Assessing Economic Opportunity of Improving Mortality Rate in Breed-to-Wean Swine Production

Ag Decision Maker
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File B1-79

One of the challenges facing many sow farms is high death loss. The Pig Computerized Health and Management Program, or PigCHAMP, is a database that includes information from nearly 300 farms. PigCHAMP's website provides publicly accessible benchmark summaries which have shown an increase in sow mortality rate from 8.12% in 2012 to 14.86% in 2021.[1] In 2021, the upper 10 percentile of herds for sow mortality had an average death rate of 21.30%. On the other hand, the lower 10 percentile for sow mortality had a death rate of 7.30%. These values clearly illustrate the extremes that can be seen on individual farms for sow mortality and the potential to improve.

Improving sow mortality, and pre-wean mortality which is a secondary focus of this analysis, results in greater efficiency and producing more pigs, which can increase potential profits. In most, if not all cases, there will be some cost associated with reducing mortality rate, so producers need to weigh the costs against the potential economic benefits. Individual farms may have different methods to reduce mortality and the costs will also vary. For example, costs could include additional labor, health and management interventions, or facility improvements depending on the causes of mortality. This analysis focuses on the benefit of improving mortality on an individual operation. By knowing the benefit, one can back into indifference points to guide decision-making and help identify an optimal level of mortality for an operation at a particular point in time.

Quantifying the pig production effect and economic returns associated with improving sow mortality is complicated because of the numerous interacting factors. For example, if sow mortality decreases, do total sow numbers decrease or stay the same and are there other production implications on a particular operation? Because of the numerous factors to consider, any economic analysis will require several assumptions. The validity of these assumptions must be tested within an operation and how the model projects actual performance. A sensitivity analysis with some of these key factors is an important part of the economic analysis to help determine what factors are most important.

Method of Economic Analysis

Projected annual budgets of an operation that is in steady-state or on-going, not one that is starting up, are used to compare costs and returns for alternative sow mortality rates. Costs in the budget reflect full economic costs rather than cash flow costs. The annual budget model uses annual averages for production efficiencies and mortalities and does not account for variation that may occur during seasons (i.e., summer versus winter) or from one farrowing group to the next but does provide a basis for assessing the economic opportunity for improving mortality rate over time.

The model uses a current and improved mortality rate and other related inputs to quantify the economic effects of changes in mortality. Key inputs that affect net income changes are highlighted in this Information File. An accompanying Decision Tool spreadsheet, www.extension.iastate.edu/agdm/livestock/xls/b1-79improvingmortalitybreedtowean.xlsx, allows users to employ their own production and budget inputs to assess their individual situation. A sensitivity analysis that compares net income changes due to changes in sow mortality and pre-wean pig mortality and changing costs or prices is also an important component of the tool.

Assumptions in the Economic Analysis

Numerous assumptions were made to construct the model. The following are some of the key assumptions that impact the analysis.

- The model requires inputs for current mortality rate, litters per mated female per year and average

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sow inventory. These should be as accurate as possible and based on record information over a period of steady production.

- It is assumed that most breed-to-wean operations use breeding targets that maximize litters for the space available. However, the potential litters from sows that die between breeding and farrowing cannot be replaced. To model this loss, litters per mated female per year change by 0.637% per 1% of sow mortality change that occur after breeding and before farrowing. The 0.637% factor is based on the average change in litters per mated female per year of production simulations with different breeding and farrowing schedules, farrowing rates, and mortality rates.
- Average sow inventory is assumed not to change with mortality rate. With lower mortality rates, fewer sows may be needed to produce the same number of pigs, but it is assumed sow numbers will be based on facility size and operating at full capacity.
- It is assumed facilities and space are not limiting and are available for all gilts, sows, and farrowings.
- For simplicity, the parity of individual sow mortalities is not considered in this analysis. It is recognized that several studies have analyzed the economic benefit of sow longevity and the productivity advantages of mid-parity sows versus gilts or older sows, but it is not modeled here. Along these same lines, wean-to-finish performance of progeny by parity is not considered.
- Replacement gilt cost changes 1% for each 1% in change in total sow mortality. It is assumed sow mortalities are replaced by gilts that are ready to be bred. In other words, a supply of developed gilts is available to replace all sow mortalities. The cost input for replacement gilts should reflect the cost of developing the gilt and the additional cost of gilts in the gilt pool that do not enter the breeding herd. The inputs of culling rate and mortality rate added together determine the replacement rate in the model.
- Cull sow income changes by 1% for each 1% change in total sow mortality. It is assumed cull sow sales will increase with lower mortalities. All cull sow values are considered equal. The user can input a culling rate which is independent of mortality rate.
- The amount of feed consumed is assumed not to change as mortality rate changes. An annual feed quantity per sow is used in the budget and sow numbers are considered static.
- The selling price of a weaned pig is constant across all scenarios. In other words, it is assumed that sow mortality has no impact on progeny value.

