Evaluación económica de programas de control *vs* erradicación de enfermedades porcinas.

Evaluation of the Control *vs* Eradication of Endemic Diseases of Swine

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It is widely recognized that a large variation in productivity and profitability exists between farms in a country, and similarly, between countries in a global economy. Some profitability variables are due to cost of inputs and management and these are controllable by producers; other factors are not so easily predicted or controlled, for example:

65% of income variation is estimated to be due to

- Feed conversion,
- growth rate,
- mortality rate of the pigs on a farm

Pig diseases cause unpredictable financial losses and so cause anxiety to producers and their bankers. Pathogens have a unique ability to adapt to production systems. Farrow to finish single site barns developed endemic diseases that settled into nursery and finishing pigs and remained there. As we developed multisite systems with all-in-all out flow to control endemic disease, other problems such as PRRS and PCVAD adapted methods to move from sow barns into nurseries and continue to cause losses. Disease will continue to evolve to match production styles.

This paper will discuss diseases that are susceptible to eradication and try to provide a comparison of the cost of control vs complete eradication. Discussion will be limited to specific diseases and will discuss methods and their comparative costs.

Cost of Key diseases:

Enzootic (mycoplasma) Pneumonia

- A loss of 34gm/day (5%) for every 10% lung involvement
- A gain of 24gm/day Minimal disease pigs vs. conventional pigs

Batch	Feed conv.	ADG	Mycoplasma Serology
Fill 3	2.8	930 gm/d	neg
Fill 4	2.65	920 gm/d	Neg
Fill 5	2.77	920 gm/d	Neg
Fill 6	2.65	950 gm/d	Neg
Fill 7	2.8	920 gm/d	Pos
Fill 8	2.78	890gm/d	Pos
Fill 9	2.82	850gm/d	Pos
Fill 10	3.08	880gm/d	Pos

The economic impact of *Mycoplasma hyopneumoniae* needs to be considered whenever control measures are considered. Disease is a major determinant of profitability of pig farms. Caution is needed when extrapolating the impact of disease from research to a farm situation. Tremendous variation exists in management style, virulence of pathogen and coinfections so that losses reported in the literature may not match a given farm. Losses increase when mixed infections occur. Viral disease such as PRRS, and Swine Influenza appear to make mycoplasma infections more difficult to control. Pigs with lesions of *Mycoplasma hyopneumoniae* and Atrophic rhinitis grew 17% slower, indicating disease effects may accumulate.

Transmissable GastroEnteritis

- $1.50 (US) per pig sold

Actinobacillus Pleuropneumoniae

- 12 days growth loss, 3 % mortality rate

PRRS

Studies	Breeding Barn	Nursery	Finishing Barn
Polson *et al.* (1992)	236 US$/sow		
Polson *et al.* (1994)		0,7 to 18 US$/pig	
Dee *et al.* (1997)	228 US$/sow		
Neuman *et al.* (2005)	74 US$/litter	6 US$/pig	8 US$/pig
Kliebenstein (2004)	52-189 US$/litter	3-11 US$/pig	6-15 US$/pig
Holck and Polson (2003)	255 US$/sow		6-15 US$/pig
Cardinal (2004)			8-19 CA$/pig
Châtillon (2004)	157-386 CA$/sow/year		
Yeske (2003)	41 US$/sow	2,19 US $/pig	8,75 US$/pig

Mange

- 10 % growth and feed conversion loss
- equipment damage
- secondary disease – Greasy pig disease – immunosuppression

Swine Dysentery

- 7.44$/pig
- pig losses +/- medication cost

Control Options

Management

The diseases can be managed quite successfully simply through management. The severity of most diseases are dose dependent, thus if the initial dose exposure to the agent is low, the pigs may not be severely affected. Herds with batch flow production methods and disciplined pig flow can have good production parameters without any specific control measures. The management practices that minimize risk of disease problems include:

- group production with all-in all-out flow of pigs,
- control of secondary bacterial or viral infections,
- finishing pigs raised away from the sow herd, and
- stable sow age structure and immunity.

