

# Modeling the Economics of Sow Longevity

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**Dr. Derald Holtkamp, DVM, MS**  
**Iowa State University**

ISU College of Veterinary Medicine, Food Supply Veterinary Services

# Approaches used to evaluate economics of sow longevity

- Majority of evaluation have focused on individual animals - “asset replacement” approach
- Simulation
  - Net present value per sow
  - Examples
    - J. Anim. Sci. 2003. 81:2915-2922 (Rodriguez-Zas, et al.)
    - JSHAP. 2003. 11:69-74 (Stalder et al.)
- Optimization
  - Dynamic modeling
  - Based upon hypothesis that a sow should be kept in the herd as long as the marginal profit is greater than the expected average profit of a replacement gilt
  - Examples
    - J. Anim. Sci. 2006. 84:2555-2565 (Rodriguez-Zas, et al.)



# Commonly used measures of sow longevity at the sow level

- Parity at removal
- Days in herd at removal
- Lifetime pigs weaned



# Commonly used measures of sow longevity at the herd level

- Removal rate,
- Culling rate,
- Replacement rate,
- Percent gilts in herd,
- Average parity of females in herd
- Average parity at removal
- Average pigs per female lifetime



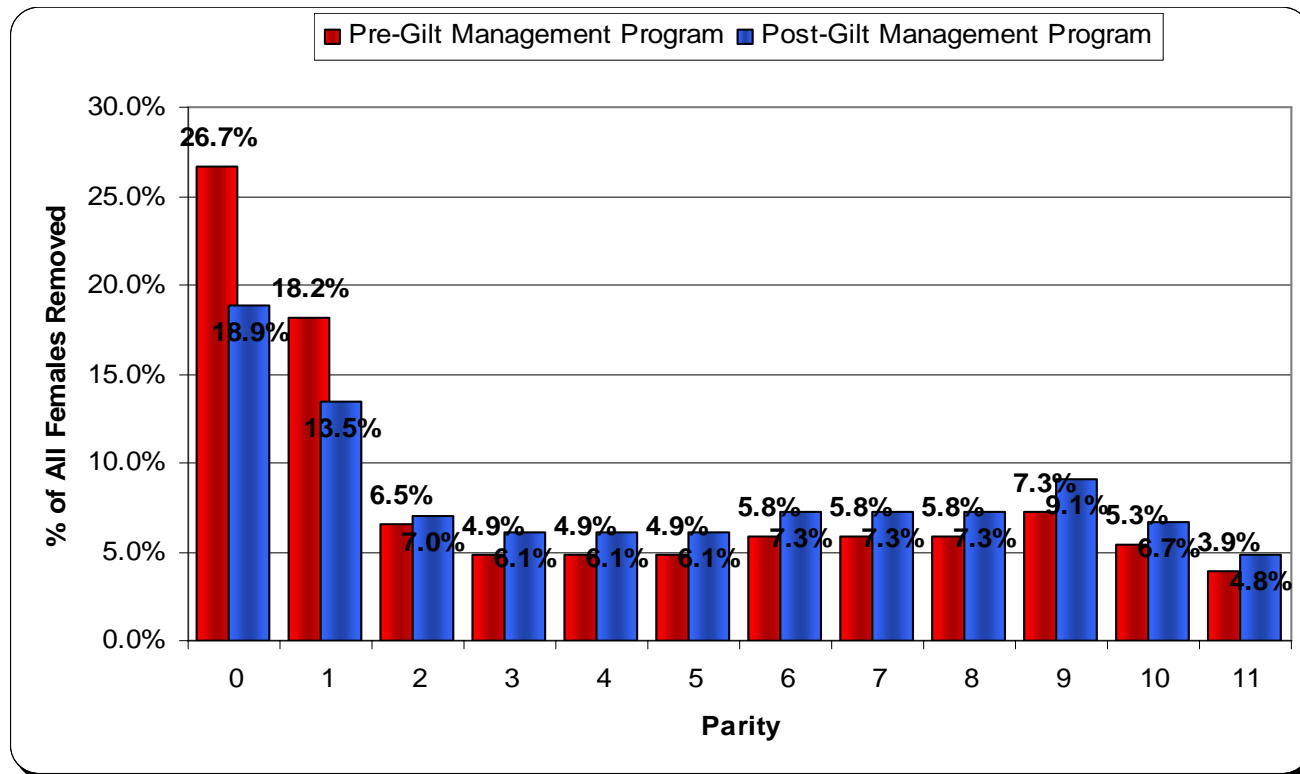
# The good and bad

- The Good
  - All of the herd-level measures are a single number that can easily be calculated
- The Bad
  - None of them provide enough information to evaluate the economics of sow longevity at the herd level



# Removal parity distribution

- Value calculated for each parity is  
(culls in parity per year) / (total culls per year)



# Objectives

- To evaluate the herd level impacts of shifts in the “removal parity distribution”
  - Evaluate implementation of a gilt management program as an example
- To estimate the components of the losses associated with shifts in the removal parity distribution
  - Cost of replacement gilts less salvage value of culled females
  - Breeding herd productivity
  - Grow pig productivity



# Methodology

- Developed a budget model of production and costs in the breeding and grow pig herd to simulate the profitability under alternative removal distributions
- The populations of females in each parity are modeled separately
  - Outcomes for each parity population are combined to calculate whole herd outcomes





