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ARTICLES

Comparing Alternative Closed Swine Production Cooperatives: Adding Value to Corn Under Uncertainty

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Returns from establishing closed (defined membership) cooperatives owned by grain producers to produce hogs in Iowa are evaluated. Using a computer-simulated production model incorporating biological and price factors and statistical techniques, uncertainty of production and the market environment are modeled. The returns to each farmer-member are analyzed, and the distributions of value added and total payments for each operation are ranked using a stochastic dominance criteria. Additionally, the net present value of each cooperative is computed and these are compared against each other.

Rapid changes in the hog production sector over the past decade have created the need for traditional producers to seek new and innovative approaches to how production is done. Before the late 1980s, the vast majority of production occurred on diversified crop and livestock farms in the western Corn Belt states (Rhoades and Grimes 1995). Grain produced on farm or locally was fed to hogs to add value in the face of weak basis[1] and the need to diversify income sources. Farm demographics, increasing technical complexity, and increasing capital requirements for both crops and livestock have challenged the traditional diversified corn soybeans and hogs production system. At the same time, the rise of large, intensively managed production systems with low production costs in the Southeast has added further competitive pressure on the traditional producer in the Midwest (Grimes and Rhoades 1994). "The U.S. pork industry is rapidly evolving from one of relatively small independent producers and processors connected by the spot market to a contract-coordinated industry involving fewer and substantially larger firms" (Lawrence et al. 1997). Contracting and other features of the

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operations in the Southeast are now increasingly prevalent in the western Corn Belt production areas. These changes have been characterized, and Schrader and Boehlje (1996) documented examples throughout Europe and the United States.

These changes have created a great deal of concern in the traditional western Corn Belt production areas (Good et al. 1995). The key role of hog production in the farm financial structure and its importance as a means for farmers to market grain more profitably lend urgency to the issue (Schrader and Boehlje 1996). Farmers have traditionally looked to the cooperative form of organization to address this type of situation. It offers a great deal of flexibility in pursuing different producer goals. Farmers have attempted to use cooperatives as a means to adapt to the changing structure through existing and, in some cases, newly formed cooperatives.

However, federated farm input supply and marketing cooperatives have faced controversy as they have approached the need to make adjustments to the changing industry. While many have developed a variety of excellent options for producers, most of these options involved providing feeder pigs as an input for members' finishing operations or contracting with farmers for finishing. Portions of the membership have viewed these efforts as competing with more traditional producers (Hogeland 1995). Few have offered grain producers the option of marketing corn through the hog operation with the choice as to whether they provide finishing labor and buildings. The Valadco Cooperative in Minnesota is one example of a cooperative that has offered this option (Schrader and Boehlje 1996). It differs from most federated input supply cooperatives in that it is a closed membership cooperative. This effort was also viewed by some as competing with traditional producers. Both the federated cooperative approach and the Valadco approach are useful in some circumstances.

Open Versus Closed Cooperatives

Open membership cooperatives have been used extensively by producers in the marketing of farm products and the purchase of farm production inputs. The open membership form has proven to be well adapted to these activities. However, open membership cooperatives have not been as widely employed in production or processing cooperatives. Differences in the ways the two types of cooperatives are capitalized and the ways financial benefits are distributed may be important factors in the use of the closed cooperative form in these activities.

In most open cooperatives no fixed level of capitalization is required, and the real financial value returned to the member is a function of the percentage of the patronage refund returned in cash and the length of time between the issue of the deferred portion of the patronage refund and the time when the deferred portion is redeemed in cash (Junge and Ginder 1986). Where cooperatives are involved in providing feeder pigs on a buy-sell basis as an input to the members' finishing enterprise, open cooperatives requiring lower levels of up-front capitalization and using deferred patronage programs have worked well. However, the remaining members in the cooperative must be willing to provide the necessary equity to make the initial investment and launch the venture even though many of them are not using the service. This has led some federated input supply cooperative programs to require capitalization from those members receiving feeder pigs. For example, the Land O'Lakes Swine Alignment program and the Farmland Industries Alliance Farm program both require up-front investments.

Open cooperatives have not been as widely used for production and further processing as closed (or defined membership) cooperatives. The closed form is particularly well suited for activities where members desire more direct and immediate return of financial benefits and where they are willing to commit the needed capital and their business volume to the cooperative at the time they join.

In order to return financial benefits promptly as cash, the closed cooperative is organized and operated much differently then the open cooperative. Membership is strictly defined by the capacity of the cooperative plant in the closed cooperative. Unlike the open cooperative structure, each member is required to make a defined capital commitment and a defined volume commitment for each share owned. The closed cooperative does not face uncertainty in acquiring raw products from its members. Where members desire to add value to corn through joint hog production, this form of committed production cooperative may provide some distinct advantages (Ginder 1995).

As farmers approach the question of whether or not to organize a closed cooperative for hog production, several critical issues must be addressed. Potential members must consider the costs, returns, and risks associated with the venture. The level of equity capitalization members are willing or able to provide must also be established. Since the equity is not earned through patronage, as in the existing open cooperative, farmers must be willing and able to provide the required level of risk capital up front and in cash. Finally, the group organizing must decide which type of operation will most effectively achieve their goals. Since producer goals for hog production vary it is desirable to have a variety of options to fit the needs of different producers (Ginder 1995). Some are primarily seeking a means to market and add value to the corn they produce and to diversify income risk. Older producers and producers with large capital and management demands from the cropping operation may wish to gain these same benefits from hog production. Other producers may wish to market their labor in addition to realizing the value added and reduction in income-risk goals. Younger producers with better health and less equity may wish to gain these benefits. The heavy capital demands of building a state-of-the-art hog production system frustrate the goals of both of these producer groups. To obtain the economies of scale required to compete effectively with the large, intensively managed systems it is necessary to have significantly larger equity levels than most farmers can provide by themselves. "To compete, many of today's hog producers must increase efficiency to match the efficiency standards of the large producers. They should be able to help themselves in this effort through cooperatives" (Rhoades 1994).

Examining Closed Cooperatives

This paper examines the risks and returns from establishing a closed cooperative in Iowa for the purpose of producing hogs on a large scale in a state-of-the-art, 2,400-sow operation. The closed cooperative model was used in this study to pass back net margins generated in hog production. The patronage relationship was based on corn the members provided to feed the production unit. It was assumed that the cooperative was capitalized by grain producers and that their objective was to add value to corn by feeding it through hogs. The equity capital required (at the assumed level of leverage) was divided by the quantity of corn consumed annually by the hogs in the production facility to arrive at an equity requirement per bushel. Shares were denominated in 5,000-bushel delivery units to establish the up-front capital requirement per share. Net margins were distributed in proportion to the number of bushels delivered. Thus, each member provides the capital associated with 5,000 bushels and receives the net margins associated with those bushels.

