

EFFECT OF CORN AND SOYBEAN MEAL PRICE ON
PROFITABILITY OF CONTROL VS LOW EXCRETION
DIETS OF FINISHING PIGS

By

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TABLE OF CONTENTS

Chapter	Page
I. INTRODUCTION.....	1
Statement of the Problem.....	3
Purpose of the Study.....	5
Objectives	6
General Objectives.....	6
Specific Objectives	6
II. REVIEW OF LITERATURE.....	7
Oklahoma Market pig Industry and Legislations	7
Alternative Manure Management Practices.....	9
Model to Compare Cost Effectiveness	15
Effect of Increased Corn and Soybean Meal Prices	16
Use of Excreta as Fertilizer.....	18
III. METHODOLOGY	20
Effect of Feed Price Level and Variability during the Feeding Period on Diet Choice	23
Corn Price Variability.....	24
Soybean Meal Price Variability.....	27
Correlation between Corn and Soybean Meal Prices	31
Stochastic Dominance Analysis	34
IV. FINDINGS.....	38
Effect of Changes in the Price of Corn.....	38
Effect of Changes in the Price of Soybean Meal.....	40
Stochastic Dominance Analysis for Different Corn Prices	41
Stochastic Dominance Analysis for Different Soybean Meal Prices	45
Stochastic Dominance Analysis at Varying Corn and Soybean Meal Prices	48
V. REDUCTION IN NUTRIENT EXCRETION FROM MARKET PIGS COST OR BENEFIT?	52
Drawbacks of Excess Nutrient Excretion	57
VI. CONCLUSION	60
REFERENCES.....	63

LIST OF TABLES

Table	Page
Table III-1. Comparison of the Growth and Performance of Feeder to Finish Pigs Fed Conventional and Low Excretion Diets*	21
Table III-2. Mean Annual Corn Price and associated Coefficient of Variation for monthly Prices within Selected Years.....	24
Table III-3. Expected Total Feed Cost and the Standard Errors of Actual Feed Cost for the Control and LED* Diets based on Selected Corn Prices in the month the diet is chosen.....	26
Table III-4. Mean Soybean Meal Price and associated Coefficient of Variation for Selected Years.....	27
Table III-5. Expected Total Feed Cost and the Standard Errors of Actual Feed Cost for the Control and LED*	30
Table III-6. Correlation between Corn and Soybean meal prices.....	31
Table III-7. Expected feed cost and Standard errors for the control and LED* at selected decision month prices of corn and soybean meal.....	33
Table IV-1. Relationship between Estimated and Actual Feed Cost for Naïve Model for Control and Lower Excretion Diet.....	38
Table IV-2. Predicted Feed Cost and Standard Error of Predicted Feed cost at Selected Corn Prices for Control Diet.	39
Table IV-3. Predicted Feed Cost and standard Error of Predicted Feed Cost at Selected Corn Prices for Lower Excretion Diet.....	39
Table IV-4. Relationship between Estimated and Actual Feed Cost for Naïve Model for Control and Lower Excretion Diet.....	40
Table IV-5. Predicted Feed Cost and Standard Error of Predicted Feed cost at Selected Soybean Meal Prices for Control Diet.	40
Table IV-6. Predicted Feed Cost and Standard Error of Predicted Feed cost at Selected Soybean Meal Prices for Lower Excretion Diet.....	41

LIST OF FIGURES

Figure	Page
Figure I-1. Market pigs inventory in Oklahoma and United States: A comparison.....	1
Figure I-2. States' ranking on the basis of market pig number in each State.	2
Figure I-3. Number of market pig farms and number of market pigs in United States: A Comparison between 1997 and 2002.	3
Figure III-1 Monthly Variation in Corn Prices for Selected Years	25
Figure III-2 Monthly Variation in Soybean Meal Prices for Selected Years	28
Figure III-3. Scatter Plot Showing Correlation between Corn and Soybean Meal Prices.....	31
Figure III-4 Theoretical Model Flowchart.....	36
Figure III-5. Theoretical model flowchart used while simulating the data in SIMETAR.	36
Figure IV-1. Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when corn prices average \$3.25/bushel and other prices are constant (soybean meal price at 18.3/cwt and a market pig price at \$0.45/lb).....	43
Figure IV-2. Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when corn prices average \$4.25/bushel and other prices are constant (soybean meal price at 18.3/cwt and a market pig price at \$0.45/lb).....	43
Figure IV-3. Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when corn prices average \$5.25/bushel and other prices are constant (soybean meal price at 18.3/cwt and a market pig price at \$0.45/lb).....	44
Figure IV-4. Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when corn prices average \$6.25/bushel and other prices are constant (soybean meal price at 18.3/cwt and a market pig price at \$0.45/lb).....	44
Figure IV-5. Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when Soybean Meal prices average \$17.25/cwt and other prices are constant (Corn price at 6.25/bushel and a market pig price at \$0.45/lb).....	46

Figure IV-6	Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when Soybean Meal prices average \$18.25/cwt and other prices are constant (Corn price at 6.25/bushel and a market pig price at \$0.45/lb).....	46
Figure IV-7.	Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when Soybean Meal prices average \$20.25/cwt and other prices are constant (Corn price at 6.25/bushel and a market pig price at \$0.45/lb).....	47
Figure IV-8	Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when Soybean Meal prices average \$22.25/cwt and other prices are constant (Corn price at 6.25/bushel and a market pig price at \$0.45/lb).....	47
Figure IV-9.	Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when Corn prices average \$3.25/bushel and Soybean Meal Prices average \$11.47/cwt. (Market pig price at \$0.45/lb)	50
Figure IV-10.	Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when Corn prices average \$4.25/bushel and Soybean Meal Prices average \$11.47/cwt. (Market pig price at \$0.45/lb)	50
Figure IV-11.	Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when Corn prices average \$5.25/bushel and Soybean Meal Prices average \$17.45/cwt. (Market pig price at \$0.45/lb)	51
Figure IV-12.	Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when Corn prices average \$6.25/bushel and Soybean Meal Prices average \$20.45/cwt. (Market pig price at \$0.45/lb)	51
Figure V-1	Nitrogen and Phosphorus Excretion from Control and Lower Excretion Diets for Finishing Pigs.....	52
Figure V-2	Daily Excretion of Macro Minerals from Control and Lower Excretion Diet for Finishing Pigs.	53
Figure V-3	Daily Excretion of Micro Minerals from Control and Lower Excretion Diet for Finishing Pigs.	53
Figure V-4	Daily Excretion of Ammonia and Hydrogen sulfide from Control and Lower Excretion Diet for Finishing Pigs.	54
Figure V-5	Report from ERS showing the increase in price of fertilizer nutrient	55
Figure V-6	Report from ERS showing increase in fertilizer price while crop prices started to decline.....	55

CHAPTER I

INTRODUCTION

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.).

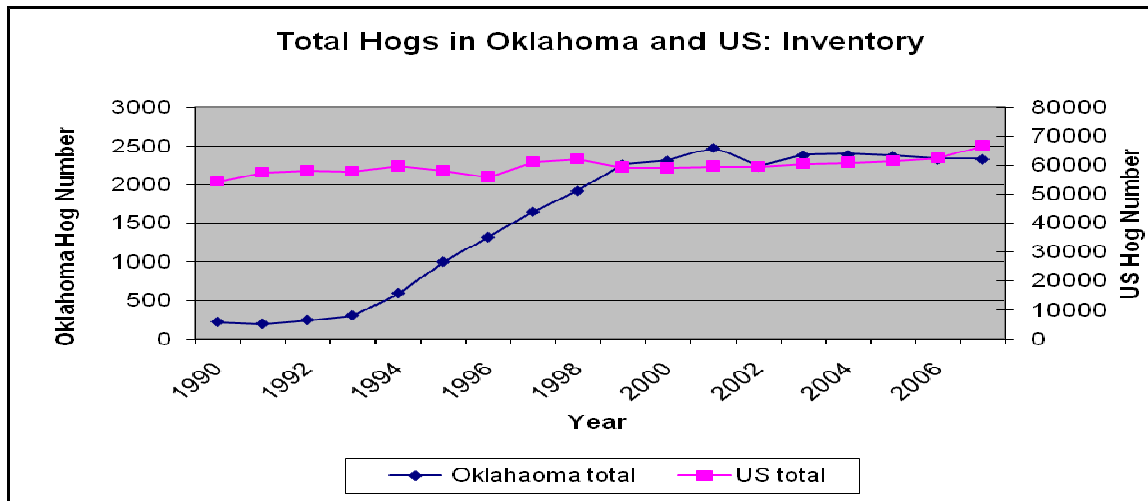


Figure I-1. Market pigs inventory in Oklahoma and United States: A comparison.

Source: Census US State Data (USDA, NASS)

Because of its relatively sparse population and its hot, dry climate that facilitates manure utilization, as shown in Figure I-1, Oklahoma has seen its market pig numbers increase almost seven-fold from 1991 to 1997 (Mildred et. al.).

In between 2006 and 2007 Oklahoma tripled its market pig numbers (Stephens, 1998). Figure I- 2 shows that based on market pigs produced, Oklahoma was ranked 8th in the nation in 2007 (USDA-NASS, 2007).

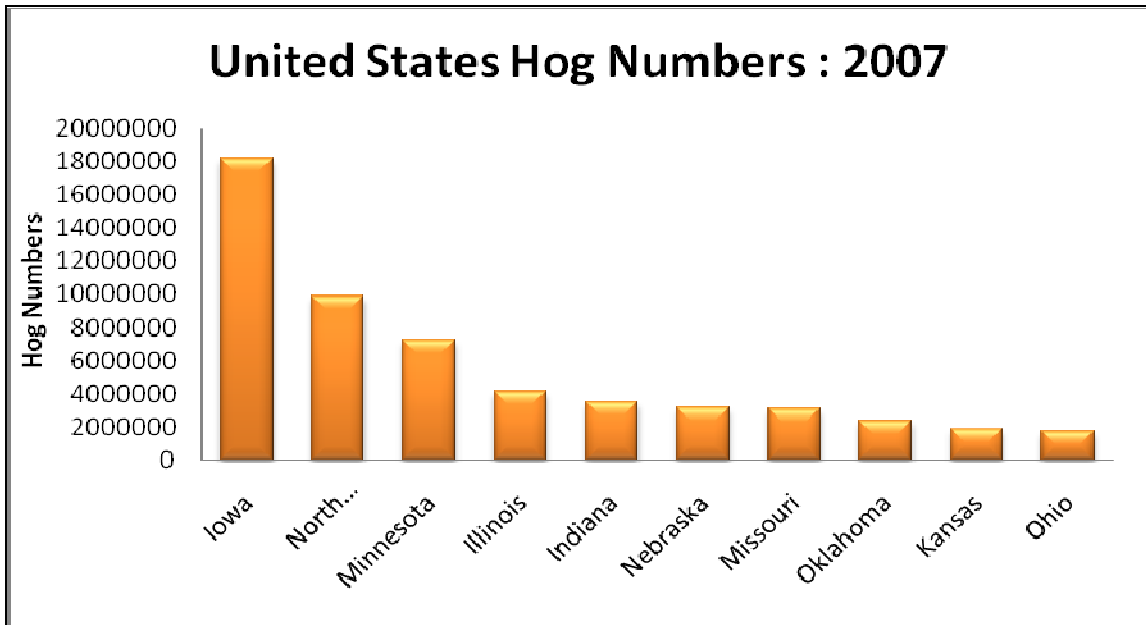


Figure I-2. States' ranking on the basis of market pig number in each State.

Source: Census US State Data (USDA, NASS)

However, as shown in Figure I-3 structural changes in market pig industry have led to decline in the number of market pig farms and a dramatic increase in the number of animals produced (Yap et. al., 2004).

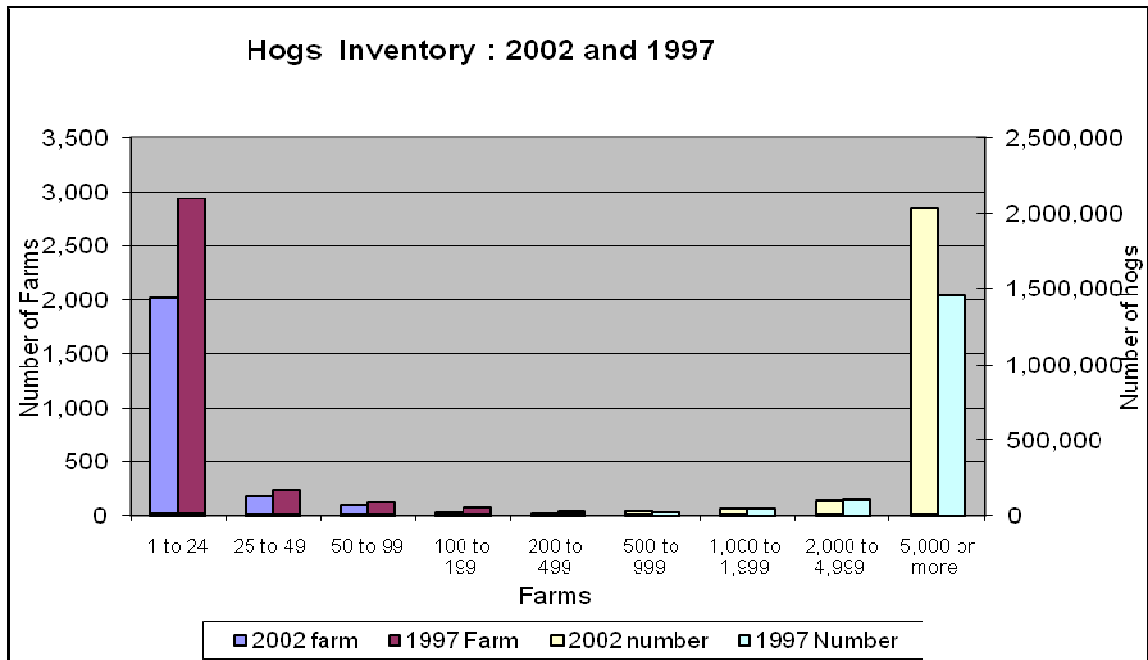


Figure I-3. Number of market pig farms and number of market pigs in United States: A Comparison between 1997 and 2002.

Source: Census US State Data (USDA, NASS)

Statement of the Problem

The Oklahoma market pig 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 market pig 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.

Purpose of the Study

The market pig 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,2001).