	Parity 0	Parity 1	Parity 2	Parity 3	Parity 4	Parity 5	Parity 6	Parity 7	Parity 8	Parity 9	Parity 10	Parity 11	Totals
<b>Breeding, Farrowing and Weaning Performance</b>													
Annual female replacement / removal rate (% of breeding herd/year) - all parities	62%												
Replacement gilts entered per year	622												
Average female inventory in parity	220	146	127	113	100	87	72	57	42	24	10	1	1000
Parity structure of the herd	22%	15%	13%	11%	10%	9%	7%	6%	4%	2%	1%	0%	100.0%
Average entry to farrow interval - Parity 0 only (days / female)	156.0												
Average entry to cull interval - Parity 0 only (days / female)	55.0												
Average farrow to farrow interval - Parity 1+ only (days / female)		141.0	147.0	146.5	145.5	144.5	141.5	139.0	139.5	134.5	130.0	151.0	
Average farrow to cull interval - Parity 1+ only (days / female)		45.0	45.0	45.0	45.0	45.0	45.0	45.0	30.0	20.0	15.0	18.0	
Litters farrowed per year for females not removed in parity	456	343	302	272	242	212	175	139	103	57	24	0	2,324
Average lactation length (days)	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0		
Average gestation length (days)	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0	115.0		
Average parity of herd	3.08												
Total annual sow days of females in parity	80,221	53,393	46,234	41,198	36,530	31,922	26,429	20,951	15,419	8,628	3,641	435	365,000
Total annual productive sow days of females in parity	52,407	45,560	40,186	36,167	32,149	28,130	23,308	18,485	13,663	7,635	3,215	-	300,905
Total annual non-productive sow days of females in parity	27,814	7,832	6,049	5,031	4,381	3,792	3,121	2,466	1,755	993	426	435	64,095
Average non-productive sow days of females in parity	127	54	48	45	44	43	43	43	42	42	43	365	64
Pigs born alive/litter farrowed	9.25	9.49	9.68	9.83	9.93	10.01	10.04	10.06	10.05	10.03	10.03		
Prewean mortality	14.0%	12.0%	13.0%	13.8%	14.3%	14.5%	14.8%	15.0%	15.3%	15.3%	15.3%		
Pigs weaned/litter farrowed	7.96	8.25	8.42	8.53	8.61	8.66	8.68	8.68	8.67	8.64	8.64		
Pigs born alive per year to females in parity	4216	3251	2925	2672	2401	2116	1760	1399	1033	576	242	0	22,591
Prewean piglet deaths per year from females in parity	590	390	380	367	342	307	260	210	158	88	37	0	3,129
Pigs weaned per year from females in parity	3626	2827	2544	2320	2080	1831	1521	1207	891	496	209	0	19,551