Twelve specific cooperative production systems were defined for this analysis based on (1) owned or contract finishing, (2) marketed gilts or multiplier herd supplier, and (3) debt-to-equity structure. The base production operations fell into two main categories: farrow-to-finish and farrow-to-wean with contract finishing. The farrow-to-finish operations were set up as three-site production operations with the cooperative raising market hogs from the farrowing stage all the way through the finishing stage, at which time the hogs were sold as market hogs. All of the facilities, including nurseries and finishing buildings, were owned by the cooperative in the farrow-to-finish operations.

The farrow-to-wean with contract finishing operations also raised market hogs. However, the breeding and gestating and farrowing facilities were the only buildings owned by the cooperative in these operations. After weaning from the sow, the pig was placed in a rented nursery facility. Once the weaner pig reached approximately 60 pounds it was moved into a rented finisher facility. The finisher facilities were contract rented (including utilities, bedding, and waste disposal) for the year on a pig-space basis. The contract farmer was responsible for the finishing process with all other inputs provided by the cooperative.

In the farrow-to-finish and farrow-to-wean operations, a multiplier herd was added to each operation to provide another variation of the production operation. The cooperatives with multiplier herds select gilts at the end of the finishing stage, much like a seed stock supplier. While the opportunity to sell select gilts may not be present in many cases, there are opportunities in some areas to market breeding gilts at a premium price. Where these opportunities exist the farrow-to-finish as a multiplier herd and the farrow-to-wean as a multiplier herd operations analyzed would be a viable choice. Where there is little or no demand for breeding gilts these operations should not be considered. The only difference was the premium that was paid for the select gilts sold as multiplier herd animals. The select gilts consumed similar amounts of feed, received similar care, and were given similar medication throughout all stages of production. Thus, the production costs were the same for select gilts and market hogs. However, the multiplier herd gilts generated more sales revenue than market gilts. These production classifications generated four unique hog production operations: farrow-to-finish, farrow-to-finish as a multiplier herd, farrow-to-wean, and farrow-to-wean as a multiplier herd. In each of the four types of hog production operations, the level of equity contributed was varied over three levels set for comparison: low, medium, and high equity contributions.

The equity capital levels for the farrow-to-finish operations were decomposed into three categories based on the type of capital asset needed. These were total (1) construction capital, (2) breeding herd capital, and (3) operating capital sufficient to finance three months' operation at full capacity. The equity structures were based on current banking requirements for minimum equity contribution percentages required for operations of this type. It was determined that lenders for operations of this size and type typically require a minimum 30% equity contribution for total construction capital. The minimum equity contribution required to finance the breeding herd was 40% to 50%. Finally, the minimum equity requirement for operating capital was 65% to 85% of the operating capital requirement for a three-month period.

Table 1 shows the equity required for the proposed cooperatives. The equity structure used is shown in column one as a percentage of total construction capital, breeding herd capital, and current (three months') operating capital, respectively. The cash requirements associated with each equity structure are shown in the remaining columns to the right, with the total equity required per bushel in the last column on the right.

Equity for the farrow-to-wean with contract finishing operations was handled differently. Construction and facilities capital requirements were lower in this operation when compared to the farrow-to-finish operations. However, there were substantially higher variable expenses associated with paying contract-finishing fees. Therefore, the farrow-to-wean (with contract finishing) operation typically had a higher equity contribution requirement for the three months' operating cash contribution.

Table 1. Equity Positions and Equity Requirements

Equity Structure	Construction	Breeding Herd	3 Months' Operation	Total Equity	Total Equity per Bushel
		Farrow-to-Finish Operations			
30-40-65	$1,922,029	$321,360	$809,250	$3,052,639	$5.02
30-45-75	$1,922,029	$361,530	$933,750	$3,217,309	$5.29
30-50-85	$1,922,029	$401,700	$1,058,250	$3,381,979	$5.56
		Farrow-to-Wean Operations			
30-40-100	$692,460	$321,360	$1,450,302	$2,425,602	$3.99
30-45-117	$692,460	$361,530	$1,696,853	$2,712,323	$4.46
30-50-133	$692,460	$401,700	$1,928,902	$2,984,542	$4.90

Table 1 also shows the equity structure used and the cash requirements for each of the farrow-to-wean with contract finishing operations. The first column shows the equity requirement as a percent of total equity required for construction, breeding herd, and current (three months') operating capital, respectively. The remaining columns show the dollar amount required for construction, breeding herd, and three months' operating capital for each of the three equity structures analyzed. The total equity dollars required per bushel associated with each structure are shown in the far right column. Cooperatives using contract finishing paid $32.00 per nursery space per year and $34.00 per finisher space per year. In these contracts the cooperative must supply the needed dietary and health inputs required for the finishing stage.

Table 2 lists all twelve operations analyzed. The first set of letters denotes the production classification of the operation, farrow-to-finish (FTF), farrow-to-finish as a multiplier herd (FTFMH), farrow-to-wean (FTW), and farrow-to-wean as a multiplier herd (FTWMH). The second position denotes whether or not the hog production operation owns the finishing facilities (O) or contracts buildings for the finishing of hogs (C). In the third position, the level of the equity contribution is given as low (L), medium (M), or high (H). See Appendix A for more detailed specifications of the individual production setups.

Table 2. Closed Cooperative Operations Analyzed

Operation	Low Equity	Medium Equity	High Equity
Farrow to Finish	FTF.O.L	FTF.O.M	FTF.O.H
Farrow to Finish as Multiplier Herd	FTFMH.O.L	FTFMH.O.M	FTFMH.O.H
Farrow to Wean with Contract Finishing	FTW.C.L	FTW.C.M	FTW.C.H
Farrow to Wean with Contract Finishing as a Multiplier Herd	FTWMH.C.L	FTWMH.C.M	FTWMH.C.H

To effectively evaluate the performance of the cooperative hog production operations, Iowa State University Extension's TEAM Pork swine production model, Swine Feasibility Analysis, was used. This model permits both financial and biological parameters to be varied. The key stochastic biological variables[2] in the model were: farrowing rate, pigs weaned per liter, nursery mortality, and finisher mortality. The stochastic price variables[3] were: corn, soybean meal (44%), sows, barrows and gilts, feeder pigs, and weaner pigs. Using a large swine production database (PigChamps) maintained by University of Minnesota for biological data and historical price data from Iowa State University Extension, each biological and price variable was modeled, and estimation techniques were then used to determine the production performance from each proposed cooperative under uncertainty.

Since the main objective of these closed cooperatives was to provide an additional corn marketing opportunity for grain farmers, a marketing contract was established. As specified in the cooperative's uniform marketing contract, all cooperatives required the owner of each share to deliver 5,000 bushels of corn a year for a minimum period of five years. The farmer-members were paid the Posted County Price[4] (PCP), $1.74 per bushel, when they delivered corn to the cooperative. At the end of each quarter, the hog production operation made a second cash advance payment, Quarterly Corn (QC) payment = Average Cash Corn Price at Local Market - PCP, based on the average corn price at the principal local market for corn. A ceiling was established for the QC at $1.50 per bushel.