Measures taken in response to the rapid expansion of market pig 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 percent of the cost of producing market pigs (Nigel and McBride, 2007). 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 market pig consumes, it is necessary to look at returns over the cost of feeding at different corn prices as well. With the increase in the price of corn soybean meal prices are also increasing as there is a growing demand of soybean oil for biodiesel. Therefore it is also necessary to look at the relative increase in the price of soybean meal before any major dietary changes are made. This study departs from previous studies on market pig diets in that it accounts for cost and returns from the cost at different corn prices and different soybean meal prices as well.

Objectives

General Objectives

The overall objective 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.

Specific Objectives

The specific objectives are to

Determine effect of stochastic corn prices on relative cost of conventional and low excretion diets for finishing market pigs.

Determine the effect of stochastic soybean meal prices on relative cost of conventional and low excretion diets for finishing market pigs.

Determine whether reduced nitrogen and phytase enhanced diet has a significant effect on reducing feed cost.

CHAPTER II

REVIEW OF LITERATURE

Oklahoma Market Swine Industry and Legislation

Since 1830s market pigs have been an agriculture resource in Oklahoma (Hart and Mayda, 1997). Although Oklahoma was wheat producing state Oklahomans raised market pigs for subsistence meat supply. Oklahoma's market pig production slowly declined following the World War II and the reason was inconsistent corn production in the State. After 1945 the geographic distribution of market pigs changed from small aggregation of market pig in farm to larger aggregation of market pigs. In 1991 new State law "Right to Farm "facilitated corporate market pig farm growth. After 1995 market pig farm grew rapidly reaching second to cattle as the highest agriculture producer in Oklahoma by 2001.

Various contentious arguments in agriculture are related to market pig production and environment. Nontraditional pork producing states also produce large amount of pork. Environmental regulations of the market pig production facilities were not rigid initially. But, as the animal density is increasing market pig production facilities are being regulated by costly and rigid legislative requirements. The legislation on water resources protection was the 1899 Rivers and Harbors Act, which had the objective of protecting the nation's waters and promoting commerce. In 1948 the water pollution

Control Act was enacted to promote the protection of water quality by offering federal assistance to states interested in protecting the quality of their water resources. The legislation was changed again in 1965, with the enactment of Water Quality standards for interstate water. Finally in 1972, clean water Act was enacted. The clean water act is the federal legal framework affecting market pig producers today (Carreira, 2000). The 2003 Clean Water Act rule proposed the most fundamental changes in 30 years to water-quality requirements for animal agriculture. EPA estimated that more than 5,400 swine operations would be required to get permits. Producers would be required to develop and use nutrient management plans (NMPs) and to adopt specific land application management and conservation practices (Capital PorkReport, 2007). Today, the market pig industry has adopted water-quality protection systems to manage its manure, and the percentage of sites with water-quality incidents, spills or discharges is well under 1 percent in the major market pig-producing states (Capital Pork report 2007).

Expansion of manure handling procedures and structures before expansion of animal facility, isolation of open lots and their waste from outside surface drainage, and disposal of dead animals within three days of their death are among the best management practices specified in the Environmental Laws impacting Oklahoma Livestock producers (Copeland and Hipp, 1994). Some guidelines for managing animal wastes were developed by Chistensen, Trierweiler, Ulrich and Erickson in 1998. They focused on educating the producer and making them aware of environmental constraints.

Alternative Manure Management Practices

Different restrictions forced researchers 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. Several approaches were reviewed: feeding according to the pig's growth phase, formulation according to the feed's digestible amino acids, use of crystalline amino acids, the ideal protein approach, formulation according to available phosphorus, and the addition of phytase enzyme. Each has the potential to lower nitrogen or phosphorus excretion levels and thus reduce the pollution. Together they can dramatically reduce the nitrogen and phosphorus concentration of swine manure, which could be a major advantage in regions with a high density of swine or for swine operations with limited access to arable land. However, the value of the swine manure would be reduced as a fertilizer because these two elements are important plant nutrients.

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 market pig 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 the 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.

Boland, Foster, and Preckel (1999) compared a survey of feed companies, and found that using profit maximization rather than live weight growth maximization criterion targets nutrients to an animal's actual needs and, hence, fewer nutrients are excreted and higher returns for producers are obtained.

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 pigs fed soybean meal, and pigs fed soy protein isolate had another 11% decrease in total nitrogen excretion compared to soy protein concentrate. Thus, pigs fed soy protein isolate had a 23% reduction in nitrogen excretion as compared to soybean meal. Increase in Nitrogen digestibility and decrease in phosphorus excretion was possible by removing the soluble sugar and fiber content in the soybean meal. The author also suggested that the practice of adding soy hulls to soybean meal can increase nitrogen and phosphorus excretion leading to environmental concerns.

Levels of soil phosphorus have increased as the amount of swine manure has increased (Boland Foster and Preckel, 1998). This is because when manure is applied to meet the nitrogen need of crops, the phosphorus is over applied. Excess phosphorus mainly from soil surface may result in the degradation of water quality by causing algae

blooms in surface water drinking supplies. Therefore, the objective of the paper is to determine costs of adopting synthetic amino acids or phytase that helps to reduce the amount of phosphorus and nitrogen excreted, for a profit maximizing feeder pig finisher pork producer.

Han and Lee from Seoul National University suggested several effective feeding and management systems to reduce environmental pollution in swine production. According to them, in order to reduce the environmental impact of pork production it is logical that reducing the excretion of nutrients in manure should be a first step. It is evident that the excretion of nitrogen and phosphorus can be reduced when more digestible or available feedstuffs are used. Also, it is well known that proper feed processing can reduce anti-nutritional factors (ANF) and improve nutrient digestibility. Supplementation of effective feed additives can reduce excretion of nitrogen and phosphorus due to efficient feed utilization. One of the most effective ways to reduce pollutants from swine manure is to use synthetic amino acids in feed manufacturing. Many studies showed that reduction of 2 to 4% unit (U) of dietary protein with supplemental amino acid (AA) could reduce dramatically (15 to 20%) nitrogen excretion. It has also been recognized that a phase feeding regimen could be used to reduce nitrogen and phosphorous excretion by feeding pigs in better agreement with age and physiological state. Feeding barrows and gilts separately, known as split sex feeding, can also decrease excretion of nitrogen and phosphorus. With the increasing concern on the negative impact of animal production systems on the environment, animal nutritionists and producers should be aware that sustainability of animal agriculture is as important as high production performance.

There is vast change in the structure of market pig industry in Oklahoma. From small market pig farms the industry has grown to large market pig operations. In Oklahoma water is a scarce resource therefore water intensive manure disposal technology may seem to be inefficient disposal system for Oklahoma. Oklahoma market pig farmers may provide less water to treat market pig manure creating odor problem. But, it is important to know to properly manage the manure in a cost effective way for a particular location. Therefore Carreira (2000) worked on a research with an objective to decrease the cost associated with manure handling system. The study sites were Delaware, Seminole, and Texas. Different combination of methods was tested. The most efficient method that fitted well across the state for different farm sizes was slated floor/pull plug/anaerobic lagoon/irrigation using a travelling gun. The limitation of this study was that although valuable instrument for both producers and policy makers was used the spreadsheet used fixed cost which was subject to change over time. Also the spreadsheet had the present legislations as the constraint that is also subject to change over time.

Lin, 2005 set up the objective to minimize waste management cost by diet manipulation while achieving production goals. In Oklahoma, most manure management systems are lagoon systems. Studies conducted by Carreira and Stoecker (2000) found that land available for waste application is a crucial factor in determining total waste management costs. With concentrated animal production, the huge amount of manure can result in either increase in cost of hauling manure away from the farm, or excess land application that threatens the safety of both surface and ground waste.

In 2006, Vukina figures out some linkages between animal waste problem and contracting. This linkage is of importance because livestock waste is considered as environmental problem needing regulatory policy and the cause of livestock waste is the industry's organizational structure most probably the vertical integration and contracting with the producers. The article tries to find out if contracting is the major reason behind the livestock waste problem. The literature presented doesn't support the hypothesis that the contract livestock producers tend to be larger than individual farmers. Regardless of whether the farmer is contract operator or an independent the farmer is going to apply the phosphorus in excess if manure is applied to meet nitrogen needs. The excess phosphorus eventually leads to nutrient runoff. On the other hand, the growers may be socially optimal if the integrator is the only game in town and the probability of growers defecting to another integrator is low, making integrators liable for environmental damages.

Charleston (2004) talked about the vertical integration in the pork industry. According to him, North Carolina is the second leading market pig producer in the US and like any other profit seeking business pork business is also a profit seeking industry. In North Carolina studies showed that the number of small scale farms was not a predictor of market pig population. Also, race was not found to be significantly related to the increase in market pig population. Median income was negatively related to number of swine in that state. The most important parameter is the social and economic networks. (Charleston, 2004)

Honeyman (1993) stated that, besides the advantages of reducing the nitrogen and phosphorus emission by using various dietary treatments in regions with high density of swine and operations with limited access to arable land, there is negative effect on the

value of swine manure. The value of swine manure would be less because of less nitrogen and phosphorus present in the fertilizer. By manipulating the composition of pig's diet the nutrient composition of swine excreta can be altered. Feeding according to the pig's growth phase, formulation according to the feed's digestible amino acids, use of crystalline amino acids, the ideal protein approach, formulation according to available phosphorus, and the addition of phytase enzymes are among the several methods of feeding pig. There are both the positive and the negative aspect of reducing nitrogen and phosphorus from pig's excreta.

Kilpatric (2001) discussed the impact of concentrated animal feeding operation on the proximate land values. According to the author, currently, the USDA and the EPA estimate that livestock in the United States produces 130 times the amount of manure produced by the entire human population of this country. Severe restrictions on permits have been enacted in various states because of the noxious and obvious problems associated with CAFOs. CAFO may be viewed as negative externality because of its negative impact on the proximate land values. Case studies in different regions within United States have been reported which showed that the concentrated animal feeding operations had negative effect on the proximate property value. The amount of the value loss of the property was inversely related to the distance, property type, property use (Kilpatric, 2001).

There is literature from states other than Oklahoma where there is an increasing environmental and socioeconomic concern. The State of Mississippi has expressed environmental concern because of the growth and restructuring of swine industry (Wilson et al., 2002). Wilson et al. (2002) also studied if African-American and low income

communities have higher prevalence of market pig operation located near their neighborhoods. Data used were obtained from the department of environmental quality which included permitted swine operation in Mississippi. The results showed that most of the market pig operations were located near to where there were African-Americans and other poor people were located. This result supports the idea that the market pig operation is distributed disproportionately where there were more resource poor people. This has a negative effect to Mississippians because the exposure to lagoons and other noxious excreta can cause harmful disease (Wilson et al., 2002).

Model to Compare Cost Effectiveness

Several authors have proposed models to compare the cost effectiveness of different feeding trials. Zering (1996) addressed the budgeting of a swine manure operation. According to the author, for a swine production system, profit is given by the difference between the revenue from products and byproducts and the cost from production and waste management. This study is helpful because author estimates the cost of certain operations.

Coffey in 2001 accounted for risk management responses to price variability associated with feeding a particular ration over time. As seen in various literatures, feed expenses greatly affect producer's net income variability. A producer usually prefer to feed a consistent ration over a time and expect variation of feed ingredient prices over the feeding period to be a part in the rational decision making (Coffey,2001). Cromwell et. al. (1998) studied how livestock producers can manage input price risk. The methodology involved is the classic minimum cost feed ration linear programming model with E-V analysis. This method is an option for the livestock producer wishing to manage

input price risk and some extent the net income risk. The results suggested that input price risk could be managed by selection of the combination of feed ingredients that are less variable in prices than their substitutes. (Cromwell et. al., 1998).

Effect of Increased Corn and Soybean Meal Prices

With the increase in price of corn at an alarming rate it has become necessary to incorporate the effect of increased corn price in the researches. The profitability of control and the lower excretion diet is entirely dependent upon the cost of corn because corn comprises 79-80 percent of feed that feeder-finisher market pig consume. Therefore, it has become a necessity to look at returns over the cost of feeding at different corn prices.

In American mythology a market pig was “nothing more than fifteen to twenty bushels of corn” (Holt and Craig, 2006). But, now that the cost of fifteen to twenty bushels of corn is higher as compared to few years back the statement “nothing more than” sounds like a false statement. In a magazine “weekly outlook, 2006 ” Chris Hurt an extension specialist at Purdue University stated that “The market pig 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 market pig 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).

In an article published in “USA Today, 2007” Pork producer Joy Philippi of Bruning, Neb., says the industry can adapt to the higher corn prices with time. But in the short-run, it is struggling because it has happened so rapidly, and has become a tremendous concern. Philippi says her feed costs have risen by a third since September even though she grows some of the corn used in her 2,000-head operation. At the same time, market pig prices have fallen. But she says she and her fellow producers are most concerned about supply. Already, she has been told at the local grain elevator that no corn is available for delivery in August (Hagenbaugh, 2007).

With the sharp drop in South America’s spring harvest the soybean meal prices are likely to go up. According to Dr. Robert Wisner an economist at Iowa State University there are three factors causing the feed prices to soar up. The first factor is delayed planting of corn acres in mid-west. The second factor is huge drop in South American crops and the third factor is decline in feed wheat supplies which has been a competitor to corn. Dr. Wisner also added that apart from the factors explained above sharp increase in ethanol demand is also a driving factor for increase in corn price.

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

Use of Excreta as Fertilizer

Market pigs, like most livestock, are not very efficient at converting feedstuffs into meat. About 75 to 90% of the feedstuffs' nutrients are excreted with the manure. (Tishmack and Jones, 2003) High concentration of organic matter is found in swine manure. It has higher nitrogen content than beef or dairy manure, but less than poultry manure. The amount of organic matter and nutrients in manure depends on the rations, the type of bedding, and whether the manure is applied as a solid, slurry, or liquid. (Tishmack and Jones, 2003)

There are various discussions on the fact that the excreta of market pig can also be used to make valuable fertilizer. Therefore, many economists see the excreta as benefit rather than cost. In a report entitled "The changing economics of US Market pig Production" Key Nigel and William McBride state that:

Increases in the scale of production resulting in greater animal density may require operations to store manure in larger lagoons/pits—creating concentrated levels of odor, ammonia emissions, and the potential for larger manure spills. The concentration of market pig manure makes it more costly to use as fertilizer as more land is needed and transportation costs to fields are greater. On the other hand, concentrating manure sources in fewer locations potentially affects fewer people. Additionally, greater concentration may make some manure treatment technologies feasible (e.g., energy from bio waste, or processing into concentrated fertilizer).

