ADAPTIVE PLANNING UNDER PRICE UNCERTAINTY IN PORK PRODUCTION

Ronald L. Plain and Joseph E. Williams

INTRODUCTION

Market hog prices historically have shown great variation and have often followed a cyclical pattern. Franzmann (1979) finds evidence of a four-year and a twenty-eight-year cycle in hog prices. Price cycles imply the possibility of forecasting long-range prices. In turn, forecasting suggests the opportunity to vary the production or marketing process in order to maximize profits.

Profit is maximized by producing so that marginal cost equals marginal revenue. Since hog prices (marginal revenue) vary widely, it follows that the profit-maximizing level of production would also vary. Many swine producers vary the size of their operation in response to market prices. Purcell (1979) reports that variation in supply is a major cause of fluctuation in hog prices and the resultant price cycle (Figure 1). Unfortunately, due to production lags, swine growers often find that production adjustments occur too late to take advantage of price trends. An alternative that some swine growers might choose is to ignore price variation and produce where average total cost is minimized.

If a producer can combine accurate price forecasts with proper decision criteria, he can enhance profits by adjusting production to market more hogs when prices are high and fewer hogs when prices fall. This paper presents results of a swine simulation model that is used to compute income and analyze alternative production and marketing strategies associated with flexible pasture and confinement swine enterprises. Flexible strategies examined are varying sow herd size and marketing feeder pigs or slaughter hogs.

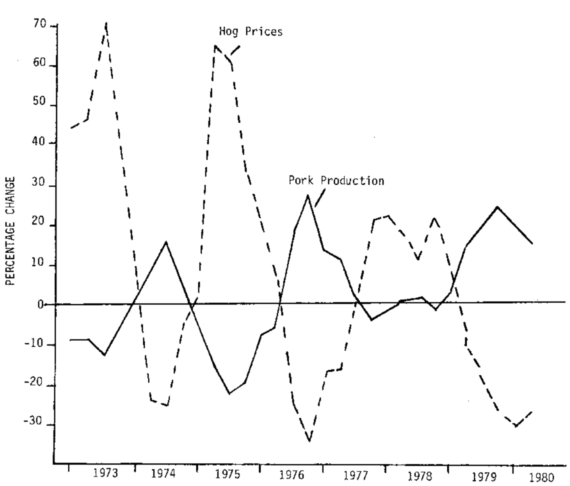

FIGURE 1. Percentage Change in Hog Prices and Production from Previous Year's Level

THEORY

Profit is defined as total revenue minus fixed and variable costs. Total revenue is equal to the price of the product times the amount produced. If average variable costs per unit and the level of production are assumed constant, profit will vary directly and linearly, with price as depicted by π_0 in Figure 2. The profit function, π_0, is the type facing a firm that has constant costs and pro-

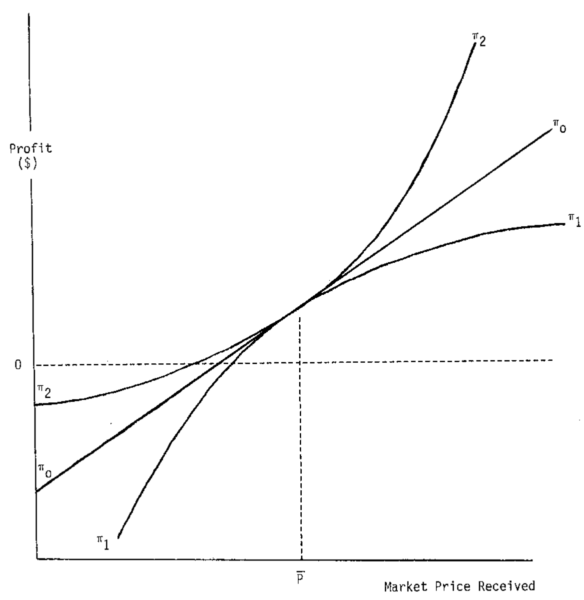

FIGURE 2. Relationship Between Profit and Product Price for Three Production Strategies—Varying Output Directly with Price (π_2), Producing at a Constant Level (π_0), and Varying Output Inversely with Price (π_1)

Ronald L. Plain is Assistant Professor, University of Missouri-Columbia, and Joseph E. Williams is Associate Professor, respectively, Department of Agricultural Economics, Oklahoma State University.

duces at a constant level of output, regardless of product price.

