

# Financial Evaluation of Disease Eradication

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## ■ Introduction

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 as a major stumbling block on the road to stable and profitable production. SEW and Multi-site production have been bastardized to improve system efficiencies but have failed to eliminate disease. Faced with chronic health problems that cripple their efficiency, many producers look at disease eradication as an option to improve profitability of their enterprise.

All eradication programs incur direct and indirect costs that need to be recovered by increased efficiency; (lower cost of production and/or increased through-put) and/or increased product value (better premium at slaughter house or increased value of replacement animal). Another important factor to evaluate is risk. Risk is an inherent part of an eradication project. Risk of partial or total failure of the eradication project; or if the project is successful, risk of recontamination with the same agent or a new agent. Eradication projects often create major shifts in the age of the population that can also trigger new health problems.

In swine production, the decision to eradicate a disease needs to be evaluated not only from a health aspect, but also as a business decision, looking at return on investment which encompasses a thorough risk assessment.

## ■ Information Needed before Starting an Eradication Project

Before starting to evaluate the feasibility of an eradication project, it is wise to do a thorough evaluation of the system to insure that the decision will consider every aspect of production:

- **Final product:** This is what the farm sells and on which the profitability of the enterprise is based; (weaned pigs, feeder pigs, market pigs, lbs of pork, Replacement animals etc).
- **Performance data:** Evaluation of all aspects of production involved with the project directly or downstream.
- **Facility design:** Essential to know for the pig flow planning during the program. It is important to assess risk factors associated with system layout, facility design, and waste handling system. Facility design will influence down time and whether there is necessity to use extra facilities for the project.
- **Cost of production:** Essential to evaluate the possible benefit of an eradication program. Both fixed and variable costs are usually necessary to know in order to evaluate the feasibility of an eradication project.
- **Disease knowledge:** Do we know enough about the disease agents, pathogenesis, and epidemiology in order to eradicate the disease? Do we understand transmission and biosecurity issues in order to prevent reinfection? In the presence of new disease, where the agent(s) are fairly unknown, it is hard to establish the probability of short or long-term success of the eradication project.
- **Disease cost:** Essential to evaluate the possible benefit of an eradication program. Literature is available on estimated cost of disease. But as you see in Table 1, there is a wide variation in the estimate cost for each disease. A sound evaluation combining historical farm data with a literature review is ideal. In cases of discrepancy between the two, one should favour the least cost. One should be able to economically justify an eradication program with a conservative estimation of disease cost.

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

Disease	ADG	Feed Efficiency	Cost
Mange	4.5 to 12% 8% 0-5.7% 10%	a b c d	10% d
Swine dysentery	10-17%	e	3-10% e \$2.60-8-60/pig f \$15/pig g \$8.28/pig h
Enzootic pneumonia	3 to 7% 17%	e i	3% e 14% i
APP	8 to 17% 0-20% 34% 0-35%	e a i j	3 to 10% e 26% i
Atrophic Rhinitis	3 to 9% 5-8% 0-13% -2.5 -7%	e k a j	3 to 6 % e
PRRS	10-20%	n	\$236/Sow m \$18.21/pig m \$7.5-15/pig n \$18/pig o 6.90/17.25/sow m
Salmonellosis	7-44%	j	1 – 22% j

Source:

a – Cargill & Davies, 1999      f – Lysons, 1983      k – Neilsen, 1983  
 b – Wooten, 1987                  g – Wood, 1988      m – Polson, 1992  
 c – Davies, 1995                  h – Walter, 1990      n – Dee, 1993  
 d – Cargill & Dobson 1999      i – Straw, 1989      o – Moore, 1990  
 e – Moore, 1993                  j – Tubbs, 1997

- Survivability of the agent in the environment:** A program combining washing, disinfection, and down time of the premise needs to be developed specifically to the disease(s) you want to eradicate. Some facility designs and waste handling systems can make the success of the program harder to realize (ex; rotation of farrowing house for TGE, open flush gutter for

swine dysentery). The time of the year will usually play an important role as microorganism survivability outside the host is influenced by temperature and humidity.

