# Economic Incentives for PST Adoption by Midwest Hog Producers

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*Abstract*

A whole-farm simulation model is used to analyze the impacts of PST adoption on representative farms in Missouri and Indiana. Farmers who do not adopt experience lower average annual net cash farm incomes than adopters. Lower feed prices and/or an average PST/feed response decrease the incentive to adopt. Payment of a 5 percent carcass merit premium (CMP) and/or higher grain prices greatly increase the economic incentive to adopt.

**Key Words: Carcass Merit Premium, PST, Simulation**

Porcine Somatotropin (PST) is a naturally-occurring hormone in swine which accelerates the rate of growth, increases feed efficiency, and produces leaner hogs. Although the effects of PST on feeder hogs has been known for many years, it was not used commercially in the United States because of lack of federal approval. The ability to produce PST using recombinant DNA technology has heightened interest in using the product on commercial hog farms. Considerable research has documented the benefits of injecting hogs with supplemental PST and the Food and Drug Administration (FDA) is considering approval of PST for use by commercial hog farms. Numerous studies have been published which document the benefits of injecting hogs with PST. Articles by Etherton and by Meisinger provide a thorough review of the feed trial literature on PST. Meisinger summarized eight feed trial studies and reported increases in feed efficiency of 7 to 40 percent, reductions in fat of 12.5 to 32 percent, and growth rate increases of 10 to 33 percent. Etherton summarized the feed time literature for PST and concluded that supplemental PST, "increases average daily gain approximately 10 to 20 percent, decreases adipose tissue mass and lipid accretion rates by as much as 50 to 80 percent and concurrently increases protein deposition by as much as 50 percent" for feeder hogs treated for 30 to 77 days.

The economic benefits of administering supplemental PST to feeder hogs have been demonstrated by both budgeting (e.g., Kliebenstein, Buhr and Hayenga; and Meisinger) and simulation (e.g., Lemieux and Richardson; and Lemieux, Richardson and Smith) studies. These studies have shown moderate to large economic payoffs to PST adoption and suggested that the increased pork production would likely lead to lower hog prices. To date, an integrated firm level/aggregate-sector level study of PST introduction and adoption has not been reported in the literature. That is to say, an econometric model to project the effect of PST introduction and adoption on hog prices has not been combined with a budgeting or simulation model to examine the benefits of PST for U.S. hog farmers.

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*J. Agr. and Applied Econ.* 25 (2), December, 1993: 95-105

The purpose of this study is to quantify the economic benefits to representative hog farms in the Midwest who adopt PST and the costs to producers who do not adopt PST. This study uses annual hog price projections developed from an econometric model of the U.S. agricultural sector to endogenize the price effects of increased pork production in response to PST introduction and adoption. Alternatively higher and lower feed prices are evaluated as well to demonstrate the effect of changes in farm programs on the benefits of PST adoption and costs of non-adoption.

## Procedure

Four representative Midwestern grain/hog farms, two in Missouri and two in Indiana, are used in this study. The moderate and large Missouri farms have 75 and 225 sows, respectively. The Indiana farms have 150 and 600 sows. The farms are simulated for six years using the Farm Level Income Tax and Policy Simulation Model (FLIPSIM). FLIPSIM is a Monte Carlo simulation model developed by Richardson and Nixon (1986).

Analyzing the consequences of alternative technologies on the economic viability of a representative farm involves several steps. First, data for the representative grain-hog farm, using existing or base technologies, must be developed. Second, modifications to the base farm's input/output coefficients must be made for each technology change to be analyzed. For PST, this is done by changing the ration, variable costs of production for hogs, sale weight of market hogs and feed consumption per animal. The result is a new representative farm which adopts PST. Third, projections for hog prices, feed prices, and macroeconomic variables (interest and inflation rates) for the policy/technology scenario being analyzed are merged with the farm's data. Projections of hog prices and feed prices are provided by the LIVESIM model (Peel), national feed prices by the AGSIM model (Taylor), and macroeconomic variables by the AG-GEM model (Penson and Chen). Hog and feed prices are regionalized in FLIPSIM based on regional price differences over the 1980-89 time period.

By changing the policy scenario and the technology assumptions, the model can be used to analyze an array of scenarios for each farm. Changes in the economic viability of the farm under the alternative scenarios can be used to assess the long-run impacts of technological change on the farm and the economic payoffs from adoption of the technology.