The odor of market pig manure is also a biggest concern among the environmentalists. Before making decisions on converting the excreta to fertilizer there might be question of storing the excreta and the odor from the excreta. In an article from Inside agro forestry the author states that:

People respond to odor differently. Although the human olfactory organ is quite sensitive, the response to odor is related more to past memories or cultural experiences. There is not very much information about the impact of odor to human health. Most of the existing information refers to the adverse health effects of individual gases, e.g. ammonia, or dust,

but no specific information about odors. One study did show that odors from a swine facility had a negative effect on the moods of the neighbors such as anger and frustration. These psychological impacts can be as significant as a person's physical health (Anon., 2002).

CHAPTER III

METHODOLOGY

Data used were collected by Carter et al. (2003) from three different experiments. In each experiment different amounts of a feed ration was fed to market pigs under two dietary systems. These were the control diet and phytase enhanced diet also referred to as lower excretion diet (LED). According to the study done by Lachmann et al (2006), the market pig 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 average 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 market pigs with an initial weight of 61 lbs reached the targeted weight of 260 lbs. 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 III-1.

Table III-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. Source: Sevilla (2007).

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 and soybean 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:

$$TR = P_h * Q_h,$$

Where, P_h = Output Price (current market price)

Q_h = amount of output (final wt. of market pigs)

$$Q_h \text{ (final wt. of market pig)} = f(X_i, P_i)$$

Where, X_i = amount of feed fed to market pigs

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.

$$TC = FC + VC$$

Where, TC = Total Cost

FC= Fixed cost

VC= Variable cost

$$VC = \sum P_i * X_i \quad (i=1 \text{ to } n)$$

Where, X_i =amount of feed fed to market pigs

P_i =Price of feed ingredients

In order to realize a profit, the weight gained by market pigs is an important factor to be considered. In this research the initial cost of the 61.72 lb pig has not been 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 and soybean prices and the different amounts of corn and soybeans 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 market pig price necessary to yield a 90 percent chance of breaking even are examined below.

Effect of Feed Price Level and Variability during the Feeding Period on Diet Choice

In current confined swine feeding operations operators typically operate houses on an all-in and all-out basis. That is the operator may place a 1,000 feeder pigs in one building in the same time and later market all of the finished pigs at the same time. This leaves the finishing house completely empty of pigs for cleaning and disease control.

The producer is assumed to select either the control (conventional) or the LED diet before the feeding begins and then continue with the diet until the pigs reach a market weight (260lb), four months later. The actual cost of corn and soybean meal for each diet depends on the market price of these items over the future feeding period. In

the text below, the historical changes in the level and variability of monthly corn and soybean over the 1970-2008 period and their effect on feed cost of the control and LED diets are examined.

Corn Price Variability

After remaining stable for several decades the corn price has reached new heights. Various factors such as increased starch based corn for ethanol production associated with increased energy costs, declining value in United States dollar, increased global commodity demand has been reported as the major cause of increase in corn price. The price variability of corn was calculated using the coefficient of variation (CV) of monthly U.S. prices. The mean and standard deviation of the monthly U.S. prices for corn were calculated. The standard deviation was then divided by the mean to compute the CV for U.S. monthly prices of corn. It was found that the percent change in the coefficient of variability was 10.44 from 2007 US monthly corn prices to 2008 US monthly corn prices.

Table III-2. Mean Annual Corn Price and associated Coefficient of Variation for monthly Prices within Selected Years.

Year	Mean(\$/bushel)	Coefficient of Variation(CV)
1970	1.32	4.63
1980	2.75	11.06
1990	2.27	15.32
2000	2.1	4.17
2007	3.17	7.52
2008	3.94	17.96

According to Carl Zulauf and Matt Roberts, professors at Ohio State University, percent change in the measure of price variability of corn from 1989-91 to 2003-06 was 1% while from 2003 to 2007 it was 61%. This implies that the price variability has increased during 2007 crop year. Zulauf and Roberts (2008) believe that this increase is a

part of a longer trend of higher price variability. The Figure III-1 below illustrates the monthly corn prices for different selected years.

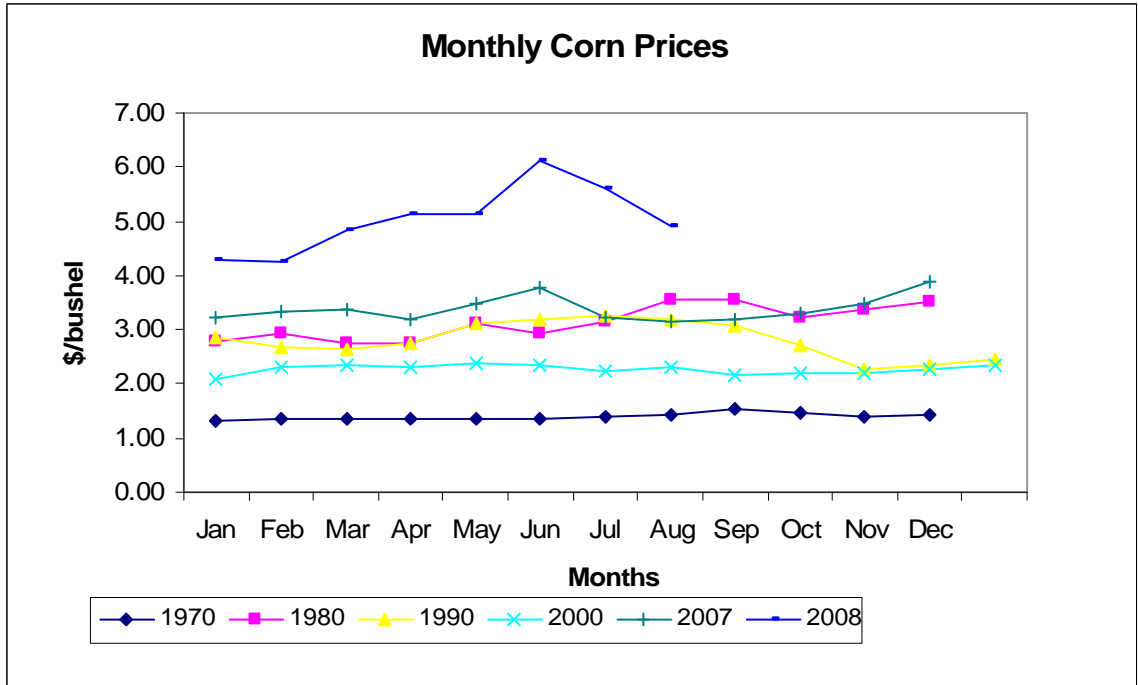


Figure III-1 Monthly Variation in Corn Prices for Selected Years

A naive feed cost prediction model is developed below. It is assumed the producer makes decision on which diet to feed based on the corn price in the current month and that feeding begins in the following month. Thus the expected feed cost for the control and the lower excretion diets when the per bushel corn price is P_{ct} are $EFC_{tc} = P_{ct} * 387.4/56 + FC$ and $EFC_{tL} = P_{ct} * 420.7/56 + FC$ respectively where EFC_{tc} is the expected feed cost for control diet based on current (P_{ct}) corn prices and EFC_{tL} is the expected feed cost of lower excretion diet based on current (P_{ct}) corn prices. The variable “t” is the decision month and FC is the cost of non-corn feeds. It is expected that the actual or the realized feed cost will be a function of the market price in which the corn is fed. Because market pigs are feed for a period of almost four months, the change in the

corn price over the four month period will definitely affect the realized feed cost.

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 from choosing LeD diet in month t is $AFC_{iL} = Q1*P_{c_{t+1}} + Q2*P_{c_{t+2}} + Q3*P_{c_{t+3}} + Q4*P_{c_{t+4}} + FC$ where Q1 is the quantity of corn required in month t+1 and $P_{c_{t+1}}$ is the price of corn during that month t+1 and so forth. FC is non-corn feed cost. An OLS regression on monthly US corn prices from January, 1970 through August 2008 was used to estimate the accuracy and standard error of the naive feed cost model for each diet.

The actual feed cost for diet i, (AFC_{i}) was treated as dependent variable and expected feed cost for diet i, based on the corn price at time t, EFC_{i} was treated as an independent variable. The variable i represents the diet control or LED.

Table III-3. Expected Total Feed Cost and the Standard Errors of Actual Feed Cost for the Control and LED* Diets based on Selected Corn Prices in the month the diet is chosen.

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	dollars	40.71	40.71	40.71	40.71
Expected Total 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	dollars	35.21	35.21	35.21	35.21
Expected Total 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. The soybean meal cost was held constant at 18.3/cwt.

The general form of regression model was $AFC_{ti}=a+bEFC_{ti}+ e_t$ where, AFC_{ti} is the actual feed cost incurred by feeding diet “i” over months t+1, t+2, t+3, t+4 and EFC_{ti} is the expected feed cost for diet “i” when the feed cost is estimated in month t.

The expected feed costs and the standard errors of the diets for corn prices at \$3.25, \$4.25, \$5.25, and \$6.25 per bushel are given in Table III-3. The standard error of the LED diet is greater than the control diet because the amount of corn is greater. The variability of the cost 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.

Soybean Meal Price Variability

As shown in Figure III-2, soybean meal prices have also gone up as soybeans compete with corn for land and as soybean oil demand for biodiesel is rising. The price variability of soybean meal is also calculated using the coefficient of variation measure where the standard deviation of the monthly prices of soybean meal was divided by the mean of the monthly soybean meal prices. Table III-4 contains the mean soybean meal price and the coefficient of variation in selected years.

Table III-4. Mean Annual Soybean Meal Price and associated Coefficient of Variation for monthly prices within Selected Years.

Year	Mean(\$/Cwt)	Coefficient of Variation(CV)
1970	3.94	6.95
1980	9.40	16.00
1990	6.90	3.31
2000	7.43	5.35
2007	10.65	16.97
2008	16.63	10.89

It can be noted that the coefficient of variation was very highest during 2007 but decreased by 2008.

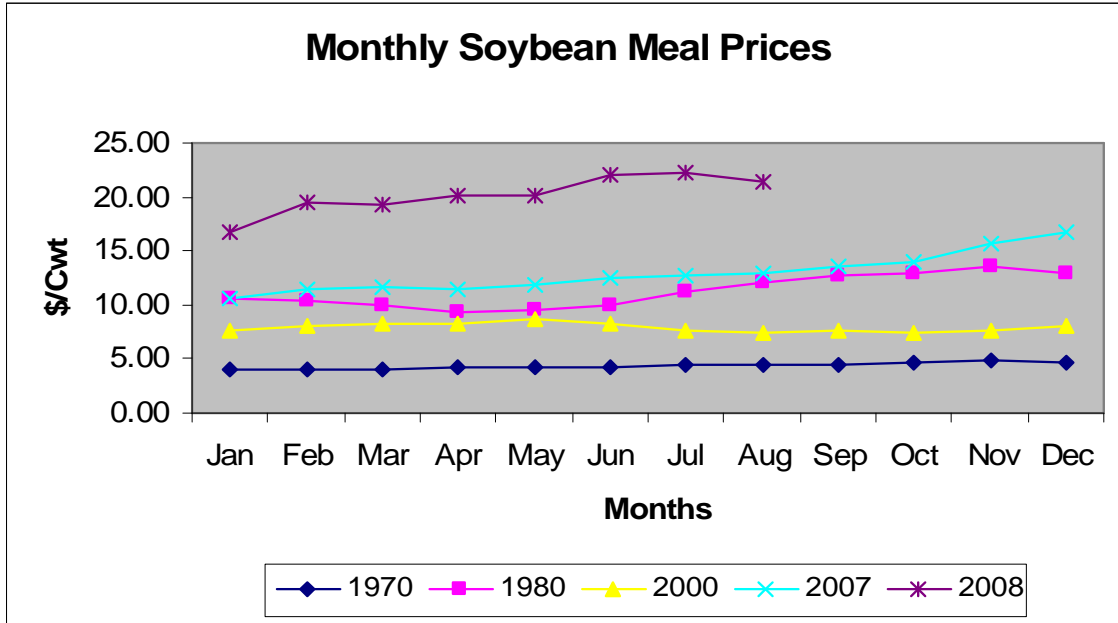


Figure III-2 Monthly Variation in Soybean Meal Prices for Selected Years

In order to determine the effect of soybean meal prices on two different diets again a naïve feed cost prediction model is developed. Simple regression analysis was used to establish the standard error associated with the control and lower excretion diet using the current input prices of soybean meal. Let, $EFC_{tc} = P_{s_t} * 114.63 / 60 + FC$ be the expected feed cost for the control diet based on the current soybean meal price in month t and $EFC_{tL} = P_{s_t} * 67.52 / 60 + FC$ be the expected feed cost for the lower excretion diet based on current soybean meal price in month t. FC is the cost of non-soybean feeds. The total soybean meal consumed during the finishing phase of market pigs was 114.63 and 67.52 in pounds for the control and LED diets respectively. As already discussed above there is variability in the price of soybean meal from month to month and year to year. Each month the price of soybean meal may change and the total feed cost will change if

the producer buys soybean meal as it is fed. The variability in the soybean meal price is a partial determinant of the variability of total feed cost during that month. If the LED diet is chosen, the actual feed cost is $AFC_{IL} = Q1 * P_{S_{t+1}} + Q2 * P_{S_{t+2}} + Q3 * P_{S_{t+3}} + Q4 * P_{S_{t+4}} + FC$. $Q1$ is the quantity of soybean meal required in month $t+1$ and $P_{S_{t+1}}$ is the price of soybean meal during that month $t+1$. For soybean meal, as the weight of the pig increases and as the protein of the ration amount required in each phase or month is different depending on the soybean meal fed during that period. Thus, for calculating the actual feed cost unlike the expected feed cost it is convenient to divide the total feed required into the different amounts required during each of the four months and multiply the amount fed in each month by its respective monthly price. FC is non-soybean feed cost i.e., FC is the total cost of feed ingredients other than the soybean meal. An OLS regression on monthly US soybean meal prices from January, 1970 through August 2008 was used to estimate the accuracy and standard error of the naive feed cost model as was done with corn prices. For the OLS model actual feed cost was treated as the dependent variable and the expected feed cost was treated as an independent variable. The actual feed cost was regressed over the expected feed cost at selected soybean meal prices. The expected feed cost and associated standard error of the feed cost at soybean meal prices \$17.25/cwt, \$18.25/cwt, \$20.25/cwt and \$22.25/cwt are given in Table III-3 below. In contrast to higher standard error for LED diet in case of corn price variability, the standard error of the control diet is higher than the LED diet in case of soybean meal price variability because the amount of soybean meal is higher. With soybean meal price varying at selected levels corn price was held constant at \$4.25/bushel which was the mean market price of corn during year 2008.