- **Source of animals negative for the disease:** A key point before doing a project is to know if replacement animals will be available with a health status compatible to the new improved health of the herd. If a switch in genetic supplier or program (ex: closed herd with internal replacement) is necessary to fit the new health status of the herd, it is also necessary to evaluate the effect that the new genetics, or genetic program will have on overall performances. Example: An improved health status will reduce abortion rates and preweaning mortality; but it will require you to use F2 females instead of F1. This will cause a reduction of born alive that will contribute negatively to the performance of the farm. Be sure pro and cons are carefully evaluated.
- **Biosecurity assessment:** One of the most critical questions to answer, is how long can we keep the eradicated disease out of the herd. Unfortunately, it is also one of the hardest to answer. In order to assess the risk of reintroduction over time into the herd, a thorough assessment of biosecurity risk associated with everything that is introduced into the farm and leaves the farm should be done (Figure 1). Risk of aerial spread needs to be assessed by evaluating the swine density in the area, and prevailing wind. Improper biosecurity measures can be modified to reduce the risk of recontamination. Unfortunately, farms cannot be moved, and eradication of diseases known to spread between neighbouring barns without direct contact can be very risky in hog dense area.
- **What is the threshold to apply or decline protocol:** Unless it is a mandatory program; (PRV in the USA), a decision to eradicate/eliminate a disease is essentially an economical one. The economic decision is based on the ability of the project to reduce the cost of production, to increase value (antibiotic free niche market, genetic supplier) or to maintain sale of the product (genetic supplier). Eradication of disease needs to be a decision that is cost effective. The decision will usually be based on a return on investment or on time to break even; integrating cost, benefit, and the risk associated with the protocol. Acceptable return needs to be established and accepted by the owners/decision makers of the enterprise. Tools like a decision tree can be used to integrate risk and probability to standardize the decision process.

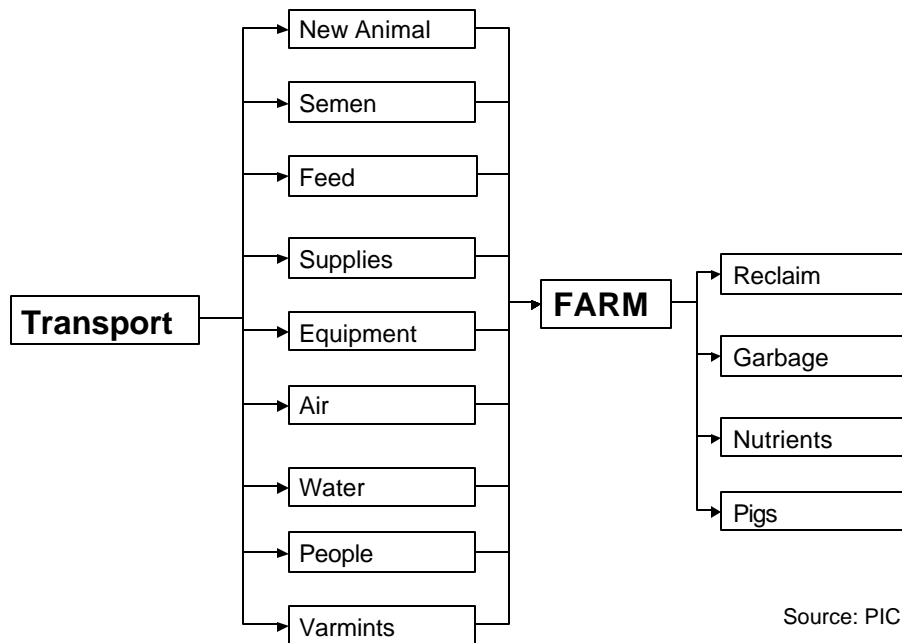


Figure 1. Farm biosecurity – Potential portal of entry for disease.

## ■ Factors Influencing the Cost of an Eradication Program

- **Medication:** Costs associated with any antibiotic, vaccine, insecticide, disinfectant, and all other products used in the process of disease eradication.
- **Diagnostic test:** Costs associated with all serology, bacteriology, virology, necropsy, or other diagnostic work done in the process of disease eradication.
- **Inventory modification:** All costs associated with increased farm inventory, or loss of throughput and revenue due to reduction of inventory below target levels in the process of disease eradication.
- **Flow disruption:** Revenue losses due to any type of flow disruption (sell/cull of animals) during the process of a disease eradication.

- **Rent of extra facility:** All costs associated with renting or leasing extra facilities in the process of disease eradication (off- site breeding project, partial depop, SEW project).
- **Personnel:** All costs associated with extra personnel hired in the process of disease eradication.
- **Down time:** All costs added and revenue lost associated with running a facility empty in the process of disease eradication.

### ■ **Benefits associated with Eradication Program**

Disease eradication can improve the profitability of the enterprise by improving sow herd performance (pigs/sow/year), and growing pig performance (Average daily gain, feed efficiency, mortality, and culling rate). Improvement of performance will improve profitability by reducing production costs and increase throughput (pounds produced).

