Effect of Corn price on Profitability of Control Vs Phytase Enhanced Diet of Hogs

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ABSTRACT

Economic Simulation model (SIMETAR) was used to investigate the effect of future corn price on profitability of control and phytase enhanced diet of hogs. The completed simulation model was used to estimate probability distribution for control vs lower excretion diet profitability under different corn prices. Data used was collected from recent field trials in Oklahoma that tested the effect of phytase enhanced diets on reducing phosphorus emission. The results showed that as the market price of corn increases control diet will be more profitable than phytase enhanced diet, given the cost of other remaining feed ingredient is constant for both the diets.

Key words: profitability, SIMETAR, control diet, phytase enhanced diet, swine

Back in 1992 when swine companies came to Oklahoma, following a change in corporate farming laws, there was not a whole lot of public concern about the environment (Lyford and Hicks, 2001). Attention was on the economic benefit that the facility would bring which included more jobs, increased income, and a larger tax base. Analysis showed that in 1997 there were an additional 3,947 jobs in Oklahoma directly based on the pork industry (Willoughby et al.). Because of its relatively sparse population and its hot, dry climate that facilitates manure utilization, As shown in Figure 1, Oklahoma has seen its hog numbers increase almost seven-fold from 1991 to 1997 (Mildred et. al.). In between 2006 and 2007 Oklahoma tripled its hog numbers (Stephens, 1998). Figure 2 shows that based on hogs produced, Oklahoma was ranked 8th in the nation in 2007 (USDA-NASS, 2007). However as shown in Figure 3, structural changes in hog industry have led to decline in the number of hog farms and a dramatic increase in the number of animals produced (Yap et. al., 2004).

The Oklahoma hog industry has in some ways been a victim of its own success. As animal density is increasing, so are concerns regarding air and water quality, occupational health, and waste management. There is increasing attention from the environmentalists, government, and public towards the impact of farming practices on the environment such as contamination of drinking water (Taylor, 1998). A particular concern is the swine waste in Western Oklahoma.

Rural citizens are concerned about degradation of their quality of life through air and water pollution caused by hog waste (Stephens, 1998). Concentrated animal feeding operations (CAFOs) are cited as adversely affecting environmental and public health (Taylor, 1998). Public concerns related to potential water and air pollution from intensive livestock production led to the Oklahoma Concentrated Animal Feeding Operations Act, signed into law in June 1997(USDA). The law requires licensing for animal confinement operations of more than 5,000 head built after September 1, 1997, requires facilities for storage of liquid waste, establishes set-backs based on operation size and location within the state, and sets minimum distances between the base of manure lagoons and local water tables. In 1999, USDA and the Environmental protection Agency (EPA) announced the Unified National Strategy for Animal Feeding Operations (USDA, EPA). The strategy sets forth a framework for minimizing impacts to water quality and public health from AFOs (Animal Feeding Operations) and establishes a national performance expectation for AFOs. This coordinated effort grew as the land disposal of manure is unregulated by the Clean Water Act because it is not considered as a discharge from the facility. And also, effluent discharge guidelines of the Clean Water Act were developed when facilities were a lot smaller (the 1970s). The initial guidelines are considered to be no longer adequate for addressing problems of land applied waste from the current large operations. The Unified Strategy outlines approaches to be taken by USDA and EPA to address the environmental concerns with AFOs, and presents a goal for all AFOs to have a nutrient management plan. To carry out the strategy, EPA is focusing on the large operations (CAFOs) that require a NPDES (National Pollutant discharge elimination system) permit.

EPA has proposed changing the effluent discharge guidelines, and is expecting CAFOs to develop comprehensive nutrient management plans (CNMPs) for properly managing animal waste, including on farm application and off-farm uses. Inclusion of the CNMP as part of the NPDES permit means that, for the first time, the land application of manure will be part of a required Federal permit. USDA is using voluntary approaches to get CNMPs on AFOs not under EPA regulation. Therefore, the Unified Strategy outlines a general goal for all animal feeding operations to have a nutrient manure management plan, and the proposed EPA CAFO regulations and the USDA manure management strategy are the means by which the Unified Strategy goal is to be met.

Introduction

The hog industry has grown substantially in the last few years, but this growth has tapered off due to increasing regulation and potential threat of the new regulations (Lyford and Hicks, 2001). New Clean Water Act regulations compel the largest confined animal producers to meet nutrient application standards when applying manure to the land, and USDA encourages all animal feeding operations to do the same. The additional costs for managing manure (such as hauling manure off the farm) have implications for feed grain producers and consumers as well (Gollehon et al).

Measures taken in response to the rapid expansion of hog production and the environmental damage done by the excessive application of nutrients from manure exceeding crop requirements have involved alternative and more costly disposal methods. Many researchers including those at OSU have begun to investigate dietary supplements with synthetic amino acids and phytase that more closely match the dietary needs of the pigs, reducing the total nitrogen and phosphorus excreted. Results showed that total gains could be maintained while the excretion of dry matter, nitrogen and phosphorus was reduced by changing the diet from conventional to Low Excretion diet (LED), (Carter et al. 2003). But the cost of manipulating the feed was not taken into account.

Feed cost represents 55 to 70 percent of the cost of producing hogs (Luce). Before dietary changes are made more information is needed on cost. Due to the ever increasing market price of corn which comprises 79-80 percent of feed the feeder-finish hog consumes, it is necessary to look at returns over the cost of feeding at different corn prices as well. This study departs from previous studies on hog diets in that it accounts for cost and returns from the cost at different corn prices.

The purpose of this research is to document the findings of the recent field trials in Oklahoma that tested the effect of phytase enhanced diets on reducing phosphorus emission. An economic simulation model (SIMETAR) was constructed to investigate whether reduced nitrogen and phytase enhanced diets had a significant effect on reducing feed cost. In particular, the effect of future corn price on cost of control vs Phytase enhanced diet of hog will be documented.

