Title: Economic Analysis of the UNL Gilt Development Project – **NPB #08-256**

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Industry Summary: Restricting energy intake during gilt development lowered costs associated with gilt development and increased subsequent productivity of these females. The study modeled costs and value of market pigs through four parities from production data of 631 gilts that were fed on an ad libitum basis until breeding or were restricted to 75% of ad libitum energy intake from 123 days of age until breeding (approximately 230 days of age). Gilts developed with energy-restriction had a greater probability of reproductive success than those developed with ad libitum feeding. The budget showed that progeny of both LWxLR and L45X gilts developed with energy-restriction generated greater profits than progeny from their littermates developed with ad libitum feeding.
Keywords: Energy Restriction, Breeding Gilts, Market Pig Production, Sow Longevity

Scientific Abstract. Because swine production is a low-margin business, producers have increasingly sought ways to increase efficiency in market pig production and gilt development. Restricting energy intake during gilt development has the potential to lower costs associated with gilt development, but the extent to which the lower costs offset production responses has not been previously analyzed.

This study utilized gilt development and market pig production data from biological studies that included a 2x2 factorial arrangement of half-sibling maternal lines (LWxLR and L45X) entering two gilt development programs. In one program, gilts were fed on an ad libitum basis. In the other, gilts were restricted to 75% of ad libitum energy intake from approximately 123 days of age until breeding (approximately 226 days of age).

The gilt development data were used along with historical average prices to develop deterministic enterprise budgets to evaluate the relative profitability of both the ad libitum and restricted energy gilt development programs for both genetic lines. Additionally, stochastic budgets were simulated using distributions of input and output prices to evaluate how the relative advantage of the two development programs changed under different market price scenarios.

In both genetic lines, energy-restricted gilts had a greater probability of reproductive success than ad libitum gilts. Results from the budget showed both LWxLR and L45X energy-restricted progeny generated greater profits than ad libitum offspring. Restricted LWxLR market pigs had a lower breakeven selling price than ad libitum LWxLR progeny ($38.12/cwt restricted vs. $38.60/cwt ad libitum) while ad libitum L45X progeny had a lower breakeven selling price than restricted L45X offspring ($38.07/cwt ad libitum vs. $38.21/cwt restricted).

In the stochastic simulation, both LWxLR and L45X progeny from restricted energy gilts generated greater profits than their ad libitum counterparts in 93.7% and 79.2% of the iterations, respectively. Restricted LWxLR market pigs had lower breakeven selling prices than ad libitum LWxLR market pigs at all iterations while ad libitum L45X progeny had lower breakeven selling prices than restricted L45X progeny in 89.7% of the iterations of the simulation experiment.

Introduction. Swine production is centered on the constant pursuit of increasing efficiency in breeding programs and market swine production. Feed costs have increased in recent years due to an increased demand for corn bio-energy production and index fund speculative buying in the corn futures markets. Cost of gain for market swine has increased and maintaining a breeding herd is more expensive given increased input costs. Thus, swine producers have faced a shrinking profit margin and have an increasing need for further production efficiencies. Reducing the feed cost of breeding gilt production could improve swine producers' profitability. Historically, the number of pigs per litter and annual litters per sow have trended upward sharply (USDA National Agricultural Statistics Service Hogs and Pigs Report) thus reducing the size of the U.S. breeding herd. However, sow replacement rates have been increasing for the past 10-20 years (Johnson and Miller, 2005).

The traditional method of developing breeding gilts is to feed females on an ad libitum basis until they reach a body weight of 300 lb., at which point they are bred. The conventional reasoning behind self-regulation of feed intake is to grow the animals as fast as possible to hasten the onset of puberty as more mature animals have a greater likelihood of successful conception. However, body weight has not been conclusively found to affect age of puberty (Newton and Mahan, 1992). Additionally, this process results in an increased probability of overweight animals and the possibility for lost reproductive production as heavier animals would not be optimal breeding stock. Increased body weights could also cause mobility problems later in life, leading to increased culling rates or even death losses, both of which producers intend to minimize.