Ikerd (1976) reports that many producers try to anticipate short-run price changes and adjust output accordingly to maximize profits. Sow numbers are increased if higher prices are expected and reduced when lower prices are anticipated. The existence of price cycles for many agricultural commodities indicates that producers are often wrong in their expectations; thus, they increase production, only to find that prices have fallen, and then reduce production to find stronger prices for their smaller quantities. The price-quantity cycle is typified by the familiar cobweb theorem and is represented by profit function π_1 in Figure 2. The inverse relationship between output and current prices causes a producer to profit less both from higher and lower prices than does one who bases output on long-run expectations, $\bar{P}$, and therefore maintains a constant level of output.

Profit function π_2 in Figure 2 also represents a producer who adjusts output to expected prices, but, in this case, it is assumed that the expectations are accurate. The producer markets more product when prices are high and less when prices are low. Again, it is assumed that average variable costs are held constant. By taking advantage of the changing optimum output levels associated with changing prices, that grower is able to achieve greater profit than one who maintains a constant production level. When prices are low, output adjustments allow the producer to minimize losses. The constant output producer (π_0) incurs a greater loss during low prices than does one who correctly adjusts his output. A still greater loss would result if a higher price had been anticipated and output had been adjusted accordingly (π_1).

Determination of production level is one of the crucial decisions a manager must make. Although output is determined to some extent when production facilities are selected, there is often much a manager can do in the short run to vary output without making major alterations in fixed facilities. Production can always be discontinued, and often there is the opportunity to expand (decrease) output by increasing (decreasing) variable inputs used in the production process. For purposes of clarity, the term "optimal output level" is used to designate the minimum point on the short-run average total cost curve for the expected life of the fixed facilities. Assuming the normal "U"-shaped average total costs curve, changes in output from the designed optimal level may cause average total costs to increase (Stigler, 1939). Increasing hog numbers beyond designed capacity drops production efficiency because of overcrowding, hence, average variable costs increase. Decreasing numbers mean that fixed costs are averaged over fewer hogs. If the minimum average total cost of a flexible firm is higher than for an inflexible firm (as it would be assuming either a loss in technical efficiency or an increase in fixed costs due to flexibility), then the profit curve of the flexible firm will be lower at the price associated with the optimal output level ($\bar{P}$).

THE SWINE SIMULATION MODEL

The economics of adaptive planning under price uncertainty is analyzed using a computer model to simulate selected production and marketing strategies for two commercial farrow-to-finish swine enterprises over a ten-year period beginning in January, 1970. This period was characterized by unusually large fluctuations both in hog and feed prices, and, therefore, presents a good opportunity for analyzing the possible benefits of adaptive planning. The analysis utilizes a deterministic, profit-optimizing, dynamic simulation model. The model allows weekly management decisions and reports levels of production and cash flows that result from the decisions. Hog numbers are varied to equate expected marginal cost and expected marginal revenue within the constraints placed on output levels (zero to designed capacity).

To eliminate the problems posed by variations in production efficiency due to output flexibility, production coefficients are assumed to be independent of herd size. In order to make this assumption more realistic, maximum output is constrained at the designed capacity level. The only alterations in output that are considered are temporary decreases in breeding herd numbers and marketing of feeder pigs instead of slaughter hogs. Constant technology over time is assumed. A short-run planning horizon is used in making flexibility decisions. Although sows can be retained for a maximum of four litters, only the economics associated with the next litter is incorporated when making culling decisions.

The model operates in the following general manner. Initial economic values and production coefficients are assigned. These values include such things as observed feed and hog prices, initial investment costs, and maximum number of sows or gilts allowed. The model can simulate a wide range of swine production systems under a variety of circumstances by altering these initial parameters. The model then begins the simulation phase.