The data used to describe the representative farms was developed using the panel farm process. An extension farm management specialist in each state selects the primary production area for the state. The county agent in the primary production area is asked to select producers to participate in two producer panels. Each panel consists of five to six farmers. The moderate-size panel is made up of farmers who are representative in size of full-time commercial operators. The large-farm panel consists of producers who operate farms that are two to three times larger than the representative-size farm.

Using a questionnaire designed to gather the information to describe the farm, the panel members meet together to develop consensus values which represent a typical farm for their size group. Data from the panel are processed and mailed back to the panel. A conference call is held within three weeks of the meeting to review the panel's data and insure it was interpreted correctly. Pro forma balance sheets, income statements, cash flow and livestock summary pages are sent to the panel. A conference call is held to validate FLIPSIM's ability to simulate the farm. If changes in the panel's data are necessary, the data are modified, the farm is simulated and new pro forma summary sheets are mailed for a second conference call. The process is repeated until the panel is confident that FLIPSIM accurately depicts the typical farming operation in their area.

Each panel member is asked to provide a 10 year history of crop yields and livestock production. These data are combined with a history of local crop and livestock prices to develop a multivariate empirical probability distribution of yields, livestock production, and prices. FLIPSIM randomly samples from the probability distribution using the procedure described by Richardson and Condra (1981) so the historical correlation of the random variables is maintained and the coefficient of variation for each stochastic variable remains constant over the planning horizon.

Panel farms of this type have been developed in major crop and livestock production regions throughout the U.S., and are used to analyze policy and technology changes. The process is designed to develop data for a "typical" farm with above average management. While it is no one producers operation, producers in the area would be able to relate to the data and the analytical results. The data avoids the use of one person's records and any peculiarities that may be involved with that operation. Also, the process avoids the problems associated with calculating averages that are often adversely affected by one or more extreme values.

## Farm Characteristics

The Missouri and Indiana hog farms represent two different types of Midwest hog farms. The Missouri farms raise fewer pigs per sow, in part, because their operations are not total confinement operations like those represented in Indiana (Table 1). The Missouri farms are generally smaller in terms of the number of sows farrowed per year. A moderate- size Missouri hog farm in Carroll county has an average of 75 sows while the moderate-size hog farm in Carroll county Indiana has 150 sows. The large Missouri farm had a 225 sow herd while the large Indiana hog farm had 600 sows. Feed efficiency in terms of pounds of feed per pound of gain was lowest for the largest farm (3.30) and roughly the same for the three smaller farms (3.75). The two Missouri farms and the moderate-size Indiana farm participated in the farm program for corn and wheat. The large Indiana farm produced corn and wheat outside of the farm program. All four farms produced corn to be fed on the farm to the hogs. Soybeans were produced and sold for cash.

Resource differences (cropland acres), land costs between regions, and investments in buildings account for the major differences in the value of assets for the four representative farms. The initial net worth for each of the four farms was calculated assuming the farm had 10 percent debt on land and buildings and 20 percent debt on machinery and livestock. This level of debt results in an overall debt to asset ratio of 15 to 18 percent and is a reasonable assumption for moderate debt producers.

## Technology Scenarios

The economic consequences of PST introduction and adoption were analyzed assuming PST was introduced in the first year of the six-year planning horizon and the farm either adopted immediately or did not adopt over the 1992-1997 planning horizon. The wide differences in feed trial results, reported by Etherton and Meisinger, suggest that managerial abilities could greatly affect the level of PST benefits received by producers. The first scenario assumes a 25.1 percent improvement in feed efficiency and 6.6 percent increase in sale weight for market hogs (Table 2). The improvement in feed efficiency in the first scenario assumes a 12.7 percent increase in average daily gain, based on the range of results reported by Etherton, et al. (1986), Etherton, et al. (1987), and McLaren, et al. (in Meisinger).

The second PST scenario assumes the producer is able to get the maximum benefit out of supplementally administered PST. Under this scenario average daily gain increases 33.3 percent and feed efficiency improves 34.8 percent (Table 2). This scenario is consistent with research by Goodland, et al. and by Ivy, et al.

