the grain. For the five storage facilities considered, it was assumed that handling facilities were identical.

The amount of investment in the grain storage facility was based upon budgets published by the University of Illinois Agricultural Experiment Station [6, p. 16]. The amount of investment in long-term storage was determined from 1975 costs and adjusted to 1971 using the *Construction Price Index* [14, p. 778]. Investment costs were included for the storage bin, unloader, auger, erection costs, and concrete. Since the hand-to-mouth or weekly option had no long term storage, investment cost was zero. Fixed costs associated with the handling facility were not included because the handling facility was identical for each storage facility option. Therefore, costs associated with the handling facility remained the same for all storage options.

Fixed cost per bushel was estimated based upon budgets from the University of Tennessee Agricultural Extension Service [3]. Fixed cost was calculated on a per bushel basis by adding depreciation, insurance, repairs, maintenance, taxes, and interest on investment. Construction costs associated with the bin, concrete, and erection were depreciated over a 20-year period. Augers and unloaders were depreciated over a 10-year period. Repairs and maintenance were calculated as 2.5 percent of the investment in buildings. Taxes were calculated as 0.7 percent of the investment in buildings. The cost of insurance on stored grain was considered a fixed cost since the amount of insurance carried would be based on maximum capacity and would probably not be varied temporarily as actual grain in storage fluctuated. The insurance charge was based upon a rate of 0.6 percent of the delivered corn price. Interest on investment was calculated as 8.1 percent over the study period (9 years). The interest rate was the rate on non-real estate farm loans at all banks in 1971 [12, p. 28].

Variable Costs of Storage

Budgets designed to represent variable storage costs were structured based upon budgets published by the University of Tennessee Agricultural Extension Service [3]. Variable storage costs per bushel included labor costs, power costs, and interest or opportunity cost on operating capital invested in stored grain.

Interest charges represented the largest component of variable storage costs. Quarterly data for interest rates were taken from *Agricultural Finance Data Book* [1, p. 36]. However, this source provided a data series extending back only to 1976. Data on interest rates prior to 1976 were obtained from

Agricultural Finance Statistics [11, p. 212]. Both of these sets of data represented an average of interest rates on outstanding non-real estate farm loans at all banks. Interest cost per bushel stored was determined by multiplying interest rates by delivered corn prices.

Power costs for storage included the use of fans for aerating grain and the augering of grain. The annual power requirement was determined to be 0.075 kilowatt hours per bushel for all options [6, p. 16]. Power cost per bushel was determined by multiplying the electrical requirement by the price of electricity. Electricity price per kilowatt hour was based upon yearly data in USDA *Agricultural Statistics* [12, p. 431].

Most of the labor required was assumed to be associated with augering grain. Accordingly, the labor charge per bushel was based upon the wage rate and the amount of time required to auger grain into the bins. The amount of time required varied with the storage facility because larger facilities had larger augers and thus lower labor costs per bushel. The amount of time required was based upon two transfers of grain. One transfer was into long-term storage from the truck and the other transfer was from long-term storage into the handling facility. The weekly option involved only one transfer of grain (from the truck to the handling facility). Consequently, the weekly option's labor requirement was less than any of the other facilities. The time required for augering grain was multiplied by the wage rate to obtain labor cost per bushel. Data for wages were taken from USDA *Agricultural Statistics* where the wage rate was based upon all hired farm workers [12, p. 435]. Shrinkage was not considered as a cost because it was assumed that dried grain was purchased which would cause shrinkage to be minimal.

All variable costs were added to obtain monthly variable storage cost per bushel for each facility for October 1971 through September 1980.

RESULTS

Comparison Among Purchasing Strategies for 1971-80

Average cost per bushel was used to determine the effectiveness of the various purchasing strategies in reducing cost. The averages of purchase price and storage cost for each purchasing strategy for the nine-year period are shown in Table 2.