In addition to the assumptions listed above, there are key inputs that affect incomes and costs across alternative sow mortality rates. The income changes related to sow mortalities are weaned pig income and cull sow sales.

The main inputs for weaned pig income are sow mortality rate after farrowing and before breeding, current litters per mated female per year, pigs born alive per litter, pre-wean mortality rate, and weaned pig price.

The main inputs for cull sow income are total sow mortality rate, cull sow weight, and cull sow price.

The primary cost change that occurs with changes in sow mortality rate is increased replacement gilt costs. The key inputs are the cost per head of replacement gilts, total sow mortality, and culling rate.

The number of pigs weaned per sow per year is a commonly cited measure of breeding herd productivity, and pre-wean mortality is one of its principal determinants. Pre-wean pig mortality reduces the number of pigs weaned and results in lower income as pre-wean mortality rates increase. If pigs born alive per sow increases due to changes in sow mortality rate, the pre-wean mortality rate would need to decrease to compare the same number of pigs lost due to pre-wean mortality.

Other variable and fixed costs in the budget do not change for the operation as sow or pre-wean mortality rate changes. Those cost may be different

on a per pig weaned basis in comparison as total costs are divided by different numbers of pigs.

Example Analysis

The Ag Decision Maker Decision Tool spreadsheet, www.extension.iastate.edu/agdm/livestock/xls/b1-79improvingmortalitybreedtowean.xlsx, has been developed to aid in analyzing the economic opportunity for improving mortality rate. Example inputs and outputs from the Decision Tool will be used here to show the economic opportunity of reducing sow mortality by one percentage point.

Inputs

Inputs used for this analysis were estimated from industry averages, where possible, except for the number of sows. A herd size of 2,500 sows is used. Total sow mortality of 14% is compared to 13%. The mortality percent after farrowing but before breeding is assumed to be 50% of total mortalities based on industry reports.[2] So in this example, 7% as compared to 6.5%. Pre-wean mortality is 15% for current and changed to 14.95% in the improved scenario to maintain the same number of pigs lost to pre-wean mortality.

The current litters per mated female per year is 2.20 which increases to 2.207 due to a one-half percentage point improvement in sow mortality during gestation. Pigs born alive per litter and pigs weaned per sow per year is 13.50 and 25.25, respectively, and pigs weaned per sow per year increases to 25.34 with the improvement in sow mortality. The culling rate is 45% and cull sows are assumed to weigh 450 pounds. Table 1 shows the remaining information used for the example analysis.

Table 1. Production, price, and cost inputs

Price inputs		
Weaned pig price	$58.00	per head
Cull sow price	$48.00	per cwt.
Cost of developed replacement gilt ready to breed	$375.00	per head
Variable inputs and costs		
Feed cost	$ 0.15	per lb.
Feed processing and delivery cost	$18.00	per ton
Pounds of feed	2,350	per sow per year
Labor cost	$15.00	per hour
Labor hours	7.00	per sow per year
Veterinary and health cost	$40.00	per sow per year
Semen cost, genetic fee	$30.00	per sow per year
Marketing and professional fees	$4.00	per sow per year
Utilities and fuel cost	$25.00	per sow per year
Machinery, facility and equipment repairs	$22.00	per sow per year
Other variable costs	$10.00	per sow per year
Fixed costs		
Machinery, facilities, and general overhead	$170.00	per sow per year
Taxes and insurance	$10.00	per sow per year
Legal and accounting	$11.00	per sow per year
Other fixed costs	$0.00	per sow per year

Outputs

A partial budget is divided into two sections designed to separately present important components of the analysis. Table 2 shows the current and improved sow mortality rates compared to zero mortality on a per sow per year and per operation per year basis. While it may seem unrealistic to consider operations that have zero sow mortality, these scenarios are included in the analysis for comparison purposes and to highlight the cost of mortality. It is important to keep in mind that there is an optimal level of mortality, which is not zero because the marginal benefit of reducing, or attempting to reduce, mortality below a certain point is less than the marginal cost. In other words, determining the optimal death loss is about determining the percentage of mortality at which the cost of saving additional sows is no longer offset by the added revenue those sows will bring in.

Pre-wean mortality rates for the improved scenario are adjusted so the number of pigs that die before weaning is the same and there is no difference in the current and improved scenarios due to pre-wean mortality. Table 2 also summarizes the impact of the one percentage-point change in total sow mortality from 14% to 13% and a one-half percentage point change in sow mortality from farrowing to breeding. The results are presented on an annual per sow and per operation basis.