Previous research has shown that different restrictions forced producers to develop alternative management practices to reduce the pollution. Honeyman (1993) observed that the nutrient composition of swine excreta can be altered by manipulating the composition of the pig's diet. Swine production produces negative externalities such as excess of nitrogen and phosphorus that are hazardous to human as well as animal health. According to Svoboda and Jones (1999), “The negative impacts can be minimized, if not completely eliminated, by the correct management of the farm and livestock wastes and, by relatively new development in minimizing hog feed nutrient input in a form of enzymatic additives promoting digestion of plant phytin-phosphorus (Hoppe et al.1993) or supplementation of protein/nitrogen input by properly balancing the diet synthetic amino acids (Mordenti et al.1993)."

According to a study done by Boland, Foster, and Preckel (1998), phytase is an alternative for reducing phosphorus excretion if the producers' state regulatory agency institutes a phosphorus based application requirement and if producers are constrained by land. The study concluded that additional cost of the manure storage was high enough so that producers could consider using a combination of technologies such as synthetic amino acid and phytase even though their unit cost is greater than the ingredient they are replacing, if constrained by land.

Different forms of the ration were formulated and fed to see the effects on the nitrogen and phosphorus excretion. Based on the study done by Senne et al. (2000) total nitrogen excretion for pigs fed soy protein concentrate was 12% less than for pigs fed soybean meal. Pigs fed soy protein isolate had another 11% decrease in total nitrogen excretion compared to those fed soy protein concentrate.

With the price of corn increasing at an alarming rate it has become necessary to incorporate the effect of increased corn price in the research. The profitability of control and the lower excretion diets are entirely dependent upon the cost of corn because corn comprises 79-80 percent of feed that the feeder-finished hog consumes. Therefore, it has become a necessity to look at returns over the cost of feeding at different corn prices.

In American mythology a hog was "nothing more than fifteen to twenty bushels of corn" (Holt and Craig, 2006). According to Chris Hurt an extension specialist at Purdue University "The hog industry is expected to continue to operate at modest profits through the first-half of 2007, but the potential for higher corn prices appears to be the biggest threat to this thin profit potential." Since there is less change in the number of hog the threat is not related to profits but the author points out two major threats one of which is the potential for rising corn prices and the other is potential loss of pork exports with reopening of the Asian beef market (Hurt, 2006). During 2008 when corn prices reached $6.00 per bushel, the cost of fifteen to twenty bushels of corn reached a record high.

The situation people are facing today implies that the producers will keenly look at returns over the cost before any major change in feeding hog is done. Therefore, this paper will help answer the question to whether recent corn price change has significantly affected the profitability or rationale for phytase enhanced diet over the control diet.

Richardson (2004) has developed models that can be used to estimate profitability under risk. Richardson's "Simulation for Applied Risk Management" pointed out that simulation models can be solved both deterministically and stochastically. The risk involved isn't sufficiently analyzed by deterministic or point estimate models. Therefore, deterministic isn't useful tool to use in risky environment. Richardson states that "When decision is made in a risky environment the manager cannot use such a simple rule, because the economic return for each alternative is a distribution of returns rather than a single value". Due to increasing corn price and steady hog price hog producers operate in a risky environment. Because risk is involved in the production of hog a stochastic approach to simulation, which produces distribution of estimate is used in this research. Also, Ray, et al, (1998) states that the results from stochastic simulation provides estimated probability distribution for the endogenous variables which in turn provides an important dimension to the information base for decision makers.

Data and Methods

Data used were collected by Carter et al. (2003) wherein three different experiments were performed separately in which different amount of feed ration was fed to hogs under two dietary systems, control diet and phytase enhanced diet also referred to as lower excretion diet. According to the study done by Lachmann et al (2006), hog diet can be manipulated by reducing dietary crude protein with addition of crystalline amino acids and also dietary phosphorus can be reduced by addition of phytase (Cromwell et al., 1995). Therefore, the treatment factors employed are the typical corn soybean meal diet and a lower excretion diet. Only the third and final experiment is considered here. In experiment 3 a total of 76 crossbred pigs with an initial body weight 61 lbs were housed in an environmentally controlled building with four identical rooms, shallow pit and pull plug system. The pigs were stratified by sex and ancestry, blocked by body weight, and assigned to one of the two dietary treatments. There were two blocks (replications) for each diet. The control diet was a fortified corn soybean meal diet for phase1 (61-119 lbs), phase2 (119-180lb), phase4 (180-220lb) and phase4 (220-260lb). The next diet was a low excretion diet (LED) which was similar to the control but the LED diet was reduced in crude protein (CP) by 3 percent, phosphorus (P) by 0.1 percent, trace mineral premix (TMP) by 50, 77, 83 and 100%, respectively over 4 dietary phases. Also in the LED, phytase was added to provide 500 phytase units/kg of diet. Feed intake was measured until the finishing period for both the feeding systems. All hogs with an initial weight of 61 lbs reached the targeted weight of 260lbs. There was no significant difference between the two diets in terms of days to finish, average daily gain, and total weight gain. However amount of corn required for the LED diet was significantly greater than for the control. The results are summarized in Table 1.