Profitability can also be improved by increasing the premium on the final product. Slaughter may pay a premium for healthier pork, or pigs free of some specific disease or pigs raised without any antibiotic. For genetic companies, the presence of healthy pigs can represent a competitive advantage that allows a better selling price, or remaining in business.

Evaluation of the economic benefit must be done on the final product. Evaluation of an eradication program in a farrow to finish system that measures pigs weaned per sow year only, is at best, incomplete and possibly misleading. In a farrow to finish system, sow herd, nursery, and finisher performance should all be evaluated and considered as cost centers, and profitability is evaluated when pigs are sold to market.

### ■ **Other Factors to Consider**

**Market Price:** Although the producer can not influence the market price, it has a huge effect on the cost of an eradication program. High market price will reduce the cost associated with culling sows, but will increase the revenue lost or opportunity lost due to disruption of flow.

**Facility cost and interest rate:** Cost of facilities and the interest rate on loans to finance buildings and equipment have a huge effect on the cost of an eradication project where depopulation and/or downtime of facilities are required. Table 2 shows the cost/week of keeping a growing pig facility down for different facility costs and interest rates.

**Table 2. Utilities, maintenance, taxes, depreciation, interest cost per week per pig space<sup>1</sup>**

Facility Cost per pig space	Interest Rate					
	6.0%	8.0%	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

<sup>1</sup> 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

## ■ Eradication Technique

### Medication elimination

#### *Technique*

Utilization of a specific chemotherapeutic agent to eliminate the disease from a specific population.

#### *Pathogen*

This technique has been widely used for the Eradication of Swine Dysentery and Mange. Medication of the entire herd using various antibiotics (Carbadox, Nitromidazoles, Lincomycin and Tiamulin) has been shown to be highly efficacious to eliminate Swine dysentery. *Sarcoptes scabiei* var. *suis* can also be easily eliminated in a swine population by whole herd treatment with certain avermectins.

### ***Economic impact***

A medication elimination protocol is fairly easy to evaluate because the main cost incurred is the treatment cost (direct and indirect). The only other estimation of direct and indirect cost is associated with the disease itself, and measures used to control it. Using a standard partial budget spreadsheet with sensitivity analysis, you can compare performance and production cost before and after the eradication program. In my past experience, I have never encountered a situation where it was not highly profitable to use medication to eradicate these diseases. The protocols have been proven highly efficacious and have paid for themselves in less than a year, even in low challenge situation, just by eliminating costly preventive medication. Replacement animals free of these diseases are easily available, which helps justify the decision. This is why these diseases are now rarely seen in North America.

### ***Comment***

Although this technique functions very well for Mange and Swine dysentery, the results are less consistent for App and M hyo. Medication will reduce clinical appearance but rarely will medication alone eradicate these diseases from a specific population. Combination with other techniques is necessary to effectively eliminate these pathogens from a population.

## **Elimination by Vaccination/Exposure and herd closure**

### ***Technique***

Using vaccine/field virus exposure to the entire population to insure the development of an effective immunity within the entire population. Following exposure, the agent is eliminated through the use of all in/all out pig flow. Thorough cleaning and disinfecting of facilities, and temporarily closing the herd to breeding stock introduction is an important step in this technique.

### ***Pathogen***

The technique has been used and proven efficacious mainly for TGE eradication. The same technique has been used for PRV and PRRS. However, the latency of Pseudorabies virus, and the uncertainty of persistence of PRRS virus leaves some risk on the success rate of this technique alone to eradicate the disease from a population; especially a sow population.

### ***Economic***

The cost and revenue losses encountered for this eradication program are mostly associated with the disruption in flow and inventory. In the case of TGE, where the infection is acute and you can use infected pigs for feedback exposure, the cost of these pigs can hardly be evaluated because they would have most likely died of the disease anyway. In the case of the endemic infection, the preferred way is to use negative pigs that you infect and euthanize the day after. In these cases, 1 piglet per 50 sows has been used for an exposure ratio with high success of infecting 100% of the animals in the target population. The cost associated with the disruption in replacements can be greatly reduced if animals of different ages can be introduced into the farm before herd closure, and control the infection to insure availability of gilts for the duration of the program. Cost of replacement animals should be adjusted considering the extra costs encountered to rear, feed, and select these animals. This technique has been used successfully to eradicate PRRS with field virus exposure or modified live vaccine, but failures also occur using the same technique and it is hard to evaluate the actual success rate of both protocols. In the case of PRRS, questions remain on how long the herd should stay closed and how to evaluate success.