One way to eliminate the problems brought about by self-regulation of feed intake and lower the feed cost of producing breeding gilts is to restrict feed intake for a period of time before puberty. Developing gilts in this manner is not completely revolutionary; however, little economic analysis has been done to evaluate whether it is economically optimal. Because prices are not static, determining the optimal production program for gilts would change at differing input and output price ratios. Because price ratios have a large effect on the optimal gilt development system and also because there are both positive and negative effects of energy restriction during gilt development, a comprehensive budget would need to analyze how input and output prices affect profit, not just how production levels are affected by gilt development systems.

The objectives of the economic analysis of the gilt development system are three-fold. First, the relative returns to each development system will be estimated. Second, the variability of the returns to each system will be analyzed across the years in the study and through a simulated budget framework to determine the variability of each system. Third, decision rules for the gilt development profitability will be created.

Materials and Methods. The Department of Animal Science at the University of Nebraska–Lincoln conducted a multi-year study (Johnson and Miller, 2005; Johnson et al., 2007) that evaluated production differences in a 2x2 factorial arrangement using two separate half-sibling maternal lines (Large White-Landrace [LWxLR] and Nebraska Line 45 cross [L45X]). The production data were obtained from approximately 650 gilts over the course of 4 replications. Gilts entered one of two development programs: (1) ad libitum access to feed or (2) restricted-fed from approximately 123 days of age to approximately 226 days of age. The feed provided to gilts in the restricted group was formulated to be equivalent to 75% of the energy consumed by gilts with unrestricted access to feed, while intake of essential nutrients and minerals were held at constant levels between treatment groups as to provide daily recommended levels of nutrients to the animals.

After a minimum 2 estrus periods, gilts were artificially inseminated and limit-fed a standard corn and soybean meal-based gestation diet (13.8% CP, 0.66% lysine) until approximately 4 days pre-farrowing. If a gilt failed to express estrus in a timely fashion, she was culled from the herd. From 4 days pre-farrowing until weaning, each group received a standard lactation diet (18.5% CP, 1.0% lysine) until progeny were weaned at approximately 12 to 15 lb. or 21 days of age. Gilts from each group were then fed a standard diet (13.8% CP, 0.66% lysine) until they were rebred. At this time, if an animal was open or had mobility issues, they were culled from the experiment. This process was continued until the fourth parity at which data were collected and used to evaluate each combination of line and group by production parameters. Production record (e.g., number of pigs weaned, weaning weights, lactation feed intake) through four parities were recorded for each sow. These production data, along with three-year historical averages from 2004-2006 for commodity and energy prices and other production assumptions, were used to construct the enterprise budgets used in this research project.

The unit of measurement for the budget was an individual sow and the enterprise budget was organized into three main sections: gilt development, nursery and market pig production for the first four parities, and an output page summarizing the revenues and costs for the sow and her market pigs throughout their lifetime. In the development section, production parameters were used to estimate costs and returns to each development system by genetic line. Feed cost was determined from the average feed consumed by a developed gilt multiplied by the percentage of each feedstuff included in each diet, and multiplied by a unit price. Diets differed among development groups to ensure each treatment group was fed according to NRC requirements.

Market pig selling price was the national net market pig price average from 2004-2006 multiplied by a constant dressing percentage of 74% to convert into a live basis for market pig selling price. Culled sow selling price was calculated as a percentage of market swine selling price to allow sow price to vary with market pig selling prices. The percentage value of culled sows in relation to market pigs was determined by dividing monthly historical national direct sow selling prices (300 to 449 lb. weight range; reported by the Livestock Marketing Information Center) by national net market pig live selling price. Thus, the percentage value of culled sows to market pigs was calculated to be 74% of the market swine selling price. Table 1 reports other input and output prices used in the budget.

Table 1 Input and Output Prices for Market Pig Production per Unit[1].