If a farm's production parameters are good with a pathogen present, the room for improvement with eradication may not be great. Most diseases have a management component.

Treatment

Bacterial diseases are generally sensitive to the choices of therapies we have -assuming we make the correct diagnosis. Testing coupled with bacterial sensitivity analysis, gives the treatment of affected farms some measure of disease control. Treatment efficacy in most cases is dependant on management, if workers are trained to spot and treat disease early, good control can be achieved. Much treatment failure is a human problem with training, motivation, or lack of adequate labour to blame. Bacteria develop resistance to antibiotics, so antibiotic use for long-term control may fail. Consumers, due to the potential to pass antibiotic resistance to human pathogens, view routine antibiotic use in livestock negatively. There will be increasing pressure for us to limit antimicrobial use; as the global economy grows, that pressure will be international.

For viral disease control, medication is limited to treating secondary infections; little can be done for the primary viral infections.

Vaccination

Mycoplasmosis

Vaccination for *Mycoplasma hyopneumoniae* has been available since the early 1990's. The consensus appears that vaccination can limit the financial losses due to the infection. Transmission of the pathogen still occurs, but clinical signs and lesions are reduced, and production parameters can improve. Feeder pigs need to be vaccinated, the extra handling increases labour costs significantly and creates the risk of broken needles remaining in meat products. Broken needles are becoming a significant concern for the pork industry. It is essential for a vaccination program to be effective that *Mycoplasma hyopneumonaie* is the major cause of the production loss, in cases where other secondary infections are involved, immunization for mycoplasma only may not be of help.

Key points for a successful vaccination program are as follows:

- The financial losses experienced by the farm are caused by *Mycoplasma hyopneumoniae*. Many cases of Porcine Respiratory Disease Complex are caused by multiple agents. PRRS virus, Influenza virus, *Pasteurella Multicida*, *Strep suis* all can be a part of an airway disease of swine. Prophylactic measures need to aim at the correct pathogen. Adequate diagnostics are needed. In most cases, mycoplasmosis is a chronic disease that impairs airway function, allowing the other agents to be the secondary invaders.
- A useful way to determine the effectiveness of a vaccination program, is to conduct a farm trial. It is important to vaccinate a whole room or barn and measure the effect on subgroup of pigs. Farm trials can generate the data needed to construct a proper financial analysis of vaccination effectiveness.
- Vaccination can reduce mortality, improve growth rate and reduce feed required. All factors need to be measured to determine the financial value of the program
- Slaughter data can be a useful method to monitor the presence of and the level of activity, it has become a routine monitoring tool, as it can be easily automated and implemented in a slaughter house.
- Vaccination can also be used to eradicate Mycoplasma in a targeted program. In a recent case, in our area, eradication of Mycoplasma was achieved by the following process:
    - A single site 200 sow herd conventional health status herd (mycoplasma positive) changed to:
    - Feeder pigs raised offsite from 20 kg to market
    - Incoming replacement gilts were from a negative Mycoplasma herd, but were vaccinated before entry into the sow herd.
    - After 3 years of the above process, the feeder pigs are seronegative, and sows are seronegative. The herd is now functioning as a Mycoplasma negative herd.

  Off site finishing of pigs reduces the challenge and the *Mycoplasma hyopneumoniae* may die out as in an eradication program. Access to Mycoplasma negative replacement gilts is essential.

PRRS vaccination

The PRRS virus is a highly mutable virus that to date evades effective vaccination. Modified live vaccines are required that infect pigs with an attenuated infection that can spread to non-vaccinated pigs. Immunity appears to be strain specific, and losses have been associated following vaccination. PRRS remains the primary disease of concern in North America, despite vaccine being available since 1995. Current enthusiasm in North America appears to focus on farm and regional eradication efforts.