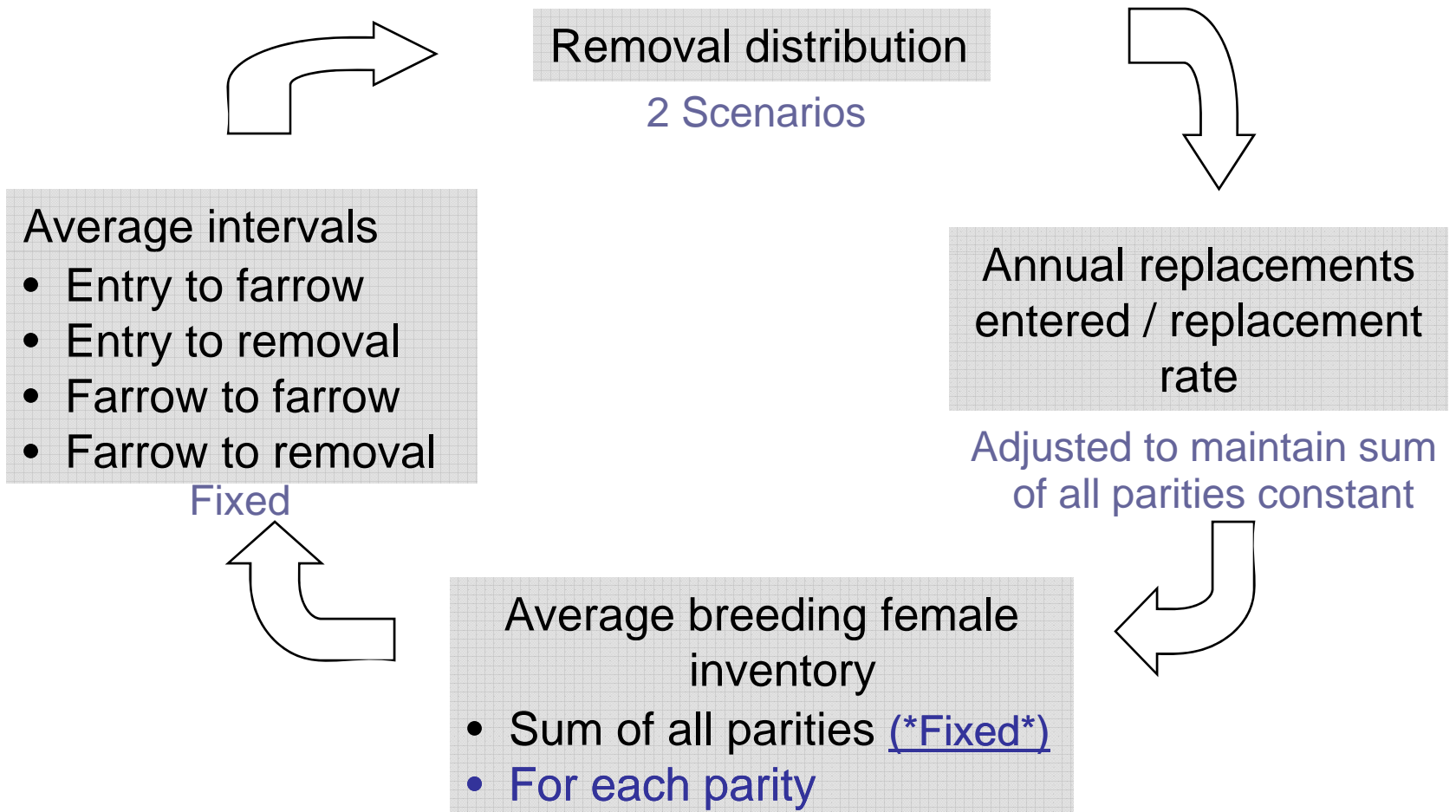
**Summary for entire herd**

Nonproductive days per female per year	64
Litters farrowed per year	2324
Litters farrowed per female per year	2.3
Pigs born alive per year	22591
Pigs born alive per female per year	22.6
Prewean piglet deaths per year	3129
Prewean mortality (% of piglets born alive)	13.8%
Pigs weaned per year	19551
Pigs weaned per female per year	19.6

