Economics of Pig Health Improvement

Luc Dufresne, DVM
PIC

The last decades have seen great improvement in swine production. Better genetics, nutrition, flow management and building design have helped improve production efficiency and profitability. Unfortunately, disease challenges remain a major (if not the major) stumbling block on the road to stable and profitable production. When producers are presented a choice between better genetics and better health, they choose health in great majority. The choice of health over genetics is even more apparent with the development of complex production systems that are more and more challenging to control.

Through genetics and genomics, scientists are looking intensely in the area of disease resistance and robustness, and some breakthroughs occur for specific diseases (e.g., F-18 *E. coli*). However, we have long way to go before those tools are useful to improve health in the presence of infectious agents like PRRSV, *M. hyo* and SIV. We still rely heavily on populating a system with high health animals, or disease elimination strategies combined with high biosecurity standards. Unfortunately, in our mature industry, few producers are currently starting from scratch, so most health improvement programs incur direct and indirect costs that need to be recovered by increased efficiency (lower cost of production and/or increased throughput) and/or increased product value (higher premiums at slaughter house for commercial producers, or increased value of replacement animal for seedstock suppliers).

As everyone involved in swine production is aware, there is huge variation in performance in the swine industry. Health status explains only a part of those performance differences. As same-health status systems also vary in their performance, it would be naïve to believe that health improvement will have the same impact in all production schemes. Thoroughly understanding the system and adequately estimating the cost of disease in that specific system are essential to determine the feasibility of any health improvement strategy. Another important factor to consider is risk. Risks are inherent in all health improvement projects. One must consider the risk of partial or total failure of the project, OR, if the project is successful, risk of recontamination with the same agent or a new agent.

I The Profitability Equation

PROFITABILITY = THROUGHPUT X MARGIN

Where Throughput is a measure of the number of product made per unit of production and unit of time (ex: pig market/sow/year, lb sold per 1000 sows/week) and margin is the revenue made when this product is sells minus his cost of production.

That simple equation summarizes how an enterprise can make (or lose) money, manufacturing goods. An enterprise can increase profitability by either increasing throughput or increasing. Increasing margin can be achieved either by reducing cost or by increasing revenue per unit. One must understand that most of the time, each component of the equation is not independent -- it can work synergistically or antagonistically. For this reason, it is necessary to look at the impact health improvement (or any other change in production) can have on the throughput and the margin components of the equation.

<u>II Performance Benefits Associated with Health Improvement</u>

Health improvement strategies may improve the profitability of the swine enterprise by increasing both throughput (e.g., pigs sold per sow per year) and margin (e.g., reduced cost per pound marketed or increased premium per genetic animal). One important consideration is that estimation of the economic benefit must be done on the products sold. Evaluation of a health improvement strategy in a farrow-to-finish system, based only on pigs weaned per sow per year is at best incomplete, but it may also be misleading. In a farrow-to-finish system, performance parameters in the sow herd, nursery, and finisher should all be evaluated – each should be considered a cost center, and profitability is evaluated when pigs are sold to market.

Table 1: Estimated effect of different diseases on ADG, FE, and cost of production

Disease	Average Daily Gain (ADG)	Feed Efficiency (FE)	Cost
Mange	4.5 to 12% (Diseases of Swine) 8% (Wooten, 1987) 0-5.7% (Davis, 1995) 10% (Cargill, 1979)	10% (Cargill, 1979)	
Swine dysentery	10-17% (Moore, 1993)	3-10% (Moore, 1993)	$2.60-8.60/pigs (Lyson, 1983) 15$/pig (Wood, 1988) 8.28$/pig (Walter, 1990)
Enzootic pneumonia	3 to 7% (Moore, 1993) 17% (Straw, 1989)	3% (Moore, 1993) 14% (Straw 1989)	
APP	8 to 17% (Moore ,1993 0-20% (Disease of swine) 34% (Straw, 1989) 0-35% (Tubbs, 1997)	3 to 10% 26% (Straw, 1989)	Moore, 1993)
Atrophic rhinitis	3 to 9% (Moore 1993) 5-8% (Neilsen 1983) 0-13% (Diseases of Swine) 2.5 -7% (Tubbs, 1997)	3 to 6 % (Moore, 1993)	
PRRS	10-20% (Dee, 1993)		$236/Sow (Polson, 1992) $18.21/pig (Polson, 1994) $0.75-15/pig (Dee, 1993) $18/pig (Moore, 1990) $6.90-17.25/sow (Polson, 1995)
Salmonellosis	7-44% (Tubbs, 1997)	1- 22% (Tubbs, 1997)	