Table 1. Comparison of the Growth and Performance of Feeder to Finish Pigs Fed Conventional and Low Excretion Diets*

Item	**Unit**	**Control**	**LED***	**Difference**	**Significance**
Initial weight	lbs	61.7	61.7	0	NS
Final weight	lbs	260.8	257.9	2.9	NS
Average Daily Gain	lbs	1.81	1.78	0.03	NS
Diet Phases					
Phase 1 (61 to 119 lbs)					
Time	days	38.5	38.5	0	NS
Feed Consumed	lbs	118.8	115.5	3.3	NS
Corn consumed	lbs	62.9	68.5	-5.6	S
Phase 2 (119 to 180 lbs)					
Time	days	31.5	31.5	0	NS
Feed Consumed	lbs	166.7	160.4	6.3	S
Corn consumed	lbs	100.9	108.8	-7.9	S
Phase 3 (180 to 220 lbs)					
Time	days	24.7	24.7	0	NS
Feed Consumed	lbs	145.8	144.8	1	NS
Corn consumed	lbs	129.1	141.6	-12.5	S
Phase 4 (220 to 260 lbs)					
Time	days	15	15	0	NS
Feed Consumed	lbs	94.9	91.6	3.3	S
Corn consumed	lbs	94.5	101.6	-7.1	S
Total Feed Consumed	lbs	526.3	512.3	14	S
Total Corn Consumed	lbs	387.4	420.7	-33.3	S

*Diet with crude protein reduced by 3 percent, supplemented with amino acids and 500 units of Phytase/kg of diet

Feeding the lower excretion diet significantly decreased the daily and cumulative nutrient excretion. Daily and cumulative reductions in excretions of DM (12 percent), Nitrogen (31 percent), Phosphorus (34 percent), macro minerals (13 percent) and micro minerals (46 percent) from the LED diet were significantly lower than for the control diet. The expected costs and variability of costs at alternative corn prices are discussed below.

Historically, farming has been a risky venture. The amount of risk is a function of many factors. The possibility of realizing less profit than expected or the possibility of losing money are the greatest risk in farm production. For a production system, the input prices, the output prices and the amount of produce produced are the major factors determining the amount of profit realized. Total Revenue is:

1) $TR=P_h*Q_h$,

Where, P_h= Output Price (current outputs' market price)

Q_h=amount of output (final wt. of hogs)

2) Q_h (final wt. of hog) = $f(X_i, P_i)$

Where, X_i=amount of feed fed to hogs

P_i=Price of feed ingredients

Hence, current market price of feed ingredients directly impacts total revenue. Since, profit is a function of total revenue and total cost, current market prices of feed ingredient also affects profit. In agricultural production, input price is of importance and defines a general risk to producers.

3) $TC=FC + VC$

Where, TC=Total Cost

FC= Fixed cost

VC= Variable cost

4) $VC=\sum P_i*X_i$ (i=1to n)

Where, X_i=amount of feed fed to hogs

P_i=Price of feed ingredients

In order to realize profit weight gained by hogs is an important factor to be considered. There were no significant differences in daily weight gains between the two diets. At this point, variability in producer's returns would be a function of corn prices and the different amount of corn required for a producer ordering feed as needed. The LED diet requires more corn than the conventional diet in all the 4 phases. The risk associated with differences in future feed cost from corn variability and the minimum hog price to yield a 90 percent chance of breaking even are examined below.

A naive feed cost prediction model is developed below. It is assumed the producer makes a decision on which diet to feed based on the corn price in the current month. Thus the expected feed cost for the control diet and the LED diets are $EFC_{c,t} = Pc_t*387.4/56+FC$ and $EFC_L = Pc_t* 420.7/56+FC$ respectively where t is the decision month and FC is the cost of non-corn feeds. Assuming the producer purchases feed as needed, the actual feed cost is based on corn prices during the next four months. If the LED diet is chosen, the actual feed cost is $AFC_{Lt} = a + b*(Q1*Pc_{t+1} + Q2*Pc_{t+2} + Q3*Pc_{t+3} + Q4*Pc_{t+4})+FC$ where FC is non-corn feed cost. An OLS regression on monthly US corn prices from January, 1970 through August was used to estimate the accuracy and standard error of the naive feed cost model. The expected feed cost and the standard error for corn prices at at \$3.25, \$4.25, \$5.25, and \$6.25 per bushel are given in Table 3 below. The standard error of the LED diet is greater than the control diet because the amount of corn is greater. The variability of each diet tends to increase with the price of corn since the variability of the predicted feed cost is greater with higher corn prices.

Table 2. Expected Feed Cost and the Standard Errors for the Control and LED* Diets with Selected Decision Month Prices

Diet		Current or Decision Month Corn Price			
Conventional	$/bu	$3.25	$4.25	$5.25	$6.25
Total Feed Required	lbs	526.3	526.3	526.3	526.3
Corn Required	lbs	387.4	387.4	387.4	387.4
Non Corn Feed cost	lbs	40.71	39.86	39.01	38.14
Expected Feed Cost	dollars	63.19	69.26	75.33	81.38
Standard Deviation	dollars	2.16	2.17	2.19	2.22
Low Excretion Diet*					
Total Feed Required	lbs	512.3	512.3	512.3	512.3
Corn Required	lbs	420.75	420.75	420.75	420.75
Non corn Feed cost	lbs	34.76	33.84	29.41	32.00
Expected Feed Cost	dollars	59.18	65.77	68.86	78.96
Standard Deviation	dollars	2.34	2.36	2.37	2.41

*Diet with crude protein reduced by 3 percent, supplemented with amino acids and 500 units of Phytase/kg of diet