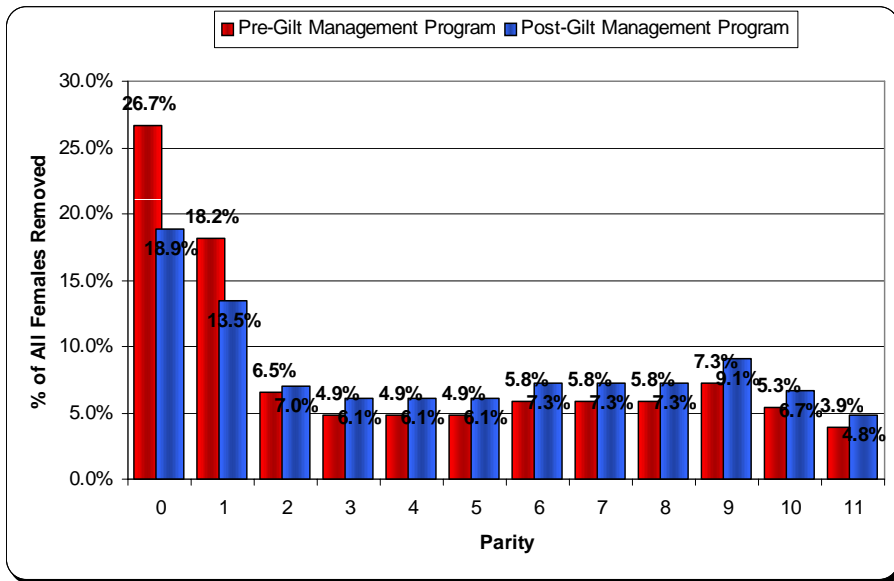
## Breeding herd performance section of budget model



# Methodology



# Two scenarios evaluated



		Percent of females removed in parity (% of all removals)	
		Higher early culling scenario	Lower early culling scenario
Parity	0	26.7%	18.9%
	1	18.2%	13.5%
	2	6.5%	7.0%
	3	4.9%	6.1%
	4	4.9%	6.1%
	5	4.9%	6.1%
	6	5.8%	7.3%
	7	5.8%	7.3%
	8	5.8%	7.3%
	9	7.3%	9.1%
	10	5.3%	6.7%
	11	3.9%	4.8%
SUM		100.0%	100.0%



# Description of the herd in which program was implemented

- 2400 sow farm-Monsanto genetics
- Group-house gestation
- PRRSV stable
- 6 week isolation, gilts directly enter breeding herd



# Gilt management procedures

- V-Boar exposure in finishing beginning at 145 days of age
- Isolation – 6 weeks, no boar exposure
- Gilts moved into pens in breeding & gestation
- Moved to stalls 5-7 days prior to MATRIX; by size and as needed
- 14 day treatment beginning Fri. ending Thur.



# Gilt management procedures

- “Casual” boar exposure during treatment
- Return to pens day 14, fence-line, heat detection; breed in pens
- Non – responders are treated with PG 600
  - Given on day 10



# Cycling and fertility data

<u>PARAMETER</u>	<u>VALUE</u>
NUMBER OF WEEKS	120
NUMBER TREATED WITH MATRIX	3650
PERCENT SERVED OFF MATRX TREATMENT	81.5%
PERCENT MATRIX TREATED PREGNANT	88.7%
PERCENT NOT TREATED WITH PG600	0.3%
PERCENT PG600 TREATED	18.2%
PERCENT PG600 TREATED PREGNANT	87.9%
PERCENT CULLED	5.7%
TOTAL PERCENT SERVED	94.2%
TOTAL PERCENT PREGNANT VS SERVED	88.4%
TOTAL PERCENT PREGNANT VS TREATED	83.2%