Item	Price per Unit	Unit	Type of Expense	Cost per Pig	Cost per Litter
Market Pig Selling Price[2]	$49.68	/cwt	Veterinary and Health Cost	$4.72	
Cull Sow Selling Price[2]	$36.76	/cwt	Utilities	$1.57	
Corn	$2.14	/bu	Marketing and Transportation Costs	$1.68	
Soybean Meal	$199.79	/ton	Other Misc. Costs		$10.00
Tallow	$0.29	/lb	Labor		$62.28
Dicalcium Phosphate	$220	/cwt	Annual Fixed Costs (per pig-space)	$18.24	
Limestone	$0.02	/lb	Annual Fixed Costs (per sow-space)		$79.30
Salt	$0.07	/lb	Breeding Costs		$20.00

[1]Prices From 2004-2006

[2]Live Weight Basis

Several steps were used to calculate the total costs of gilt development. The initial cost of a gilt entering the development program was calculated by multiplying the average beginning weight of gilts entering the program by 110% of the market pig selling price (shown on Table 1). The reasoning behind the 10% upward adjustment was to account for a feeder pig price slide because gilts entering the development programs were approximately 140 lb. and would have more value on a per unit basis than a market pig.

Cull credits were calculated by multiplying the cull percentage of gilts during development by an average weight for gilts from each treatment group and genetic line and the market pig selling price (because culled gilts were priced as market pigs).

Veterinary expense, utilities, and miscellaneous costs were based on Lawrence and Ellis (2007) and were estimated at $5, $2, and $4/gilt, respectively. These expense categories were also adjusted for production costs associated with culled and dead gilts. It was assumed that one hour of labor would be needed for each gilt produced. An agricultural labor wage rate of $10.53/hour was obtained from the United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) (2009).

Interest expense was calculated in a two-step process. First, variable production costs (feed cost, veterinary expense, utilities, miscellaneous cost, and labor) of gilt development were summed and multiplied by an assumed annual interest rate of 7%. This number is then multiplied by the development time period after it was converted to a yearly basis. Because production costs were assumed to be incurred at a constant rate, the interest amount calculated above is then halved. Second, the interest from the purchase cost of gilt was calculated by multiplying the purchase cost of gilt by the assumed interest rate of 7%, and then by the time the gilt spent in the development program in years. Lastly, the interest from the purchase of the gilt is added to the interest on production costs.

The final variable cost included in the enterprise budget was overhead and management. These costs were based on industry estimates and were calculated to be 2% of operating costs for all treatment groups.

Building and equipment costs were calculated based on costs from Lawrence and Ellis (2007). Because gilts were developed in a finishing facility, the facilities cost of a finisher was used when calculating fixed costs during gilt development. Lawrence and Ellis' budgets assume a 9,600 head finisher would have an equipment cost of $570,000 with a useful life of 10 years; the building cost of the finisher was assumed to be $1.33 million with a useful life of 25 years. The total building and equipment cost was then divided by its useful life to give an annual facilities cost. This annual cost was then divided by the capacity of the building to give an annual facilities cost on a per animal basis, then multiplied by the time the gilt spent in the gilt development period to give a building and equipment cost on a per gilt basis. To account for interest, annual repairs, insurance, and taxes on the facilities, the facilities cost was multiplied by 109.6% (7% for interest, 1.5% for annual repairs, 0.4% for property insurance, 0.7% for property tax; Lawrence and Ellis, 2007). Finally, this figure was multiplied by the amount of time the gilts spent in the development program.

The next section of the budget itemized production costs from nursery and market pig production. The amount of feed consumed by sows during gestation was estimated to be 490 lb. per bred female: 460 lb. of the gestation ration and 30 lb. of the lactation ration. Gestation feed intake was calculated as pregnant females were limit-fed specific daily amounts: 4 lb per day for the first 90 days, 5 lb per day for the next 20 days, 6 lb per day of the lactation ration for the final 5 days of gestation. Feed intake during lactation was recorded by Johnson and Miller (2005) and Johnson et al. (2007) for each sow during repetition 4 of their experiment. These individual totals were averaged by genetic line and treatment for use in the production budget. Post-weaning and before rebreeding, the sows were fed the same ration as during the gestation period. During this recovery period, feed intake was estimated to be approximately 4.08 lb per day per female. This number was calculated based on Johnson's assumption that 85% of sows were in good physical condition and therefore required 4 lb of feed per day (2009). The remaining 15% of sows were considered "light" by the researchers and needed an additional 0.5 daily lb of feed. The average amount of feed consumed during the recovery period per litter was calculated by finding the amount of feed consumed daily by both groups and multiplying each amount by the percentage of sows in that group, then summing those totals and multiplying this amount by the number of days sows spent in recovery.