Table III-5. Expected Total Feed Cost and the Standard Errors of Actual Feed Cost for the Control and LED* Diets based on Soybean Meal Price Month Prices in the month the Diet is chosen

Diet		Current or Decision Month Soybean meal Price			
Control (Conventional)	\$/Cwt	\$17.25	\$18.25	\$20.25	\$22.25
Total Feed Required	lbs	526.3	526.3	526.3	526.3
Soybean Meal Required	lbs	138.9	138.9	138.9	138.9
Non Soybean Feed cost	dollars	\$49.40	\$49.40	\$49.40	\$49.40
Expected Feed Cost	dollars	\$74.59	\$75.63	\$77.70	\$79.77
Standard Deviation	dollars	\$1.23	\$1.23	\$1.24	\$1.16
Low Excretion Diet*					
Total Feed Required	lbs	512.3	512.3	512.3	512.3
Soybean Meal Required	lbs	91.55	91.55	91.55	91.55
Non Soybean Feed cost	dollars	\$54.64	\$54.64	\$54.64	\$54.64
Expected Feed Cost	dollars	\$65.78	\$66.38	\$67.59	\$68.80
Standard Deviation	dollars	\$0.71	\$0.72	\$0.72	\$0.72

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

Correlation between Corn and Soybean Meal Prices

Corn and soybeans compete for crop land and soybeans are also partial substitute for corn in feeding market pigs. The historical simple correlation of monthly price of corn and soybean meal over the 1970-2008 study periods is 0.85. The Correlation between the corn price and the soybean meal price is demonstrated in Table III-6 and Figure III-3.

Table III-6. Correlation between Corn and Soybean meal prices.

		Corn	Soybean Meal
	Average	\$2.61/bushel	\$9.56/cwt
	St Dev	0.68	1.42
Correlation	Corn	1	0.85
	Soybean Meal	0.85	1

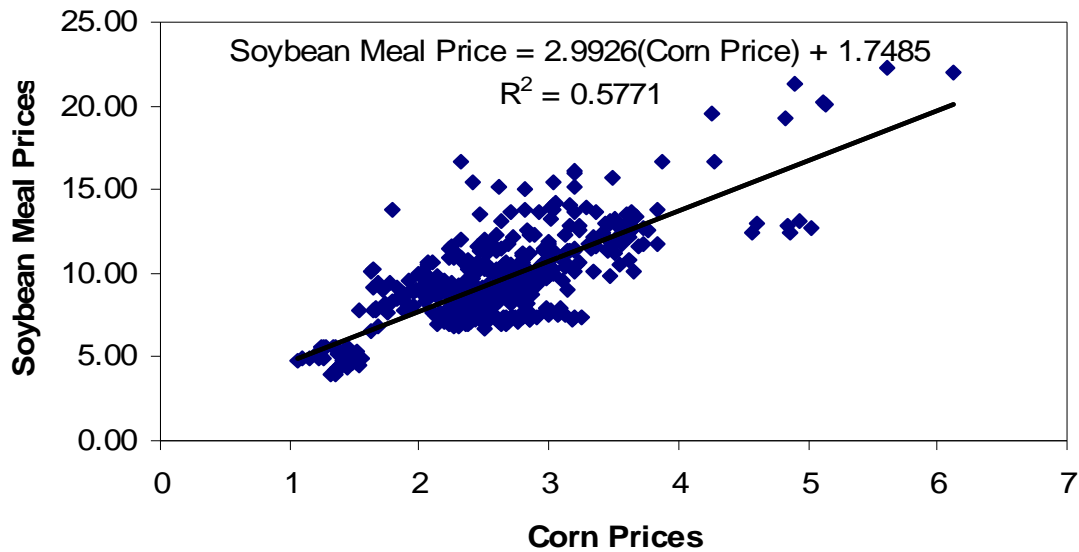


Figure III-3. Scatter Plot Showing Correlation between Corn and Soybean Meal Prices.

The Scatter plot also suggests that there is a positive correlation between the corn and soybean meal prices which means with the increase in the corn price there is simultaneous increase in soybean meal prices.

In order to determine which diet is less costly it is also necessary to incorporate the changes in soybean meal prices as the corn price changes. Therefore, total cost of feeding market pigs at different prices of corn and soybean meal was calculated by running an OLS regression on US monthly prices of corn and soybean meal from January 1970 through August 2008. The actual total feed cost and the expected total feed cost were calculated for the selected corn and soybean meal prices in the similar manner as it was explained earlier. The actual total feed cost was treated as dependent variable and the expected or the naïve total feed cost was treated as an independent variable. The Table III-5 shows the expected total feed cost and the standard error of the actual total feed cost associated with the different corn and soybean meal prices.

While comparing the total feed cost at different corn and soybean meal prices it was found that the lower excretion diet will be more profitable than the control diet. At corn price \$3.25/bu and soybean meal \$17.25/cwt total feed cost for control diet was found to be \$61.49 with standard error of 1.16 and the total cost for LED s found to be \$58.30 with standard error of 0.71.

At the highest corn price computed here at \$6.25/bu shel of corn and soybean meal price of \$22.25/cwt total feed cost for control diet is \$87.33 with standard error of 1.18. The total feed cost in the case of LED at the same corn and soybean meal price was found to be \$83.76 with standard error of 0.72.

Table III-7 Expected feed cost and Standard errors for the control and LED* at selected decision month prices of corn and soybean meal

Corn Prices	Soybean meal Prices							
	\$17.25/cwt		\$18.25/cwt		\$20.25/cwt		\$22.25/cwt	
	Control	LED	Control	LED	Control	LED	Control	LED
\$3.25/bushel	61.49 (1.16)	58.30 (0.71)	62.53 (1.17)	58.90 (0.72)	64.61 (1.17)	60.11 (0.72)	66.68 (1.18)	61.27(0.72)
\$4.25/bushel	74.59 (1.16)	65.78 (0.71)	75.63 (1.17)	66.38 (0.72)	77.70 (1.17)	67.59 (0.72)	79.77 (1.18)	68.80 (0.72)
\$5.25/bushel	75.26 (1.16)	73.26 (0.71)	76.30 (1.17)	73.86 (0.72)	78.38 (1.17)	75.07 (0.72)	80.45 (1.18)	76.28 (0.72)
\$6.25/bushel	82.14 (1.16)	80.74 (0.71)	83.18 (1.17)	81.34 (0.72)	85.26 (1.17)	82.55 (0.72)	87.33 (1.18)	83.76 (0.72)

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

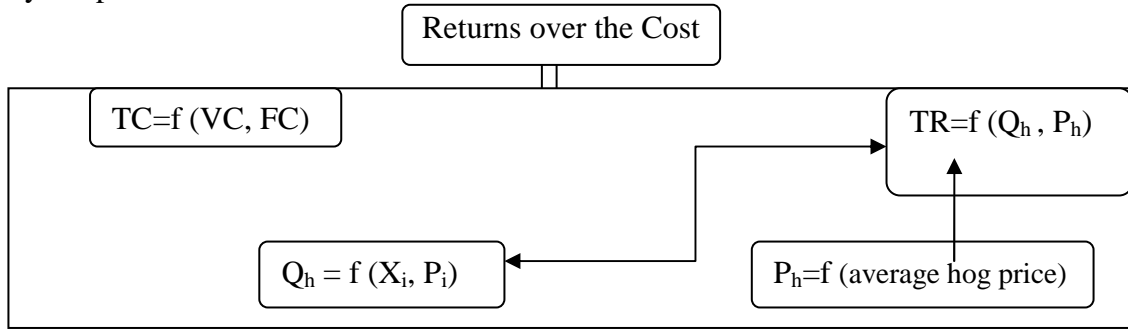
Stochastic Dominance Analysis

Next a stochastic dominance analysis was conducted with the use of SIMETAR to compare the variability or risk of returns over the 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 a pair wise comparison of the cumulative distribution functions of the outcomes resulting from different actions (Lansigan et al., 1997). Stochastic dominance has been applied to a variety of decision situations in agriculture including (1) adoption of new technologies (Hardaker and Tanago; Danok, McCarl, and White; Schoney and McGuckin), (2) participation in government programs (Kramer and pope; Richardson and Nixon (1982)), (3) evaluation of cropping strategies (McGuckin; peder son; Zacharias and Grube), and (4) selection among management strategies (Richardson and Nixon (1984); Wilson and Eidman). Under generalized stochastic dominance, when two cumulative distributions are compared, the distribution that has higher positive net returns dominates the other.

For the simulation purposes as stated above SIMETAR was used. SIMETAR is an excel add in designed developed and used by Richardson, Schumann, and Feldman at Texas A&M University to facilitate developing, validating, and using complex stochastic simulation models in Excel for decision making (Richardson, 2002). The simulation results can be interpreted through their graphical representation. Cumulative distribution

functions were used in our research for analyzing the returns over the cost. Simulations were conducted for each selected corn price and soybean meal price. Information on the amount of feed fed under the control diet and the lower excretion diet was combined with the budgeted cost estimate to simulate expected returns over the total feed cost for each of the diets. Returns over the feed cost were calculated by multiplying weight gained with the market price of finished pig which was held constant at 0.45/lb and subtracting the total feed cost. The market price of pig was of July 2008 and the weight gained from control diet was equal to 199.1lbs and for LED diet weight gained was equal to 196.2lbs. While calculating returns over the feed cost the variable feed cost was only taken into account and the fixed cost of producing pig was not included in the research. The key output variables for SIMETAR model for each diet were the returns over the feed cost and the standard error of that cost. Since the market price and weight gained are held constant, the standard error of the returns over the feed cost is equal to the standard error of feed cost. All distributions were assumed to be normal. Returns over the feed cost were simulated 100 times for each of the four price levels. For corn the price level was \$3.25/bushel, \$4.25/bushel, \$5.25/bushel and \$ 6.25/bushel and for soybean meal the price level was \$17.25/cwt, \$18.25/cwt, \$20.25/cwt and \$22.25/cwt. The prices were randomly selected based on the possible lowest and the highest price. The theoretical model flowchart of the simulation is shown in Figure III-4.

Key Output Variable



Variable Key
TC=Total Cost
FC= Fixed cost (It is not accounted for in this research)
VC= Variable feed cost
P _h = Output Price (current outputs' market price=0.45/lbs)
Q _h =amount of output (final wt. of hogs=260lbs)
X _i =amount of feed fed to hogs
P _i =Price of feed ingredients

Figure III-4 Theoretical Model Flowchart

The data was thereafter simulated by using SIMETAR that gave the cumulative density

Figure III-5. Theoretical model flowchart used while simulating the data in SIMETAR.

The flowchart illustrates how all the variables used for simulation purposes are interrelated to each other. The variables used for simulation are the weight gained by the market pig, price of the market pig, and cost of feeding the market pig and returns over the total feed cost. The return over the total feed cost is calculated by subtracting total feed cost from the total revenue. Total cost is the function of fixed cost and variable cost. As mentioned before, in this research fixed cost and the initial cost of the feeder pig are not taken into account and the variable cost is the cost of feeding market pigs at different

price levels of corn and soybean meal. Total revenue is the function of final weight of market pig and the price of market pig. Both the variables are kept constant. The final weight of market pig depends on the amount of feed fed which eventually dependent on the price of feed ingredients. Thus, price of feed ingredient plays a vital role in determining the returns over the cost.

After all the calculations the prepared data were simulated by using SIMETAR that gave the cumulative density functions used to eventually determine nature of returns over the feed cost for different dietary system under different corn and soybean meal prices.

CHAPTER IV

FINDINGS

While looking at the literature it is clear that the phytase enhanced diet will reduce the amount of phosphorus released. This was again confirmed by the experiments done by Carter et al in 2003.

Effect of Changes in the Price of Corn

Since most of the market pig 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, market pig 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.

Table IV-1. Relationship between Estimated and Actual Feed Cost for Naïve Model for Control and Lower Excretion Diet.

	Control Diet	LED*
Actual feed Cost	$a+b\text{ExpFeCost}+/-e$	$\text{ActFeCost}=a+b\text{ExpFeCost}+/-e$
Corn@3.25/bushel	$2.35+0.88*(22.08)+/-2.16$	$2.55+0.88(23.98)+/-2.35$
Corn@4.25/bushel	$2.35+0.88*(28.14)+/-2.17$	$2.55+0.88(30.57)+/-2.36$
Corn@5.25/bushel	$2.35+0.88*(34.21)+/-2.19$	$2.55+0.88(37.16)+/-2.38$
Corn@ 6.25/bushel	$2.35+0.88*(40.27)+/-2.22$	$2.55+0.88(43.75)+/-2.41$

*Diet with crude protein reduced by 3 percent, supplemented with amino acids and 500 units of Phytase/kg of diet. The data in parenthesis at each corn price are the estimated corn cost from the OLS regression.

Relationship between the actual and expected feed cost of corn is illustrated in table IV-1.

Taking into account the amount of corn fed in each of the dietary system the cost for corn was found higher for LED as compared to control diet which is illustrated in Table IV-2 and IV-3. This is because more of the energy for growth comes from corn in the LED diet.

Table IV-2. Predicted Feed Cost and Standard Error of Predicted Feed cost at Selected Corn Prices for Control Diet.

Monthly Corn Price(\$/bushel)	Estimated Cost		Predicted Actual Cost		Standard Error
	Corn Cost(\$)	Total Feed Cost(\$)	Corn Cost (\$)	Total Feed Cost (\$)	
3.25	22.08	63.20	21.78	63.01	2.16
4.25	28.14	69.26	27.11	68.34	2.17
5.25	34.21	75.33	32.45	73.69	2.19
6.25	40.27	81.39	37.78	79.02	2.22

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

Table IV-3. Predicted Feed Cost and standard Error of Predicted Feed Cost at Selected Corn Prices for Lower Excretion Diet.

Monthly Corn Price(\$/bushel)	Estimated Cost		Predicted Actual Cost		Standard Error
	Corn Cost(\$)	Total Feed Cost(\$)	Corn Cost (\$)	Total Feed Cost (\$)	
3.25	23.98	59.19	23.65	58.95	2.35
4.25	30.57	65.78	29.45	64.75	2.36
5.25	37.16	68.86	35.25	67.46	2.37
6.25	43.75	78.96	41.05	76.35	2.41

Effect of Changes in the Price of Soybean Meal

From the correlation matrix in the previous chapter it can be concluded that the increase in corn price is usually related to an increase in soybean prices. In 2008 soybean meal price was as high as \$22.21/cwt which was a record high. As in the case of corn, for soybean meal also the actual feeding cost and the expected feeding cost of soybean meal are different. The Table IV-6 illustrates the relationship between the actual and expected soybean meal cost.

