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Benchmarking: Sow productivity and PigCHAMP

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Each year, several sow productivity benchmarks are made available to the swine industry. For 2004, the annual PigCHAMP benchmark indicates improvements in the industry's average farrowing rate, totalborn and bornalive per litter and pigs weaned per mated female per year (PW/MF/Y). Likewise, increases were also observed in average female inventory, culling rates and death rates[1] (**Table 1**). Despite the improved values, the ranges between 10th and 90th percentile producers remain wide (**Table 2**). (A complete list of benchmarked parameters can be found at www.pigchamp.com.)

In all reality, what do the annual benchmarks reveal? Are individual farms actually experiencing annual, incremental improvements? Or, are the poorest performers dropping out of the final analysis? The USDA's Hogs and Pigs Reports consistently describe a higher pig crop (pigs weaned per litter) with increased herd size, but their data is derived from quarterly survey results. The industry has experienced significant changes in the past 10-15 years. Widespread use of artificial insemination, increased herd size, phase segregation, genetic advancement and health prioritization are a few examples. Few would argue that the last decade has observed both increased sow herd size and increased sow productivity. But is this correlation or coincidence? Does herd size affect productivity? [2-5]

If the data were to be summarized by weighting performance on the basis of average female inventory, one would find that the farrowing rate is better and bornalive per litter is better, but piglet survivability is less. Overall, however, in the weighted data set, the benefit of improved farrowing rates effectually increases PW/MF/Y. Then, are larger farms better producers? Not necessarily. There is no correlation between size and productivity, but a few

Table 1: Mean values from annual PigCHAMP breeding herd year-end summaries

Parameter	2004	2003	2002	2001	2000
Farrowing rate (%)	77.72	75.62	72.98	69.0	76.4
Average totalborn	11.51	11.39	11.25	11.3	11.1
Average bornalive	10.34	10.25	10.12	10.2	10.1
Pigs weaned per litter	9.10	9.02	8.98	8.9	9
Pigs weaned per mated female per year	21.25	20.15	20.28	19.7	19.6
Pigs weaned per female per year	20.27	19.12	19.19	18.6	18
Culling rate (%)	43.82	41.17	41.6	39.0	44.6
Death rate (%)	7.87	7.81	7.8	6.8	6.9

Table 2: Mean values and upper-lower 10th percentile ranges from 2004 and 1998 PigCHAMP breeding herd year-end summaries

Parameter	2004 Mean	2004 Range	1998 Mean	1998 Range
Farrowing rate (%)	77.72	17.6	73.2	15
Average totalborn	11.51	1.7	11.2	1.7
Average bornalive	10.34	1.8	10.2	1.4
Pigs weaned per litter	9.10	1.5	9.0	1.4
Pigs weaned per mated female per year	21.25	5.5	19.7	6.4
Pigs weaned per female per year	20.27	5.8	18.6	6.7
Culling rate (%)	43.82	29.8	45.5	37.4
Death rate (%)	7.87	8.3	5.9	8.2

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large, productive farms are capable of weighting the averages (**Figures 1-2**).

What, then, can the industry do to establish benchmarks that provide useful information? Cohorts could be used to compare farms of similar size, genetics, health statuses or product output. In fact, comparing cohorts of similar size offers a different picture of productivity (**Table 3-4**). Advantages of totalborn and bornalive fade away. The higher rate of PW/MF/Y among the largest herds appears to be largely a function of higher farrowing rates and better sow utilization. Size-associated performance differences, then, may not be the result of a health or genetics advantage but, instead, a function of facilities built with the capacity to utilize more recent developments in reproductive technology, including artificial insemination and sow housing that improves embryo implantation.

Product output also has the potential to influence sow productivity. For example, units selling weaned pigs are incentivized to push the most possible piglets out the door. Alternatively, units feeding a defined system flow may have additional quality stipulations, such as piglet age, or, if there is no opportunity for an overflow release, be focused on optimizing the productivity and profitability of the entire system. However, information on such cohorts is not currently available.

Another major challenge that remains with current benchmarks is the absence of a parameter that reflects fiscal efficiency. It is always possible to under-utilize physical space while improving paper productivity. Pigs weaned per lifetime could be used as a measure of sow utilization in established herds; and pigs weaned per crate per year could be used to compare farrowing space utilization.