# Parameter estimates used in the model

- “Hodge podge” approach taken for parameter estimates
- Parameter values for alternative parities used in model are derived from various sources
  - Represent a “typical” herd

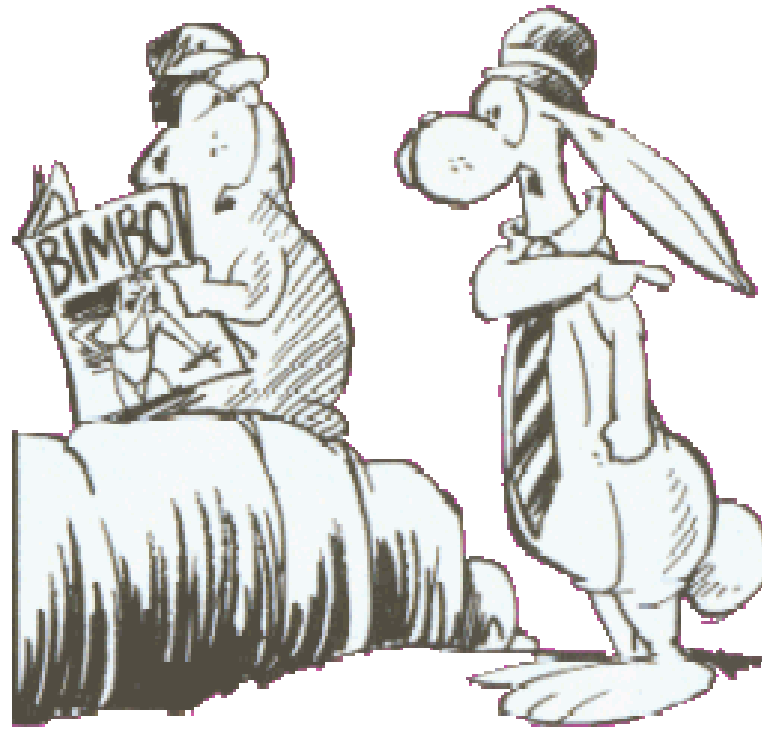




# “Hodge Podge” in Wikipedia

- Hodge-podge or hotchpotch or hotch pot is an English expression often used negatively, denoting a "mixture" or "medley" of things. According to the Concise Oxford Dictionary it is derived from the Middle English word hochepot and it is a: "Dish of many mixed ingredients, especially mutton broth with vegetables.
- Hodge-Podge the rabbit is a fictitious character from Berke Breathed's comic strip Bloom County. His best friends are Portnoy and Cutter John. Hodge is extremely conservative and fanatical about most things, though often ignorant and naive about just what those things are. When he found out that Portnoy was a Groundhog, Hodge stopped speaking with him because he did not associate with "pigs". The two eventually made up. Hodge later had an affair with Rosebud the Basselope, resulting in Rosebud's pregnancy with jackabasselopes.





Portnoy and Hodge Podge



# What drives differences between scenarios?

- Average cull weight
- Average cull price

	Average weight of females culled (pounds)	Average cull price (\$/cwt)	
Parity	0	325	\$37.87
	1	380	\$37.87
	2	425	\$37.87
	3	475	\$40.64
	4	485	\$40.64
	5	495	\$40.64
	6	505	\$40.62
	7	515	\$40.62
	8	525	\$40.62
	9	535	\$40.62
	10	545	\$40.62
	11	555	\$41.63

Source: USDA



# What drives differences between scenarios?

- Average intervals – nonproductive days – litters farrowed / female / year

		Average farrow (entry for gilts) to farrow interval	Average farrow (entry for gilts) to removal interval
Parity	0	156	55
	1	141	45
	2	147	45
	3	147	45
	4	146	45
	5	145	45
	6	142	45
	7	139	45
	8	140	30
	9	135	20
	10	130	15
	11		18

Source: Dhuyvetter, Allen D. Leman Swine Conference. 2003. 110-116.  
Calculated from litters / sow / year



# What drives differences between scenarios?

- Pigs born alive / litter farrowed
- Prewean mortality

		Pigs born alive per litter farrowed	Prewean mortality (% pigs placed)
Parity	0	9.3	14.0%
	1	9.5	12.0%
	2	9.7	13.0%
	3	9.8	13.8%
	4	9.9	14.3%
	5	10.0	14.5%
	6	10.0	14.8%
	7	10.1	15.0%
	8	10.1	15.3%
	9	10.0	15.3%
	10	10.0	15.3%
	11		

Source: Dhuyvetter, Allen D. Leman Swine Conference. 2003. 110-116.