Table IV-4. Relationship between Estimated and Actual Feed Cost for Naïve Model for Control and Lower Excretion Diet.

	Control Diet	LED*
Actual Feed Cost	a+bExpFeCost+/-e	a+bExpFeCost+/-e
Soybean Meal@17.25/cwt	1.14+0.90*(18.98)+/-0.16	0.74+0.89(11.14)+/-0.71
Soybean Meal@18.25/cwt	1.14+0.90*(20.02)+/-0.17	0.74+0.89(11.74)+/-0.72
Soybean Meal@20.25/cwt	1.14+0.90*(22.10)+/-0.17	0.74+0.89(12.95)+/-0.72
Soybean Meal@22.25/cwt	1.14+0.90*(24.17)+/-0.18	0.74+0.89(14.16)+/-0.72

*Diet with crude protein reduced by 3 percent, supplemented with amino acids and 500 units of Phytase/kg of diet. The data in parenthesis at each corn price are the estimated corn cost from the OLS regression.

Table IV-5. Predicted Feed Cost and Standard Error of Predicted Feed cost at Selected Soybean Meal Prices for Control Diet.

	Estimated Cost		Predicted Actual Cost		
Monthly Soybean Meal Price(\$/cwt)	Soybean Meal Cost(\$)	Total Feed Cost(\$)	Soybean Meal Cost (\$)	Total Feed Cost (\$)	Standard Error
17.25	18.98	82.15	18.22	81.08	1.16
18.25	20.02	83.19	19.15	82.01	1.17
20.25	22.10	85.26	21.03	83.88	1.17
22.25	24.17	87.34	22.89	85.75	1.18

Looking at the soybean meal prices at different levels it was found that the cost of feeding market pigs with the lower excretion diet was less as compared to control diet.

Below is the table of predicted feed cost of soybean meal and its standard error for control diet and lower excretion diet.

Table IV-6. Predicted Feed Cost and Standard Error of Predicted Feed cost at Selected Soybean Meal Prices for Lower Excretion Diet.

Monthly soybean Meal Price(\$/cwt)	Estimated Cost		Predicted Actual Cost		Standard Error
	Soybean Meal Cost(\$)	Total Feed Cost(\$)	Soybean Meal Cost (\$)	Total Feed Cost (\$)	
17.25	11.14	80.74	10.65	79.85	0.71
18.25	11.74	81.35	11.18	80.38	0.72
20.25	12.95	82.56	12.26	81.46	0.72
22.25	14.16	83.77	13.34	82.54	0.72

During 1970's and 1980's the soybean meal prices were more variable than the corn prices. But, during 2008 corn price was more variable than the soybean meal prices. For the lower excretion diet, soybean meal fed to finishing pig is much less than the quantity of corn. Thus the variability in soybean meal prices has less effect on the total cost of feeding hogs under the lower excretion diet.

Stochastic Dominance Analysis for Different 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

market pig price constant at \$0.45 per pound and soybean meal price at \$18.3/cwt. Figures IV-1 through IV-4 shows the CDFs for corn price \$3.25/bushel, \$4.25/bushel, \$5.25/bushel and \$ 6.25/bushel. In Figure IV-1, the points where the dotted line representing the LED diet is below the solid line representing the conventional diet represent the proportion of time when the LED is more profitable than the control diet. The LED diet is more relatively profitable as corn prices increase and reduce returns over the cost. Alternatively, if hog prices are \$0.45/lb, corn prices are \$3.25/bushel and soybean prices are 18.3/cwt there is 57 and 62 percent chance of breaking even or making a positive return over the feed costs with the control and LED diets respectively. Similarly, in Figure IV-2, at corn price of \$4.25/bushel, the control diet has an estimated 48 percent probability of resulting in negative net returns over the cost. The lower excretion diet has an estimated 43 percent probability of resulting in negative net returns over the cost. In Figure IV-3, at corn price of \$3.25/bushel, the control diet has an estimated 55 percent probability of resulting in negative net returns over the cost. The lower excretion diet has an estimated 48 percent probability of resulting in negative net returns over the cost. Lastly, in Figure IV-4, at corn price of \$ 6.25/bushel, the control diet and the lower excretion diet both has an estimated 57 percent probability of resulting in negative net returns over the cost. As the corn price increases the vertical breakeven line shifts to the right showing a lower probability of breaking even with either diet.

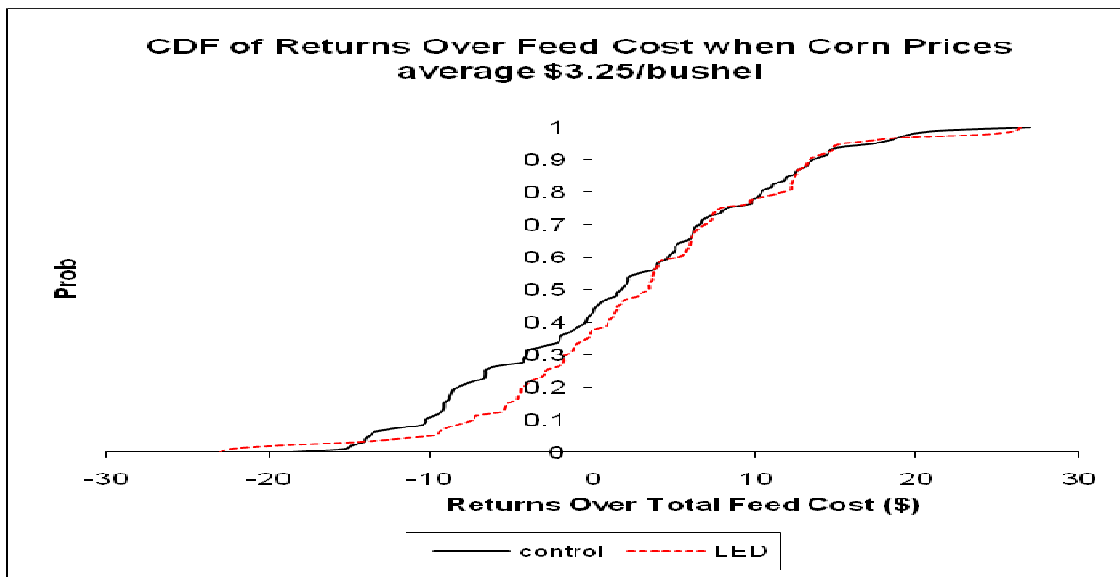


Figure IV-1. Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when corn prices average \$3.25/bushel and other prices are constant (soybean meal price at 18.3/cwt and a market pig price at \$0.45/lb)

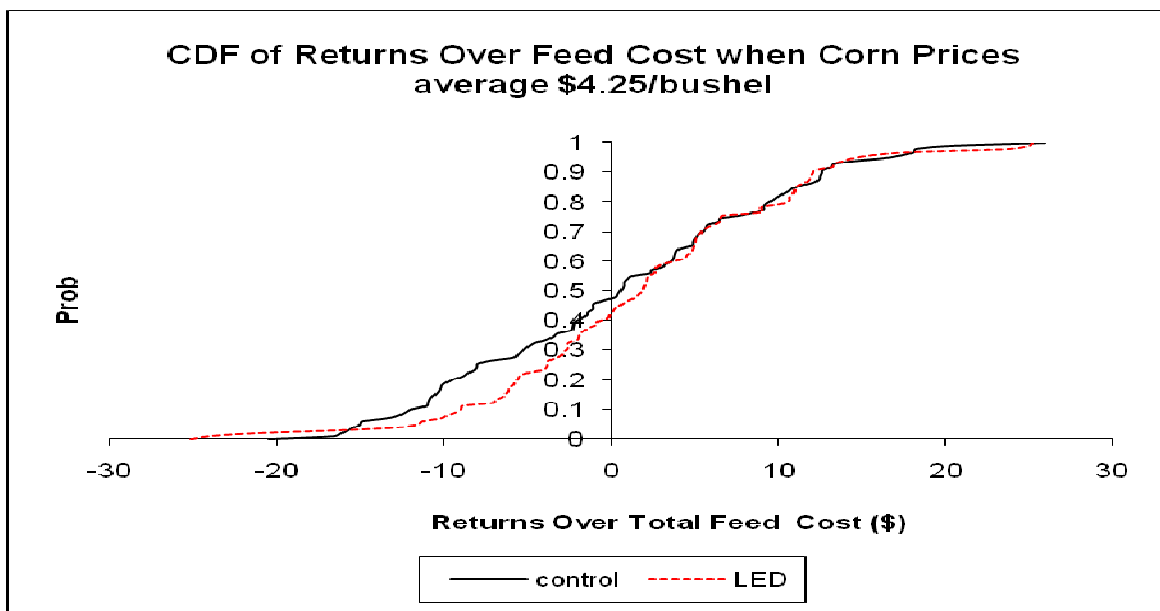


Figure IV-2. Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when corn prices average \$4.25/bushel and other prices are constant (soybean meal price at 18.3/cwt and a market pig price at \$0.45/lb)

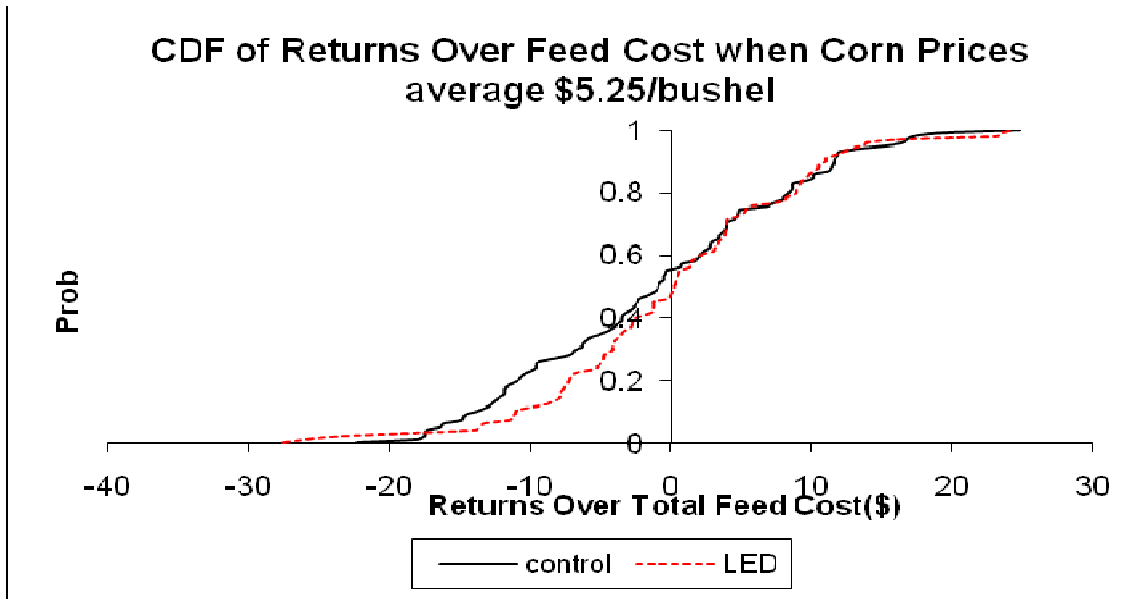


Figure IV-3. Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when corn prices average \$5.25/bushel and other prices are constant (soybean meal price at 18.3/cwt and a market pig price at \$0.45/lb)

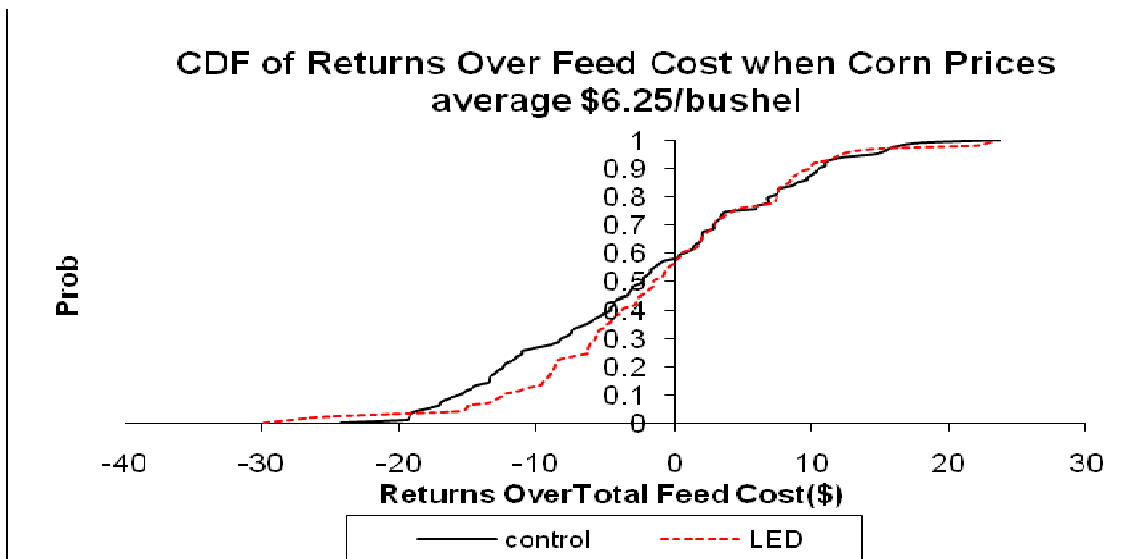


Figure IV-4. Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when corn prices average \$6.25/bushel and other prices are constant (soybean meal price at 18.3/cwt and a market pig price at \$0.45/lb)

Stochastic Dominance Analysis for Different Soybean Meal Prices

Figure IV-5 to IV-8, includes the CDFs when current monthly soybean meal prices are \$17.25/cwt, \$18.25/cwt, \$20.25/cwt and \$22.25/cwt. At this point the price of corn is kept constant at \$6.25/bushel and market pig price kept constant at \$0.45/lbs. Those were the market price of corn and market pig in July 2008. At all the budgeted input and output prices, both the control and lower excretion diet has an estimated 60 percent probability of resulting in negative net returns over the cost. This may be because there is very little chance of a positive return over total feed cost when corn is \$6.25/bushel and pigs are \$0.45/lbs. Also, the amount of corn fed to market pigs in each phase is way to higher than the amount of soybean meal fed. In the control diet approximately 65, 71, 76 and 80 percent of the ration is corn in each of the four phases whereas approximately 29, 23, 18 and 14 percent of the ration is soybean meal. Likewise, in Lower excretion diet also approximately 73, 79, 85 and 89 percent of the ration is corn is in each of the four phases and approximately 20, 15, 9, 6 percent of the ration is soybean meal. This implies that the corn price is more important than the soybean meal prices in diet choice.