Figure 1: Scatterplot of 2004 PigCHAMP PW/MF/Y versus average female inventory

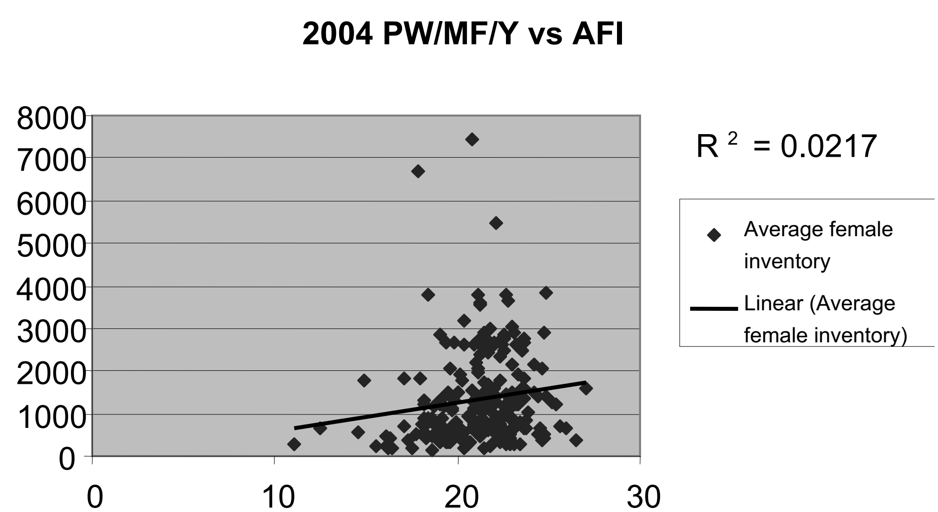

Figure 2: Scatterplot of 2003 PigCHAMP PW/MF/Y versus average female inventory

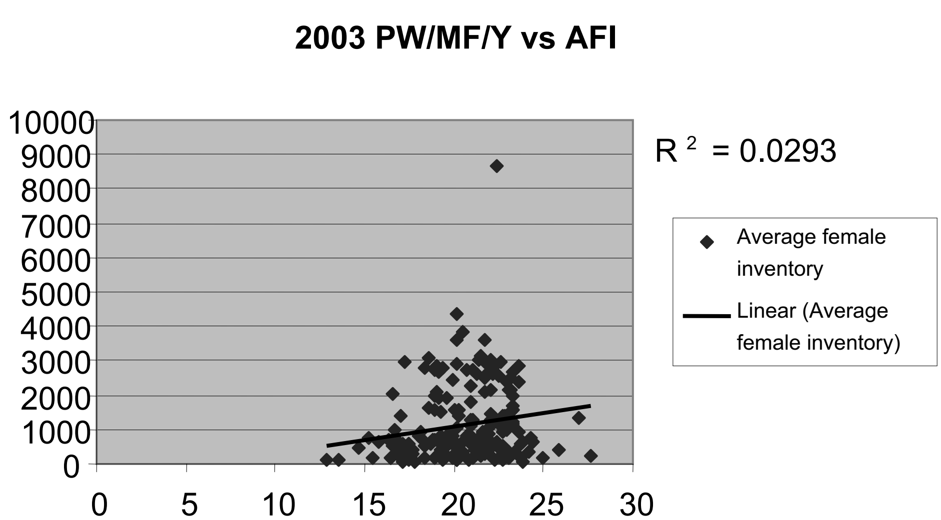

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Table 3: PigCHAMP breeding herd year-end summary values weighted by average female inventory in farm.

Parameter	2004	2004-weighted	2003	2003-weighted
Farrowing rate (%)	77.72	78.92	75.62	76.75
Average totalborn	11.51	11.57	11.39	11.36
Average bornalive	10.34	10.37	10.25	10.15
Pigs weaned per litter	9.10	9.10	9.02	8.94
Pigs weaned per mated female per year	21.25	21.53	20.15	20.92
Pigs weaned per female per year	20.27	20.47	19.12	19.95
Culling rate (%)	43.82	44.61	41.17	41.67
Death rate (%)	7.87	8.74	7.81	9.33
Average female inventory			1095.21	2196.69
Average female inventory-average gilt pool inventory[A]	1296.28	2121.45		

[A]Average female inventory-average gilt pool inventory was reported in place of the average female inventory for the year 2004.