The improvement in sow mortality results in an $11.40 per sow per year increase in net income. About 50% of the net income change is due to increased pigs weaned, 20% is additional cull sow income, and 30% is reduction in gilt replacement cost.

Table 2. Partial budget for marginal changes

	Compared to 0% mortality				Improved mortality rate compared to current rate	
Sow mortality economic impact	**Per sow per year**		**Per operation per year**		**Effect of 1% change in total sow mortality and 0.5% change in sow mortalities during gestation**	
	Current	**Improved**	**Current**	**Improved**		
Revenue change	**14% and 7%**	**13% and 6.5%**	**14% and 7%**	**13% and 6.5%**	**Per sow per year**	**Per operation per year**
Pig value (without pre-wean mortality impact)	$(76.81)	$(71.32)	$(192,027)	$(178,311)	$5.49	$13,716.20
Cull sow income	$(30.24)	$(28.08)	$(75,600)	$(70,200)	$2.16	$5,400.00
Cost change						
Replacement gilt cost	$52.50	$48.75	$131,250	$121,875	$(3.75)	$(9,375.00)
Net income change due to sow mortality	**$(159.55)**	**$(148.15)**	**$(398,877)**	**$(370,386)**	**$11.40**	**$28,491.20**
Pre-wean mortality impact	Compared to 0% pre-wean mortality				Effect of 0.048% change in pre-wean pig mortality	
Pig value	$(258.39)	$(258.39)	$(645,975)	$(645,976)	$(0.00)	$(1.01)
Net of sow and pre-wean mortality	**$(417.94)**	**$(406.54)**	**$(1,044,852)**	**$(1,016,362)**	**$11.40**	**$28,490.20**

The total cost per sow lost can also be calculated. In the example, a one percentage point change in sow mortality is equal to 25 sows. The operation income change of $28,490 divided by 25 sows is equal to $1,140 per sow lost in this example. For the purposes of this calculation, recall, the mortality percent after farrowing but before breeding is assumed to be 50%. But, if more sows die after farrowing a litter and before breeding the cost is less than if more sows die during gestation.

While a partial budget shows the marginal impact on the operation, an enterprise budget shows the impact to the bottom line. Income over variable costs and income over total costs, for example, may be more useful for a manager than net income change. Using the assumptions and production, price, and cost inputs in this example, Table 3 summarizes the full enterprise budget on an annual per sow, per pig, and per operation basis.

For this example operation, a one percentage point improvement in total sow mortality and a one-half percentage point decrease in sow mortality after farrowing and before weaning would result in a $28,490 increase in annual income over total costs. Different assumptions or inputs would change the outputs.

For this operation, sow mortality reducing strategies that would cost less than $28,490 would increase profitability of the operation assuming no other changes.

Sensitivity Analysis for Net Income per Sow

A sensitivity analysis available in the model can help determine how changing various assumptions impacts net income. The model considers differences in weaned pig price, cull sow value, and replacement gilt cost across a range of sow or pre-wean mortality rates as shown in Table 4. It is important to note that only the two variables in each sensitivity table change and all other production, price and cost inputs and assumptions are held constant at their original values used in the current scenario. The budget comparisons of the current and improved scenario may not match the net income per sow in the sensitivity tables if these other inputs are changed in the improved scenario. For the first three tables showing a range of total sow mortality, the percent sow mortality from farrowing to breeding and pre-wean mortality are 7% and 15%, respectively. For the fourth table, with farrowing-to-breed mortality, the total sow mortality is 14%.

The first three sensitivity tables consider a change in total sow mortality and changes in weaned pig price, cull sow price, and replacement gilt price. The fourth shows the effect of changing sow mortalities that occur from farrowing-to-breeding and weaned pig price. This changes the litters and number of pigs born but does not change cull sow income or replacement gilt cost, which is included in total sow mortality. Pre-wean mortality is also an important factor affecting profitability in breed-to-wean operations. A sensitivity analysis using the same inputs as the current scenario shows that a one percentage point change in pre-wean mortality, i.e., 15% to 14%, affects net income per sow by $17.23, in this example with weaned pig price at $58 per head. This net income effect increases as weaned pig price increases and vice versa.