# What drives differences between scenarios?

- Weaning weight

		Average weaning weight (lb)
Parity	0	11.7
	1	12.5
	2	12.5
	3	12.5
	4	12.5
	5	12.5
	6	12.5
	7	12.5
	8	12.5
	9	12.5
	10	12.5
	11	12.5

Source: Moore, C. 2001. Allen D. Lemay Swine Conference. 203-206.



# What drives differences between scenarios?

- Wean-to-finish mortality
- Wean-to-finish cull rate

		Wean-to-finish mortality	Wean-to-finish cull rate
Parity	0	7.34%	3.4%
	1	5.42%	2.5%
	2	5.42%	2.5%
	3	5.42%	2.5%
	4	5.42%	2.5%
	5	5.42%	2.5%
	6	5.42%	2.5%
	7	5.42%	2.5%
	8	5.42%	2.5%
	9	5.42%	2.5%
	10	5.42%	2.5%
	11	5.42%	2.5%

Source: Moore, C. 2001. Allen D. Leman Swine Conference. 203-206.



# What drives differences between scenarios?

- Wean-to-finish average daily gain
- Wean-to-finish feed conversion

		Wean-to-finish average daily gain	Wean-to-finish feed conversion
Parity	0	1.40	2.71
	1	1.46	2.60
	2	1.46	2.60
	3	1.46	2.60
	4	1.46	2.60
	5	1.46	2.60
	6	1.46	2.60
	7	1.46	2.60
	8	1.46	2.60
	9	1.46	2.60
	10	1.46	2.60
	11	1.46	2.60

Source: Moore, C. 2001. Allen D. Leman Swine Conference. 203-206.





# Other key parameter values

- Average gestation diet cost = \$186/ton
- Average lactation diet cost = \$222/ton
- Cost of replacement gilt = \$200/gilt
- Market hog price = \$0.65/lb. carcass wt
- Average wean-to-finish diet cost = \$186/ton