Table 4: PigCHAMP breeding herd year-end summary means by average farm inventory cohort.

Parameter	2004			2003		
	<500	500-1499	≥1500	<500	500-1499	≥1500
Farrowing rate (%)	74.03	77.94	79.63	73.97	76.10	77.01
Average totalborn	11.47	11.44	11.63	11.47	11.32	11.38
Average bornalive	10.29	10.31	10.42	10.40	10.21	10.12
Pigs weaned per litter	9.12	9.08	9.12	9.14	9.02	8.89
Pigs weaned per mated female per year	20.28	21.32	21.72	18.87	20.71	21.05
Pigs weaned per female per year	19.41	20.41	20.59	17.74	19.79	20.02
Culling rate (%)	38.24	45.45	44.77	35.54	47.96	39.29
Death rate (%)	7.23	7.21	9.25	6.26	7.52	10.23
Average female inventory				239.4	841.0	2569.0
Average female inventory-average gilt pool inventory[A]	313.8	891.5	2487.2			
N	44	108	73	71	74	54

[A]Average female inventory-average gilt pool inventory was reported in place of the average female inventory for the year 2004

However, differences in unit purpose (i.e., genetic nucleus, multiplier, commercial) and products can also greatly affect desired sow utilization and crate throughput.

Benchmarking implications

While benchmarks are widely available, benchmarking—the active process of improvement through the use of benchmarks—is more difficult to come by. Historically, the PigCHAMP shared data has been used for ecological benchmarking: more productive herds have shorter lactation lengths and fewer non-productive days, higher matings per service is associated with higher bornalive, etc.[3-5] The challenge with such ecologic observations is the ecologic fallacy—what holds true at the group [ecologic] level may not hold true for the individual. Furthermore, what holds true at the group level may not even be feasible for the individual herd or system given its defined constraints. The risk of ecologic benchmarking becomes a devaluation of the information gained and thus the concept of benchmarking by the individual—especially if the results don't appear relevant or are refuted by applied research.[4,6-7]

Another challenge with contemporary industry benchmarking lies in statistical understanding. Under normal circumstances, half of the farms are expected to be above average, while half will be below—some for good reason and others just by chance. Improperly used, benchmarks can be demoralizing agents rather than means to establish expectations.[8]

Swine practitioners, technical service and production personnel routinely engage in "benchmarking-like" activity. During visits, observations of in-farm activities are made as well as associations between said activities and the unit's performance. Those observations may then be shared with other herds looking for means to improve. But do those in-farm observations equate to a unit's success? Maybe; maybe not. Remembering statistics, a farm may be doing well or poorly merely as a result of the numerical lottery.[8]

How then can productive benchmarking be performed? Who or what should serve as the basis for comparison? What parameters should be considered? Essentially there are four types of benchmarking: internal, external against competitors, external against non-competitors that excel in a particular function, and generic process benchmarking.[9] Examples of internal benchmarking include competitive performance of similar herds within a system, within herd comparisons with past performance and process control charting. External benchmarking against competitors uses publicly available information to describe structures, processes and metrics. External benchmarking against non-competitors recognizes parallel functions in other industries and allows for comparison of process applications and metrics, to a lesser extent. Generic process benchmarking defines the existing process and utilizes brainstorming and analysis to improve efficiency.[9]

The parameters used as the basis for benchmarking must, first and foremost, be able to be influenced at the level where the improvements are sought. Metrics using common units can provide an objective basis for comparison. Metrics that directly reflect production and efficiency have the greatest impact on performance.