To simulate the two PST scenarios, the four representative farms were changed to reflect the assumptions in Table 2. Because producers may be unable to increase the number of sows in their confinement facilities to take advantage of shorter feeding periods to reach 250 pounds, sale weights of market hogs were increased by the percentages reported in Table 2 rather than increasing the number of sows. The assumption is that producers who use PST will feed pigs the same number of days and simply market heavier hogs. This assumption is supported by the preference of hog buyers for lean market hogs weighing more than 250 pounds. By assuming that market hogs are fed to heavier weights, existing facilities did not have to be expanded and the facilities were not under used. As a result, no changes in sow herd size, depreciation, and overhead costs are necessary for the representative farms. It was also assumed that PST was not administered to sows or to gilts kept for the replacement sow herd.

**Table 1.** Characteristics of Representative Moderate and Large Grain-Hog Farms in Missouri and Indiana

| | Missouri | | Indiana | |
|---|---|---|---|---|
| | Moderate[1] | Large | Moderate | Large |
| **Hog Enterprise** | | | | |
| Sows | 75 | 225 | 150 | 600 |
| Boars | 6 | 10 | 10 | 30 |
| Gilts (repl.) | 32 | 100 | 90 | 245 |
| Pigs raised/sow/year | 15.68 | 15.68 | 17.00 | 18.00 |
| Gilts sold/year | 556 | 1664 | 1185 | 5155 |
| Borrows sold/year | 588 | 1764 | 1275 | 5400 |
| Sale weight | 240 | 240 | 240 | 250 |
| Lbs. feed/lb. gain | 3.875 | 3.787 | 3.763 | 3.299 |
| **Assets ($1,000)** | | | | |
| Land | 232.0 | 520.0 | 630.0 | 2475.0 |
| Buildings | 70.0 | 175.0 | 120.0 | 500.0 |
| Machinery | 86.5 | 289.1 | 280 2 | 834.3 |
| Livestock | 34.4 | 65 7 | 49.9 | 158.6 |
| Other Assets | 0 | 0 | 0 | 0 |
| Total | 422.9 | 1049.8 | 1080.1 | 3967.9 |
| **Liabilities ($1,000)[2]** | | | | |
| Real estate | 30.2 | 69.5 | 75.0 | 297.5 |
| Intermediate Assets | 24.2 | 70.9 | 66.0 | 198.6 |
| Other | 20.8 | 54 8 | 70.6 | 40.6 |
| Total | 75.2 | 195.2 | 211.6 | 536.7 |
| **Net Worth ($1,000)** | 347 7 | 854.3 | 868.5 | 3431.2 |
| Acreage | | | | |
| Owned | 220 | 520 | 280 | 1125 |
| Leased | 110 | 500 | 520 | 1125 |
| Total | 330 | 1020 | 800 | 2250 |
| **Crops produced (acres)[3]** | | | | |
| Corn | 144 | 300 | 540 | 1800 |
| Soybeans | 80 | 333 | 175 | 400 |
| Wheat | 76 | 316 | 24 | 50 |

[1] The Moderate size Missouri hog farm also has 25 cows on 100 acres of pasture.

[2] Liabilities are reported assuming the farm has 10 percent debt on real estate assets and 20 percent debt on machinery and livestock.

[3] Acreage of crops represents actual planted acreage in 1990 after accounting for set aside. All farms except the large Indiana farm participated in the farm program.

**Table 2.** Alternative PST/Feed Response Scenarios Evaluated

| | No PST | PST | Change (%) |
|---|---|---|---|
| **Average Response** | | | |
| Average daily gain (lbs.) | 1.73 | 1.95 | 12.7 |
| Feed/lb. gain (lbs.) | 3.75 | 2.81 | -25.1 |
| Lysine in ration (%) | 0.50 | 1.20 | 240 0 |
| Crude protein in ration (%) | 14.00 | 17.00 | 21.4 |
| Sale weight (lbs.) | 240.00 | 256.00 | 6.6 |
| **Optimistic Response** | | | |
| Average daily gain (lbs.) | 1.73 | 2.306 | 33.3 |
| Feed/lb. gain (lbs.) | 3.75 | 2.445 | -34.8 |
| Lysine in ration(%) | 0.50 | 1.200 | 240.0 |
| Crude protein in ration(%) | 14.00 | 17.000 | 21.4 |
| Sale weight(lbs.) | 240.00 | 280 00 | 16 6 |