A chart depicting the flow of animals and decision points within the model is presented in Figure 3. Old sows are culled, new gilts are added, and breeding begins during the first week of the cycle. Females are classified according to the number of litters that they have farrowed. Conception rates and litter size vary among classes of females. A female is culled from the breeding herd after having four litters, or if the expected

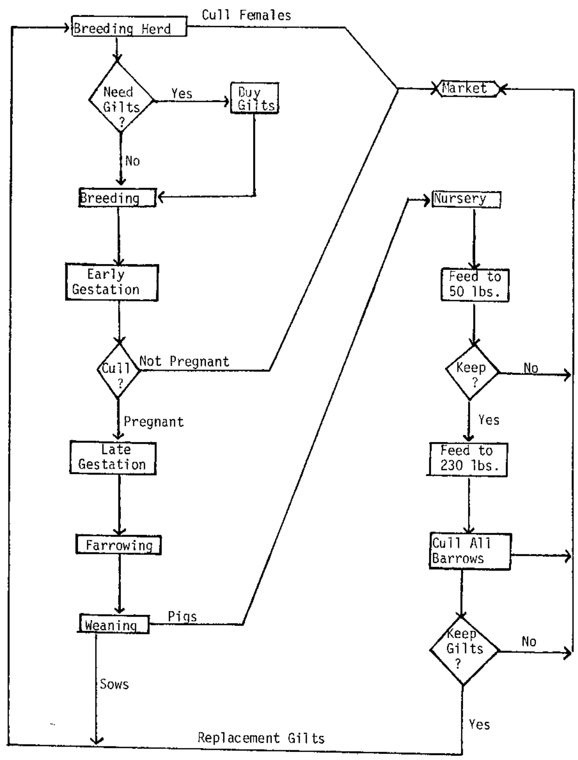

FIGURE 3. Movement of Swine and Decision Points Within Farrow-to-Finish Swine Model

net present value from breeding and farrowing the female is less than her current market value. Initially, the model decides if it appears profitable to breed and farrow gilts and/or sows. Each class of females is examined separately. The answer to this question is based on the expected level of variable costs and hog prices. If the answer is yes, the females in the breeding herd are bred. Replacements are selected from raised market gilts if they are available. If not, replacement gilts are purchased, provided their expected present value exceeds acquisition costs. If the answer is no, then a reduction in the breeding herd occurs. Owing to differences in conception rates and litter sizes between sows and gilts, there are times when it is profitable to breed and farrow sows, but not profitable to add replacement gilts to the herd. When prices are favorable, sufficient females are bred to allow for culling of open females and filling the farrowing facilities. Pregnancy testing and the culling of unsettled females occur during the 10th and 11th weeks. Farrowing occurs during the 19th and 20th weeks.

Feeding of the pigs begins when they are 2 weeks old. Pigs are weaned at 5 or 6 weeks of age. After weaning, sows are returned to the breeding herd, and the pigs are moved to the feeding facilities. When the pigs reach 50 pounds, a decision is made to sell the pigs as feeders or to feed them to 230 pounds. The pigs will be kept to slaughter weight if the expected discounted returns from continued feeding exceeds receipts realized by marketing feeder pigs. In order to simplify calculations, it is assumed that feeder pigs and market hogs are sold at weights of 50 and 230 pounds, respectively. After reaching market weight, gilts needed for the breeding herd are saved, and the remainder of the market hogs are sold.

Each week, receipts, expenses, and an accumulated total of cash flow and net revenue are calculated. This financial information is recorded, along with the number of animals sold, feed and livestock inventories, and farrowings. It is assumed that a complete building, machinery, and equipment complement is purchased when the simulation period begins. All buildings, equipment, livestock, and feed on hand at the end of the simulation period are sold before calculating the final accumulated returns. Assets are liquidated to account for differences in the value of ending inventories. No charge is made for land, risk, or management, nor are income taxes included in this analysis. Besides the initial investment in buildings and equipment, expenses include livestock, feed, feed storage, labor, utilities, veterinary and medicine, hauling and marketing, fuel, lubricants, repair, insurance, interest, and property taxes. Costs are based on historical data. Capital is borrowed at rates equal to those charged by Production Credit Associations during the period simulated. If the enterprise generates a positive cash flow position, interest is paid to the system at a 5-percent annual rate. Interest payments provide a compounding and discounting effect and yield a final value for accumulated net returns, which is in 1980 dollars.