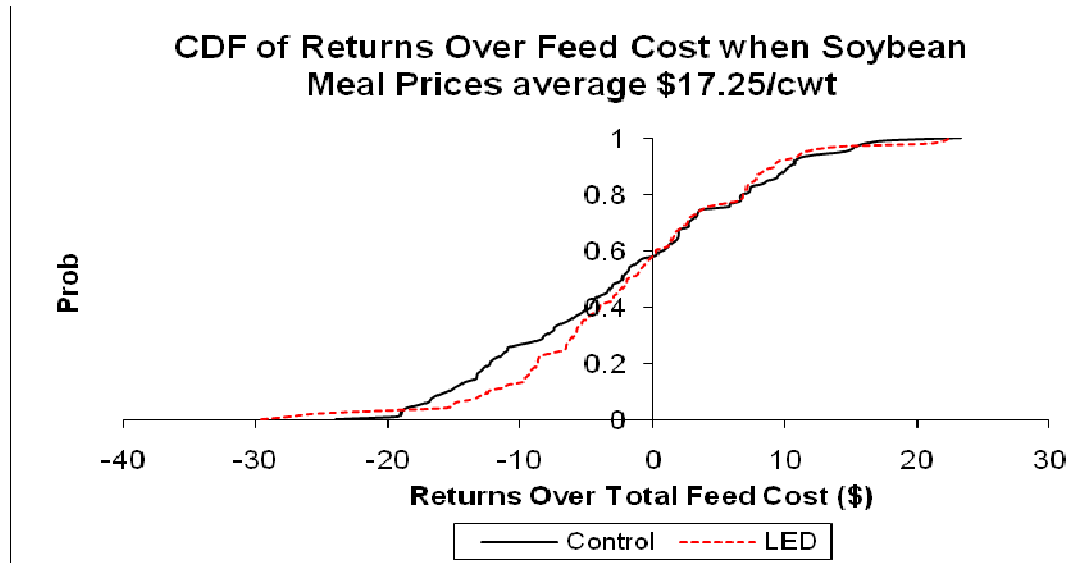


Figure IV-5. Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when Soybean Meal prices average \$17.25/cwt and other prices are constant (Corn price at 6.25/bushel and a market pig price at \$0.45/lb)

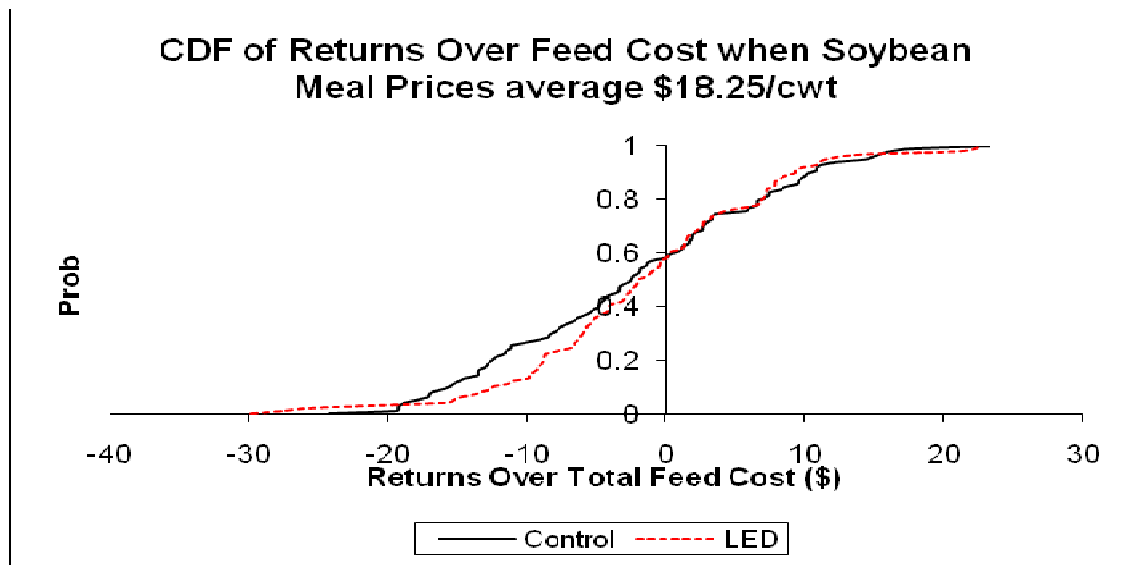


Figure IV-6 Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when Soybean Meal prices average \$18.25/cwt and other prices are constant (Corn price at 6.25/bushel and a market pig price at \$0.45/lb)

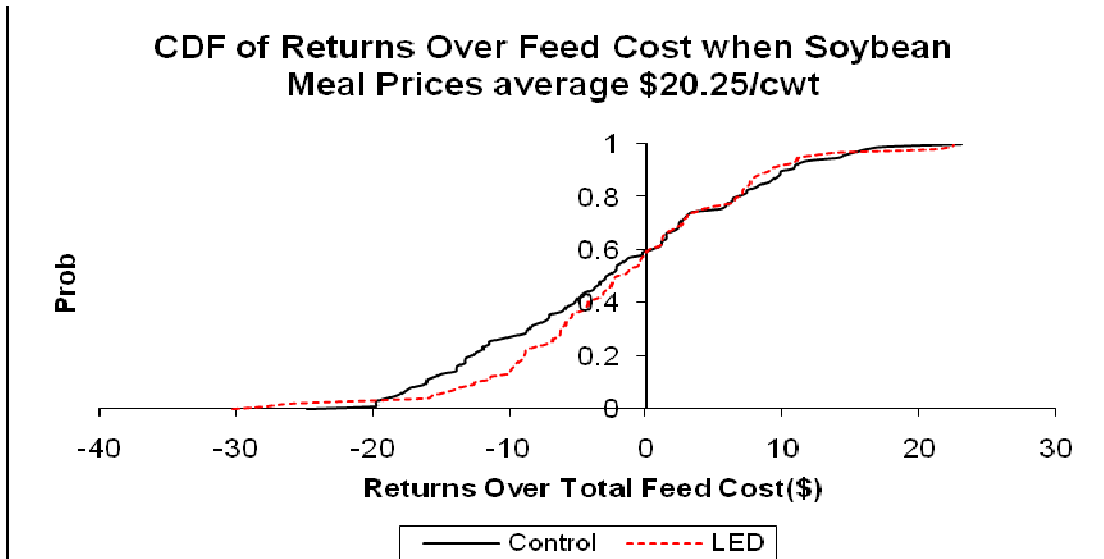


Figure IV-7. Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when Soybean Meal prices average \$20.25/cwt and other prices are constant (Corn price at 6.25/bushel and a market pig price at \$0.45/lb)

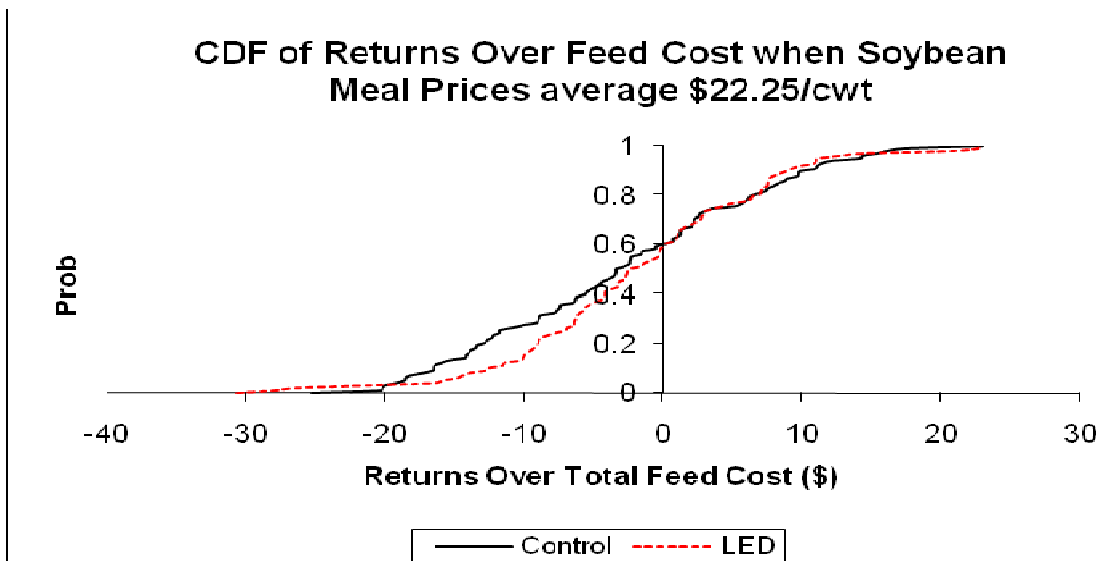


Figure IV-8 Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when Soybean Meal prices average \$22.25/cwt and other prices are constant (Corn price at 6.25/bushel and a market pig price at \$0.45/lb)

Stochastic Dominance Analysis at Varying Corn and Soybean Meal Prices

In this step the case, where both the corn and soybean meal prices are variable, is considered. Figures IV-8 to IV-10, shows the CDFs for various corn and soybean meal prices. As discussed above corn and soybean meal prices tend to move together. The correlation coefficient between monthly corn and soybean meal prices was 0.85. The prices selected for stochastic dominance analysis when both corn and soybean meal prices are variable after the month when the diet is selected were taken from the relationship that exists in Figure III-3.

At a corn price of 3.25/bushel and a soybean meal price of 11.47/cwt the control diet has an estimated 40 percent probability of resulting in negative and 60 percent chance of positive returns over the total feed cost. The lower excretion diet has an estimated 38 percent probability of resulting negative and 62 percent probability of resulting in positive returns over the total feed cost. At a corn price of 4.25/bushel and a soybean meal price of 14.46/cwt the control diet has an estimated 48 percent probability of resulting in negative and 52 percent chance of positive returns over the total feed cost. The lower excretion diet has an estimated 43 percent probability of resulting negative and 57 percent probability of positive returns over the total feed cost. At a corn price of 5.25/bushel and a soybean meal price of 17.45/cwt the control diet has an estimated 58 percent probability of resulting in negative and 42 percent chance of positive returns over the total feed cost. The lower excretion diet has an estimated 53 percent probability of resulting negative and 47 percent chance of positive returns over the total feed cost. Lastly, at a corn price of 6.25/bushel and a soybean meal price of 20.45/cwt the control diet has an estimated 60 percent probability of resulting in negative and a 40 percent

chance of positive returns over the total feed cost. The lower excretion diet also has an estimated 60 percent probability of resulting negative and 40 percent chance of positive returns over the total feed cost.

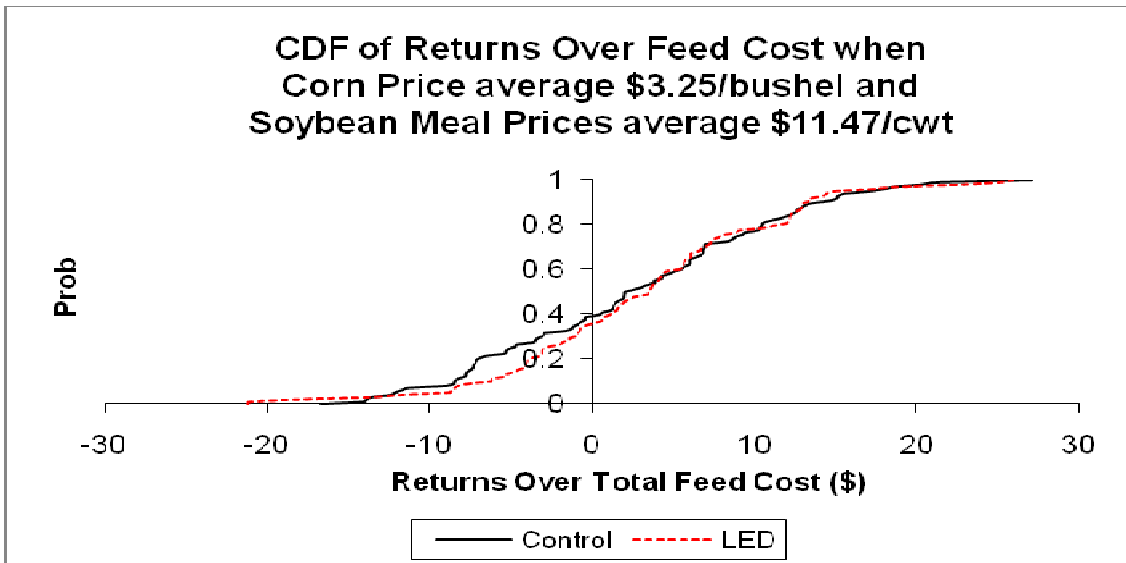


Figure IV-9. Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when Corn prices average \$3.25/bushel and Soybean Meal Prices average \$11.47/cwt. (Market pig price at \$0.45/lb)

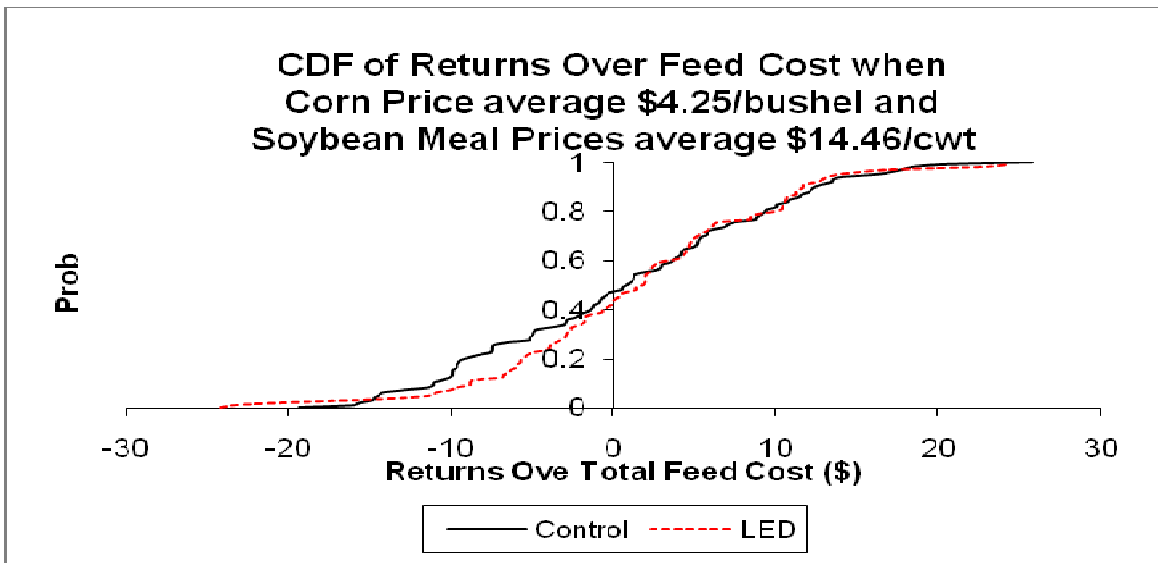


Figure IV-10. Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when Corn prices average \$4.25/bushel and Soybean Meal Prices average \$11.47/cwt. (Market pig price at \$0.45/lb)