It was assumed that PST costs $6 per pig in years 1 and 2, $5 per pig in year 3, and $4 per pig after year 3. The price is assumed to decrease due to a competitive market and wide availability. PST is assumed to be administered weekly for 6 weeks at an added labor cost of 7.5 cents per pig, assuming it takes 10 seconds to inject one hog and a wage rate of $4.50 per hour. Added Lysine in the finishing ratio is increased to avoid Amino acid deficiencies (Etherton). During the finishing period (beyond 120 pounds), corn in the ration is reduced while soybean meal is increased to achieve the higher crude protein ration. The total quantity of corn fed declines about 11 percent for the first PST/feed response scenario and about 15 percent for the second scenario. Total soybean meal fed on the farm increases about 4 percent for the first PST/feed scenario and about 5.5 percent for the second PST scenario.

Two assumptions were made regarding the producers' ability to be paid a premium for the improved fat to lean ratio for PST treated hogs. The first was that producers did not receive a price premium for the improved carcass yield benefits. The second was that producers received a 5 percent price premium for PST treated market hogs. This level of carcass merit premium (CMP) is in the range of a 4 to 7 percent premium Lemieux and Wohlgenant estimated producers could receive for PST treated hogs. Genetic selection may also produce a hog with high lean potential that could receive an added CMP. Because this study only addresses PST, the CMP discussed is only related to the premium as a result of using PST.

Three farm program scenarios were analyzed. The base policy assumed a continuation of the 1990 farm bill with 7.5 percent corn set aside and 15 percent corn triple base each year over the 1992-1997 planning horizon. Corn target price was held constant through 1997 at $2.75 per bushel. Soybean loan rates remained low as soybean meal prices rose due to increased demand for protein by hog producers (Table 3).

Lemieux, Richardson, and Smith suggested that the economic benefits to PST adoption increased under farm programs that resulted in higher feed prices. This hypothesis was tested by simulating the representative farms assuming all feed prices were increased 10 percent over the baseline and all feed prices were 10 percent lower than the baseline (Table 3).

Hog prices, excluding the carcass merit premium, for the base and all three policy scenarios are reported in Table 3. Annual hog prices were estimated using an econometric model of the U.S. agricultural economy (LIVESIM) developed by Peel (1989). Hog prices reflect the introduction of PST in 1992 and a rapid rate of adoption which results in 75 percent adoption in five years. Given the potential profitability of PST, this rapid rate of

**Table 3.** Comparison of Hog Prices With and Without PST for a Continuation of the 1990 Farm Bill, a 10 Percent Increase in Feed Prices and a 10 Percent Decrease in Feed Prices, 1992-1997

| Year | No PST 1990 Farm Bill | PST Introduction | | |
|---|---|---|---|---|
| | | 1990 Farm Bill | 10% Higher Feed Prices | 10% Lower Feed Prices |
| **Hogs** | | ($/ cwt) | | |
| 1992 | 48.10 | 47 28 | 48.45 | 47.13 |
| 1993 | 48.11 | 46.96 | 48.91 | 46 45 |
| 1994 | 47.52 | 46.14 | 48 51 | 45.39 |
| 1995 | 47 27 | 45.65 | 48.23 | 44.74 |
| 1996 | 48.28 | 46 67 | 49 23 | 45.31 |
| 1997 | 49.41 | 47.73 | 50 24 | 45.96 |
| **Corn** | | ($/ bu) | | |
| 1992 | 2.189 | 2.194 | 2.398 | 1.988 |
| 1993 | 2.184 | 2.195 | 2.390 | 1.999 |
| 1994 | 2.226 | 2.242 | 2.434 | 2.048 |
| 1995 | 2.270 | 2.284 | 2.489 | 2.082 |
| 1996 | 2.259 | 2.271 | 2.479 | 2.069 |
| 1997 | 2.214 | 2 226 | 2.432 | 2.030 |
| **Soybean Meal** | | ($/ ton) | | |
| 1992 | 215.42 | 217.96 | 236.96 | 193.88 |
| 1993 | 224.00 | 227.67 | 246 40 | 201.60 |
| 1994 | 242.35 | 247.23 | 269 01 | 218.11 |
| 1995 | 254.31 | 260.68 | 282.28 | 231.42 |
| 1996 | 253.40 | 259 42 | 281 27 | 230.59 |
| 1997 | 253.46 | 259.45 | 281.34 | 230.65 |

Source: Taylor; Peel.

adoption is not out of line with the reported adoption rates of other highly profitable innovations (for example hybrid corn varieties).