Two farrow-to-finish production systems are simulated by the model—a pasture system and a confinement system. The pasture system requires $21,831 (1980 dollars) initial investment in facilities and equipment, and requires 35 hours of labor per sow per year. Two sow groups, each with a maximum of 20 farrowing females, are farrowed twice annually. The confinement system requires an initial investment of $173,176 with 3 groups of 30 sows, or less, being farrowed an average of 2 1/6 times annually. The confinement system requires 20 hours of labor per sow per year. The production coefficients used for these systems (litter size, feed conversion, etc.) represent those of a good to above average producer. The systems are modeled after those described by Williams and Plain (1979).

MANAGEMENT STRATEGIES

The model can simulate 4 different management strategies for making operating decisions. The four strategies are: (1) constant production at designed capacity; (2) optional reduction in sow numbers below design capacity; (3) optional feeder pig sales; and (4) optional feeder pig sales and reduction in sow numbers (2 and 3). The first is a nonflexible strategy. With this option, the sow herd is always maintained at full capacity, and all pigs produced are kept until 230 pounds, at which time they are either marketed or added to the breeding herd. This is a passive management strategy since prices do not affect the production decisions of the enterprise. The other decision strategies allow the system to respond to prices by being flexible in 1 of 3 ways—production, or marketing, or both. Production flexibility (strategy 2) allows the sow herd to be reduced below, but not expanded above, the maximum level. Reduction in sow numbers occurs whenever the variable costs of producing market hogs are greater than the expected revenue from marketing those hogs. Feeder pig sales are not permitted. Marketing flexibility (strategy 3) allows the model to market 50-pound feeder pigs if this appears more profitable than feeding them to slaughter weight. Strategy 3 does not allow sow numbers to vary. The fourth strategy combines both production and marketing flexibility by allowing reductions in sow numbers and optional feeder pig sales.

PRICE PREDICTIONS

There is no need to incorporate market outlook information into the decision process if a producer follows the first management strategy, because the facilities are always maintained at full production capacity. However, the other three management strategies require the incorporation of outlook information or price expectations in making production and marketing decisions. To make the determination on sow herd size and feeder pig sales, the model employs price forecasts to estimate the future price of feeder pigs and market hogs. A 16-week forecast of market hog prices is utilized in making the feeder pig marketing decision. The sow herd size reduction decision is based upon a combination of a 32-week forecast of feeder pig prices and a 46-week forecast of market hog prices.

Five different types of price forecasts are used. The first is a perfect price predictor. In this version, the historical prices for hogs are used to make the flexibility decisions, that is, production and marketing. Market hogs and sow prices used are the weekly average of Oklahoma City prices for U.S. #1 and #2 Grade 230-pound barrows and gilts and 400-pound sows. Feeder pig prices are based on weekly average quotations for 50-pound pigs on southern Missouri markets. The economics associated with selling breeding stock are not considered. Monthly averages of prices paid for hog feed by Oklahoma farmers are used to determine ration costs. It is assumed that feed is purchased when production decisions are made and stored until fed.

The second type of price predictor is the "naive" predictor. The "naive" predictor assumes that future hog prices will be the same as when the decision is made, that is, prices will not change from current levels.

The third predictor uses live hog futures contract prices quoted from the Chicago Mercantile Exchange as the basis for decision making. Two series of hog futures prices are utilized. The first involves the current futures market price for delivery 16 weeks into the future, while the second is the futures market price for delivery in 46 weeks. The futures prices are adjusted for an Oklahoma City basis. Two variations in strategy are tested using the futures market as the price predictor. The model is simulated once without hedging and once with the pigs hedged. A brokerage fee is charged when hedging is done.