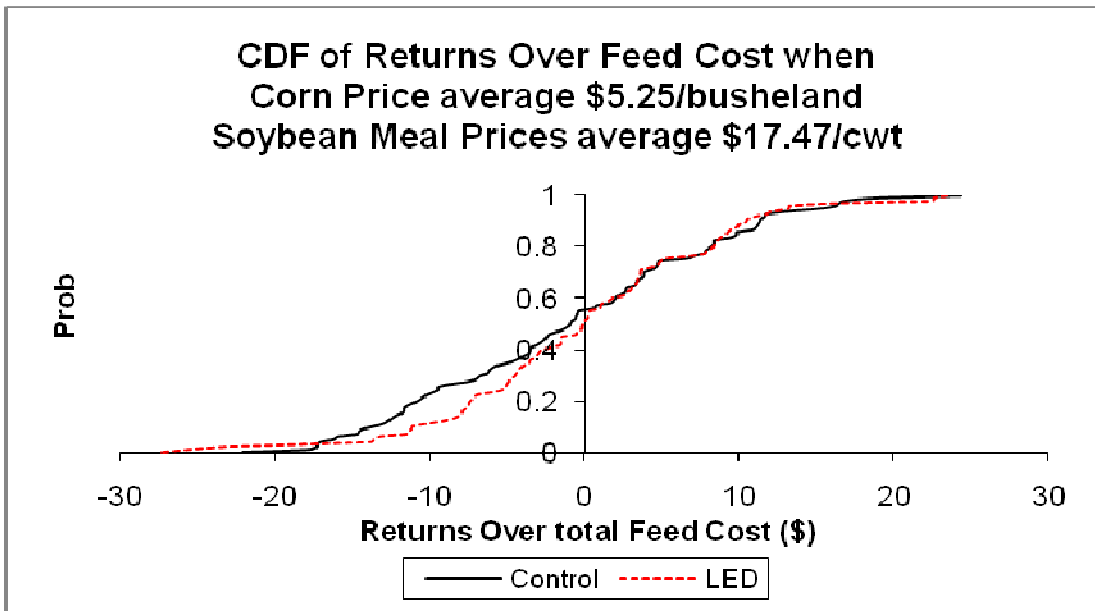


Figure IV-11. Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when Corn prices average \$5.25/bushel and Soybean Meal Prices average \$17.45/cwt. (Market pig price at \$0.45/lb)

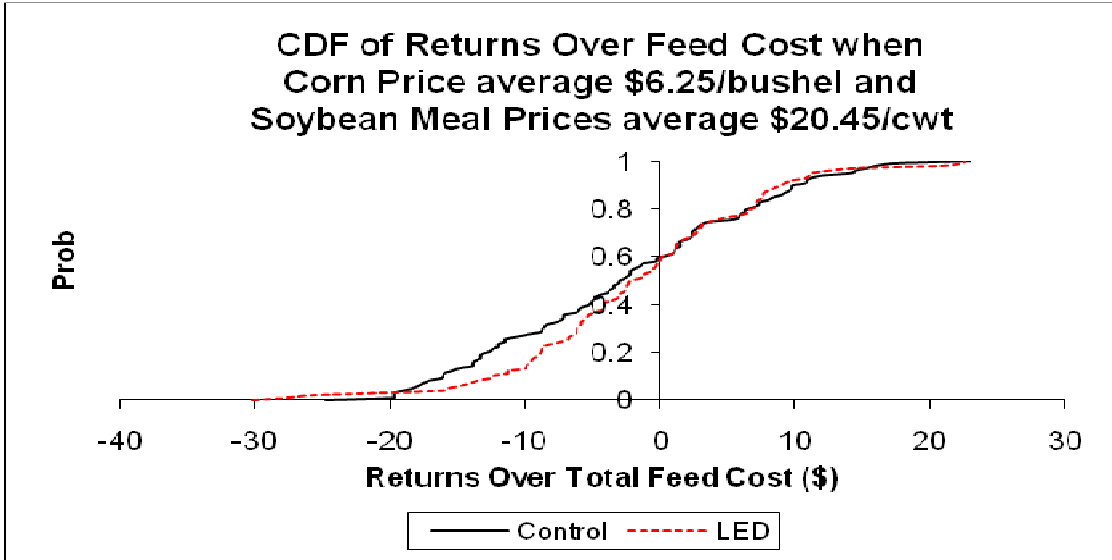


Figure IV-12. Cumulative Probability distribution of Returns Over Cost for the Control diet and the Lower Excretion Diet (LED) when Corn prices average \$6.25/bushel and Soybean Meal Prices average \$20.45/cwt. (Market pig price at \$0.45/lb)

CHAPTER V

REDUCTION IN NUTRIENT EXCRETION FROM MARKET PIGS

COST OR BENEFIT?

The lower excretion diet significantly reduces the amount of nitrogen and phosphorus as well as the amount of macro minerals, micro minerals, ammonia, and hydrogen sulfide. The graphs below shows the amount of excretions as compared within control diet and lower excretion diet.

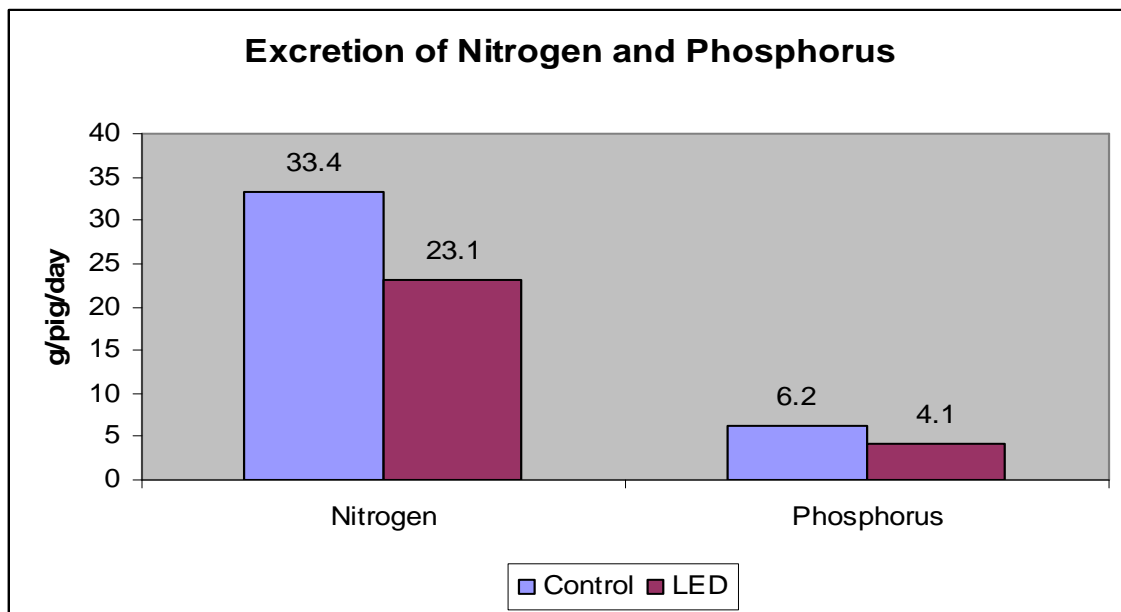


Figure V-1 Nitrogen and Phosphorus Excretion from Control and Lower Excretion Diets for Finishing Pigs.

Source: Sevilla (2007)

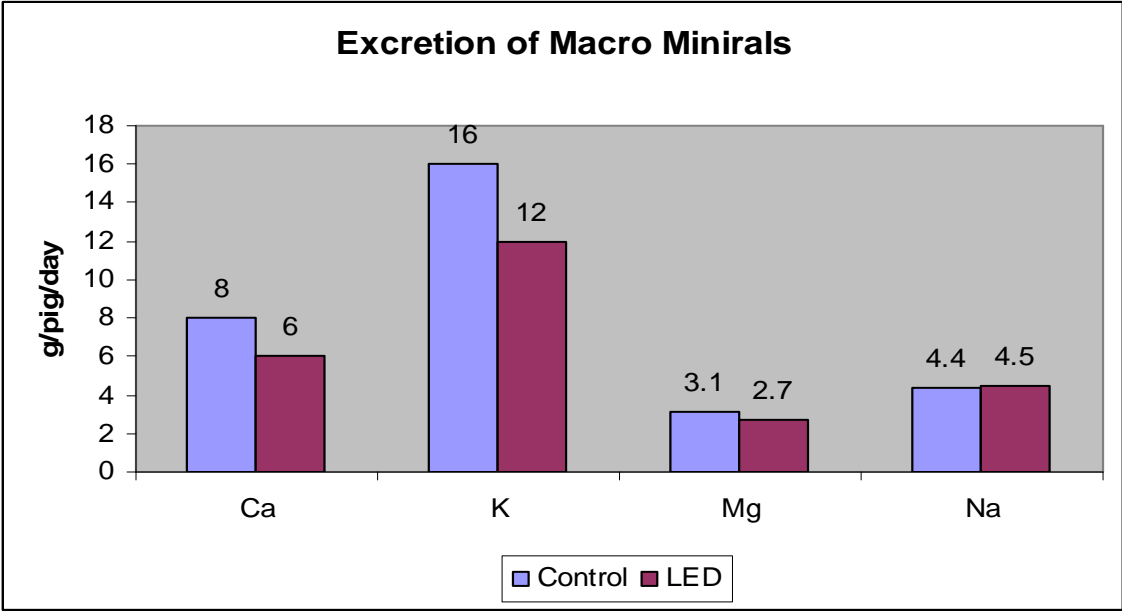


Figure V-2 Daily Excretion of Macro Minerals from Control and Lower Excretion Diet for Finishing Pigs.

Source: Sevilla (2007)

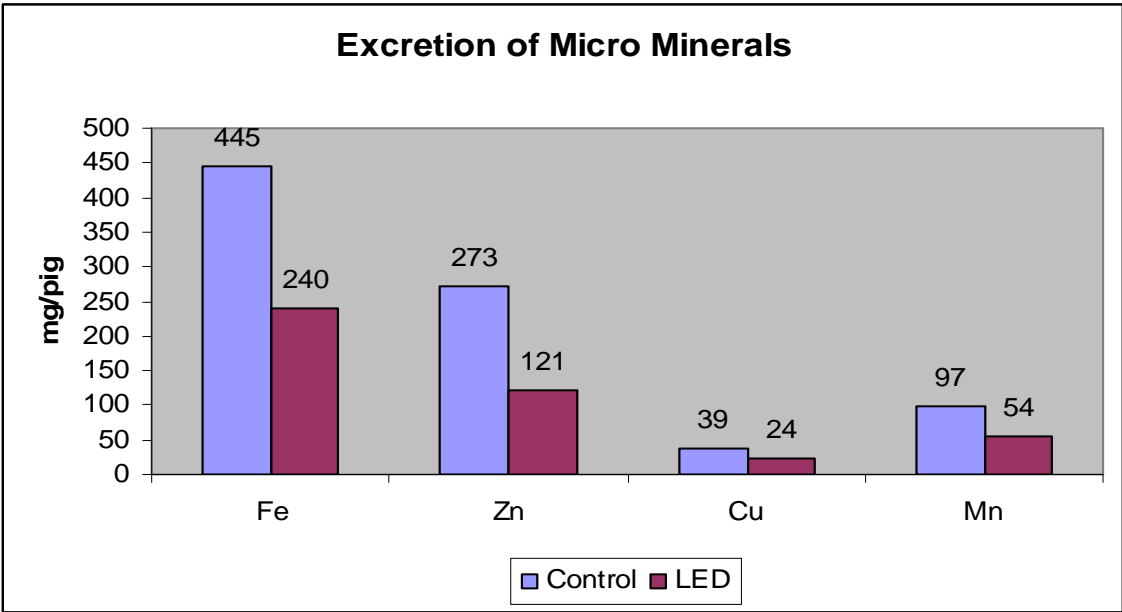


Figure V-3 Daily Excretion of Micro Minerals from Control and Lower Excretion Diet for Finishing Pigs.

Source: Sevilla (2007)

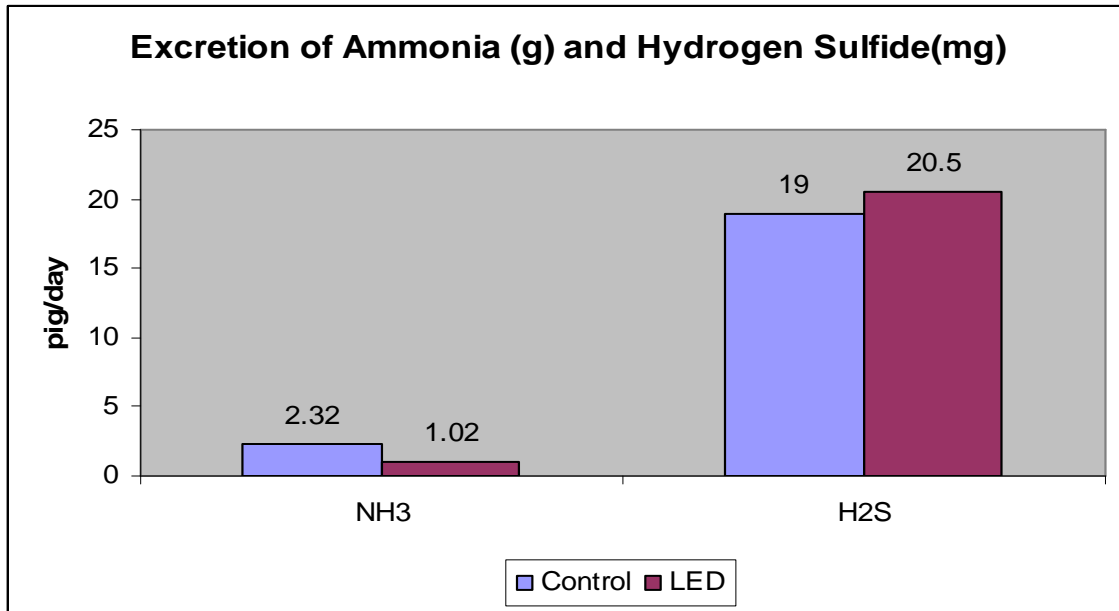


Figure V-4 Daily Excretion of Ammonia and Hydrogen sulfide from Control and Lower Excretion Diet for Finishing Pigs.