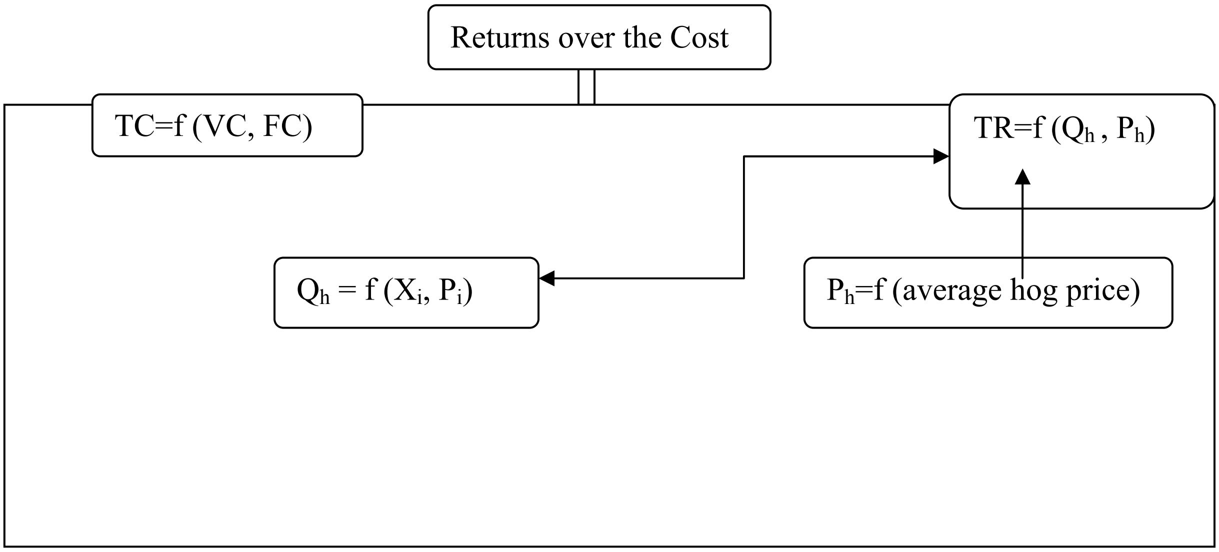
Next a stochastic dominance analysis was conducted with the use of SIMETAR to compare the variability or risk of cost of the control diet with phytase enhanced diet. Stochastic dominance analysis is a non-parametric statistical tool used to partially rank alternatives or strategies according to their risk characteristics (Hien et al., 1997).Generally; it groups the strategies into the dominated and dominating sets through the use of stochastic efficiency rules. These rules are implemented by pair wise comparison of the cumulative distribution functions of the outcomes resulting from different actions (Lansigan et al., 1997).The cumulative distribution function tend to intersect therefore second degree stochastic dominance criterion is used for indicating dominance. The key output variables for SIMETAR model for each diet and corn price were the expected cost and the standard error of that cost. All distributions were assumed to be normal. The theoretical model flowchart is shown in figure 4. The data was thereafter simulated by using SIMETAR that gave the cumulative density functions used to eventually determine nature of returns over the cost for different dietary system under different corn prices.

The graphs of the CDF functions of the returns over feed cost for two diets are shown in Figures 5 through 8.

Figure: 4

Theoretical Model Flowchart

Key Output Variable



Variable Key

TC=Total Cost

FC= Fixed cost (It is not accounted for in this research)

VC= Variable cost

P_h= Output Price (current outputs' market price)

Q_h=amount of output (final wt. of hogs)

X_i=amount of feed fed to hogs

P_i=Price of feed ingredients

Results

While looking at the literature it is clear that the phytase enhanced diet will reduce the amount of phosphorus released which was again confirmed by the experiments done by Carter et al in 2003. Since most of the hog feed is corn, producers have been burdened with a sharp increase in production costs due to the near tripling of corn prices over the past few years. Even though corn prices have soared to unprecedented levels, hog prices have remained flat. As mentioned earlier, there is always price risk for the producers. Actual cost depends on cost of corn delivered during the feeding period. Taking into account the amount of corn fed in each of the dietary system cost for corn only was found to be higher for LED as compared to control diet which is illustrated in table 4.

Table 4. Expected Corn feed Cost and the Standard Errors for the Control and LED* Diets with Selected Decision Month Prices

Parameters	*Control Diet*		*LED**	
	Coefficients	*Standard Error*	*Coefficients*	*Standard Error*
Intercept	2.35	0.39	2.55	0.42
Corn @3.25	22.08	2.16	23.98	2.35
Corn@4.25	28.14	2.17	30.57	2.36
Corn@5.25	34.21	2.19	37.16	2.38
Corn@6.25	40.27	2.22	43.75	2.41

*Diet with crude protein reduced by 3 percent, supplemented with amino acids and 500 units of Phytase/kg of diet

However, the total cost of feeding hogs was found to be higher for control diet because contrary to higher amount of corn the amount of other feed ingredients were lowered in LED which made the LED to be less costly than the control diet at each of the corn prices.

Cumulative distribution functions (CDF) of the returns over the cost from the simulation also showed similar results. CDF's showed that even if the corn price increases lower excretion diet will still be profitable than the control diet keeping the hog price constant at $0 .45 per pound. In Figure 5 at corn price 3.25 there is 39% probability that LED will make zero economic profit and there is 42% probability that control will make zero economic profit. But, there is 100% probability that LED will make more returns as compared to control diet because as the figure illustrates LED diet is dominating the control diet. Figures 6, 7, and 8 shows that as the corn prices are increasing the probability of making zero returns is also increasing. When we assume that the decision maker is risk averse the more useful version of stochastic dominance, second order stochastic dominance can be used. With second order stochastic dominance area under the cumulative distribution is taken into account. Table 5 illustrates approximate area under each of the feeding systems.

Table.5. Approximate area under the cumulative distribution for control and LED*

	Approximate Area	
Corn Price ($/bu)	Contol	LED
At 3.25	25.5	24.4
At 4.25	25.7	24.7
At 5.25	25.9	25.1
At 6.25	26.2	25.4

*Diet with crude protein reduced by 3 percent, supplemented with amino acids and 500 units of Phytase/kg of diet

The approximate area under LED diet is always smaller than the area under the control diet depicting LED dominates the control diet at all the corn prices.