Estimating the economic impact of health improvement is extremely challenging. One must estimate the impact of health improvement on a performance parameter and afterward evaluate the impact of that performance parameter on the profitability of the production system. Literature is available on the estimated cost of disease, but as you can see in Table 1, there is huge variation between authors on the estimated cost of the same disease.

That confirms field observations that the impact of disease can vary greatly from farm to farm, and system to system. Relying only on improvements observed in other farms or systems (even if they come from a well-run trial published in a respected animal science or veterinary journal) remains a risky decision. A sound evaluation must combine historic data from the system involved, combined with data from literature and/or data from other very similar systems.

Once the performance improvements are estimated, one needs to evaluate the impact on the profitability of the system. To do so, one must look at the impact of those performance parameters on either throughput or margin.

Average Daily Gain (ADG): The economic impact of improved average daily gain varies greatly depending upon space availability within the system. If growing pig space is limited and time dictates when pigs are sent to market, improvement of ADG will be the most important factor to improve profitability. By selling a market pig at a heavier weight, the producer will increase throughput but also increase margin by reducing cost in spreading feeder pig costs and facility costs over more pounds sold. It is also important to evaluate the impact of heavier weight on carcass premium or discount. On the other hand, if growing pig space is not limited (fairly rare in our current industry) and pigs are sold when they reach a target weight, increasing ADG represents limited real economic benefit.

Feed Efficiency (FE): Improvement of Feed will increase margin by reducing the cost of production; it has no effect on throughput. The economic impact will vary depending on the cost of feed ingredients.

Increase in Born-Alive and Progeny Mortality: An increase in the number of born-alive or a reduction of progeny mortality will have a significant impact on both cost and throughput. Reduction of finisher mortality will have a bigger effect on cost than preweaning mortality, due to the higher marginal value of the animal. One important point to consider when we look at mortality is what happens to the surviving animal(s) -- are they market hogs or are they sold as culls? Improvement of mortality will be economically insignificant (and even detrimental in some cases) if it only increases culls and not pigs marketed. This is why more and more producers look at "marketability" (the percentage of animals sold to the primary market) rather than mortality and livability on closeout reports.

Variation: One impact of lower health and greater disease challenges is increased variation. Increased variation in a space-limited system will either extend the shipping period or force the sale of animals below target weight. This will slightly impact the throughput, but have a larger influence on the average price paid for the animal. The impact of variation increases in slaughter plant with narrow target weight range on carcasses.

Sow Mortality: Sow mortality is an important issue for animal welfare and employee morale, but the impact on production and economic performance is smaller than the factors mentioned above. The major impact of sow mortality is the loss of the cull value of the animal, and the value of the litter if the female is pregnant. Obviously, the percentage of pregnant sows dying will drastically influence the cost associated with sow mortality

Litters per Sow per Year and Farrowing Rate: Litters per sow per year (l/s/y) looks at how efficiently the sow herd is utilized, and measures non-productive days. Farrowing rate (FR) is a component of l/s/y and will react the same way. If we consider the sow inventory to be fixed, increasing l/s/y increases weekly throughput, and profitability rises due to higher throughput and lower unit costs (increased efficiency of the sow herd). If l/s/y increases but the sow inventory is adjusted to maintain a constant throughput, the impact on profitability will be much smaller, and associated with cost reduction due to a constant throughput with a lower sow inventory cost. One must be careful when trying to maximize l/s/y, especially if it is done at the expense of lactation length or gilt acclimatization – the gain in l/s/y can be more than lost in litter size and poor piglet performance.

Table 2 looks at the impact of production parameters on profitability, looking at cost and throughput using average production and cost parameters for several large systems. The assumptions are based on a system with limited finisher space (fixed market age), and breeding targets and inventory are adjusted to farrowing rate. Current cost of production is set at $38.00/cmt and market price at $40.00/cmt live weight. In that situation, as discussed earlier, improvement in ADG has a bigger impact on both cost reduction and throughput. Improvements in sow mortality and farrowing rate have a limited impact on cost and throughput.