# Methodology

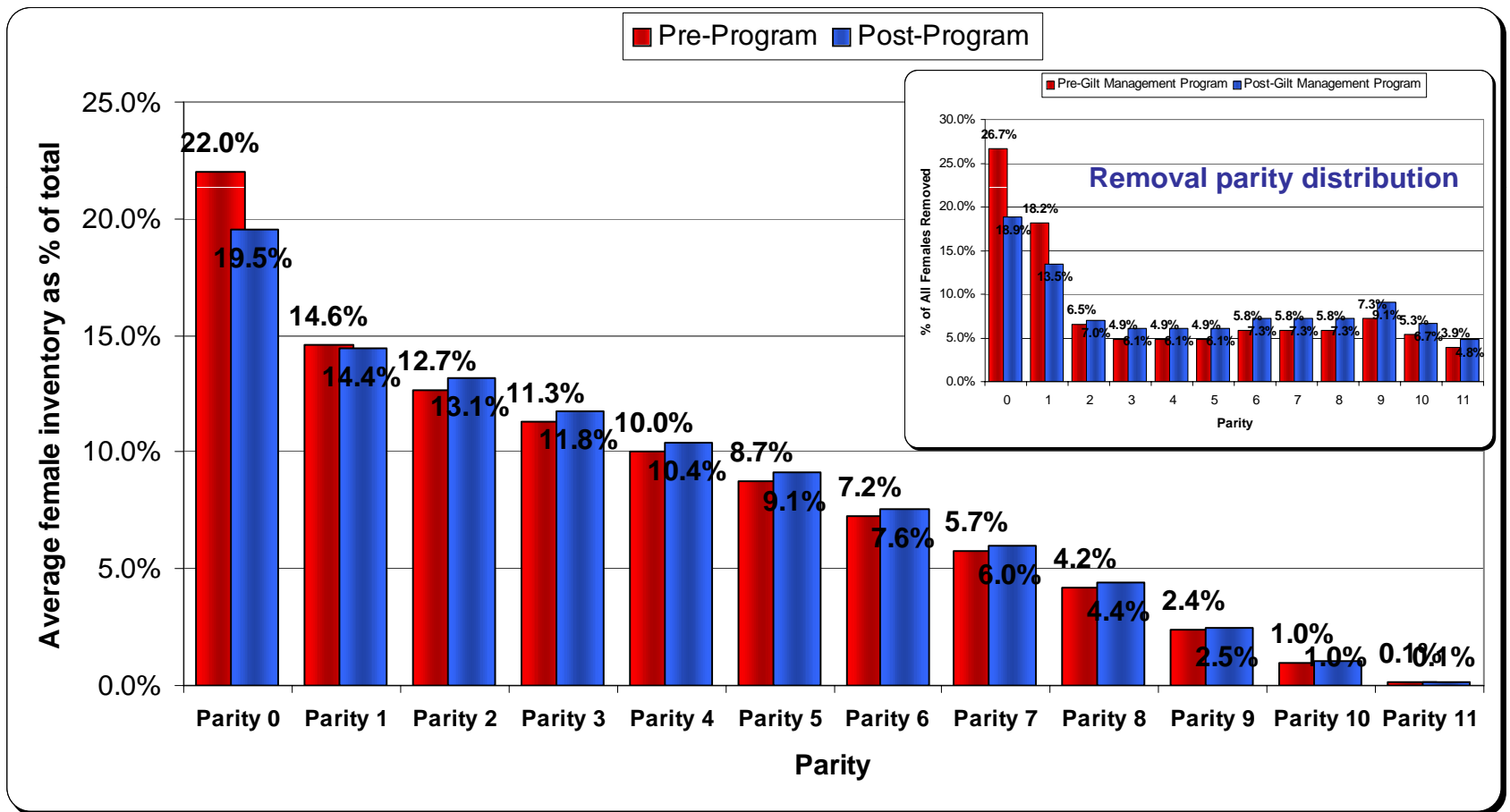
- Assumptions
  - Steady state breeding female inventory
  - Weaned pigs are attributed to previous parity
  - Sows remaining in herd are automatically culled at 11<sup>th</sup> parity
  - Fixed costs are allocated to each parity according to the average inventory in parity as % of average herd inventory



# Results



# Parity structure of the herd



# Results – Breeding herd productivity

	Pre-Program	Post-Program	Difference
Average breeding female inventory	1000	1000	0
Annual female replacement / removal rate (% of breeding herd/year)	62%	52%	-10%
Replacement gilts entered per year	622	520	-102
Average parity of herd	3.08	3.20	0.12
Nonproductive days per female per year	64.1	58.1	-6.0
Litters farrowed per year	2324	2365	41
Litters farrowed per female per year	2.32	2.36	0.04
Pigs born alive per year	22591	23012	421
Pigs born alive per female per year	22.59	23.01	0.42
Prewean piglet deaths per year	3129	3187	59
Prewean mortality (% of piglets born alive)	13.85%	13.85%	0.00%
Pigs weaned per year	19551	19918	367
Pigs weaned per female per year	19.55	19.92	0.37



# Results – Growing pig productivity

	Pre-Program	Post-Program	Difference
Wean-to-market mortality (% of pigs placed)	5.78%	5.75%	-0.03%
Cull rate (% of pigs placed)	2.66%	2.65%	-0.02%
Number of finished pigs marketed per year	17900	18245	345
Number of culls marketed per year	521	528	7
Wean-to-market average daily gain of pigs marketed (pounds/pig marketed/day)	1.439	1.440	0.001
Average live weight at market (pounds/pig)	258.2	258.4	0.2
Wean-to-market feed to gain ratio (pounds of feed/pound of gain)	2.619	2.618	-0.002