Conclusion

This study clearly demonstrates that the lower excretion diet will be less costly than the control diet during this unprecedented level of soaring corn prices. Also, previous researchers have found that the control diet is not environmental friendly diet. . A key issue that has emerged is the role of animal waste products. During the “cheap energy” era of the 1990’s animal waste products were internalized by hog producers as costs. Given the rise in energy prices and its commensurate effects on fertilizer prices, it’s possible that animal waste products have crossed the threshold from an internalized cost to an external benefit. Swine effluent is rich in nitrogen and phosphorous and can be a substitute for inorganic sources of nutrients if economic conditions are sufficiently favorable. It is necessary to assess economic profitability under high energy and feedstock prices.

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Appendix:

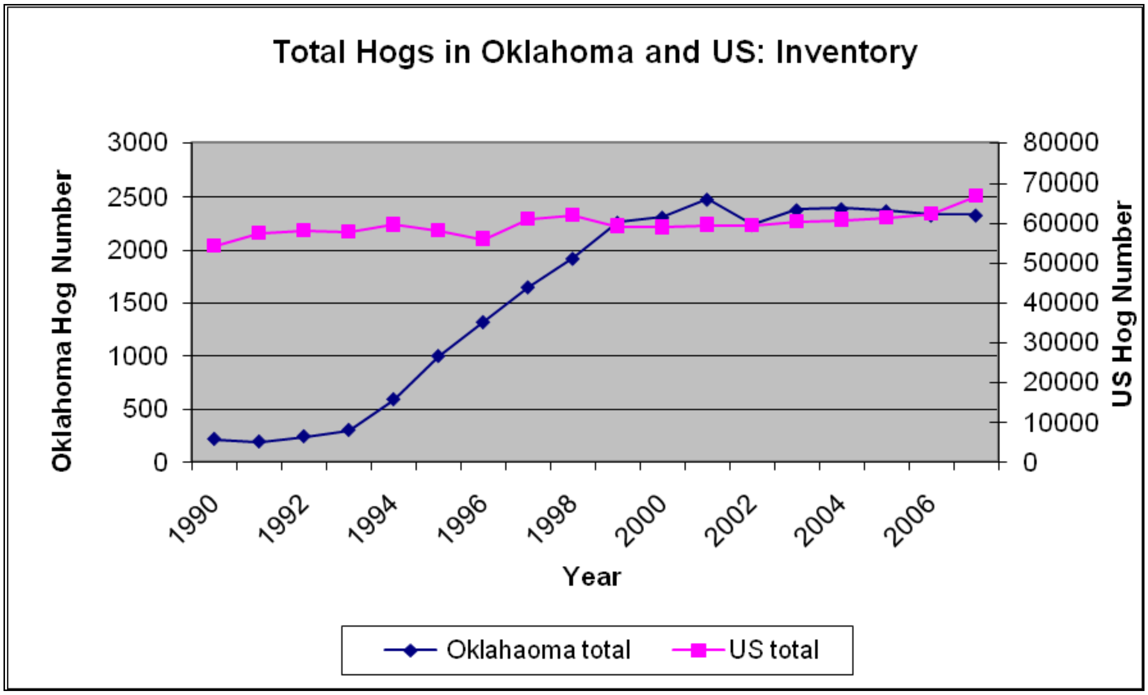


Figure 1. Hogs inventory in Oklahoma and United States: A comparison.

Source: Census US State Data (USDA, NASS)

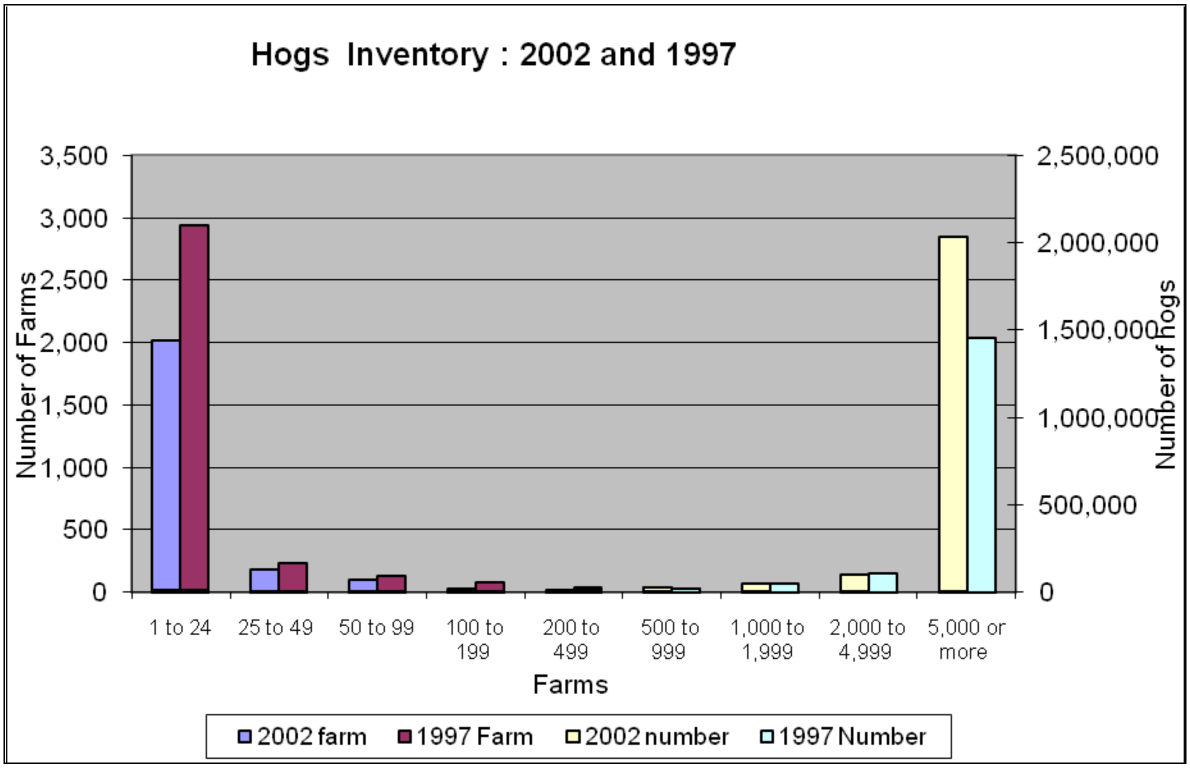


Figure 2. Number of hog farms and number of hogs in United States: A Comparison between 1997 and 2002.