Table 2. Influence of different production trait improvements on margin and throughput.

	margin/cmt	lb/sow/yr
.05 lb ADG (3.0%)	$0.80	150
.25 born alive/litter	$0.28	108
.05 increase in FE	$0.27	0
1% mortality wean to finish	$0.25	42.7
2% increase in coefficient of variation	$0.42	5
.05 LSY (2,0%)	$0.21	96
2.0% PWM	$0.20	73.8
5% Farrowing rate	$0.12	20
2% sow mortality (50% pregnant)	$0.12	20

III. Considerations Specific to the Production System

Before determining the benefit of health improvement in a specific system and evaluating the economic feasibility of implementation of a health improvement protocol, it is wise to do a thorough evaluation of the system to ensure the decision will consider every aspect of production:

- **Final product**: This is what the farm sells and upon which the profitability of the enterprise is based (weaned pigs, feeder pigs, market hog, lbs of pork, replacement animal, etc.).
- **Performance data:** All aspects of production involved with the project (directly or downstream) must be considered.
- **System capacity:** Where is the bottleneck in the system? Does the system's capacity allow pigs to be sold at a fixed weight, or does date of placement dictate when pigs are sent to market? That understanding is critical when evaluating the economic value of increased throughput.
- **Cost of production:** This is essential to evaluate possible benefits of a health improvement strategy. It is usually necessary to know both fixed and variable costs to evaluate the feasibility of the project.

- **Health status and history:** A complete picture of current health status with history of outbreak and disease introduction is required. That knowledge combined with historic production parameters and costs of production will be critical to estimate disease costs.
- **Pathogen characteristics and knowledge:** To eliminate a pathogen, it is necessary to understand the host, environmental characteristics pathogenesis of the agent, duration of shedding, latency, and viability of the agent in the environment. Another critical question to answer is "Do we know enough about the disease agent, pathogenesis, and epidemiology to know how to eliminate it and how to keep it out of the system?" In the presence of a fairly new disease where agent(s) knowledge is limited (e.g., PMWS) it is hard to estimate the probability of short or long term success of a health improvement strategy targeting that specific disease.
- **Facility design:** It is essential to know facility design to plan pig flows during the program and risk factors associated with system layout, facility design, and waste handling system**.** Facility design will influence downtime and the necessity to use extra facilities for the project.
- **Current and future genetic potential of output:** If a switch in genetic supplier or program (e.g., closed herd with internal replacements) is necessary to fit the new health status of the herd, it is also necessary to evaluate the effect the new genetics or genetic program will have on overall performances. The overall value of improved production performance associated with an improved health status may be reduced by utilization of animals with inferior genetic potential.

Table 3. Utilities, maintenance, taxes, depreciation, and interest costs per week per pig space

	interest rate					
$/pig place	6%	8%	10%	12%	14%	16%
$75.00	$0.28	$0.30	$0.34	$0.37	$0.41	$0.45
$100.00	$0.36	$0.39	$0.43	$0.47	$0.51	$0.55
$125.00	$0.44	$0.47	$0.52	$0.57	$0.62	$0.66
$150.00	$0.50	$0.55	$0.61	$0.67	$0.73	$0.78
$175.00	$0.58	$0.63	$0.70	$0.77	$0.83	$0.90
$200.00	$0.64	$0.71	$0.79	$0.87	$0.94	$1.02
$225.00	$0.72	$0.79	$0.88	$0.97	$1.05	$1.14
$250.00	$0.78	$0.87	$0.97	$1.07	$1.16	$1.26
$275.00	$0.86	$0.95	$1.06	$1.17	$1.27	$1.38
$300.00	$0.92	$1.03	$1.15	$1.26	$1.38	$1.49

Utilities cost $.05/pig/week, maintenance = 2% of building cost/year, taxes $1000 depreciation over 15 years. Financing of 100% of value of the facilities

- **Biosecurity assessment:** If the goal is to improve health status, one of the most critical questions to answer is, "How long can we keep that improved status?" Unfortunately, this is also one of the hardest questions to answer. To assess the risk of reintroduction of the pathogen(s) over time, a thorough assessment of biosecurity risks associated with everything that comes in and goes out of the farm is necessary. Risk of aerial spread needs to be assessed by evaluating the swine density in the area and prevailing winds. Improper biosecurity measures can be modified to reduce the risk of recontamination. Unfortunately, a farm cannot physically move, and eradication of a disease known to spread between neighboring barns without direct contact can be very risky in hog dense areas.