Source: Sevilla (2007)

Looking at the graphs it's clear that dietary manipulation is an effective way to reduce the nutrient excretion and ammonia emission. But, all these excreta such as Nitrogen and Phosphorus also serve as fertilizer in crop production. However according to Midwest Plan Service (MPS, 1993) 70-85 percent of the nitrogen excreted and 80 percent of the phosphorus excreted from animal is lost from the anaerobic lagoon. Remaining nitrogen and phosphorus would be approximately 20 percent and use of this 20 percent nitrogen and phosphorus to make fertilizer doesn't seem to be plausible. Therefore with increasing fertilizer prices the major question is whether reducing the excreta is beneficial to the crop producers or not? The Figure below is the graph of fertilizer prices as is posted by ERS.

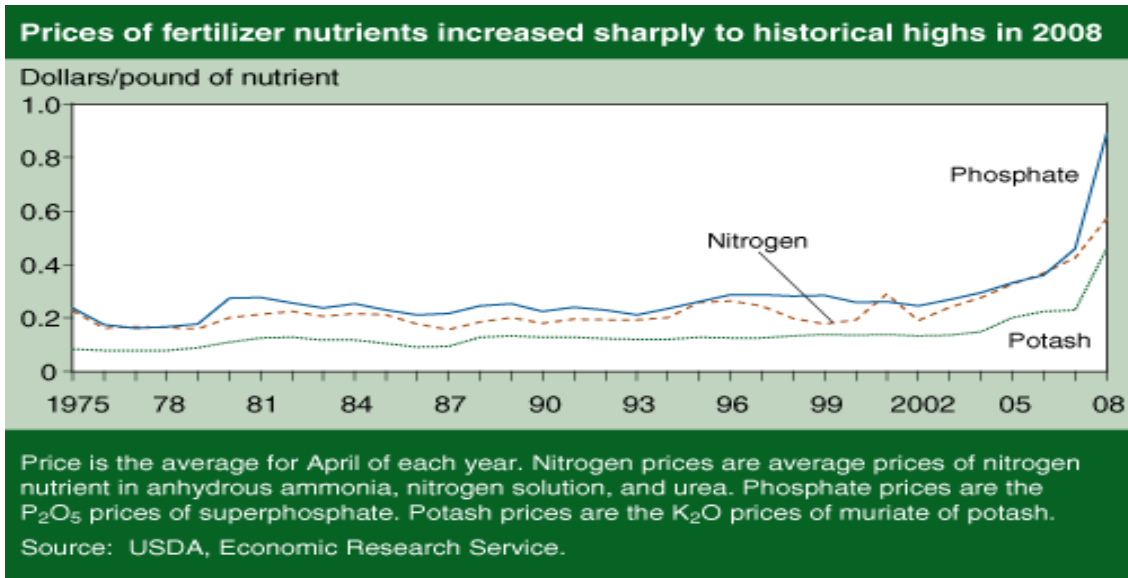


Figure V-5 Report from ERS showing the increase in price of fertilizer nutrient

According to ERS, “Fertilizer prices continued increasing in early 2008 and were 26 percent higher in August than in April. But prices began to decline in October, particularly for nitrogen fertilizer.”

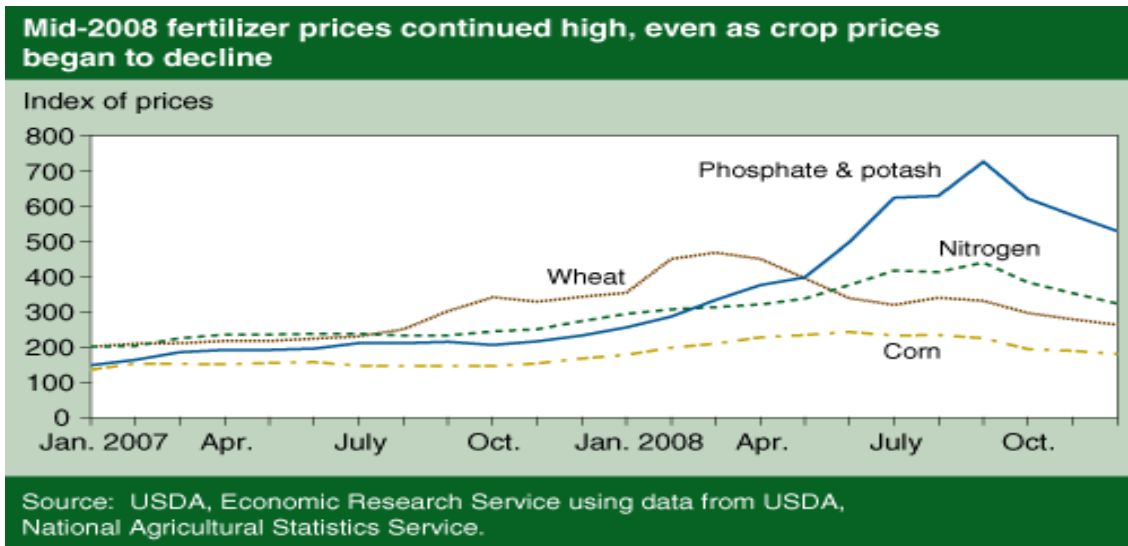


Figure V-6 Report from ERS showing increase in fertilizer price while crop prices started to decline

To maximize the performance of market pigs several nutrients are included in the diet in excess. Amount of nutrient excreted is increased by the oversupply of nutrients

(Kornegay and Harper, 1997; NRC, 1998; Creech et al., 2004). It has been reported that 70 percent of the nitrogen intake is excreted (Kornegay and Verstegen, 2001). As already discussed in introductory part at the present time nitrogen and phosphorus are the nutrients of greater concern in regards to environmental and public health risk as excess nitrogen and phosphorus results in leaching into water bodies. Also, ammonia is emitted to air during the application of manure. It is true that the high level of nutrient content in swine manure has been recognized as a valuable fertilizer (Kornegay and Harper, 1997; IFA, 2007). Swine manure and effluent are excellent sources of nitrogen to be used in crop fertilization program (Choudhary et al., 1996). But; adequacy of water in soil affects the efficiency of nitrogen utilization. It is recommended to apply swine manure close to planting dates and avoid proximity to expected rainfall (Choudhary et. al. 1996). Also, application of manure in land in excess causes reduction in crop yield. Because of the limited crop land and large volume of manure produced manure management is challenging.

If producer doesn't care about the cost of feeding market pigs and want to adopt the control diet but if the producer has to meet the manure disposal requirements than the best strategy to reduce nutrient losses from land application will be splitting manure applications in combination with appropriate irrigation schedules (Aulakh and Sandhu, 2007). The future manure application will depend on the ability of the producer to manage application rate and frequency based on spatial and temporal availability of nutrients in soil with crop needs (Fairchild and Malzer, 2007).

The business of selling manure is also growing because of the high cost of commercial fertilizer. Animal wastes from market pig barn are being used to spread on

field that will later bloom with corn, soybean and wheat. Nitrogen fertilizers price has doubled in the past four years in parts because of the rise in the natural gas price required to make it. In the same time when there are benefits associated with the manure production because of tighter environmental regulations livestock producers are also facing problem with disposal of the manure. In the areas where there is heavy livestock production there is overabundance of nutrient. Manure, like other commercial fertilizers are also subject to runoff. Also, there are other drawbacks of manure spreading such as odor. The transportation cost of manure is higher as compared to commercial fertilizers. Raw manure or slurry may contain insects and may contain seeds that may sprout weeds. So, with all these disadvantages of manure, reducing the nutrients excreted can be considered as the best option to meet all the environmental policies and avoid the risk of nutrient runoff and unnecessary excessive nutrients.

Drawbacks of Excess Nutrient Excretion

Historically, efficiency was defined as animal product output per unit of food input (Michael Vande Harr, Associate Professor, Michigan State University). Tremendous gain in efficiency using the definitions have been made in terms of improved productivity. But defining efficiency in terms of food in and food out is no longer adequate. Apart from food in and out it is necessary to consider efficiency of land use and impact on environment. There might be some unintended consequences when one tries to increase efficiency of one variable without caring other variables. Therefore, as suggested by various economists it is necessary to assign economic value to all hidden costs and benefits and strive for improved “true” economic efficiency.

The government has mandated 20% reduction in excretion of N and P and 20% reduction in emission of ammonia and 10% of hydrogen sulfide. (Theo Ven Kempen, North Carolina State University). Animal industry is urged to rethink the way it operates in light of changing environment. Feed should also be formulated to maximize profitability of an operation rather than simply minimizing feed cost. Thus, actual lean gain, the cost of nutrient disposal as well as value of lean meat and facility cost should be included.

Because of strict environmental regulation there are various techniques available that help to manage the nutrient excretion and solve environmental problems. Among those techniques is a Crystal Peak plan. The process of developing the Crystal Peak plant began following a 1999 Consent Decree between the company and the State of Missouri. That agreement called for the company to develop "Next Generation" technology with the assistance of a state-appointed panel of experts and to invest \$25 million in manure management research and technology. The Crystal Peak process is an interesting combination of technologies for solving environmental issues facing the swine industry. Emissions of ammonia from manure storage are minimized and ammonia and possibly odor emission from the housing is also reduced through acidification of flush water. Odor from the stored manure also is minimized through the digestion process. Energy contained in the manure is captured in the form of methane, and this methane is used to dry the harvested minerals in the production of a high-quality fertilizer. The plant is very fascinating but the plant will cost an estimated \$9 million which is almost impossible for small scale producers to adopt.

Skyrocketing cost of air emission will cost producers a significant amount to remain in the business. Ammonia release is a major problem but in the same time it is very crucial for nitrogen deficient soils. Removing all volatile nitrogen would cause a major source of fertilizer to deplete. But, with animal agriculture or burning of fossil fuels over the past several hundred years manure production is cited as a problem.

According to Galen E. Erickson, associate professor at University of Nebraska-Lincoln, until a vast educational effort to enhance the use of manure as fertilizer and an effort to value manure as a fertilizer source in replacing inorganic or commercial fertilizer use comes into light, the first step is to recognize the dramatic change that feeding practice will have in future on nutrient balance.

CHAPTER VI

CONCLUSION

During the “cheap energy” era of the 1990’s animal waste products were internalized by market pig 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.

With the change in economics and structure of US market pig production new and varied challenges are emerging in the market pig industry. Increasing concern about the manure management problems as posed by market pig industry is vital. USDA Economic research service used census of agriculture data to estimate manure nutrient production and the capacity of cropland and pastureland to assimilate nutrients. Most farms (78 percent for nitrogen and 69 percent for phosphorus) have adequate land on which it is physically feasible to apply the manure produced on farm at agronomic rates. But, 60 percent of nations nitrogen manure and 70 percent of nation’s phosphorus manure that is produced on operations cannot fully apply it to their own land at agronomic rates. According to USDA’s report, “In these cases, most counties with farms that produce ""excess"" nutrients have adequate crop acres not associated with animal operations, but

within the county, on which it is feasible to spread the manure at agronomic rates. However, barriers to moving manure to other farms need to be studied. About 20 percent of the Nation's on farm excess manure nitrogen is produced in counties that have insufficient cropland for its application at agronomic rates (23 percent for phosphorus). For areas without adequate land, alternatives to local land application--such as energy production--will need to be developed.”

The United States environmental protection agency has proposed to bring additional animal feeding operations under regulation which requires implementation of the nutrient management plans. Because of existing strict environmental regulation and possibility of new regulations pig producers are facing problems associated to pig waste management. Also, previous researchers have found that the control or the conventional corn-soybean meal diet is not environmental friendly diet. As a result, researchers developed a diet that would reduce the amount of nitrogen and phosphorus excreted from pigs. Before any dietary changes were made it was necessary to look at the cost of feeding pigs under both the dietary system. 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. Soybean meal prices were also rising along with the price of corn. Under the scenario of increasing soybean meal prices the Lower Excretion diet was still found to be less costly than the control diet.

Stochastic dominance analysis was also performed to see which of the diets will have positive returns over the feed cost at different prices of corn and soybean meal. The weight gained by pig and the market price of the pig was held constant. The prices of the corn and soybean meal were only variable. It was found that with the increase in the

price of corn and soybean meal the LED diet would have positive returns over the feed cost.

There were controversies on whether reducing the nitrogen and phosphorus would reduce the benefits of using nitrogen and phosphorus as fertilizers. But, since the cost of building fertilizer plant is too high and most of the nitrogen and phosphorus is lost from the lagoon, cost of handling manure seems to be higher than the benefit from utilizing the lagoon as fertilizers. So this research suggests that to comply with the regulations and to have a cost effective diet the lower excretion diet will be the best option.

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Scope and Method of Study

The market pig 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. 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. In the same time producers are facing increase in corn and soybean meal prices. So this research is conducted to see the effects of increased feed cost on two major diets, control diet which is a traditional diet and low excretion diet which is a diet that helps reduce Nitrogen and Phosphorus excreted from excreta of market pigs. Simple budgeting procedure and Economic Simulation model (SIMETAR) was used to investigate the effect of future corn and soybean meal price on profitability of control and low excretion diet of market pigs.

Findings and Conclusions

The literatures showed that the total gains could be maintained with either of the diets. With increase in corn prices, the total cost of feeding market pigs was found to be higher for control diet as compared to lower excretion diet. Looking at the soybean meal prices at different levels it was found that the cost of feeding market pigs with the lower excretion diet was less as compared to control diet. Therefore, it was concluded that with increase in price of corn and soybean meal the low excretion diet will still be less costly than the control diet. Alternatively, if corn prices decreases then the low excretion diet will be much less costly than the control diet.

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