Source: Census US State Data (USDA, NASS)

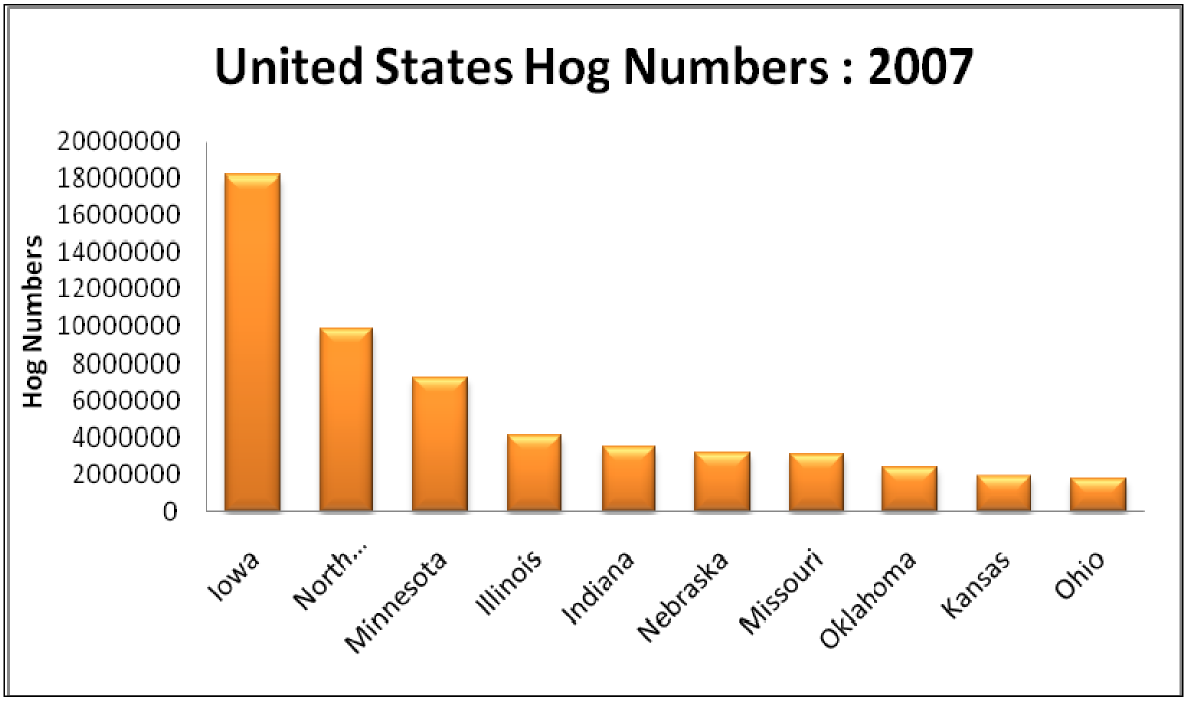
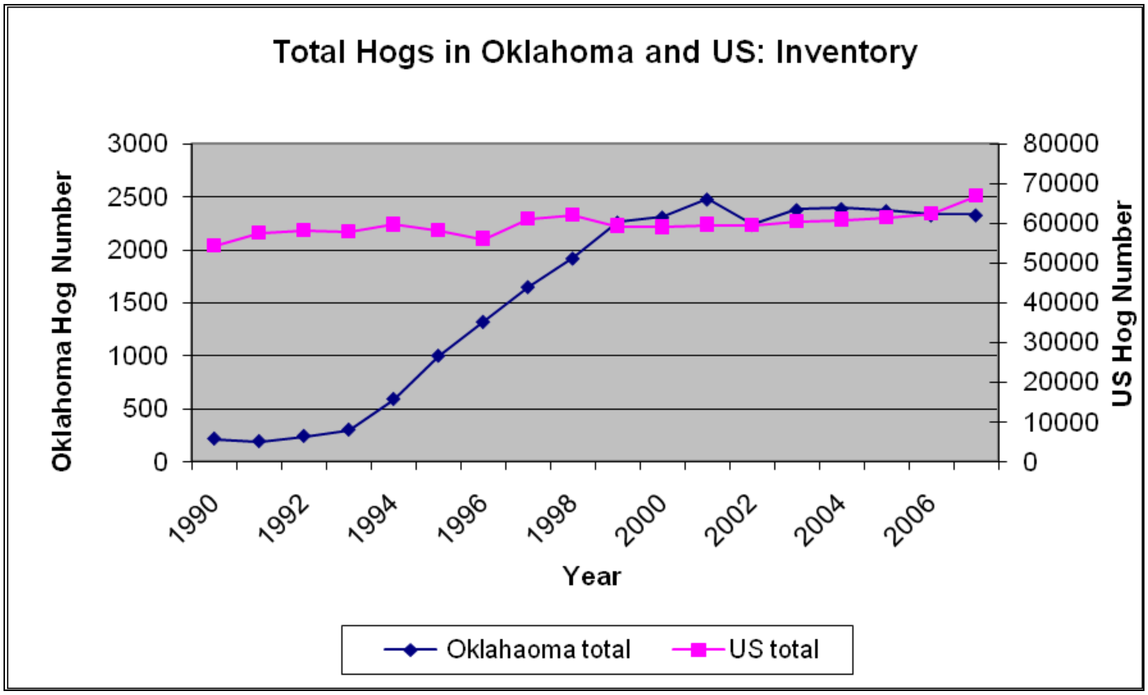


Figure 3. States' ranking on the basis of hog number in each State.