- **Facility costs and interest rates:** Cost of facilities and interest rates on loans to finance buildings and equipment will impact the cost of a project where depopulation and/or downtime of facilities are required. Table 3 shows the cost/week of keeping growing pig facilities empty, using different facility costs and interest rates.
- **Market Price:** Although the producer cannot influence the market price, this can have a huge effect on the cost of a health improvement strategy. High market prices will reduce the cost associated with culling sows but will increase the revenue (opportunity) lost due to disruption of flow.

IV Factors Influencing the Cost of a Health Improvement Strategy

- **Medication:** Cost associated with any antibiotic, vaccine, insecticide, disinfectant and all other products used in the process.
- **Diagnostic tests**: Cost associated with all serology, bacteriology, virology, necropsy or other diagnostic work done in the process.
- **Inventory modification:** All costs associated with changes in farm inventory or loss of throughput and revenue due to reduction of inventory below target inventory.
- **Flow disruption:** Revenues lost due to any type of flow disruption.
- **Rent of extra facilities:** All costs associated with renting or leasing extra facilities (e.g., off-site breeding project, partial depop, SEW project).
- **Personnel:** All costs associated with extra personnel hired as part of the health improvement project.
- **Downtime:** All costs added and revenue lost associated with running facilities empty.

V. Conclusion

Putting a value on health improvement is not an easy task, and one must resist generalizations to avoid creating false expectations. As production models and performance vary greatly between farms, one must understand those differences and tailor expected improvement on solid data from the farm itself, supported with literature and other farm data if available. To determine profitability, the economic value of each production parameter will be based on the production system itself to evaluate its specific impact on throughput and margin. Do not forget profitability is a dynamic equation, with interdependent production parameters that can act synergistically or antagonistically.

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P I C

Economics of Health Improvement

Luc Dufresne D.M.V.
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P I C

Introduction

- Disease challenges remain a major stumbling block on the road of stable and profitable production
- Producers will choose health over genetic potential
- Genetic and genomic science are looking intensely in the area of disease resistance and robustness

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Introduction

- Currently we rely on population of systems with high animal health or disease elimination strategy combined with high biosecurity standard
- Direct and indirect costs incurred need to be recovered by increase in efficiency and/or increased product value
- As everyone involved in swine production is aware there is huge variation on performance in the swine industry

P I C

Introduction

- Health improvement will not have the same impact in all production schemes
- To understand the economics of health in a system one must:
  - Thoroughly understand the system
  - Adequately estimate the cost of disease in that system (this is key)
  - Understand risk
    - Risk of partial or total failure of the project
    - Risk of recontamination

P I C

Plan

I. The profitability equation

II. Performance benefits associated with health improvement

III. Consideration specific to the production system

IV. Factors influencing the cost of a health improvement strategy

V. Conclusion

P I C

I. The profitability equation

PROFITABILITY = THROUGHPUT x MARGIN

- Throughput = number of products produced per unit of time or production
- Margin = revenue made on product - cost of production

I. The profitability equation

- Enterprise can increase profitability by either:
  - Increasing throughput
  - Increasing margin
    - Reducing cost
    - Increasing revenue per unit produced
- Branches of the equation are not independent and can work synergistically or antagonistically

II. Performance benefits associated with health improvement

- Evaluation of the economical benefit must be done on sold product
- Estimating the economic impact of health improvement is extremely challenging
  - One must estimate the impact of health improvement on performance parameter
  - Afterward, evaluate the impact of that performance parameter on the profitability of the production system