This effectively caps the corn price at approximately $3.25 per bushel until the final value-added payments are made. The QC payment cap was used to provide the cooperative with some protection when cash market corn prices rise extremely high, as was the case in 1996, for example. In the spring and summer of 1996, the farmer members could have sold their corn for more than the QC on the cash market. For the cooperative to be viable, members must commit to a long-term, value-added activity, which may not add value at all times.

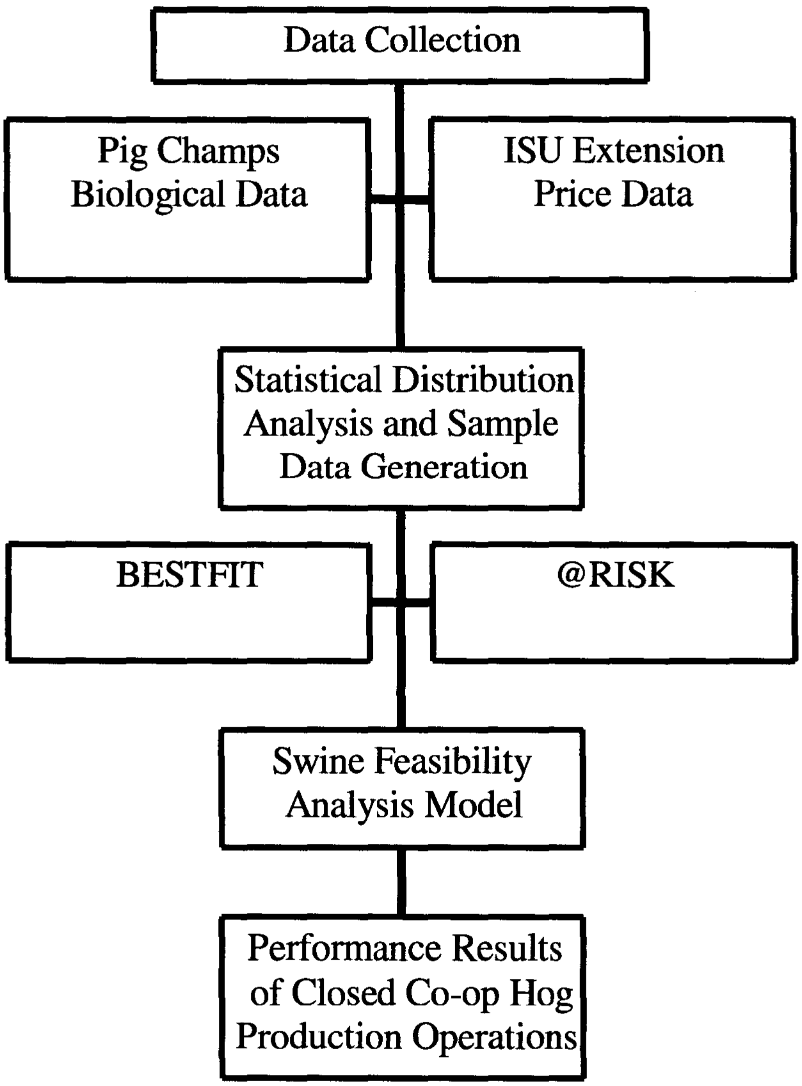
This commitment is quite similar to the one farmers make when they invest in livestock enterprises on their own farms. They must continue to feed their animals when the cash market prices are high. However, since the hog production cooperative is an independent entity with independent financing, there must be assurance that it can meet its own cash requirements during short-run periods of adverse prices. If members were to take a QC payment larger than $1.50, there would be the potential for the hog production operation to become unprofitable because the cooperative lacks operating cash. Additionally, most lenders would not permit such excessive payments to equity holdings when cash flow problems arise.

A final, value-added (VA) payment was made at the end of the year. This VA payment was based on accumulated cash at the end of the year after all expenses (including depreciation) and after cash obligations, including principal and interest on long-term and intermediate-term loans and line of credit payments, have been met. This final payment incorporated the extra value gained from feeding the corn through livestock. It would be possible to eliminate the QC payment and roll all the proceeds into the VA payment if deemed appropriate by a specific cooperative during formation.

Procedure

The following procedure was used to empirically evaluate the performance of the proposed cooperatives. Biological data was collected from the PigChamps database and price data was collected from Iowa State University Extension. A computer software program called BESTFIT® [5] was used to analyze the data and determine the distribution parameters for each biological and price variable. The results from BESTFIT® were then used in @RISK® [6] to perform Monte Carlo data simulations. The simulated data was used in the Swine Feasibility Analysis (SFA) model to generate returns for each of the proposed hog production operations. The returns were sorted and the payment distributions were calculated from these outputs. See figure 1 for a diagrammatic summary of the procedure used.

Figure 1. Procedure Summary



To incorporate uncertainty into the production model, the statistical distributions for the price and biological variables used were also calculated. The price variables were assumed to be distributed log normal. In Osborne (1959) it was derived that stock prices are distributed log normal; we extended the results to commodity prices. The biological variables were modeled using the beta distribution because of its flexibility. That is the probability density has the ability to take a variety of different shapes (Freund 1992). BESTFIT® was used to analyze the production and price data. Among other functions, BESTFIT® can be used to estimate the parameters of specified distribution given data.[7] The final results were used as inputs to @RISK® to generate samples from the specified distribution.

A key feature of @RISK® is that it permits the correlation structure among variables to be estimated and used in the data generation process. After approximating the correlation among the monthly price and biological data, this correlation structure was used as input for data generation in @RISK®. After the distributions for the uncertain production and price variables were identified by BESTFIT®, @RISK® was then used to generate five years of input data, on a monthly basis, for the SFA model. Each set of draws was used as input data for an iteration of the SFA model and the results were stored. This process was repeated one hundred times.

The computer-simulated production model used models production, pig flows, and cash flows and provides financial statements. Using the SFA model, the costs of production were easy to compute, along with detailed pig flows, for given assumptions about hog diet and the facility set up. The SFA model provides flexibility in selecting user inputs. This allows the model to be used by many different types of swine farms. The Growth Curve for the SFA model was computed based on the average daily gain of the barrows and gilts. It was assumed that the weight of weaned pigs was 12 pounds and that the weight of market hogs was 265 pounds.

The model also incorporated the effects of diets at different stages in the life cycle of the animal based on calculated growth curves. The model computed the average daily gain for each diet based on the ingredients the user specified. The weight gained on each diet was computed using the average daily gain of the diet and the length of time on the diet. The SFA model also computed pig flows required to maintain a constant flow of market hogs to be sold and to keep the sow-boar ratio at 20:1. In determining pig flows, the model factored in death loss in the nursery and finisher and the farrowing rate the user entered. Finally, the model specified the required boars and gilts needed after the effects of culling in the breeding herd.