## Results

Table 4 contains the results for each scenario on the two Missouri farms. The NO PST BASE scenario represents the two farms if PST was not introduced in 1992. This base scenario is compared to the nonadoption scenario, and five adoption scenarios. Each adoption scenario is run under the assumption of no CMP and a 5 percent CMP paid for PST treated pigs.

The moderate-size Missouri hog farm would experience a 6.56 percent increase in real net worth over the six year planning horizon if PST is not introduced. If PST introduction leads to lower hog prices and the farm does not adopt, the real change in net worth would be 3.96 percent lower than the BASE. Adoption of PST on the moderate-size Missouri hog farm results in a 6.44 percent lower net cash farm income than the BASE if the producer is unable to obtain a 5 percent CMP and experiences an average PST/feed response. Even though the adopter's net cash farm income falls the decline is not as large as the decline resulting from nonadoption (8 percent). The benefits of increased net cash farm income (5.37 percent) from the average PST/feed response and a 5 percent CMP translate into a 2.48 percent greater increase in real net worth than the BASE scenario. A more optimistic PST/feed response increases a moderate-size Missouri hog farm's net cash farm income 22.57 percent without a 5 percent CMP and 34.89

**Table 4.** Comparison of PST Adoption, Nonadoption, the 1990 Farm Bill, 10% Higher Feed Prices, and 10% Lower Feed Prices for two Representative Missouri Hog Farms, 1992-1997

| | NO PST BASE | DO NOT ADOPT PST | Average PST | | Optimistic PST | | 10% Lower Feed | | | 10% Higher Feed | | | 1990 Farm Bill | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | No CMP | 5% CMP | No CMP | 5% CMP | DO NOT ADOPT | No CMP | 5% CMP | DO NOT ADOPT | NO CMP | 5% CMP | NO CMP | 5%CMP |
| **Moderate-Size Missouri Farm** | | | | | | | | | | | | | | |
| Percentage Change in Real Net Worth | | | | | | | | | | | | | | |
| Percentage (%) | | -3.96 | -3.25 | 2 48 | 10.75 | 16.55 | -1.46 | -1.22 | 4 28 | -2.33 | -0 99 | 4 92 | -3 25 | 2 48 |
| Absolute ($1,000) | 6 56 | -4.22 | -3.46 | 2.65 | 11.45 | 17 63 | -1.56 | -1 30 | 4 56 | -2 48 | -1 06 | 5.24 | -3.46 | 2.65 |
| Average Annual Cash Receipts | | | | | | | | | | | | | | |
| Percentage (%) | | -1.99 | 3.15 | 6 57 | 10 58 | 14.32 | -2.94 | 2 11 | 5 47 | 0 91 | 6 24 | 9 83 | 3 15 | 6.57 |
| Absolute ($1,000) | 197.91 | -3.93 | 6 22 | 12 99 | 20.92 | 28.32 | -5 81 | 4.17 | 10.81 | 1.80 | 12.34 | 19.43 | 6 22 | 12.99 |
| Average Annual Cash Expenses | | | | | | | | | | | | | | |
| Percentage (%) | | 0.74 | 7.49 | 7.11 | 5.14 | 5.00 | -2.90 | 4 14 | 3.84 | 3.37 | 9 83 | 9 48 | 7.49 | 7.11 |
| Absolute ($1,000) | 136.04 | 1 01 | 10.19 | 9 68 | 6.99 | 6.80 | -3 95 | 5.63 | 5.23 | 4.58 | 13 37 | 12 90 | 10.19 | 9.68 |
| Average Annual Net Cash Income | | | | | | | | | | | | | | |
| Percentage (%) | | -8.00 | -6.44 | 5 37 | 22 57 | 34.89 | -3.02 | -2 38 | 9.06 | -4 51 | -1.67 | 10.60 | -6 44 | 5 37 |
| Absolute ($1,000) | 61.67 | -4.94 | -3.97 | 3.31 | 13.92 | 21.52 | -1.86 | -1.46 | 5.58 | -2.78 | -1.03 | 6 54 | -3 97 | 3 31 |
| **Large Missouri Farm** | | | | | | | | | | | | | | |
| Percentage Change in Real Net Worth | | | | | | | | | | | | | | |
| Percentage (%) | | -4.84 | -3.24 | 3 88 | 14 86 | 22.38 | -1.21 | -0.28 | 6 58 | -3 67 | -1 13 | 6 28 | -3 24 | 3 88 |
| Absolute ($1,000) | 18 87 | -5.75 | -3.85 | 4 61 | 17 66 | 26.61 | -1.44 | -0.33 | 7.82 | -4.36 | -1 34 | 7 47 | -3 85 | 4 61 |
| Average Annual Cash Receipts | | | | | | | | | | | | | | |
| Percentage (%) | | -2 00 | 2.89 | 6.37 | 10 24 | 14.04 | -3.36 | 1.46 | 4 87 | 1.22 | 6.32 | 9 96 | 2 89 | 6 37 |
| Absolute ($1,000) | 587 26 | -11 76 | 17.00 | 37.40 | 60.14 | 82 44 | -19.71 | 8.55 | 28.57 | 7.18 | 37.13 | 58 49 | 17 00 | 37 40 |
| Average Annual Cash Expenses | | | | | | | | | | | | | | |
| Percentage (%) | | 0 74 | 6 40 | 6.09 | 3.55 | 3.46 | -3.75 | 2 30 | 2 06 | 4.31 | 9 59 | 9 29 | 6 40 | 6 09 |
| Absolute ($1,000) | 423 22 | 3.11 | 27.11 | 25 78 | 15.03 | 14 63 | -15 88 | 9.73 | 8.72 | 18.25 | 40 59 | 39 33 | 27 11 | 25.78 |
| Average Annual Net Cash Income | | | | | | | | | | | | | | |
| Percentage (%) | | -9.07 | -6.16 | 7.08 | 27.50 | 41 34 | -2.34 | -0.72 | 12.10 | -6 75 | -2 11 | 11 68 | -6 16 | 7 08 |
| Absolute ($1,000) | 164.04 | -14.88 | -10.11 | 11 62 | 45.11 | 67.81 | -3.84 | -1.18 | 19.85 | -11 07 | -3 46 | 19 16 | -10 11 | 11 62 |