Monthly Storage Capacity. Four purchase strategies were analyzed under the monthly storage capacity option. Since grain buys were restricted to one per month for the optimum and futures forecast strategies, these strategies were not considered for the monthly storage capacity option. Purchase strategies analyzed included cash buy (unhedged), and hedging for quarterly, semi-annual, and annual periods. The strategy which gave the smallest average purchase plus storage cost (including fixed cost) was hedging in semi-annual periods ($3.265 per bu.) with the strategies for cash buy and quarterly hedging period having a purchase and storage cost approximately three cents more than the semi-annual hedging strategy (last column

Table 2. Averages of Purchase Price, Storage Costs, and Purchase Price Plus Storage Cost Per Bushel for Sir Corn Purchase Strategies and Storage Capacities, 1971-1980, Tennessee.

Storage Capacity and Purchase Strategy	Purchase Price	Storage Cost		Purchase Plus Storage	
		Variable	Fixed	Excluding Fixed Cost	Including Fixed Cost
	dollars per bushel				
Weekly Storage Capacity					
Cash Buy	2.947	.348	0	3.295	3.295
Monthly Storage Capacity					
Cash Buy	2.925	.359	.008	3.283	3.291
Quarterly Hedging	2.939	.349	.008	3.288	3.296
Semi-Annual Hedging	2.909	.348	.008	3.257	3.265
Annual Hedging	2.962	.350	.008	3.312	3.310
Quarterly Storage Capacity					
Cash Buy	2.895	.344	.015	3.239	3.253
Semi-Annual Hedging	2.918	.348	.015	3.266	3.280
Annual Hedging	2.945	.349	.015	3.293	3.308
Futures Forecast	2.895	.338	.015	3.234	3.249
Optimum	2.775	.334	.015	3.109	3.124
Semi-Annual Storage Capacity					
Cash Buy	2.814	.342	.022	3.157	3.179
Annual Hedging	2.940	.347	.022	3.287	3.309
Futures Forecast	2.854	.319	.022	3.173	3.195
Optimum	2.644	.323	.022	2.968	2.990
Annual Storage Capacity					
Cash Buy	2.750	.337	.038	3.087	3.125
Futures Forecast	2.755	.312	.038	3.068	3.106
Optimum	2.469	.302	.038	2.771	2.809

of Table 2). Hedging in annual periods had the highest purchase and storage cost which was 5.5 cents greater than the purchase and storage cost for the semi-annual hedging strategy.

Quarterly Storage Capacity. For the quarterly storage capacity the lowest average purchase plus storage cost was provided by the futures forecast strategy ($3.249 per bu.) which was only 12.5 cents greater than the optimum strategy. The cash buy strategy ranked second with cost only one-half cent per bushel greater than the futures forecast strategy. The two hedging strategies resulted in the highest cost. The lowest achievable cost if all prices had been known in advance (optimum strategy) was $3.124 per bushel.

Semi-Annual Storage Capacity. For the semi-annual storage capacity option, the cash buy strategy gave the lowest average purchase plus storage cost ($3.179 per bu.) which was 19 cents greater than the optimum. The futures forecast strategy closely followed the cash buy strategy with an average purchase plus storage cost 1.6 cents greater. Hedging for annual periods had the highest cost.

Annual Storage Capacity. The futures forecast most closely approached the optimum for the annual storage capacity option. The average purchase plus storage cost ($3.106 per bu.) was 29.7 cents higher than the cost for the optimum strategy. The average purchase plus storage cost for the cash buy strategy was only two cents greater than the futures forecast strategy.

The results from the comparison among purchase strategies showed that the average purchase plus storage costs were usually higher for the strategies involving hedging than for the other strategies. In all cases except the case of semi-annual hedging for the monthly storage capacity option, hedging strategies produced the highest costs. Annual hedging was the poorest strategy every time it was evaluated. The simple cash buy strategy gave surprisingly good results. It gave lowest or next to lowest costs in all comparisons. The futures forecast strategy also performed well giving the lowest cost for two capacity options and next to lowest cost for the other capacity option.