Table 3. Annual enterprise budget for bottom line changes, summary

	Per sow		Per pig produced		Per operation	
	Current	Improved	Current	Improved	Current	Improved
Gross Income	$1,574.41	$1,582.06	$62.37	$62.43	$3,936,025	$3,955,140
Total Variable Costs	827.75	824.00	32.79	32.52	2,069,375	2,060,000
Total Fixed Costs	191.00	191.00	7.57	7.54	477,500	477,500
Total Costs	1,018.75	1,015.00	40.35	40.06	2,546,875	2,537,500
Income Over Variable Costs	746.66	758.06	29.58	29.92	1,866,650	1,895,140
Income Over Total Costs	555.66	567.06	22.01	22.38	1,389,150	1,417,640

Table 4. Sensitivity tables for annual net income per sow

		Weaned pig price				
Net income per sow		**$54.00**	**$56.00**	**$58.00**	**$60.00**	**$62.00**
Percent total sow mortality	**12.00%**	$483.87	$535.00	$586.13	$637.27	$688.40
	13.00%	$469.27	$520.09	$570.90	$621.71	$672.52
	14.00%	$454.68	$505.17	$555.66	$606.15	$656.64
	15.00%	$440.09	$490.25	$540.42	$590.59	$640.76
	16.00%	$425.49	$475.34	$525.19	$575.03	$624.88

		Cull sow price				
Net income per sow		**$44.00**	**$46.00**	**$48.00**	**$50.00**	**$52.00**
Percent total sow mortality	**12.00%**	$577.67	$581.90	$586.13	$590.36	$594.59
	13.00%	$562.62	$566.76	$570.90	$575.04	$579.18
	14.00%	$547.56	$551.61	$555.66	$559.71	$563.76
	15.00%	$532.50	$536.46	$540.42	$544.38	$548.34
	16.00%	$517.45	$521.32	$525.19	$529.06	$532.93

		Replacement price				
Net income per sow		**$355.00**	**$365.00**	**$375.00**	**$385.00**	**$395.00**
Percent total sow mortality	**12.00%**	$597.53	$591.83	$586.13	$580.43	$574.73
	13.00%	$582.50	$576.70	$570.90	$565.10	$559.30
	14.00%	$567.46	$561.56	$555.66	$549.76	$543.86
	15.00%	$552.42	$546.42	$540.42	$534.42	$528.42
	16.00%	$537.39	$531.29	$525.19	$519.09	$512.99

		Weaned pig price				
Net income per sow		**$54.00**	**$56.00**	**$58.00**	**$60.00**	**$62.00**
Percent sow mortality farrowing-to-breeding	**5.00%**	$437.31	$487.16	$537.01	$586.85	$636.70
	6.00%	$446.00	$496.16	$546.33	$596.50	$646.67
	7.00%	$454.68	$505.17	$555.66	$606.15	$656.64
	8.00%	$463.36	$514.18	$564.99	$615.80	$666.61
	9.00%	$472.05	$523.18	$574.31	$625.45	$676.58

*Total mortality is 14%.

		Weaned pig price				
Net income per sow		**$54.00**	**$56.00**	**$58.00**	**$60.00**	**$62.00**
Pre-wean mortality	**13.00%**	$486.76	$538.43	$590.11	$641.79	$693.47
	14.00%	$470.72	$521.80	$572.89	$623.97	$675.05
	15.00%	$454.68	$505.17	$555.66	$606.15	$656.64
	16.00%	$438.64	$488.54	$538.43	$588.33	$638.23
	17.00%	$422.60	$471.91	$521.21	$570.51	$619.81

The relative effect of a change in mortality rates, weaned pig price, cull sow price, and replacement gilt price in this example is summarized in Table 5.

Table 5. Relative effect of a change

Relative change	Net income per sow change
One percentage point in total sow mortality	$14.59 to $15.88
$2.00 per head in weaned pig price	$49.85 to $51.13
$2.00 per cwt in cull sow price	$3.87 to $4.23
$10 per head in replacement gilt cost	$5.70 to $6.10
One percentage point change in sow mortality from farrowing-to-breeding	$8.68 to $9.97
One percentage point change in pre-wean mortality	$16.04 to $18.41

Summary

Sow mortality and pre-wean mortality rates affect productivity and potential profit in breed-to-wean swine production. Assessing the economic opportunity of improving mortality rates is important when considering approaches and costs to accomplish pig survivability goals.

The assessment presented here provides an example of possible net income changes due to a reduction in mortality for a representative operation. It is not intended to represent any one operation, production system, or firm, which would be defined by notable variation in specific situations and managerial approaches. Users are encouraged to use this and related resources to conduct their own economic analyses with the coordinating Ag Decision Maker Decision Tool spreadsheet, www.extension.iastate.edu/agdm/livestock/xls/b1-79improvingmortalitybreedtowean.xlsx.

References and Additional Resources

[1] PigCHAMP Benchmarking summaries, www.pigchamp.com/benchmarking/benchmarking-summaries

[2] When are sows dying? Is it different in the US compared to Canada, Ron Ketchem, Mark Rix, Valerie Duttlinger, National Hog Farmer Feb 28, 2018. www.nationalhogfarmer.com/reproduction/when-are-sows-dying-it-different-us-compared-canada

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