Source: Census US State Data (USDA, NASS)



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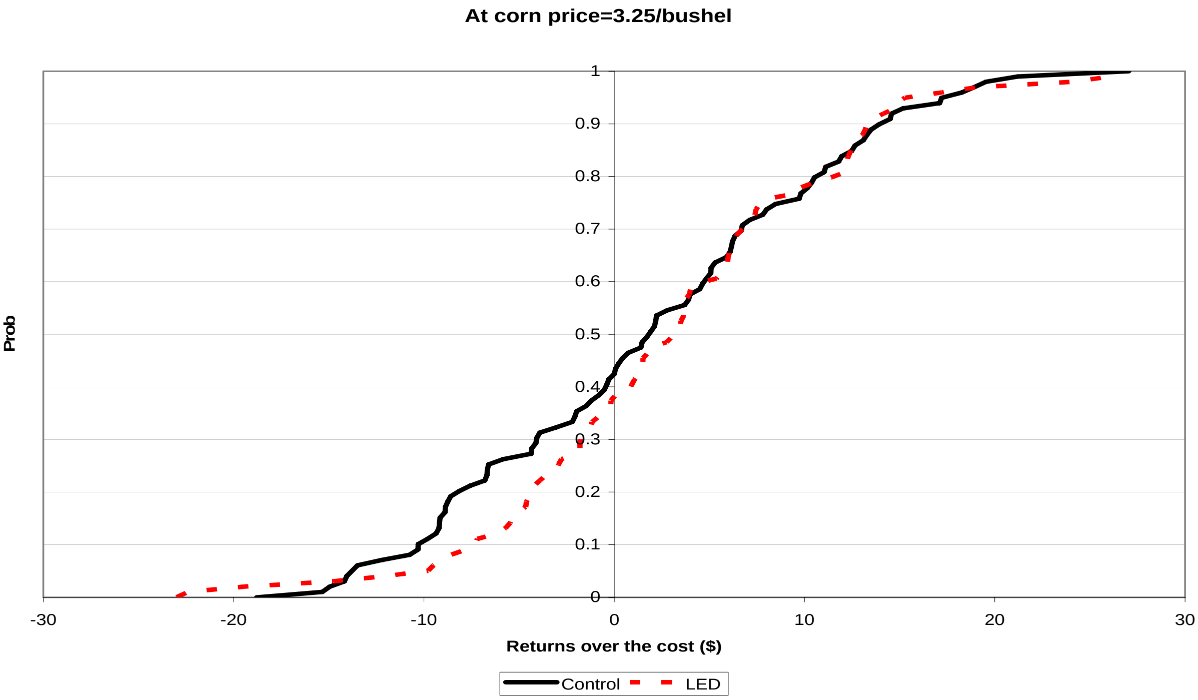

Figure 5. Cumulative Probability distribution for Control diet and Lower Excretion Diet (LED) at corn price =3.25/bushel.

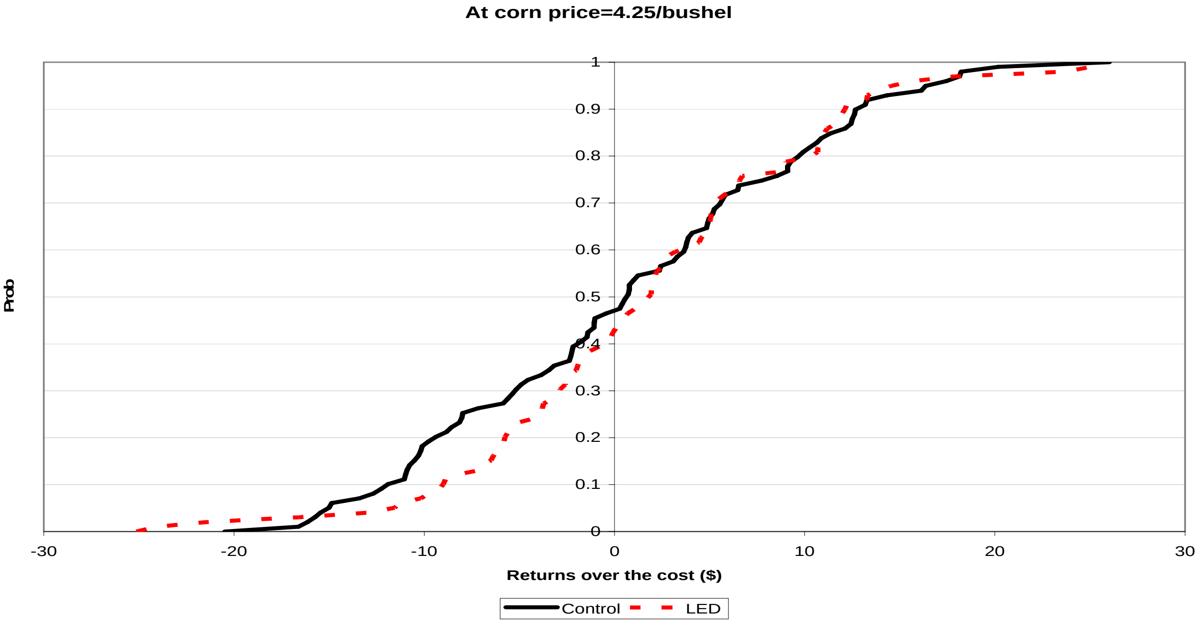

Figure 6. Cumulative Probability distribution for Control diet and Lower Excretion Diet (LED) at corn price =4.25/bushel