percent with the CMP. Real net worth for the farm increases 10.75 to 16.55 percent from the BASE depending on whether the CMP is received or not, if the farm enjoys the more optimistic PST/feed response.

The large Missouri hog farm would experience an average increase in real net worth of 18.87 percent under the BASE scenario and a 4.84 percent lower growth in real net worth if the farm does not adopt PST. Like the moderate size Missouri farm, the large farm experiences a lower average annual net cash farm income if it experiences the average PST/feed response and does not receive the 5 percent CMP. The 5 percent CMP adds $11,620 in average annual net cash farm income (or 7.08 percent) for the large Missouri hog farm. If the large Missouri hog farm experiences the more optimistic PST/feed response, the benefits to PST adoption are substantially greater than under the average response scenario (Table 4).

The 10 percent lower feed price scenario results in smaller economic incentives to adopt PST. The difference between average annual net farm income of the nonadopter and the adopter (economic payoff to adoption) is lower for the low feed price scenario than the 1990 farm bill scenario. For the moderate Missouri farm the difference with no CMP is $400 (-$1,860 vs. $1,460) per year under the low feed price scenario and $970 (-$4,940 vs. -$3,970) per year for the 1990 farm bill scenario (Table 4). Larger economic payoffs were observed for the large Missouri farm.

Higher feed prices result in more favorable rates of growth in real net worth than the 1990 farm bill, for both the moderate and large farms. A higher rate of change in real net worth due to higher feed prices is observed for all three of the PST scenarios. As PST is substituted for a more expensive input (corn) to produce hogs that have a greater value, the economic benefits to PST should increase. The results suggest that this hypothesis is correct. For example, the economic payoffs to the moderate-size Missouri hog farm are $1,750 (-$2,780 vs. -$1,030) per year if there is no CMP and higher feed prices while it is only $400 (-$1,860 vs. -1,460) per year with lower feed prices.

The results for the Indiana farms are contained in Table 5. The moderate-size Indiana hog farm has an increase in real net worth of 17.96 percent under the BASE scenario. Real net worth declines 2.59 percent by not adopting PST. If the farm experienced an average PST/feed response and no CMP average net cash farm income would decline 3.07 percent or $6,890 per year from the BASE. The inclusion of the CMP causes a 3.67 percent increase in average annual net cash farm income over the BASE.