Feed intake by market swine was recorded for 240 pigs during the experiment, 120 of each genetic line. However, this intake was only recorded when pigs were 40 to 260 lb. Feed intake from 11 lb (weaning) to 40 lb was estimated using growth curve from Reese et al. (2000). On average, weaning weights among treatment groups were statistically different. Thus, each line × treatment × parity interaction led to a different amount of feed consumed by litter. Therefore, feed consumption by ration type was adjusted to account for differences in weaning weights between the 16 line × treatment × parity interactions. The amount of feed consumed during market pig production was itemized by diet ingredient in a four-step process. First, the percentage of diet composition was calculated for each ingredient. Second, the ingredient percentage was multiplied by the total amount of feed consumed for each ration. Third, these ingredient amounts were summed and the resulting quantities were multiplied by the price of each feedstuff. Lastly, the partial feed costs by ingredient were summed to give a total cost of feed during market pig production.

Non-feed variable costs were also included in the market pig budgets similar to the gilt development budgets. Veterinary expense, utilities, and miscellaneous costs were $10, $3, and $6/litter during the gestation and lactation periods, respectively, and an additional $4.72, $1.57, and $1/market pig produced. Marketing/transportation costs and breeding costs were assumed to be $10 and $20/litter, respectively. It was assumed that two hours of labor would be needed during gestation and lactation per litter and an additional four hours of labor would be needed for market pig production per litter. Interest expense was calculated on the variable production costs

Building and equipment ownership costs were calculated on a per litter basis for the gestation, lactation, and recovery periods, and on a per market pig basis for ownership cost incurred due to market pig production, using assumptions from Lawrence and Ellis (2007).

Income from market swine production can be divided into four categories: manure credits, market pig sales, culled gilt/sow sales, and culled pig sales. Manure credits were assumed to be a constant $25/litter produced. Manure credits did not vary between treatment × line × parity interactions. Income from market pig production was calculated by multiplying the number of pigs weaned per litter (after adjusting for culls and death loss) by the average market weight and by the national net market price in $/lb (on a live-weight basis; Table 1) to give the total income of market pig sales. Cull sow and pig income was included by valuing them at 74% and 50% of market hog selling prices, respectively.

The calculations discussed above give results on a parity-specific basis. Thus, a simple summation of costs and revenues from all parities would not be sufficient for reporting results for an average gilt for each treatment × line interaction because the probability of each event differed between treatment groups and among genetic lines. Therefore, to compute results, each cost and revenue was multiplied by the probability an average gilt would complete the outcome successfully. These outcomes were gilt development, gilt through first parity of market pigs, gilt through second parity, gilt through third parity, and gilt through fourth parity. So, the probability of each of these outcomes was used to determine the weighted average revenue, costs, and profit for an average gilt entering the program. These probabilities are summarized below in Table 2.

Table 2 Event Probabilities for Two Prolific Maternal Lines.[1]

	Line			
	LWxLR		**L45X**	
Outcome	**Ad Libitum**	**Restricted**	**Ad Libitum**	**Restricted**
Parity 1 Litter	0.7714	0.7910	0.8695	0.8152
Parity 2 Litter	0.4581	0.5298	0.4846	0.5477
Parity 3 Litter	0.3848	0.4140	0.3841	0.4697
Parity 4 Litter	0.2888	0.3265	0.3242	0.3610

[1]Event probabilities based on successful completion of development program

Results.

Objective 1

The results of the deterministic budget analysis generally revealed that energy-restricted gilts produced a greater amount of offspring and were more profitable than their ad libitum counterparts. Results for each line and treatment are summarized on Table 3 in the form of revenue, variable costs, fixed costs, and total costs for gilt development and market pig production. Energy-restricted gilts were more productive than non-restricted females as they produced an average of 4.93 more cwts per developed LWxLR gilt (46.33 cwts sold per ad libitum gilt vs. 51.26 cwts sold per restricted gilt; Table 3) and 2.97 more cwts per developed L45X gilt (49.75 cwts sold per ad libitum gilt vs. 52.72 cwts sold per restricted gilt; Table 3). Thus, restricted gilts generated more revenue than ad libitum gilts by an average of $245.02 per LWxLR gilt ($2,301.61 per ad libitum gilt vs. $2,546.63 per restricted gilt; Table 3) and $147.63 per L45X gilt ($2,471.76 per ad libitum gilt vs. $2,619.39 per restricted gilt; Table 3). The increased production was primarily caused by energy-restricted females having a greater probability of farrowing a litter than an ad libitum gilt at each parity. However, in no case were these differences statistically significant. Additionally, as selling price increases, energy restriction during gilt development becomes more economically advantageous because energy-restricted gilts produced a greater number of hundredweights than ad libitum gilts.