In the startup budgets, the model assumes the land, building, and equipment will be paid for with equity first, and then with long-term loans, ten to twenty-five years, and that the cost for the breeding herd is covered by short-term loans, three to ten years. When a negative net cash flow occurred for any month, a line of credit was automatically assessed for the amount of negative cash flow, unless there was a large enough cash balance to cover the amount of the negative net cash flow. For this analysis, the output used from the SFA model was the cash accumulated after five years of operation. The cash accumulation after five years was used as an estimate for total net margins that could be passed back to the farmer-members at the end of a five-year marketing contract.

Results

The average annual farmer-member payments over a five-year period are listed in table 3. This would be the average payment made on a per-bushel basis for a five-year contract to deliver 5,000 bushels annually, or a total of 25,000 bushels over the five years. The Total Payment (TP) per Member column represents the average annual payment the member can expect to receive each of the five years, in dollars per bushel, for the corn delivered to the cooperative.[8] Compared to the Iowa average corn price from 1990 to 1995 of $2.24 per bushel, all operations provided the grain farmer with a means to add value to that portion of their corn marketed through the livestock production cooperative.

Table 3. Average Annual Member Payments by Source for Five-Year Period ($/bu), Standard Deviations in Paraentheses

Operation	Posted County Price Paid	Quarterly Corn Payment	Value-Added Payment	Total Payment per Member	Operation Avg. TP per Member
FTF.O.L	$1.74	$0.47	$0.40 (0.1767)	$2.62 (0.1571)	
FTF.O.M	$1.74	$0.47	$0.50 (0.1721)	$2.71 (0.1526)	$2.71
FTF.O.H	$1.74	$0.47	$0.59 (0.1690)	$2.81 (0.1495)	
FTFMH.O.L	$1.74	$0.47	$0.97 (0.1667)	$3.18 (0.1470)	
FTFMH.O.M	$1.74	$0.47	$1.06 (0.1653)	$3.27 (0.1456)	$3.27
FTFMH.O.H	$1.74	$0.47	$1.15 (0.1647)	$3.37 (0.1450)	
FTW.C.L	$1.74	$0.47	$0.09 (0.1835)	$2.31 (0.1638)	
FTW.C.M	$1.74	$0.47	$0.23 (0.1727)	$2.44 (0.1532)	$2.44
FTW.C.H	$1.74	$0.47	$0.35 (0.1695)	$2.56 (0.1500)	
FTWMH.C.L	$1.74	$0.47	$0.50 (0.1758)	$2.71 (0.1570)	
FTWMH.C.M	$1.74	$0.47	$0.63 (0.1676)	$2.84 (0.1479)	$2.84
FTWMH.C.H	$1.74	$0.47	$0.74 (0.1671)	$2.96 (0.1473)	

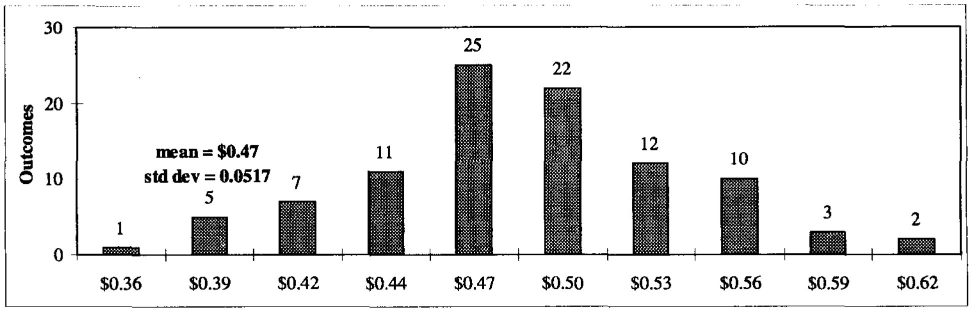
The QC payments were identical for all operations because it was assumed that they faced identical market conditions. The difference between the posted county price and the market price for corn was always the same regardless of the closed cooperative set-up and production methods. Only the VA payments differ significantly. This separation is useful in isolating the effects of fluctuations in the cash market for corn from the effects of value added from hog production. It is important for members to clearly understand where returns originated when they are weighing the benefits from membership in the closed swine production cooperative against the cash grain market alternative.

Distribution of Payments

The member payments were sorted, and distributions for each type of payment were constructed for each proposed cooperative. In the set up of the simulation model, the QC payments are made each quarter, and the amount of the payment was deducted from the cash accumulation. This ensures that producers receive local cash corn price during startup. However, during startup there are likely to be no VA payments. The VA payments were computed using the cash accumulation after the fifth year of operation. Using this as a proxy for determining the cash available to pay VA payments may not clearly identify the ups and downs of operations over the five-year period. They are, nevertheless, useful in evaluating whether to join the cooperative.

At the end of each quarter, the cooperative made a payment to each member based on the PCP as defined in the cooperative formation contract. The QC payment made was the difference between the PCP and the average Tuesday-Thursday close at the local elevator for that quarter. In this analysis, all operations faced identical feed input circumstances, prices, and biological performance inputs, resulting in identical QC payments for all operations. In figure 2, the QC payments look roughly normal, with the average payment each member received $0.47 per bushel. The QC payment can also be viewed as a risk management tool, giving the member-farmers the benefit of participating in a value-added activity, but not leaving them subject to the possibility of large windfalls in corn prices from a bull corn market.

Figure 2. Average Quarterly Corn Payments per Year ($/bu.)



Each farmer-member was eligible for a VA payment based on the cooperative's performance for the fiscal year. In the model used, this payment was calculated from the cash accumulation at the end of five years of operation and the total amount of corn delivered over five years, 25,000 bushels. Figure 3 shows the distributions of VA payments. Each graph includes the three equity levels for each type of operation.