Estimate of effect of different diseases on ADG, FE and cost of production

Disease	Average Daily Gain (ADG)	Feed Efficiency (FE)	Cost
Mange	4.5 to 12% Disease of swine 8% Wooten 1987 0-5.7% Davis 1995 10% Cargill 1979	10% Cargill 1979	
Swine dysentery	10-17% Moore 1993	3-10% Moore 1993	$2.60-8.60/pigs Lyson 1983 15$/pig Wood 1988 8.28$/pig Walter 1990
Enzootic pneumonia	3 to 7% Moore 1993 17% Straw 1989	3% Moore 1993 14% Straw 1989	
APP	8 to 17% Moore 1993 0-20% Disease of swine 34% Straw 1989 0-35% Tubbs-1997	3 to 10% Moore 1993 26% Straw 1989	
Atrophic Rhinitis	3 to 9% Moore 1993 5-8% Neilsen 1983 0-13% Disease of swine 2.5 -7% Tubbs-1997	3 to 6 % Moore 1993	
PRRS	10-20% Dee 1993		$236/Sow Polson 1992 $18.21/pig Polson 1994 $0.75-15/pig Dee 1993 $18/pig Moore 1990 $6.90-17.25/sow Polson 1995
Salmonellosis	7-44% Tubbs-1997	1- 22% Tubbs-1997	

II. Performance benefits associated with health improvement

- Impact of disease can vary greatly from farm-to-farm and system-to-system
- Relying only on observed improvement from other farms or systems
  - Risky decision
  - Even if they come from well run trials
- A sound evaluation
  - Historical farm data evaluation from the system involved
  - Literature and/or data from other very similar system

II. Performance benefits associated with health improvement

- Once the performance improvements are estimated, then evaluate their impact on the profitability of the system
- To do so it must look at the impact of performance parameter on either throughput or margin

II. Performance benefits associated with health improvement

<u>Average Daily Gain (ADG)</u>

- Economical impact will vary depending on space availability
- If growing pig space is limited
  - ADG is the most important factor to improve profitability
  - ✍ ADG✍ ✍ Market pig weight ✍ throughput
    - ✍ Market pig weight ✍ ✍ margin
      - Amortizing feeder pig, facilities and labor cost on more pounds sold
  - It is also important to evaluate the impact on carcass premium or discount

II. Performance benefits associated with health improvement

Average Daily Gain (ADG)

- If growing pig space is not limited (fairly rare in our current industry) and pigs are sold when they reach a target weight
  - Increase in ADG represents limited economical benefit

II. Performance benefits associated with health improvement

Feed Efficiency (FE)

- ✍ margin by reducing feed cost
- No impact on throughput

II. Performance benefits associated with health improvement

- ✍ in born alive and progeny mortality
- Impact both cost and throughput
- ✍ finisher mortality ✍ effect on cost due to the higher marginal value of the animal
- Need to consider what happens to the saved animal(s)
  - Market hogs or culls
- Marketability vs viability

II. Performance benefits associated with health improvement

Variation

- Bigger impact in system with limited space
- Will either extend the shipping period or force the selling of animal below target weight
- Minimum impact on throughput but large impact on margin by ✍ revenue
- Impact ✍ as the slaughter price matrix target zone gets narrower

II. Performance benefits associated with health improvement

Sow Mortality

- Important issue for animal welfare and employee moral
- ✍ impact on technical and economical performance
- Loss of the cull value
- Loss of the litter if the animal is pregnant
  - % of pregnant sows dying will drastically influence the cost associated with sow mortality

II. Performance benefits associated with health improvement

Litters/Sow/Year and Farrowing Rate

- Measure efficiency of the sow herd
  - Farrowing rate (FR) is a component of l/s/y
- If we consider the sow inventory to be fixed
  - ✍ l/s/y ✍ weekly throughput, and profitability rises due to higher throughput and lower production costs
- If sow inventory is adjusted to maintain a constant throughput
  - ✍ l/s/y much smaller impact
  - ✍ cost due to a constant throughput with a lower sow inventory

II. Performance benefits associated with health improvement

Litters/Sow/Year and Farrowing Rate

- **Be careful when trying to maximize l/s/y**
  - **if it is done by ✍ lactation length or gilt acclimatization then the gain in l/s/y can be offset by ✍ litter size and poor piglet performance**