The general phases of benchmarking are planning, analysis, integration and action.[9] The planning phase identifies potential benchmarking partners, metrics and the methods by which they can be collected. In the analysis phase, differences between performance and potential gains are considered. The integration phase builds excitement around approaches to the achieve performance gains and the action phase implements the new strategies, measures success over time and recalibrates unit or system standards according to newly recognized performance.[9]

The active benchmarking process in the swine industry merits a few caveats, however. First, everything must be taken in context. Are the differences observed a function of unit quirks or system requirements, or are they done for productivity or quality purposes (i.e., animal ages, parity structure, replacement rates, feeding programs, housing, semen rotation, etc.)? Incidental differences should be left as observations within context. Second, address parameters that can be influenced at the worker, owner or system level with the level of actual influence. Third, one thing at a time. When there is ample opportunity for improvement, focusing on the most influential factors first will yield the most encouraging results—the first improvements are miles, the later improvements are inches. Finally, the unit for comparison must have sufficient numbers to validate its processes. After all, all systems, especially biological systems, are subject to normal variation, and benchmarking against normal variation yields unfruitful results.

Using herd records for internal benchmarking

Example 1

A PRRSV- and Mycoplasma-free start-up herd was unable to achieve the desired conception rate after a summer 'slump.' Several factors contributing to conception rate were reviewed, including types of animals bred, semen handling, quality, and insemination technique. Herd records were used to determine conception rates for Observer1 [the breeder identifying the animal in estrus] by week. To identify individual breeder ability to detect estrus, conception rates [and corresponding sample size] of 4- to 7-day weaned sows, first-service gilts, second-service gilts and second service sows were evaluated. Expectations are that conception rates for all breeders will be best among 4- to 7-day weaned sows. First-service gilts and repeat sows and gilts require more skill to identify estrus and their conception rates are considered a measure of skill level. The differences observed among breeder conception rates suggested that #2 was too aggressive. By addressing this issue, the herd was able to attain desired performance. Furthermore, the breeders began to look for regular feedback about their conception rates. Reports were used only as a source of information and motivation, not as part of a reward or penalty system (**Tables 5-6**).

Example 2

An internally replacing PRRSV- and *Mycoplasma*-free herd experienced a gradual decline in bornalive since its repopulation in 1999 (**Figure 3**). Many factors were identified that could affect bornalive, including lactation length, insemination practices and semen quality. Another factor considered was a gradual transition in the genetic program from one breeding stock line to another. In order to yield a "high health" population of Line B, the unit was stocked with a healthy Line A which was crossed to Line B (AxB). The offspring were bred back to Line B (Ax2B), and finally, a small, sterilely-derived population of 'pure' Line B was brought into the unit.

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Table 5: Conception rate and count by servweek for Observer1.

Servweek	**Conception rate**					**Count**				
	1	**2**	**3**	**4**	**Total**	**1**	**2**	**3**	**4**	**Total**
27	0.71	0.81	0.81	0.75	0.77	58	64	26	4	152
28	0.76	0.73	0.76	0.82	0.75	29	40	17	11	97
29	0.77	0.69	0.70	1.00	0.73	47	39	54	3	143
30	0.84	0.70	0.67	0.86	0.76	43	27	39	21	130
31	0.77	0.58	0.75	0.46	0.69	44	31	40	13	128
32	0.80	0.69	0.89	0.85	0.80	35	29	28	20	112
33	0.85	0.74	0.84	0.81	0.81	53	46	38	16	153
34	0.80	0.63	0.79	0.91	0.76	50	49	33	22	154
35	0.81	0.64	0.80	0.74	0.75	54	50	44	23	171
36	0.85	0.75	0.81	0.70	0.80	59	36	43	10	148
37	0.70	0.71	0.78	0.62	0.72	40	34	37	13	124
38	0.75	0.63	0.75	0.67	0.70	56	48	44	52	200
39	0.84	0.77	0.84	0.92	0.83	70	47	67	12	196
40	0.90	0.79	0.80	0.69	0.82	61	47	49	13	170
41	0.92	0.87	0.77	0.82	0.85	51	38	48	11	148
42	0.88	0.83	0.88	0.75	0.85	42	48	32	12	134
43	0.86	0.88	0.92	0.92	0.89	35	32	38	25	130
44	0.96	0.82	0.88	0.80	0.89	52	38	40	5	135
45	0.94	0.83	0.90	1.00	0.90	54	41	29	1	125
46	0.82	0.80	0.90	0.79	0.84	60	51	51	14	176
47	0.77	0.73	0.83	1.00	0.79	57	41	41	6	145
48	0.90	0.80	0.87		0.86	68	46	53		167
49	0.92	0.81	0.78	1.00	0.87	60	37	23	13	133
Total	0.84	0.75	0.81	0.79	0.80	1178	959	914	320	3371

Table 6: Conception rate and count by type of bred animal for Observer1.