Figure 3. Value-Added Payment Distributions

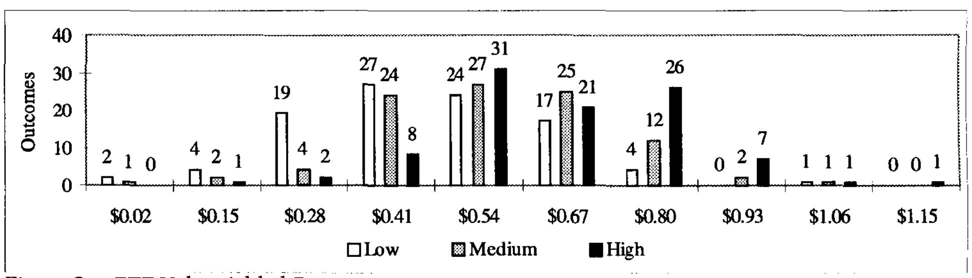


Figure 3a. FTF Value-Added Payments

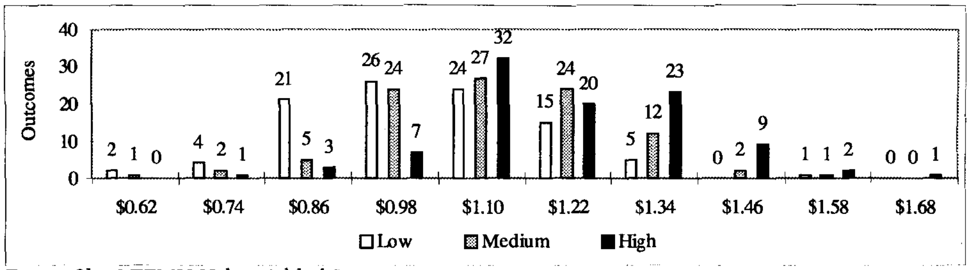


Figure 3b. FTFMH Value-Added Payments

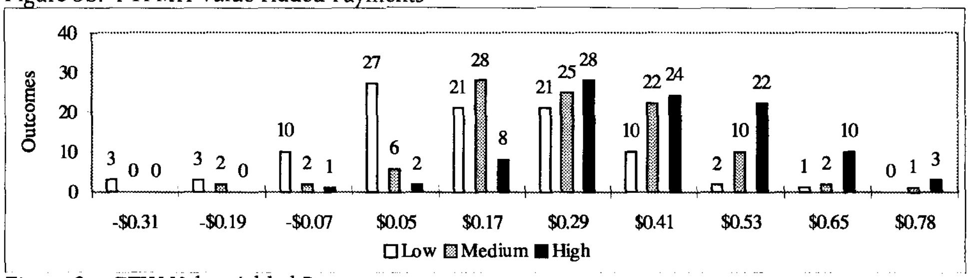


Figure 3c. FTW Value-Added Payments

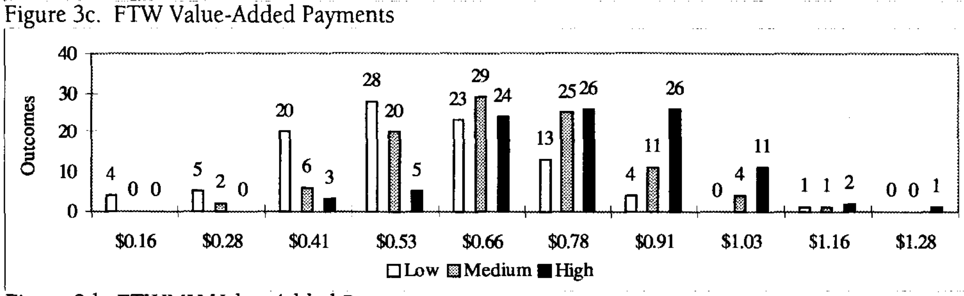


Figure 3d. FTWMH Value-Added Payments

The distribution of VA payments varied among the different hog production operations analyzed. In all hog production operations, the VA payments became increasingly skewed to the higher end of the payment scale as the equity contribution increased. For all operation types, FTF, FTFMH, FTW, FTWMH, higher equity levels increased the chance that the VA payment was in the top 30% of all payments for that operation type, as seen in table 4. Looking across the equity levels for each operation, there is a positive effect from the higher equity contribution. The increased equity contribution greatly increased the chances of generating a higher VA payment. This result is due, at least in part, to the cooperative's enhanced ability to sustain adverse operating results early in the production period (i.e., startup period) without additional borrowing. The SFA model's specification of paying off the line of credit before any other payments are made constrained the cooperatives with lower equity.

The TP payment per member was the sum of three payments, the PCP, QC, and VA payments. Figure 4 shows the distributions of the TP payments. The distributions appear to be roughly normal in shape, but there are significant differences in mean TP payment amounts (see also table 4). The skewness in the distributions has increased. In all operations, except for the FTFMH value-added payment, the percentage of outcomes from the high equity operations were concentrated at the higher end of the distribution.

Comparing table 4 values for the FTWMH, the VA payments that were in the top 30% were 14-5-1, for high-medium-low equity, respectively. The inequality in payments grew to 17-5-1 for the TP payment. Looking across all operations, it became evident that there was a clear, beneficial effect from relatively small increases (less than 10%) in the equity invested.