### ***Comment***

The protocol has a much higher chance to be successful in farrow to wean than farrow to feeder or farrow to finish herds. In these cases, vaccination of the growing animal and or partial depopulation is necessary to insure the elimination of the virus from the growing population. This will present the major cost of the eradication program. This cost can fluctuate according to the duration of the depopulation and the value of the opportunity lost (profit on sale of wean/feeder pig Vs profit on finish product).

## **Elimination by Test & Removal**

### ***Technique***

Using one or a combination of diagnostic tests to eliminate positive animals from the herd. The technique can be combined with vaccination (PRV) or medication (App) and herd closure (PRRS) to reduce the risk of transmission to susceptible animals within the population.

### ***Pathogen***

This technique has been used in combination with PRV GP1 vaccination to very successfully eradicate Pseudorabies from sow herds. App has been eradicated from sow herds by freezing sow infection using antibiotic treatment and then removing all seropositive animals. Test and removal has been used successfully to eliminate PRRS in positive stable herds.

***Economic***

This program will increase cost associated with increased diagnostics, increased usage of medication/vaccination and higher replacement rates. This program can also significantly reduce through-put if productive animals (gestating/lactating) are removed immediately, especially if prevalence is high. Also, high replacement rates will distort the parity distribution of the herd that can cause apparition of disease that was otherwise subclinical in the herd (Greasy pig disease, Glasser disease, etc.).

***Comment***

Test and removal is the ideal program for elimination of a disease in a stable herd with low prevalence. High prevalence of disease increases the risk of failure of the eradication program. PRV; however, has been successfully eliminated from one herd where the prevalence was above 90% using this technique. The drastic change of parity without total depopulation has caused performance to decrease below the pre-eradication standard for more than a year.

**Elimination of disease by using Medicated Early Weaning*****Technique***

Using a combination of medication, vaccination, weaning at an early age, and movement of the weaned animal to another site to eradicate disease.

***Pathogen***

The technique can be used to eradicate diseases that can be transmitted horizontally or vertically. MEW of vertically transmitted disease can be achieved if the offspring is not exposed/infected in-utero or through the birth canal, and if the level of shedding of the sow is low and can be frozen using strategic vaccination or medication.

***Economic cost***

Most MEW eradication projects are temporarily established to eliminate specific diseases. In such, the cost is mostly associated with rental of extra facilities (nursery, finisher), medication cost, and testing cost to insure the success in each batch produced. Higher production cost is also incurred by higher feeding cost for the MEW piglets, and production losses with early weaning of the female.

### ***Comment***

MEW and SEW programs have been bastardized by many production systems and fall short of expectations. However, if applied properly, the program is very efficacious in eliminating multiple diseases at the same time. One important consideration is that the program is not efficacious 100% of the time and some batches of production will fail. Testing protocols need to be in place to accurately test every batch to insure success of the eradication project. At the same time, the production system needs to be flexible enough to discard the infected batch. This is why this technique is not often seen as a long-term strategy to produce pigs free of disease, but as a means to get healthier replacement animals to do a repopulation project.

### **Partial depopulation**

#### ***Technique***

Movement of animals out of the nursery and/or finisher in order to create a disruption in the flow of growing animals.

#### ***Pathogen***

This technique can apply to any pathogen. An important point to always remember is that the source of animals needs to be free of the targeted disease, or producing pigs free of the disease 100% of the time.

#### ***Economic***

The cost and lost revenues encountered with this technique are associated with the downtime of facilities, through-put reduction, and opportunity losses associated with the sale of product before optimal values. If ownership of the pig is retained, the system needs to lease extra facilities to finish the animal.

#### ***Comments***

Although the technique applies to any disease, the main drawback is being able to insure that the source of animals is free of the targeted disease. Very often, systems do partial depopulation in nurseries for PRRS or TGE without insuring that the source is free of the disease. Improvement of performance can be seen with partial depopulation by elimination of the non-specific pathogen load of the environment. The recontamination with the specific pathogen is often immediate and the improvement of performance is of short duration.

## **Depopulation/Repopulation**

### ***Technique***

Eradication technique where the breeding herd is completely culled, the facility entirely washed and disinfected, and left empty for a various length of time. The facility is then repopulated with animals free of specific diseases to increase the health of the herd.