The large Indiana hog farm, much like the moderate-size farm, would experience lower average annual net cash farm income (-$2,900) if it adopted PST and experienced the average PST/feed response without a CMP. Given a 5 percent CMP, the farm earns an additional $40,700 annually in net cash farm income over the BASE by adopting PST and experiencing the average PST/feed response. The 5 percent CMP increases net cash farm income 22.48 percent more than the BASE if the farm experiences the optimistic PST/feed response.

As with the two Missouri farms, the more optimistic PST/feed response substantially increases the economic benefits from PST adoption. Without a CMP net cash farm income is $31,060 (13.84 percent) per year greater than the BASE and with a 5 percent CMP average net cash income is $47,280 (21.07 percent) per year greater than the BASE. The farm can increase its real net worth without the 5 percent CMP if it can realize the optimistic PST response in contrast to the average response where a CMP must be received to increase real net worth.

Like the Missouri farms, lower feed prices result in lower economic incentives to adopt PST. The economic payoffs to adoption for the moderate-size farm with a 5 percent CMP is $16,820 (-$7,730 vs. $9,090) for the low feed price scenario and $18,440 (-$10,200 vs. $8,240) for the 1990 farm bill. The payoffs to adoption increase as feed prices increase. Under the 10 percent higher feed price scenario and no CMP the payoffs to the moderate-size farm for PST adoption are $5,060 (-$1,500 vs. $3,560) per year compared to $3,310 (-$10,200 vs. -$6,890) per year for the 1990 farm bill scenario. Adding the 5 percent CMP increases the incentive to adopt PST. The large farm gains similarly to the moderate-size farm when higher grain prices are assumed. Adoption of PST under higher feed prices and a 5 percent CMP increases real net worth 10.35 percent over the BASE while adoption under 1990

**Table 5.** Comparison of PST Adoption, Nonadoption, the 1990 Farm Bill, 10% Higher Feed Prices, and 10% Lower Feed Prices for two Representative Indiana Hog Farms, 1992-1997