Figure 4. Total Payment Distributions

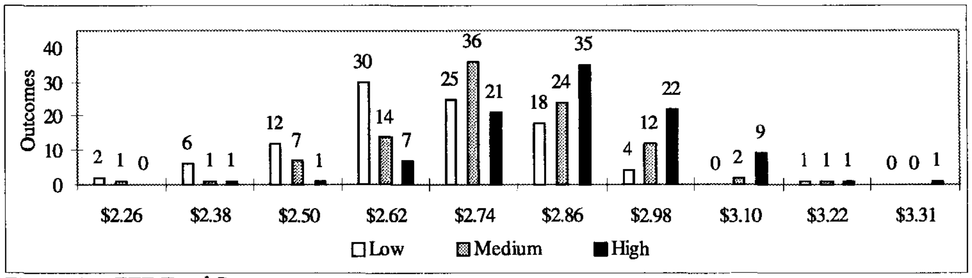


Figure 4a. FTF Total Payments

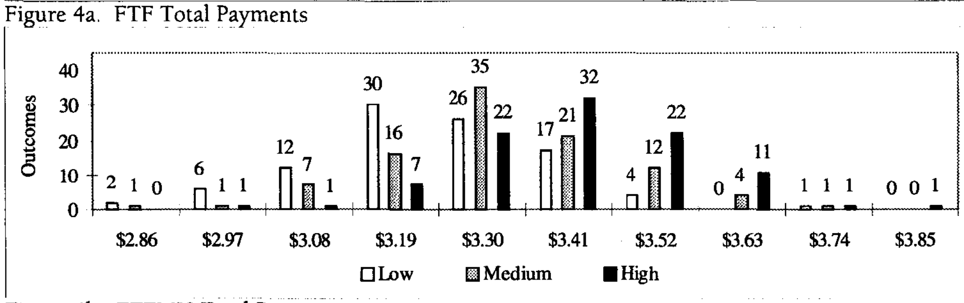


Figure 4b. FTFMH Total Payments

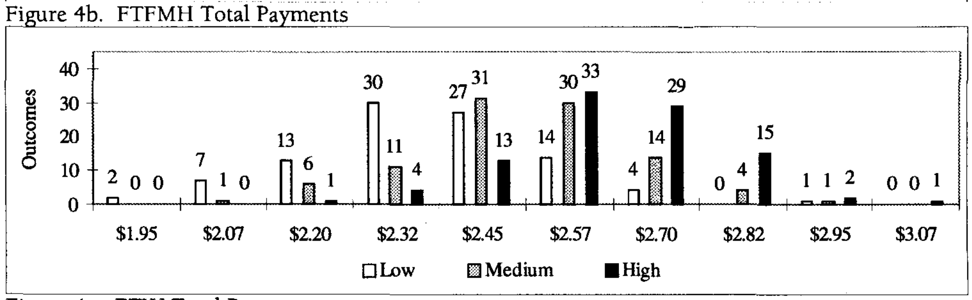


Figure 4c. FTW Total Payments

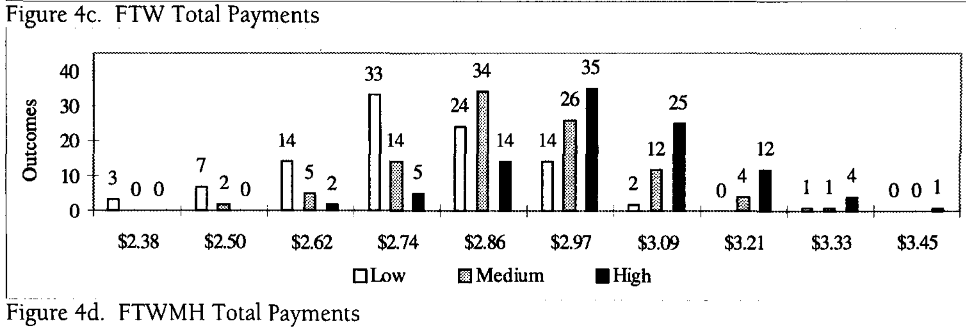


Figure 4d. FTWMH Total Payments

Table 4. Number of Times the Outcome was in Top 30% of Payments for Each Operation

Operation	Low Equity	Medium Equity	High Equity
	Value-Added Payments		
FTF	1	3	9
FTFMH	1	3	12
FTW	3	13	35
FTWMH	1	5	14
	Total Payments		
FTF	1	3	11
FTFMH	1	5	15
FTW	1	5	18
FTWMH	1	5	17

Using the standard deviation of each operation's payments as a measure of the risk associated with each operation, again the lower-capitalized non-multiplier herd operations performed much below the more highly capitalized multiplier herd operations. Comparing the FTFMH.O.H's and FTW.C.L's standard deviation values from table 3, the FTWMH.O.H cooperative was able to reduce the standard deviation of TP payments by approximately 12% over the entire five years. This may turn out to be a vital factor among farmer-members when considering forming or joining a cooperative. However, it is important to keep in mind that if all new hog production operations were to have multiplier herds, there could be a surplus of breeding animals and a reduction in the prices paid for these animals. But nevertheless, looking across all operation types, adding more equity reduces the standard deviation of all payment made.

Stochastic Dominance

The foregoing analysis gave no indication to which, if any, of the hog production cooperatives are superior to the others. Stochastic dominance provides a way of ranking risky alternatives without knowledge of decision-makers preferences (McCarl 1990). The stochastic dominance criteria used in this paper was second-order stochastic dominance (SSD). SSD was chosen over first-degree stochastic dominance (FSD) because FSD was unable to provide a complete ordering of probability distributions when preferences toward risk differed (Eichberger and Harper 1997). SSD requires that

$$\int_{-\infty}^{x} F(y)dy \leq \int_{-\infty}^{x} G(y)dy,$$

where $F(y)$ second order stochastically dominates $G(y)$. The distribution with the smallest area underneath it is the dominant distribution. It also follows from intuition, that the distribution with more of its area concentrated under the higher payment levels would be expected to provide more opportunities to achieve those higher payments.

Examining the stochastic dominance frontiers in figure 5, shows no drastic differences in the position or shapes of the VA and TP payment frontiers. The FTFMH cooperatives are clearly dominant under both payments. The FTFMH cooperatives were able to generate the highest levels of payments with the highest probability. On the opposite end of the payment scale, the FTW cooperatives were consistently dominated by all other cooperatives. The FTWMH cooperatives dominated all FTF cooperatives except the high equity FTF cooperative. The use of the cooperative as a multiplier herd supplier clearly increases the probability that the farmer-members will get the highest possible payment. The top five stochastically dominant cooperatives were all used as a multiplier herd. If the addition of a multiplier herd is not practical, then, to increase the probability of the largest payment, the operation would need to have higher levels of equity contributed.