### ***Pathogen***

This technique works well to eliminate most pathogens except for those that are difficult to eliminate even with disinfection and down time; (Ex: roundworm), or diseases where it is hard to determine the carrier status of the new herd; (ex: PMWS, Ileitis).

### ***Economic***

Depop/Repop is the most effective, but also the most costly technique of eradication mainly due to replacement cost, and cost of facilities that sit empty creating a loss of profit during each week of downtime. Cost and profit loss associated with down time are substantial. This is why facilities are leased to do a breeding project where animals are bred at the same time that the farm is to depopulate. By doing so, the down time can be moved from 20 to 23 weeks to 3 to 4 weeks. It is also why eradication by depop/repop is more difficult to justify in farrow to finish herds where the facility sits for a year without any revenue and added cost accumulates to maintain the new breeding herd, nursery and finisher inventory.

### ***Comments***

Depop/Repop remains the technique of choice when multiple diseases need to be eliminated from the herd at the same time. The technique applies very well to multi-site production, where in combination with an offsite breeding project, losses of through-put are minimized.

## ■ Example

2400 sow herd in multi-site production and positive for PRRS and *Mycoplasma hyopneumoniae* wants to look at the feasibility of an eradication project by Depopulation/Repopulation to eliminate both diseases.

### Expected performance improvement

#### *Sow herd:*

- Reduction of born alive 0.3 due to change from mature herd to gilt herd.
- Reduction of 2% in sow mortality
- Reduction of 4% in preweaning mortality
- Improvement of .05 litter/sow/year

#### *Nursery finisher*

- Reduction of 4% in mortality from weaning to market
- Improvement of 10% in the feed efficiency
- Increase of 20 lbs. at market
- Increase of \$1/pig on carcass premium

#### *Financing*

- Building and equipment cost :\$3,500/sow place
- Breeding cost :\$243/sow place
- Operating cost: \$1000/sow place
- Mortgage on 75% of total value of project at an interest rate of 7.5%

Tables 3 and 4 show the details of the proforma and return on investment for a project doing a 4 week down time with an offsite breeding project or a 20 week downtime without an offsite breeding project. For sake of simplicity a detail cash flow was not added to the simulation.

Using these parameters, the enterprise after the repopulation would show an improvement of revenue of \$968,597.40 or \$16.04/ pig marketed over the actual situation. When the cost associated with the purchase and culling of animals, leased facility (off site breeding project), total down time cost, and profit losses; the cost of the eradication project amounts to \$384,387.70 for the 4 weeks downtime and \$1,081,918.50 for the 20 weeks downtime. Considering the improvement of performance it would take 20 weeks to break even for the 4 weeks downtime, and 58 weeks to recuperate the lost value for the 20 weeks downtime.





**Table 4. Evaluation of eradication cost and return on investment.**

	<b>4 week depop with off site breeding project</b>	<b>20 week depop with no breeding project</b>
Excess genetic cost	\$122,505.00	\$122,505.00
lease facility/project	\$70,000.00	\$0.00
fixed cost week	\$24,571.76	\$24,571.76
variable cost still incur during depop	\$10,976.98	\$10,976.98
profit lost /week	\$12,421.94	\$12,421.94
total cost & lost profit/week	\$47,970.67	\$47,970.67
number week empty	4.00	20.00
cost of project	\$384,387.70	\$1,081,918.50
excess benefit per week	\$18,626.87	\$18,626.87
number of week to breakeven	20.64	58.08
ROI after one year	252%	90%

If the owner put a 300% ROI as the cut off to implement the project, it would take 1 year and 2 months to reach it for the 4 weeks downtime, and over 3 years and 4months for the 20 weeks downtime. One needs to evaluate the likelihood of maintaining the health status for at least that amount of time. Now with all the information one can properly advise the producer if the decision makes sense, and what approach is more likely to succeed. In this case, the extra cost of the breeding project will easily compensate for the reduction of downtime cost and lost revenue.

## ■ Conclusion

The decision to eradicate specific diseases is one of the most important that a producer will make. Eradication programs demand sacrifice and commitment from everybody involved in the project. It is expensive and has a constant risk of failure. Some eradication programs; although offering improvements in health and performance, are not ideal and can be harmful for the viability of some producers.

These decisions are too important to be taken without a deep understanding of the disease situation and a deep knowledge of the system itself. Eradication programs need to be carefully analyzed and planned to be sure that one applies the technique that will be the best fit to improve health and profitability in that specific system. If done properly and successfully, the eradication project will improve not only technical and economical performance but employee morale and animal welfare.

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