Influence of different production trait improvements on margin and throughput

	Margin/cwt	lb/sow/yr
.05 lb ADG (3.0%)	$0.80	150
.25 born alive/litter	$0.28	108
.05 increase in FE	$0.27	0
1% mortality wean to finish	$0.25	42.7
2% increase in coefficient of variation	$0.42	5
.05 LSY (2.0%)	$0.21	96
2.0% PWM	$0.20	73.8
5% Farrowing rate	$0.12	20
2% sow mortality (50% pregnant)	$0.12	20

III. Considerations specific to the production system

- **Final product**
- **Performance data**
- **System capacity**
- **Cost of production**
- **Health status and history**
- **Pathogen characteristics and knowledge**
- **Disease(s) knowledge and costs**

III. Considerations specific to the production system

- **Facility design**
- **Current and future genetic potential of output**
- **Biosecurity assessment**
- **Facility costs and interest rates**
- **Market prices**

Fixed cost/week/pig space

Facility cost/ pig/yr	Interest rate 6.0%	8.0%	10.0%	12.0%	14.0%	16.0%
$150.00	$0.50	$0.55	$0.61	$0.67	$0.73	$0.78
$175.00	$0.58	$0.63	$0.70	$0.77	$0.83	$0.90
$200.00	$0.64	$0.71	$0.79	$0.87	$0.94	$1.02
$225.00	$0.72	$0.79	$0.88	$0.97	$1.05	$1.14
$250.00	$0.78	$0.87	$0.97	$1.07	$1.16	$1.26
$275.00	$0.86	$0.95	$1.06	$1.17	$1.27	$1.38
$300.00	$0.92	$1.03	$1.15	$1.26	$1.38	$1.49

Utilities cost $.05/pig/week, maintenance 2% of building cost, taxes 1000, depreciation 15 years, financing 100%

IV. Factors influencing the cost of a health improvement strategy

- **Medication**
- **Diagnostic test**
- **Inventory modification**
- **Flow disruption**
- **Rent of extra facility**
- **Extra personnel**
- **Downtime**
- **Genomic**
  - **Prevalence of the suitable genotype in the population**

Example

- 2400 sow multisite
- +PRRS and M hyo
- Depop/Repop
- Financial
  - Fixed cost $3500/sow place
  - Breeding cost $243
  - Operating cost $1000/sow
  - 75% mortgage value at 7.5%

Expected performance

- Sow herd
  - born alive 0.3
  - sow mortality 2%
  - PWM 4%
  - 0.05 litter/sow/yr....
- Nursery finisher
  - mortality from wean to market of 4%
  - 10% FE
  - 20 lbs. at market
  - 1$/pig premium

Pro-forma annual income statement

	Total	Per pig/mkt	Total	Per pig/mrkt	Diff total	Diff per pig/mrkt
Revenue	$6,199,152.	$117.85	$7,275,083.	$127.63	$1,075,930	$9.78
Variable cost	$4,275,480.	$81.28	$4,380,926	$76.86	$105,445.	($4.42)
Contr margin	$1,923,672.	$36.57	$2,894,157	$50.78	$970,484	$14.20
Fixed costs	$1,277,731	$24.29	$1,279,618	$22.45	$1,887.52	($1.84)
Total cost	$5,553,211	$105.57	$5,660,544	$99.31	$107,333	($6.26)
Net income	$645,940	$12.28	$1,614,538	$28.33	$968,597	$16.04

Eradication cost & return on investment

	4 wk down time + Breeding project	20 wk downtime
Genetic cost	$122,505.00	$122,505.00
Lease facility	$70,000.00	$0.00
Fixed cost week	$24,571.76	$24,571.76
Profit lost/week	$12,421.94	$12,421.94
Week empty	4.00	20.00
Cost of project	$384,387.70	$1,081,918.50
Excess benefit/wk	$18,626.87	$18,626.87
# of wk to break even	20.64	58.08
ROI after one year	252%	90%

Conclusion

- Putting a value on health improvement is not an easy task
  - Resist generalizations
  - Avoid creating false expectations
- Production models and performance vary greatly between farms
  - Understand those differences
  - Tailor expected improvement on solid data
    - From the farm itself
    - Supported with literature and other farm data if available

Conclusion

- To determine profitability
  - Economic value of production parameter will be based on the production system itself
  - Evaluate their specific impact on throughput and margin
  - Do not forget profitability is a dynamic equation
    - Interdependent production parameters that can act synergistically or antagonistically