Two price prediction equations were developed as the fourth and fifth predictors and tested using the simulation model—a cyclical predictor and a causal predictor. In both cases, ordinary least squares regression was performed, and then a Cochrane-Orcutt procedure was used to correct for first-degree autocorrelation. Often in using time series forecasting methods, the variation of the dependent variable is separated into four components: trend component, seasonal component, cyclical component, and an irregular component. As a first step in attempting to take this approach, spectral analysis was performed on 522 weeks of 1970s hog price data. Results indicate numerous cycles of very short length, cycles of approximate lengths of six months and one year, a strong cycle of length 130 weeks (2.49 years), and an even stronger cycle of length 525 weeks (10.06 years). A harmonic analysis similar to that used by Abel (1962) was employed in a regression equation to predict hog prices. The harmonic analysis method utilizes sine and cosine functions to model cyclical variation over time.

Two different cycle lengths (26 weeks and 52 weeks) were tried in testing for a seasonal component. The results obtained using the 26-week seasonal variation were superior to those using 52-week season. Cycle lengths varying from 2.5 to 4.2 years were tried to determine a cyclical component in the data. The highest R^2 value (0.7024) is obtained by using a cycle length of 2.75 years. In response to the results from the spectral analysis and to account for the general shape of the data a second, longer cycle was incorporated into the harmonic regression model. Period lengths varying from 8.8 to 10.1 years were fitted in combination with a seasonal variation of six months (26 weeks) and a short-cycle length of 2.75 years. Although there is only minor variation in the R^2 values for different long-cycle lengths, the highest value (0.9174) is obtained by using a long-cycle length of 9.0 years. The form of the harmonic regression predictor for market hog prices is given in equation 1. The t-test statistics are given in parentheses.

$$
\begin{aligned}
(1)\quad P'_t = {} & \underset{(11.23)}{24.62} + \underset{(7.09)}{.0526}\, t + \underset{(5.81)}{1.946} \sin \frac{2\pi t}{S} + \\
& \underset{(2.51)}{0.8376} \cos \frac{2\pi t}{S} + \underset{(4.327)}{5.019} \sin \frac{2\pi t}{C_1} + \\
& \underset{(3.20)}{3.723} \cos \frac{2\pi t}{C_1} - \underset{(2.29)}{3.878} \sin \frac{2\pi t}{C_2} - \\
& \underset{(3.81)}{5.289} \cos \frac{2\pi t}{C_2}
\end{aligned}
$$

The variables are defined as:

- P'_t = predicted average weekly cash price of market hogs in dollars per hundredweight
- t = linear time trend in weeks (first week of 1970 equals one)
- S = six month seasonal length (26 weeks)
- C_1 = 2.75 year short cycle length (143.5 weeks)
- C_2 = 9.0 year long cycle length (470 weeks)

The fifth predictor, a causal model, attempts to duplicate a cause and effect relationship among real world phenomenon. Although price is determined by both supply and demand, the variables tested in this study emphasize supply factors. In an attempt to determine the amount of variation in hog prices that is due to changes in supply, hog prices were regressed on trend, seasonality factors, and average hog slaughter. This regression produced an R^2 value of 0.8610, which indicates that approximately 86 percent of the variation in hog prices during this sample period is the result of variation in hog numbers. Numerous combinations of the following data series were tested in trying to explain market hog prices: U.S. federally inspected hog slaughter; U.S. federally inspected sow slaughter; U.S. pork production, hog-corn ratio; USDA estimates of 14 state inventories of breeding hogs, market hogs, and total hogs. The best fit obtained for a 16-week forecast has an R^2 value of 0.8892. The model is given in equation 2.

$$
\begin{aligned}
(2)\quad P'_t = {} & \underset{(10.82)}{96.09} + \underset{(8.87)}{.0419}\, t + \underset{(7.11)}{2.816} \sin \frac{2\pi t}{S} + \\
& \underset{(3.53)}{1.264} \cos \frac{2\pi t}{S} - \underset{(2.65)}{.0049}\, HS_{t-16} + \\
& \underset{(2.67)}{.0734}\, ARSS_{t-37} - \underset{(5.78)}{7.897}\, BHI_{t-32}
\end{aligned}
$$

The variables are defined as:

- P'_t = average weekly market hog prices per hundredweight at time t
- t = linear time trend in weeks
- S = 26-week seasonal length
- HS = 5-week moving average of U.S. federally inspected hog slaughter
- ARSS = 5-week moving average of residual sow slaughter. The residual sow slaughter is developed by regressing sow slaughter on trend and a twelve-month seasonal component
- BHI = USDA estimate of 14-state breeding hog inventory

The best fit obtained for a 46-week forecast yields an R^2 of 0.8111. It is given in equation 3.

$$
\begin{aligned}
(3)\quad P'_t = {} & \underset{(4.72)}{66.47} + \underset{(4.36)}{.0389}\, t + \underset{(5.42)}{1.917} \sin \frac{2\pi t}{S} + \\
& \underset{(1.84)}{.6352} \cos \frac{2\pi t}{S} + \underset{(2.50)}{.1958}\, HCR_{t-52} - \\
& \underset{(3.98)}{6.505}\, BHI_{t-46} + \underset{(2.11)}{.0645}\, ARSS_{t-46}
\end{aligned}
$$

HCR represents the hog-corn ratio in Omaha. The other variables were previously defined.

The simulation model uses the predicted prices to make decisions about sow herd size and feeder pig sales. It should be noted that the causal and cyclical predictors have enhanced accuracy because they were developed with the use of the same data series that they are meant to predict.

RESULTS

The results of the simulation model for selected management strategies and price prediction methods associated with pasture and confinement farrow-to-finish systems are shown in Tables 1 and 2, respectively.

The simulation model shows a positive accumulated total return to land, risk, and management for all strategies simulated except two. The returns to the confinement system are greater than to the pasture system for all management strategies, regardless of the price forecast method used. The higher returns associated with the confinement system result largely from a greater number of sows and more frequent farrowings. However, even on a per-litter-farrowed basis, the confinement system shows greater profitability than does the pasture system. Using the nonflexible strategy, the confinement system shows a net return of $101 per farrowing, as compared to $57 for the pasture system. However, when the rate of return on investment is calculated, the relationship is reversed. The an-

TABLE 1. Accumulated Returns, Standard Deviation of Annual Cash Flows, Maximum Debt Load, Payback Period, and Years with Negative Cash Flows Using Selected Management Strategies for a 40 Sow Farrow-to-Finish Pasture System, Oklahoma 1970–79

Price Prediction Method	Type of Flexibility	Accumulated Ten Year Returns	Standard Deviation of Annual Cash Flows	Maximum Debt Load	Payback Period	Years With Negative Cash Flow
		($)	($)	($)	(Weeks)	(No.)
Naive	Optional Feeder Pig Sales	8,138	12,276	51,818	491	5
	Variable Sow Numbers	8,580	13,605	47,378	523	4
	Both	-3,382	13,886	53,666	Failed[a]	7
Futures Market	Optional Feeder Pig Sales	29,849	10,727	41,814	322	4
	Variable Sow Numbers	17,415	18,033	42,941	352	4
	Both	11,186	14,907	47,628	323	5
Hedging	Optional Feeder Pig Sales	36,531	10,054	42,214	322	3
	Variable Sow Numbers	-1,974	14,932	47,995	391	6
	Both	11,798	14,130	43,379	325	5
Causal	Optional Feeder Pig Sales	53,042	12,887	41,807	318	2
	Variable Sow Numbers	55,480	13,105	38,832	217	4
	Both	54,708	14,773	40,816	217	3
Cyclical	Optional Feeder Pig Sales	60,880	13,795	39,853	308	4
	Variable Sow Numbers	61,448	13,471	40,084	321	4
	Both	63,076	14,117	38,720	201	4
Perfect	Optional Feeder Pig Sales	63,337	13,302	41,143	308	2
	Variable Sow Numbers	64,546	12,855	35,631	217	3
	Both	74,284	13,056	36,665	193	2
None	Constant, Full Production	44,537	13,019	45,035	334	3

[a] Management strategy failed to generate sufficient returns to eliminate debt during the simulated period.