Servclass	**Conception rate**					**Count**				
	1	**2**	**3**	**4**	**Total**	**1**	**2**	**3**	**4**	**Total**
0-3	0.78	0.71	0.90	0.50	0.73	23	17	10	12	62
4-7	0.89	0.87	0.90	0.86	0.88	572	438	393	144	1547
8-14	0.82	0.63	0.74	0.91	0.75	88	83	81	33	285
15-21	0.78	0.64	0.70	0.78	0.71	45	53	37	9	144
22-28	0.84	0.75	0.80	0.86	0.81	43	24	41	7	115
28+	0.80	0.69	0.79	0.73	0.75	91	107	82	30	310
1xGilt	0.85	0.76	0.81	0.70	0.80	131	109	112	44	396
2xGilt	0.77	0.43	0.73	0.67	0.67	39	23	33	6	101
3+ Gilt	0.36	0.36	0.38	0.67	0.39	11	11	8	3	33
2xSow	0.76	0.53	0.66	0.59	0.66	114	77	104	27	322
3+ Sow	0.52	0.53	0.62	0.80	0.57	21	17	13	5	56
Total	0.84	0.75	0.81	0.79	0.80	1178	959	914	320	3371

Figure 3: Performance monitor excerpt

	SEP 02 OCT 02	NOV 02 DEC 02	JAN 03 FEB 03	MAR 03 APR 03	MAY 03 JUN 03	JUL 03 AUG 03	SEP 03 OCT 03	NOV 03 DEC 03	JAN 04 FEB 04	MAR 04 APR 04	MAY 04 JUN 04	JUL 04 AUG 04
FARROWING PERFORMANCE												
Number of sows farrowed	474	437	442	454	440	463	492	465	490	503	477	347
Ave parity of farrowed sows	3.2	3.0	3.4	3.3	3.2	3.2	3.6	3.5	3.8	3.8	3.6	3.8
Average total pigs per litter	11.1	11.6	11.6	11.5	11.5	11.1	11.4	10.7	11.1	11.1	10.8	10.7
Average pigs born alive/litter	10.0	10.6	10.5	10.4	10.4	10.0	10.1	9.8	9.9	10.1	9.9	9.7

Upon evaluation of the bornalive by genetic line for parities 1 and 2, Line A and AxB bornalive data were statistically indistinguishable. However, highly significant differences were observed in parity 1 and 2 comparisons of Line A and AxB with Ax2B, Line B and Ax2B with Line B (**Figures 4-5**).

Identification of the cause of declining bornalive allowed the farm to institute an action plan to address the issue. Specifically, replacement females were identified at birth on the basis of dam bornalive and an indexing program was implemented for performance-based culling.

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Figure 4: Parity 1 bornalive by genetic line

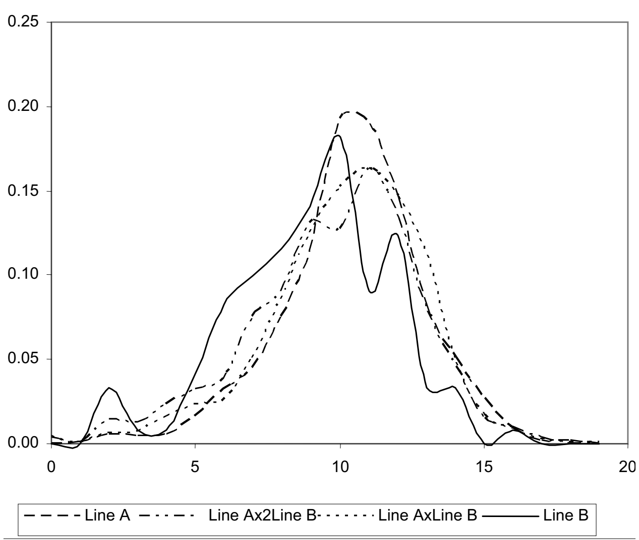

Figure 5: Parity 2 bornalive by genetic line