Comparison Among Storage Capacity Options for 1971-80

Comparisons among storage capacities were made to determine whether the greater flexibility of the larger facilities allowed savings in prices paid for corn which were large enough to offset the larger investment associated with the larger facilities. The lowest average purchase plus storage cost attainable (last column of Table 2) was for the annual storage capacity option utilizing the optimum strategy ($2.809 per bu.). The purchase-storage alternative which most closely approached the optimum cost was the annual storage capacity option using the futures forecast strategy ($3.106 per bu.). The overall ranking of purchasing strategies showed the strategies associated with the annual storage capacity options to have the lowest cost followed by semi-annual, quarterly, monthly, and weekly storage capacity options in that order. That is, larger storage capacity was generally associated with lower total

cost of corn. The producer could have lowered average costs by 17 cents per bushel by changing from weekly to annual storage capacity using the cash buy strategy during the 1971-80 period.

Further examination of Table 2 (first column) reveals that average purchase price declines as storage capacity increases. This reflects the greater flexibility in timing of purchases available to the producer with greater storage capacity. Variable storage costs (second column of Table 1) also tend to decline as storage capacity increases which results from the economies of size of larger facilities. The exception to this pattern is the weekly storage option which has lower variable costs because less handling of the grain is required. Fixed cost of storage per bushel (third column of Table 2) increases as capacity increases because of the larger investment required for larger facilities. Increasing fixed costs fail to completely offset declining purchase price and variable costs with the result that total costs of providing grain decline as storage capacity increases.

Comparison Among Purchasing Strategies for 1975-80

The analysis was also conducted for the 1975-80 period to determine whether the relative success of the strategies might be different during the more recent period. Also, the higher cost of the storage facility construction in 1975 might have affected the comparison of storage capacity options. The results were analyzed as if the producer entered production in October 1975. The period analyzed was based upon data from October 1975 to September 1980. The same method of analysis was used for the 1975-80 period as for the nine-year period. Fixed costs per bushel were calculated based upon 1975 construction costs.

The means of purchase price, variable storage cost, fixed storage cost, and purchase price plus storage cost for the 1975-80 period are shown in Table 3. The same storage capacity options and purchase strategies were analyzed as for the nine-year period.

The cash buy strategy resulted in the lowest purchase plus storage cost (including fixed cost) per bushel for the monthly storage capacity option ($3.541 per bu.). The hedging strategies resulted in costs which were five to eleven cents higher than the cash buy strategy.

For the quarterly storage capacity option, the futures forecast strategy minimized cost with an average of $3.492 per bushel. The cash buy strategy gave the next lowest cost of $3.547. Semi-annual and annual hedging strategies resulted in the highest costs of $3.558 and $3.578, respectively. The optimum strategy resulted in $3.425 per bushel.

The futures forecast strategy also was the least expensive for the semi-annual storage capacity option with an average purchase plus storage cost of $3.483 per bushel. The optimum resulted in a cost of $3.322. The cash buy strategy was approximately 2.5 cents per bushel higher than the futures forecast strategy. The annual hedging strategy had the highest cost — approximately 25 cents higher than the optimum.

Table 3. Averages of Purchase Price, Storage Costs, and Purchase Price Plus Storage Cost Per Bushel for Simulated Corn Purchase Strategies and Storage Capacities, 1975-1980, Tennessee.

Storage Capacity and Purchase Strategy	Purchase Price	Storage Cost		Purchase Plus Storage	
		Variable	Fixed	Excluding Fixed Cost	Including Fixed Cost
	dollars per bushel				
Weekly Storage Capacity					
Cash Buy	3.147	.399	0	3.546	3.546
Monthly Storage Capacity					
Cash Buy	3.127	.042	.012	3.529	3.541
Quarterly Hedging	3.171	.403	.012	3.574	3.586
Semi-Annual Hedging	3.200	.404	.012	3.604	3.616
Annual Hedging	3.232	.405	.012	3.636	3.648
Quarterly Storage Capacity					
Cash Buy	3.125	.400	.022	3.525	3.547
Semi-Annual Hedging	3.134	.402	.022	3.536	3.558
Annual Hedging	3.154	.402	.022	3.556	3.578
Futures Forecast	3.100	.370	.022	3.470	3.492
Optimum	2.999	.404	.022	3.403	3.425
Semi-Annual Storage Capacity					
Cash Buy	3.077	.399	.032	3.476	3.508
Annual Hedging	3.139	.401	.032	3.539	3.572
Futures Forecast	3.074	.377	.032	3.451	3.483
Optimum	2.896	.394	.032	3.289	3.322
Annual Storage Capacity					
Cash Buy	2.987	.392	.056	3.379	3.435
Futures Forecast	3.010	.372	.056	3.382	3.438
Optimum	2.784	.381	.056	3.166	3.221

The optimum cost for the annual storage option was $3.221 per bushel. The cash buy strategy was the minimum-cost practical strategy with an average of $3.435 and futures forecast strategy was a very close second with an average purchase plus storage cost of $3.438. In practice there would probably be no difference between the two.