# Results – Economic impact

## Total for 1000 sow herd (\$/year)

	Pre-Program	Post-Program	Difference
<b>Cost of replacement gilts less salvage value of culled females</b>			
Cost of replacements purchased (\$/year)	\$124,341	\$104,006	
Salvage value of females culled (\$/year)	\$101,299	\$89,488	
Cost of replacements purchased net of salvage value of females culled (\$/year)	\$23,042	\$14,518	<b>\$8,524</b>
<b>Breeding herd productivity</b>			
Total annual cost of production(\$/year) Less cost of replacements purchased net of salvage value of females culled	\$566,814	\$566,718	
Annual revenue from weaned pigs (\$/year)	\$586,526	\$597,535	
Total annual profit from weaned pigs (\$/year)	\$19,712	\$30,817	<b>\$11,105</b>
<b>Growing pig productivity</b>			
Total annual cost of production(\$/year)	\$2,025,717	\$2,064,102	
Total annual revenue from market pigs (\$/year)	\$2,312,403	\$2,358,746	
Total profit (\$/year) Excluding cost of replacements purchased net of salvage value of females culled	\$286,686	\$294,644	<b>\$7,958</b>
<b>Total</b>			<b>\$27,587</b>



# Results – Economic impact

## Per breeding female (\$/female/year)

	Pre-Program	Post-Program	Difference
<b>Cost of replacement gilts less salvage value of culled females</b>			
Cost of replacements purchased (\$/year)	\$6.95	\$5.70	
Salvage value of females culled (\$/year)	\$5.66	\$4.90	
Cost of replacements purchased net of salvage value of females culled (\$/year)	\$1.29	\$0.80	<b>\$0.49</b>
<b>Breeding herd productivity</b>			
Total annual cost of production(\$/year) Less cost of replacements purchased net of salvage value of females culled	\$31.67	\$31.06	
Annual revenue from weaned pigs (\$/year)	\$32.77	\$32.75	
Total annual profit from weaned pigs (\$/year) Excluding cost of replacements purchased net of salvage value of females culled	\$1.10	\$1.69	<b>\$0.59</b>
<b>Growing pig productivity</b>			
Total annual cost of production(\$/year)	\$113.17	\$113.13	
Total annual revenue from market pigs (\$/year)	\$129.19	\$129.28	
Total profit (\$/year) Excluding cost of replacements purchased net of salvage value of females culled	\$16.02	\$16.15	<b>\$0.13</b>
<b>Total</b>			<b>\$1.21</b>





# Results – Economic impact

## Per pig marketed (\$/pig/year)

	Pre-Program	Post-Program	Difference
<b>Cost of replacement gilts less salvage value of culled females</b>			
Cost of replacements purchased (\$/year)	\$124.34	\$104.01	
Salvage value of females culled (\$/year)	\$101.30	\$89.49	
Cost of replacements purchased net of salvage value of females culled (\$/year)	\$23.04	\$14.52	<b>\$8.52</b>
<b>Breeding herd productivity</b>			
Total annual cost of production(\$/year) Less cost of replacements purchased net of salvage value of females culled	\$566.81	\$566.72	
Annual revenue from weaned pigs (\$/year)	\$586.53	\$597.54	
Total annual profit from weaned pigs (\$/year) Excluding cost of replacements purchased net of salvage value of females culled Excluding cost of replacements purchased net of salvage value of females culled	\$19.71	\$30.82	<b>\$11.10</b>
<b>Growing pig productivity</b>			
Total annual cost of production(\$/year)	\$2,025.72	\$2,064.10	
Total annual revenue from market pigs (\$/year)	\$2,312.40	\$2,358.75	
Total profit (\$/year) Excluding cost of replacements purchased net of salvage value of females culled	\$286.69	\$294.64	<b>\$7.96</b>
<b>Total</b>			<b>\$27.59</b>



# Acknowledgements

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