In addition to being more productive, limit-fed gilts were also less expensive to develop by an average of $9.74 for LWxLR females ($153.78 per ad libitum gilt vs. $144.04 per restricted gilt; Table 3) and $7.58 per L45X gilt ($149.59 ad libitum vs. $142.01 restricted; Table 3). Although fixed costs were $0.73 greater per gilt for restricted LWxLR females ($6.64 ad libitum vs. $7.37 restricted; Table 3) and $0.53 per gilt more expensive for restricted L45X gilts ($6.21 ad libitum vs. $6.74 restricted; Table 3), this was more than offset by the large reduction in variable costs for energy restricted females. Variable costs were $10.47 lower per LWxLR gilt ($147.14 ad libitum vs. $136.67 restricted; Table 3) and $8.11 less expensive per L45 gilt ($143.38 ad libitum vs. $135.27 restricted; Table 3). Fixed costs during gilt development were greater for restricted gilts because gilts from this group were culled at a high rate than ad libitum gilts. Thus, to produce a gilt from each treatment group that successfully completes the development program, a greater number of restricted gilts are needed at the beginning than ad libitum females. Variable costs are lower because energy-restricted females consumed less feed than their ad libitum counterparts, even though the ration cost of energy-restricted feed was more expensive on a per ton basis than the ration fed to ad libitum gilts.

The market pig variable, fixed, and total costs of production were greater for progeny from energy-restricted gilts because of the greater reproductive production (more pigs) from those gilts. Variable costs of market pig production were an average of $147.60 greater for LWxLR gilts ($1,341.47 per ad libitum gilt vs. $1,489.07 per restricted gilt; Table 3) and $109.39 greater for L45X gilts ($1,430.13 per ad libitum gilt vs. $1,539.52 per restricted female; Table 3). Fixed costs were $27.77 greater per restricted LWxLR gilt ($293.09 per ad libitum gilt vs. $320.86 per restricted gilt; Table 3) and $18.55 greater per restricted L45X gilt ($314.29 per ad libitum gilt vs. $332.84 per restricted gilt; Table 3) because of the greater amount of building space needed to finish the restricted offspring. Summing these production costs showed that the progeny from an ad libitum gilt was less expensive to produce than the progeny from an energy-restricted female by an average of $175.37 for LWxLR gilts ($1,634.56 per ad libitum gilt vs. $1,809.93 per restricted female; Table 3) and $127.94 for L45X gilts ($1,744.42 per ad libitum gilt vs. $1,872.36 per restricted gilt; Table 3). However, as previously mentioned, one of the reasons the cost of market pig production is greater for progeny from energy-restricted gilts was because of the greater reproductive performance of these limit-fed females. Thus, one would expect total cost numbers to be greater for market pigs from these experimental treatment groups.

The total profit/loss per gilt was calculated by subtracting the total cost per gilt of each treatment and genetic line from the total revenue generated by each line $\times$ treatment interaction. Energy-restricted gilts generated larger profits than their ad libitum counterparts by an average of $79.39 per LWxLR female ($513.28 per ad libitum gilt vs. $592.66 per restricted female; Table 3) and $27.27 per L45X gilt ($577.75 per ad libitum female vs. $605.02 per restricted gilt; Table 3).

On average, progeny from restricted fed LWxLR gilts had a $0.48/cwt lower breakeven selling price than ad libitum market pigs ($38.60/cwt ad libitum vs. $38.12/cwt restricted; Table 3). The lower breakeven selling price can be attributed to the increased production of energy-restricted gilts and also to the lower feed cost of limit feeding gilts during development. However, progeny from energy-restricted L45X dams had a $0.14/cwt higher breakeven selling price than progeny from non-restricted dams ($38.07/cwt ad libitum vs. $38.21/cwt restricted; Table 3). The majority of this effect was traced back to the large number of ad libitum females that were culled after producing their first litter. Additionally, because ad libitum gilts were heavier after successfully completing the development program, this led to an even larger quantity of culled sows. Thus, the breakeven selling price of ad libitum LWxLR progeny was lower than for offspring from restricted LWxLR gilts.