While several differences in ranking of purchase strategies are evident between the 1971-80 and the 1975-80 analyses, it appears that the cash buy and the futures forecast strategies generally gave superior performance during both periods. Also, the hedging strategies did not perform well in reducing the cost of grain.

Comparison Among Storage Capacity Options for 1975-80

For the 1975-80 period average purchase plus storage cost per bushel tended to decline as storage capacity increased (Table 3) with the lowest cost associated with annual storage capacity. This is consistent with the results for the 1971-80 period indicating a degree of stability in this finding over time. The decline in cost resulting from changing from weekly to annual storage capacity was 11 cents per bushel for the cash buy strategy.

CONCLUSIONS

Results of the simulated grain purchase and storage operations for the 1971-80 period showed that there were consequential differences between various combinations of storage capacity options and purchasing strategies. It was shown that there were no purchase strategies which consistently provided a lower purchase plus storage cost than the traditional cash buy strategy. The cash buy strategy either produced the lowest average cost per bushel or closely approached the strategy with lowest average cost. The futures forecast strategy performed well for larger storage capacities giving slightly lower costs than the cash buy strategy for two of the three large storage options. With the exception of semi-annual hedging for the monthly storage capacity, the hedging strategies generally produced higher purchase plus storage costs. This might be explained by the higher per bushel cost of hedging in smaller lots (1000 bu. contracts) on the Mid-America Commodity Exchange.

A relationship between storage capacity and grain cost per bushel becomes apparent upon examination of the results for purchase plus storage cost. As storage capacity expands from the weekly storage capacity option to the annual storage capacity option, cost per bushel of corn tends to decline. This decline occurs even when fixed cost of storage is included. This trend reflects the fact that producers with larger storage capacity are able to time purchases so as to take advantage of periods of lower corn prices. Savings on purchase price plus savings on per bushel cost of operation of the larger storage facilities more than offset the higher fixed cost of the larger storage facilities.

Therefore, assuming that past market conditions are fairly representative of what will occur in the future and the simulation procedures are sufficiently representative of the Tennessee producer's situation, a fairly specific course of action is suggested.

If the producer has no existing storage facility and he must make a decision as to whether to build and how large a facility to build, fixed as well as variable costs would be considered. Therefore the producer would consider the average purchase plus storage cost (including fixed cost). The producer would build a storage facility with annual storage capacity since that alternative gave the lowest total cost for the nine-year period.

If the producer already had a storage facility and he had to make a decision as to whether to build additional storage and how much additional storage to build, the fixed costs of the existing facility would be sunk costs and would not enter into the decision-making process. Therefore the producer would compare mean purchase plus storage cost (excluding fixed cost) for the existing facility to mean purchase plus storage cost (including fixed cost) of the other storage facility options. The average purchase plus storage (including fixed) costs for the annual storage capacity option were lower than the average purchase plus storage (excluding fixed) costs for any of the smaller storage options. Therefore, the producer would build additional storage until annual storage was approximated no matter what capacity the producer presently maintained. Either the cash buy or the futures forecast purchasing strategy should provide good results with annual storage capacity.

If the producer were facing a very short planning horizon and were constrained for some reason to the existing storage facility, he would probably be well-advised to use either the traditional cash buy or the futures forecast purchasing strategy. One exception to this generalization is if the producer had a monthly storage facility he would achieve lowest costs by using the semi-annual hedging strategy.

A separate analysis of the last five years of the study (1975-80) showed only minor differences between the results associated with the entire nine-year period and the results associated with the last five years.

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