Figure 5. Stochastic Dominance Frontiers

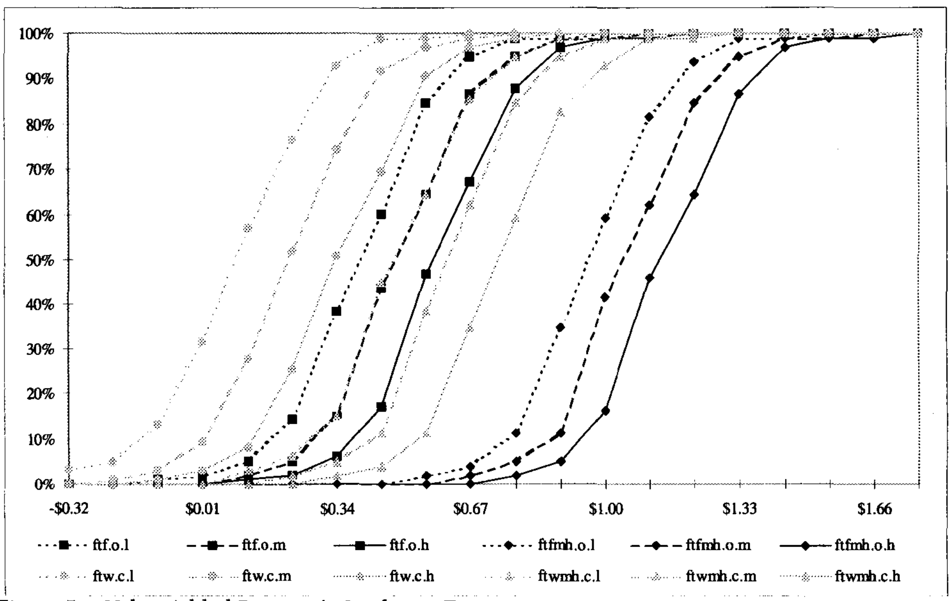


Figure 5a. Value-Added Payment's Stochastic Frontiers

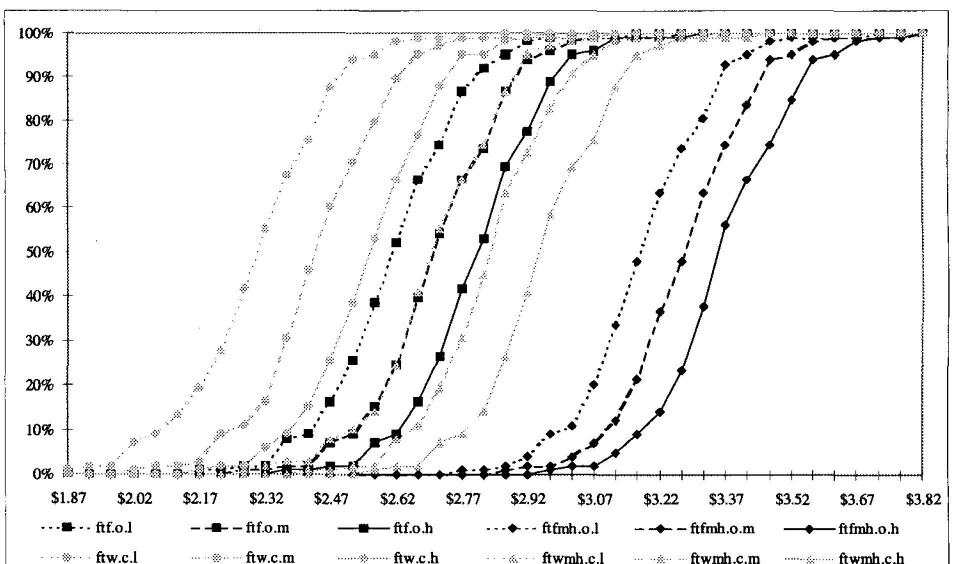


Figure 5b. Total Payment's Stochastic Frontiers

Net Present Value

The previous analysis focused on the magnitude of returns for each operation. What remains to be addressed is a comparison of all operations that accounts for both the varying levels of capital required and the timing of the value-added payments. For each operation, the Net Present Value (NPV) of each iteration was computed using a 5% discount rate. Table 5 reports the average NPV of investments made, weighted NPV[9] of investments made, maximum NPV generated from the investments made, the number of investments made (those that had a positive net present value), and the number of investments declined (those that had a zero or negative net present value).

Table 5. Net Present Value Breakdown

Operation	Average NPV of Investments Made	Weighted NPV of Investments Made	Max NPV of Investments Made	Number of Investments Made	Number of Investments Declined
FTF.O.L	$1,478402	$118,272	$2,680,308	8	92
FTF.O.M	$1,608,501	$579,060	$4,985,373	36	64
FTF.O.H	$1,748,110	$856,574	$5,678,306	49	51
FTFMH.O.L	$1,938,204	$1,860,676	$4,488,156	96	4
FTFMH.O.M	$2,565,197	$2,462,589	$5,169,337	96	4
FTFMH.O.H	$3,191,724	$3,127,890	$5,839,043	98	2
FTW.C.L	$438,217	$21,910	$628,470	5	95
FTW.C.M	$644,533	$174,024	$1,807,391	27	73
FTW.C.H	$1,107,026	$664,216	$2,998,304	60	40
FTWMH.C.L	$1,252,282	$751,369	$3,117,456	60	40
FTWMH.C.M	$1,791,553	$1,648,210	$4,311,763	92	8
FTWMH.C.H	$2,845,567	$2,788,655	$5,502,676	98	2

The NPV analysis incorporates the amount of capital required for each operation and allows direct comparisons to be made across the different types of operations. Additionally, the differential effects created by the timing of the value-added payments are also captured by the NPV. In those operations where VA payments were made earlier, higher NPVs were generated than in those where value-added payments occurred much later. Payments made later needed to be much larger to offset the benefits of receiving VA payments earlier.

All of the operations had a positive-weighted NPV. This indicated that, on average, these hog production cooperatives were profitable. However, the average NPV increased as more equity was added to each operation and, at the same time, the percentage of investments accepted, or those operations with a positive NPV, also increased. The weighted NPV also captures the lower probability of accepting the low equity operations. This result shows the greater chance of having a low or negative NPV when equity capital is inadequate. The multiplier herd operations had highest average NPVs and weighted NPVs of investments accepted when compared to their non-multiplier herd counterparts. In the comparisons between ownership of finishing facilities and contracting finishing facilities, the operations that owned the finishers had higher average NPV and weighted NPV of investments made compared to those operations that didn't own the finishing facilities. These comparisons imply two results for selecting the type of operation: (1) when conditions make it possible, having a multiplier herd may be good strategy (although market conditions for bred sows and availability of capital may not always permit these strategies, the economic returns indicate that they are superior) and (2) ownership of finishing facilities yields higher net present value when sufficient equity capital is available to finance it. For example, sixty farrow-to-wean operations were accepted at the high equity level versus only five such operations at the low equity level. The importance of greater equity capital was also apparent within the farrow-to-wean operations.

Summary and Conclusions

Closed, value-added swine cooperatives appear to be a viable alternative for Iowa grain producers as a means for adding value to grain production. Analysis of the four alternate swine production systems indicated that cumulative performance over a five-year period (including startup periods) resulted in positive cash flow and net income. This was true under all three different financial leverage positions evaluated.

For producers who are primarily interested in generating returns from feeding corn through livestock and the income diversification this provides, the farrow-to-finish (FTF) and farrow-to-finish as a multiplier herd (FTFMH) cooperatives proved to be the best option. Where there is an adequate demand for multiplier herd gilts and the cooperative is willing to fill it, an average return of $1.06 per bushel was possible. Producers joining such a cooperative may not have this option in all cases since it depends on a demand for select gilts.

Without the multiplier herd feature, producers could still expect an average return of $0.49 over the first five years of operation. These options would be well suited to producers, who for reasons such as age, physical limitations, or time limitations, do not wish to provide labor in the production activity. It should be noted that the contributed equity capital necessary for these operations is higher since nursery and finisher structures are owned by the cooperative rather than contracted.

However, since the transferability of interests makes the investment more liquid, the investment may be recovered more easily than building on the farm. Therefore, this option may be attractive to producers with limited time horizons who want the flexibility to liquidate their investment in hog production when they cease farming.

For producers who are interested in both adding value to corn produced and in earning a return for their labor, one of the farrow-to-wean (FTW) cooperatives might be a more appropriate choice. The farrow-to-wean as a multiplier heard (FTWMH) cooperative generated an average return of $0.62/bushel. However, the payments per pig space for nursery and finishing activities provide a means for members to earn a labor return for building nursery and finishing facilities that may be of value in the future. Younger producers with few physical limitations and a longer time horizon in hog production may be interested in these features. Such cooperatives might be useful as a means for entry by young producers and, in some cases, may promote intergenerational transfer between older and younger co-op members. For example, a father within eight or ten years of retirement might invest in the FTW cooperative for a corn return. A son, daughter, or son-in-law might build and operate a nursery or finisher under contract in order to obtain the contract payment per pig space. This permits an ownership position in facilities to be built by the young producer over a five- to seven-year period while a return for labor is taken. When the father wishes to exit farming, the interest in the FTW unit may be sold or transferred to the younger family member.