Table 3: Revenue and Cost of Production for Two Prolific Maternal Lines.

	Line					
	LWxLR			L45X		
Item	Ad Libitum	Restricted	Difference[1]	Ad Libitum	Restricted	Difference[1]
Total cwts Produced per sow)[2]	46.33	51.26	4.93	49.75	52.72	2.97
Revenue (per sow)	$2,301.61	$2,546.63	$245.02	$2,471.76	$2,619.39	$147.63
Gilt Production (per gilt)						
Variable Costs	$147.14	$136.67	($10.47)	$143.38	$135.27	($8.11)
Fixed Costs	$6.64	$7.37	$0.73	$6.21	$6.74	$0.53
Total Costs	$153.78	$144.04	($9.74)	$149.59	$142.01	($7.58)
Market Swine (per litter through 4 parities)						
Variable Costs	$1,341.47	$1,489.07	$147.60	$1,430.13	$1,539.52	$109.39
Fixed Costs	$293.09	$320.86	$27.77	$314.29	$332.84	$18.55
Total Costs	$1,634.56	$1,809.93	$175.37	$1,744.42	$1,872.36	$127.94
Total Cost (per sow)	$1,788.34	$1,953.96	$165.62	$1,894.01	$2,014.37	$120.36
Profit/Loss (per sow)	$513.28	$592.66	$79.39	$577.75	$605.02	$27.27
Breakeven Selling Price (per cwt)[2]	$38.60	$38.12	($0.48)	$38.07	$38.21	$0.14

[1] Restricted minus Ad Libitum

[2] Live Weight Basis

Objective 2

Cumulative distribution functions (CDFs) are used to visualize the distribution of a data set. Each point on the graph is the probability the data point will be at that corresponding level of measurement or less. Figure 1 displays profit/loss results for the LWxLR gilts in the simulated stochastic budget where corn prices, soybean meal prices, and market hog prices were allowed to change. Similarly, Figure 2 illustrates the stochastic budget profit/loss results for the ad libitum and energy-restricted L45X gilts.

Figure 1 shows that the restricted energy program typically more profitable than the ad libitum program (the restricted curves is to the right of the ad libitum curve). Consider, as an example, the 50% probability level where the restricted energy profit is $378/head versus $318/head for the ad libitum group. The differences in profitability range from ad libitum LWxLR gilts being $73.26 per gilt more profitable than restricted LWxLR gilts to restricted LWxLR gilts having a $224.08 advantage in profitability over their ad libitum counterparts. Only about 6.3% of the time, ad libitum LWxLR females are more profitable than restricted LWxLR females. The other 93.7% of the time, restricted LWxLR gilts are more profitable than ad libitum LWxLR gilts.

At the 0.50 cumulative profitability level, restricted L45X gilts had a profitability of approximately $380.07 per gilt while ad libitum females had a profitability of $362.64 (Figure 2). Restricted energy L45X gilts had a greater profitability than their ad libitum counterparts about 79.2% of the time (Figure 2). The magnitude of the upper and lower bounds of the differences in profitability ranged from ad libitum gilts being $54.16 per gilt more profitable than restricted females to restricted females having a greater profitability of $104.78 per gilt (Figure 2).

The point where each line intersects the y-axis on Figures 1 and 2 is the point where gilts from each treatment group become profitable. For restricted LWxLR gilts, this occurs at approximately the 0.1907 cumulative probability level, while the zero profitability point of ad libitum gilts occurs at approximately the 0.2077 cumulative probability level. This indicates there is a 19.07% chance restricted LWxLR gilts will earn negative or zero returns, while ad libitum LWxLR females have a 20.77% chance of earning negative or zero returns.

Figure 1 Cumulative Distribution Function for LWxLR Gilts – Profit/Loss per Gilt.