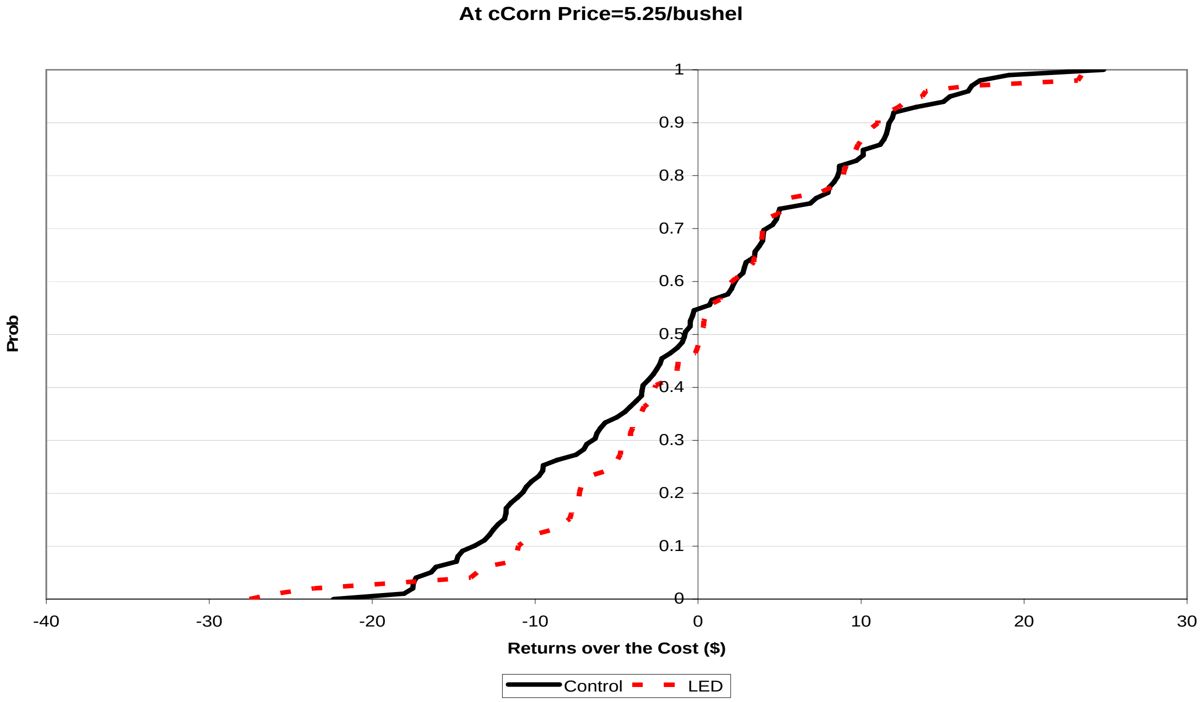

Figure 7. Cumulative Probability distribution for Control diet and Lower Excretion Diet (LED) at corn price =5.25/bushel

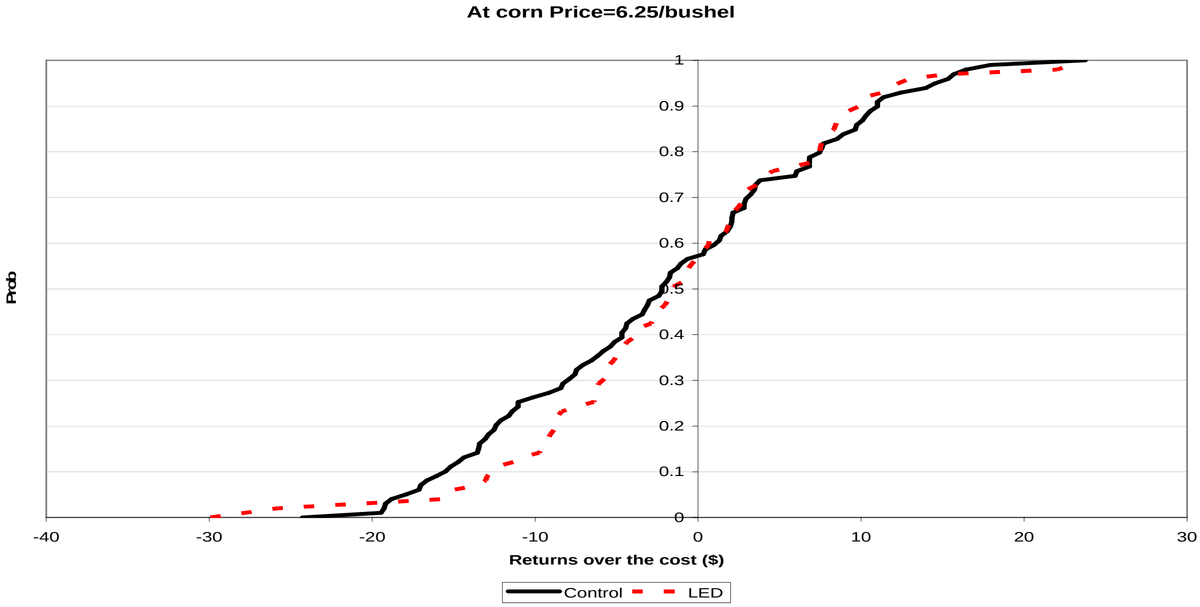

Figure 8. Cumulative Probability distribution for Control diet and Lower Excretion Diet (LED) at corn price =6.25/bushel