TABLE 2. Accumulated Returns, Standard Deviation of Annual Cash Flows, Maximum Debt Load, Payback Period, and Years with Negative Cash Flows Using Selected Management Strategies for a 90 Sow Farrow-to-Finish Confinement System, Oklahoma 1970–79

Price Prediction Method	Type of Flexibility	Accumulated Ten Year Returns	Standard Deviation of Annual Cash Flows	Maximum Debt Load	Payback Period	Years With Negative Cash Flow
		($)	($)	($)	(Weeks)	(No.)
Naive	Optional Feeder Pig Sales	158,956	45,147	142,010	366	3
	Variable Sow Numbers	82,460	49,047	159,331	493	4
	Both	137,143	46,809	146,867	382	3
Futures Market	Optional Feeder Pig Sales	162,379	43,153	141,089	325	2
	Variable Sow Numbers	121,354	43,438	142,549	341	3
	Both	142,060	49,045	136,991	326	3
Hedging	Optional Feeder Pig Sales	165,778	45,397	139,795	326	2
	Variable Sow Numbers	41,321	42,614	135,440	523	4
	Both	111,055	49,983	136,108	357	3
Causal	Optional Feeder Pig Sales	222,029	40,496	142,372	309	2
	Variable Sow Numbers	187,416	39,277	142,275	333	3
	Both	213,943	44,010	140,018	318	2
Cyclical	Optional Feeder Pig Sales	233,607	48,414	141,609	309	3
	Variable Sow Numbers	195,748	42,467	140,561	333	2
	Both	231,420	49,002	141,117	309	3
Perfect	Optional Feeder Pig Sales	247,593	44,408	139,556	302	2
	Variable Sow Numbers	212,473	44,246	131,966	317	3
	Both	247,841	44,265	136,952	302	2
None	Constant, Full Production	191,076	45,442	148,470	341	2

nual rate of return on investment (excluding land) for the pasture system under the nonflexible strategy is 17 percent, while the rate of return to the confinement system using the nonflexible strategy is 10 percent.

As would be expected, there appears to be an inverse relationship between the total accumulated returns, payback period, and the number of years with negative net cash flow. Strategies that produce greater total returns also result in shorter payback periods and fewer years with negative cash flows. For the confinement system, all but one of the simulated strategies result in a lower maximum debt than does the nonflexible strategy. Thirteen of the eighteen strategies simulated for the confinement system have lower levels of debt than does the nonflexible strategy. Maximum accumulated debt does not appear to be highly correlated with final returns.

There appears to be no clear-cut relationship between the standard deviation of annual cash flows and the other financial measures reported. All strategies result in wide fluctuations of annual cash flows. This variation appears to be independent of the type of production flexibility and simulated price prediction method.

Perfect Predictor

Compared to the nonflexible, full-capacity strategy, strategies using the perfect predictor generate higher net returns for both the pasture and confinement systems. As would be expected, production and marketing flexibility is a definite asset when a perfect predictor is simulated. The difference in returns to the confinement system between the strategy of allowing optional feeder pig sales ($247,593) and the strategy of allowing both variable sow herd size and optional feeder pig sales ($247,841) is very small. The small difference indicates that, for the confinement system, flexibility in sow herd size is not needed if the option of feeder pig sales is available. The additional returns from allowing variable sow numbers are negligible, even when using a perfect price predictor. The inclusion of the option of varying sow herd size basically adds only the possibility of incorrect decisions. This is why the greatest returns in the confinement system for each of the other price prediction methods results when sow herd is held at capacity.

The simulation using the perfect predictor indicates that approximately one-third of the litters produced by either the pasture or confinement system should be marketed as feeder pigs. There are 64 farrowings possible for the confinement system during the simulated period. Three times the perfect predictor indicates that the expected returns from breeding and farrowing a group of females is less than zero. At these times, the sows scheduled for breeding are sold. One time the model indicates that farrowing sows is profitable, but that farrowing gilts is not. As a result, no replacement gilts are added to the herd, and only 20 sows are farrowed. The remaining 60 times, the maximum number of 30 females are farrowed. Of the 39 farrowings possible for the pasture system over the 10-year period, 31 times the maximum number of sows (20) are farrowed, 7 times no sows are farrowed, and one time 13 sows are farrowed.