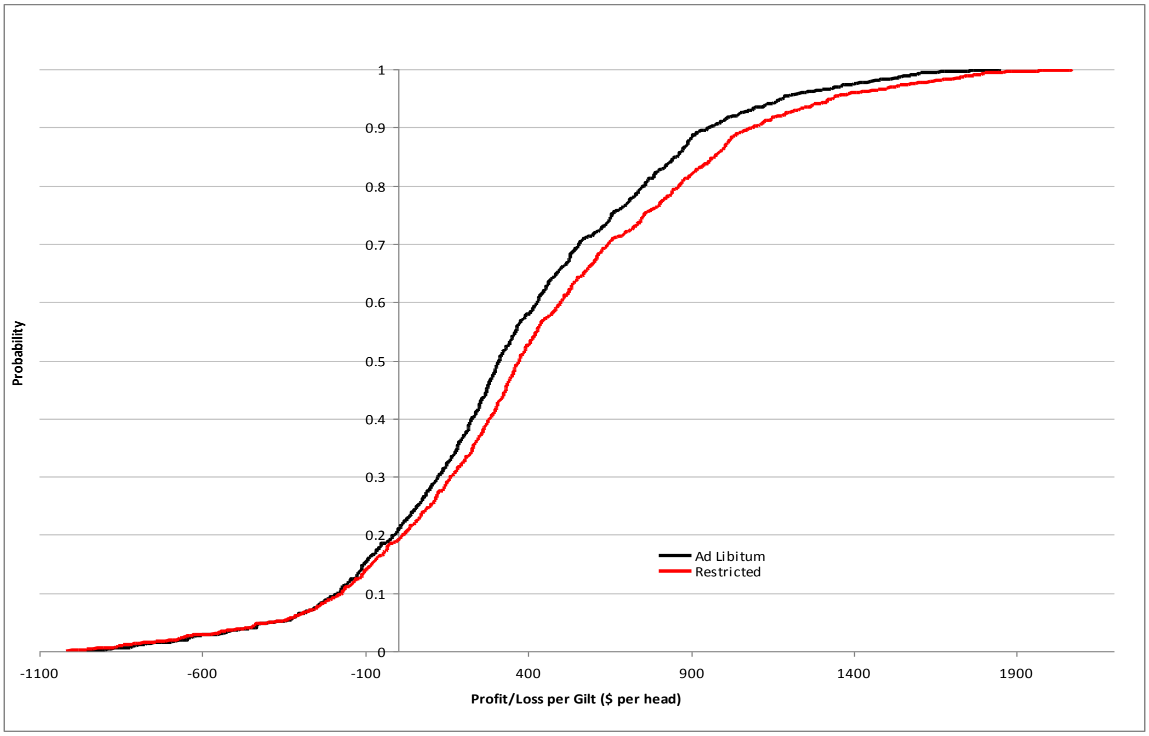
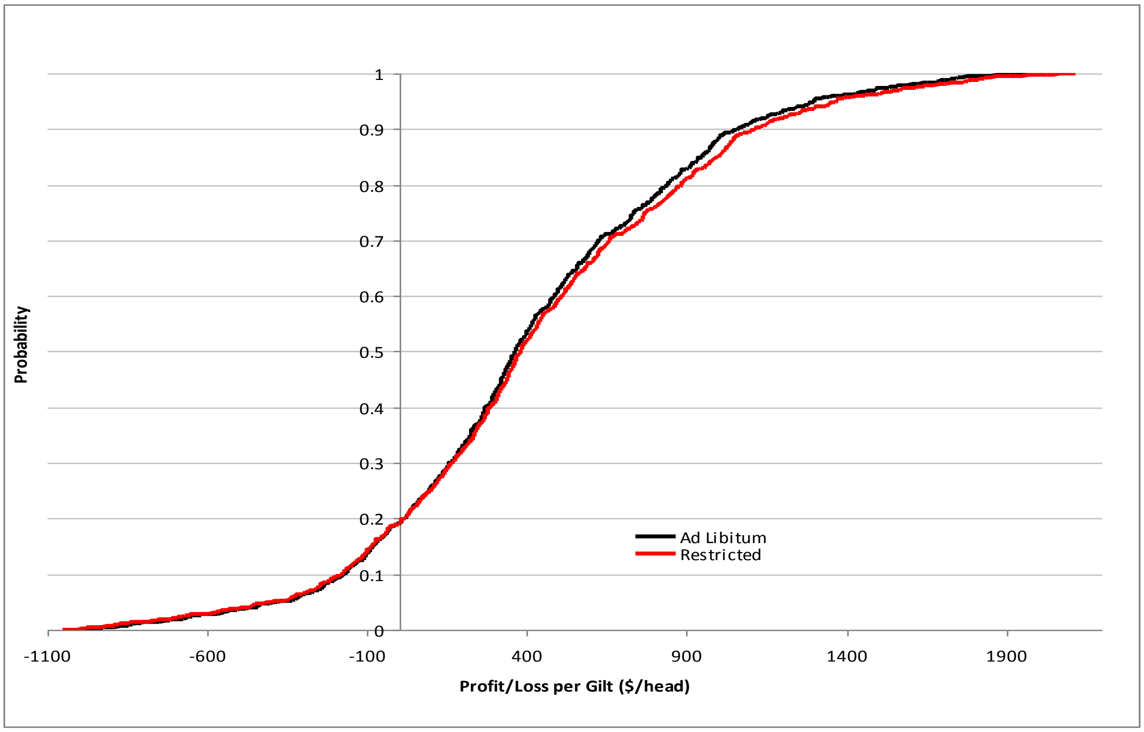