Several conclusions can be drawn from these results that may be useful to groups that are considering forming cooperatives. Using the cooperative as a multiplier herd generated higher margins for the operation from the sale of breeding females at presumed prices. Production systems not incorporating multiplier herds were universally inferior to those without a multiplier herd. Using owned finishing facilities provided higher value-added returns than contract finishing but required more equity capital from the owners. This trade-off is an important consideration for groups organizing.

Risk exposure decreased significantly when the additional equity was used and the cooperative choose the high-equity farrow-to-finish as a multiplier herd operation (FTFMH.O.H) over the low-equity farrow-to-wean with contract finishing (FTW.C.L) operation. A small increase in equity allowed the returns to increase markedly along with a reduction in the standard deviation of the returns. By using additional equity, on average, the farrow-to-finish as a multiplier herd cooperatives with owned finishers (FTFMH) were able to add an additional $0.83 per bushel each year over the farrow-to-wean with contract finishing cooperatives (FTW).

The stochastic dominance frontiers and the NPV analysis re-confirmed the previous findings. Increasing the equity contribution and establishing the cooperative as a supplier of select gilts generated the highest possible payments to farmer-members. These results also occurred with the most probability, and these operations had the highest NPV and weighted NPV of investments made. The results from the payment distributions, stochastic dominance, and NPV analysis show that adding relatively modest amounts of equity yields much higher returns. This, combined with operating as a multiplier herd supplier, greatly increases the viability of the closed cooperative swine production cooperative.

Selecting a production system and the appropriate level of equity is a difficult question facing producers who wish to form closed production cooperatives. Determining appropriate risk-reward combinations is also an important question. As potential cooperative members evaluate their alternatives for various production systems and levels of capitalization, these findings should provide useful insights.

Appendix A. Building, Production, and Economic Assumptions for All Operations

	Farrow to Finish	Farrow to Finish with Multiplier Herd	Farrow to Wean	Farrow to Wean with Multiplier Herd
Building Site Preparation	$24,000	$24,000	$12,000	$12,000
Manure Management System	$144,000	$144,000	$48,000	$48,000
Water Supply System	$36,000	$36,000	$19,200	$19,200
Electric Lines/Generator & LP Tanks	$79,200	$79,200	$75,600	$75,600
Acres of Land Needed	240	240	80	80
Average Price per Acre[9]	$2,071	$2,071	$2,071	$2,071
Community Acceptance and Legal Startup Fees	$50,000	$50,000	$50,000	$50,000
Breeding and Gestation	$1,026,000	$1,026,000	$1,026,000	$1,026,000
Farrowing	$768,000	$768,000	$768,000	$768,000
Nursery	$1,039,584	$1,039,584	N/A	N/A
Grow-Finisher	$3,058,980	$3,058,980	N/A	N/A
Isolation Building	$96,000	$96,000	$96,000	$96,000
Managers Home	$85,000	$85,000	$85,000	$85,000
Breeding and Gestation[10]	$450	$450	$450	$450
Farrowing[9]	$2,000	$2,000	$2,000	$2,000
Nursery[9]	$130	$130	N/A	N/A
Grow-Finisher[9]	$170	$170	N/A	N/A
Isolation Building[9]	$160	$160	$160	$160
Litters per Sow per Year	2.16	2.16	2.16	2.16
Market Hogs per Litter	8.53	8.53	8.53	8.53
Breeding Herd Cull Weight	400 lb.	400 lb.	400 lb.	400 lb.
Breed and Gestation sq. ft./space	11.0	11.0	11.0	11.0
Farrowing sq. ft./space	35.0	35.0	35.0	35.0
Nursery sq. ft./space	3.0	3.0	N/A	N/A
Grow-Finish sq. ft./space	8.0	8.0	N/A	N/A
Capacity of Nursery	8,000	8,000	N/A	N/A
Capacity of Grow-Finisher	18,000	18,000	N/A	N/A
Farrowing—rooms/crates	4/96	4/96	4/96	4/96
Labor (F.T.E.s)	14.63	14.63	14.63	14.63
Select Breeding Stock Premium	N/A	$25.00	N/A	$25.00
Avg. Number of Selects/Litter	N/A	2.2	N/A	2.2

Notes

1. Corn prices in the far western Corn Belt (e.g., northwestern Iowa, southern Minnesota, eastern South Dakota, and northeastern Nebraska) are historically low compared to prices in the eastern Corn Belt, which has lower cost access to most domestic processing and export markets.

2. Description of the biological variables: Farrowing Rate: $\bar{x}$ = 80.36%, s = 8.36; Pigs Weaned per Liter: $\bar{x}$ = 8.94 *pwpl*; s = 1.10; Nursery Mortality: $\bar{x}$ = 3.07%, s = 0.89; Finisher Mortality: $\bar{x}$ = 3.30%, s = 0.87.

3. Description of the price data used: Corn: $\bar{x}$ = \$2.21/bu., s = 0.4653, Iowa cash price, dollars per bushel, monthly averages, Iowa Department of Agriculture and Land Stewardship, Agriculture Market Division, Des Moines, Iowa. Soybean Meal: $\bar{x}$ = \$181.49, s = 32.12, 44% protein, FOB Decatur, monthly average, Iowa Department of Agriculture and Land Stewardship, Agriculture Market Division, Des Moines, Iowa. Sows: $\bar{x}$ = \$39.73/cwt., s = 7.14, Prices quoted at five Midwest markets: Omaha, Sioux City, St. Joseph, St. Paul, and Sioux Falls, monthly averages, U.S. Department of Agriculture (USDA). Barrow and Gilts: $\bar{x}$ = \$46.48/cwt., s = 6.91, Prices quoted at Iowa-southern Minnesota cash market for US#1-2s, 210 to 240 pounds, monthly averages, USDA. Feeder Pig: $\bar{x}$ = \$39.71/cwt., s = 9.68, Iowa average feeder pig price for US#1-2s, 40 pounds, monthly average, USDA.

4. 1996 average PCP for Iowa northwest crop reporting district.

5. BESTFIT® is a registered trademark of the Palisades Corporation. BESTFIT® is distribution fitting software that finds the statistical distribution function that best fits a data set.

6. @RISK® is a registered trademark of the Palisades Corporation. @RISK® is risk analysis and modeling software designed to be used in conjunction with BESTFIT®.

7. Five steps are used to determine the parameters that best fit the data set. Taken from the User's Manual: (1) Data is converted to the density distribution, (2) Maximum Likelihood Estimators are computed and used as a first guess at the parameters of the distribution, (3) the parameters are optimized using the Marquardt-Levenberg algorithm, (4) the goodness of fit is measured for the optimized function, (5) all results are then compared and the one with the lowest goodness of fit value is considered the best fit.

8. It should be noted that payments would not be expected during startup, and much higher payments than these averages would occur at later periods in the five-year projections. Averages were employed to characterize the returns for all bushels over the five-year period.

9. 1996 average dollar value per acre of farmland in the northwest crop reporting district (Duffy and Lillywhite 1996).

10. Cost per pig space for building.

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