Naive Predictor

There is a definite negative benefit or cost associated with using the naive price prediction model to make flexibility decisions. The net revenues for this predictor are lower than the nonflexible strategy for both pasture and confinement systems. The option of allowing both variable herd size and feeder pig sales in the pasture system gives the lowest returns (−$3,382) of any strategy tested. Although these returns appear very low, they are not as low as they might have been. Fixed costs of the two systems were calculated to give an idea of possible variation in returns. Had no hogs ever been raised, the pasture system would have an accumulated loss of $41,680, and the confinement system would have lost $109,896 during the ten-year simulation period.

Futures Predictor—Without Hedging

In all cases, the futures market predictor yields returns greater than the corresponding amount offered by the naive predictor, but inferior to the nonflexible strategy. The greatest returns from using the futures market as a price predictor for both the pasture and confinement systems are from the feeder pig sales option.

Futures Predictor—With Hedging

Hedging combined with flexible production does offer the possibility of increasing net returns over some nonhedging strategies. In no case are the returns from hedging superior to the nonflexible strategy. In some cases, the returns are less than what would have been earned had the pigs not been hedged. When the strategy of optional feeder pig sales is included, the hedge is placed when the pigs reach 50 pounds or 16 weeks prior to marketing. When the feeder pig sales option is not included, the pigs are hedged when the sows are bred, 46 weeks prior to marketing. The different hedging periods account for most of the differences in the returns. During the 1970s, the long-term futures market price consistently underestimated hog prices. The mean price for 230-pound market hogs at Oklahoma City during the 1970s was $37.90. The mean of the futures price (adjusted for an Oklahoma City basis) for delivery in 16 weeks was $36.84. The mean of the 46-week ahead futures price for the period was $34.28. As a result, hedging pigs at 50 pounds results in a slightly lower average price received than when not hedging. Hedging at breeding results in a sharply lower price received since the 46-week futures price was used.

Causal Predictor

In all cases except one, the causal predictor yields returns greater than the nonflexible strategy. Combining the causal predictor and sow number flexibility in the confinement system resulted in lower returns that the nonflexible, constant full-capacity strategy. For the pasture system, the feeder pig sales option gives the lowest returns and the variable sow herd size the highest, while the ranking is reversed for the confinement system.

Cyclical Predictor

The simulation using the cyclical price predictor yields returns superior to both the nonflexible strategy and the causal predictor for all three types of flexibility for both the pasture and confinement systems. For the confinement system, the option of selective feeder pig sales gives the greatest returns, while the strategy allowing both types of flexibility has the highest returns for the pasture system.

CONCLUSIONS

Producers can increase profits by adjusting output to the extent that there is a positive correlation between expected and realized prices. The simulation model using a perfect price predictor indicates that production and marketing flexibility enhances accumulated net returns over the simulated ten-year period. Results show, assuming perfect price information and both production and marketing flexibility, that profits increase 67 percent for the pasture system and 30 percent for the confinement system over the full-capacity nonflexible strategies. The greater returns tend to correspond with shorter payback periods and fewer years with a negative cash flow. However, the magnitude of returns does not appear to affect the standard deviation associated with annual cash flows or the maximum debt load.

Net returns are significantly reduced from a full-capacity strategy if current prices are used as the basis for flexibility decisions. For this naive predictor case, the greater the flexibility, the lower the profits.

The futures price predictor gives results superior to the naive predictor. Basing production-marketing strategies on the futures price fails to increase profits over the nonflexible, full-capacity strategy. The addition of hedging to the futures predictor offers the opportunity to increase returns, but returns fall short of the nonflexible strategy.

The causal predictor gives returns greater than the nonflexible strategy for all options, except only varying sow numbers in the confinement system.

The simulation model incorporating the cyclical hog price prediction equation is more profitable for both the pasture and confinement systems than the nonflexible strategy for all three types of flexibility.

In conclusion, the success of adaptive planning appears to be directly correlated to the accuracy of the price information used. But it appears that a method of predicting prices that is more accurate than the futures market is needed before flexibility as modeled in this study becomes profitable. However, if a method of predicting prices that is more accurate than the futures market can be developed, then speculating directly in the futures market might prove a quicker and less risky path to riches than producing hogs.

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