Figure 2 Cumulative Distribution Function for L45X Gilts - Profit/Loss per Gilt.



<u>Objective 3</u>

Calculating the average differences between the curves on the profit/loss CDFs of each genetic line gives the expected additional returns to the energy-restricted gilt development system over the ad libitum development program. The average profit increase from energy-restriction for LWxLR and L45X gilts was calculated to be $67.26/gilt and $20.17/gilt, respectively. The differences in profit for each group was found to be related to the crush margin (the difference between lean hog selling price and corn and soybean meal price). In both LWxLR and L45X gilts, as the crush margin increases so does the difference in profit/loss between treatment groups. In both cases, restricted progeny become more advantageous as the crush margin increases. For every $1 increase in crush margin, LWxLR and L45X restricted offspring generate approximately $1.93 and $1.04 of profit, respectively, while ad libitum progeny would have generated $1 of profit for every $1 increase in crush margin. The primary cause of this effect is the increased reproductive production of energy-restricted gilts of both genetic lines. However, because energy-restricted LWxLR progeny are also less expensive to produce than ad libitum LWxLR offspring per unit, the difference in profit between treatment groups is larger than that in L45X progeny.

Discussion.

In the budget analysis regarding LWxLR gilts, progeny from energy-restricted females were less expensive to produce on a per unit basis and generated greater profits. Offspring from L45X gilts generated a greater amount of profits, but also had larger per unit breakeven selling prices. Less expensive gilt development costs and greater reproductive production in both genetic lines would be expected to result in progeny from both lines being less expensive to produce on a per unit basis. This was not the case in L45X pigs because ad libitum L45X gilts were culled at a higher rate after first parity. Also, ad libitum gilts were heavier than restricted gilts. Thus, a greater quantity was sold per culled ad libitum female. Energy-restricted gilts were less expensive to produce, regardless of genetic line. These results have important implications for swine producers as restricting energy intake for breeding gilt production did not adversely affect sow productivity. The savings of feed costs counteracted the negative aspects of energy restriction in gilt development (increased rate of culling during development, etc.). Additionally, producing breeding gilts approximately $7/head cheaper, which was the average difference in energy-restricted females, reduced progeny breakeven selling prices in this study by an average of approximately $0.19/cwt sold.

The stochastic simulation experiment showed energy-restricted gilts generated a greater amount of profit than ad libitum gilts a higher percentage of the time. LWxLR gilts generated a greater profitability than their ad libitum counterparts 93.7% of the time, while restricted L45X gilts had a greater profitability than their restricted counterparts 79.2% of the time. At times when the returns to market pig production were negative, the increased rate of reproductive production from energy-restricted gilts caused the returns to this development system to be more negative than the returns to an ad libitum gilt development program. Thus, when the economics of market pig production were negative, ad libitum gilts were economically advantageous.

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