| | NO PST BASE | DO NOT ADOPT PST | Average PST | | Optimistic PST | | 10% Lower Feed | | | 10% Higher Feed | | | 1990 Farm Bill | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | No CMP | 5% CMP | No CMP | 5% CMP | DO NOT ADOPT | No CMP | 5% CMP | DO NOT ADOPT | NO CMP | 5% CMP | NO CMP | 5%CMP |
| **Moderate-Size Indiana Farm** | | | | | | | | | | | | | | |
| Percentage Change in Real Net Worth | | | | | | | | | | | | | | |
| Percentage (%) | | -2.59 | -1.73 | 2 14 | 8.26 | 12.81 | -2.10 | -1.55 | 2 22 | -0 28 | 1.04 | 5.13 | -1 73 | 2 14 |
| Absolute ($1,000) | 17.96 | -3 05 | -2 04 | 2.52 | 9.74 | 15 11 | -2.47 | -1.83 | 2.62 | -0.33 | 1 23 | 6 05 | -2 04 | 2 52 |
| Average Annual Cash Receipts | | | | | | | | | | | | | | |
| Percentage (%) | | -1 79 | 4.98 | 8 02 | 12.35 | 15.68 | -2 81 | 3.71 | 6.70 | 1.06 | 8 20 | 11.38 | 4 98 | 8.02 |
| Absolute ($1,000) | 483.87 | -8 64 | 24.11 | 38.83 | 59.77 | 75.86 | -13.57 | 17.96 | 32.41 | 5.15 | 39.66 | 55.07 | 24.11 | 38.83 |
| Average Annual Cash Expenses | | | | | | | | | | | | | | |
| Percentage (%) | | 0 60 | 11.95 | 11.79 | 11.06 | 11.01 | -2.25 | 9.11 | 8.99 | 2.56 | 13.91 | 13.80 | 11 95 | 11.79 |
| Absolute ($1,000) | 259 45 | 1 56 | 31.00 | 30.58 | 28.71 | 28 58 | -5.85 | 23.65 | 23 32 | 6.65 | 36 09 | 35.80 | 31 00 | 30 58 |
| Average Annual Net Cash Income | | | | | | | | | | | | | | |
| Percentage (%) | | -4.55 | -3.07 | 3.67 | 13.84 | 21.07 | -3.44 | -2.53 | 4 05 | -.067 | 1.59 | 8.59 | -3.07 | 3.67 |
| Absolute ($1,000) | 224.42 | -10.20 | -6.89 | 8.24 | 31.06 | 47.28 | -7.73 | -5.68 | 9.09 | -1.50 | 3.56 | 19.27 | -6 89 | 8.24 |
| **Large Indiana Farm** | | | | | | | | | | | | | | |
| Percentage Change in Real Net Worth | | | | | | | | | | | | | | |
| Percentage (%) | | -3.08 | -1.82 | 3.31 | 9.84 | 15.69 | -5 80 | -4.85 | 0.07 | 3.00 | 4 82 | 10 35 | -1.82 | 3.31 |
| Absolute ($1,000) | 20 18 | -3.70 | -2.19 | 3.98 | 11.83 | 18.86 | -6.97 | -5.83 | 0.09 | 3.61 | 5.79 | 12.44 | -2.19 | 3 98 |
| Average Annual Cash Receipts | | | | | | | | | | | | | | |
| Percentage (%) | | -1 81 | 6.20 | 9.55 | 14.25 | 17.92 | -4.99 | 2.68 | 5 98 | 3.18 | 11 65 | 15.16 | 6 20 | 9.55 |
| Absolute ($1,000) | 1954.58 | -35 36 | 121.14 | 186.74 | 278 52 | 350.26 | -97.46 | 52.42 | 116.80 | 62 25 | 227 67 | 296.36 | 121 14 | 186.74 |
| Average Annual Cash Expenses | | | | | | | | | | | | | | |
| Percentage (%) | | 0.42 | 13.32 | 13 32 | 14.35 | 14.35 | -1.99 | 10.65 | 10.65 | 2 23 | 15 33 | 15.33 | 13 32 | 13.32 |
| Absolute ($1,000) | 1096.50 | 4 55 | 146.04 | 146 04 | 157.36 | 157.37 | -21.85 | 116.81 | 116.81 | 24 48 | 168.09 | 168 10 | 146.04 | 146 04 |
| Average Annual Net Cash Income | | | | | | | | | | | | | | |
| Percentage (%) | | -4.65 | -2.90 | 4.74 | 14 12 | 22.48 | -8.81 | -7.50 | 0.00 | 4.40 | 6.94 | 14 95 | -2.90 | 4 74 |
| Absolute ($1,000) | 858.08 | -39 91 | -24.90 | 40.70 | 121.16 | 192.90 | -75.61 | -64.39 | -0 01 | 37 77 | 59 58 | 128.27 | -24 90 | 40.70 |

farm bill prices increases net worth 3.31 percent over the BASE.

## Conclusions and Implications

The purpose of this study was to quantify the likely economic benefits to representative Midwest hog farmers who adopt PST. Four representative hog farms, two each in Missouri and Indiana, were simulated under a nonadoption scenario, under two feed response scenarios and three feed price scenarios. These results were compared to a BASE scenario of no PST introduction.

The results indicate that farmers who do not adopt PST would experience lower average annual net cash farm incomes of about $65 per sow due to lower hog prices. Farmers who adopt and receive an average feed response from PST but no CMP will be better off than the nonadopters. However, they would be financially worse off than under the BASE scenario. A 5 percent CMP for leanness provides a positive economic payoff to PST adoption for all four representative hog farms who experience an average PST/feed response. Producers who experience an optimistic PST/feed response would likely observe positive economic payoffs to PST even without a 5 percent CMP.

Comparisons of economic payoffs to PST adoption across grain price scenarios indicates that lower grain prices reduce the economic incentives to adopt and higher grain prices increase the payoff to adoption, as economic theory suggests. The addition of the 5 percent CMP for leanness increases the incentive to adopt in all cases.

The economic payoffs to PST adoption do not differ greatly across farm sizes. For example, the moderate size Missouri farm's per sow payoff to PST adoption is within 10 percent of the per sow returns for the larger Indiana farm, given the optimistic feed response. These results suggest that PST may be scale neutral. However, PST adoption increases the total income of large scale producers more than smaller scale producers due to the volume of hogs produced. This increase in income to the large producers will give large scale producers an internal source of capital for future growth that may accelerate the concentration of the U.S. swine industry.

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