Actinobacillus Pleuropneumoniae vaccination

Vaccination for APP appears to be strain specific, commercial vaccines may or may not work depending on the homology between farm and vaccine strain. Autogenous vaccination has given good control, but is dependant on motivation among the staff to give consistent control.

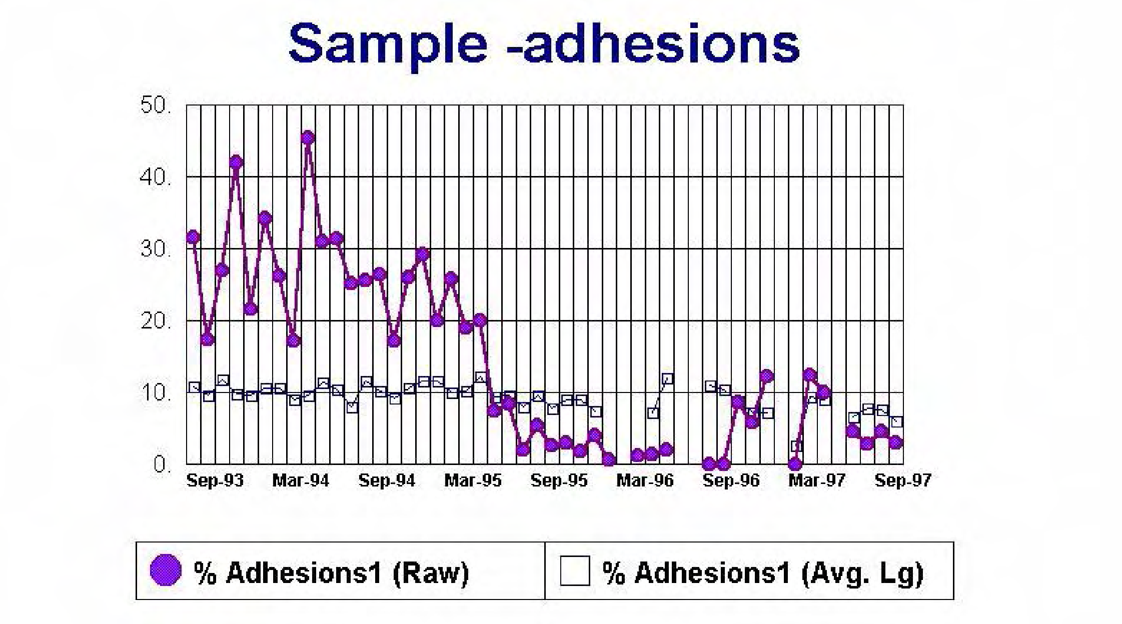

Figure 1 Autogenous APP vaccination that gave excellent control once implemented, poor vaccine complience resulted in an increase in lesions

Eradication

Eradication of the pathogens is the ultimate disease control strategy, for without the pathogen, the clinical signs, lesion and production loss disappears. A full farm depopulation and replacement with disease negative gilts can occur and offers a significant improvement in productivity. The added benefits of such a procedure is that a complete upgrade of genotype is possible, meaning the producer can see significant genetic improvement as well. If high health replacement animals are purchased, many of the secondary diseases may also be removed.

This makes whole farm depopulation and repopulation very attractive to units that have a significant disease burden and unimproved genetics. Generally, the procedure is expensive because cash flow is interrupted. An accelerated program where clean gilts are bred on one site and contaminated pigs are moved to another site while cleaning the home barn, can significantly limit the time with no production.

Simple economic models do not do justice to a full depopulation-repopulation because the following intangibles are difficult to value well:

- Value of new genetics with improvement in meat quality and productivity. Disease can have a significant impact on muscling depth and carcass quality.
- Improvement in worker morale, and motivation. Dealing with disease and dead pigs can deplete worker enthusiasm and leads to a cascade leading to management problems.
- Most diseases are additive in losses, and removal of multiple pathogens leads to improvements well beyond those predicted by literature data

The most common comment from producers following a depop-repop for chronically infected farms….”if I had known the benefits…I would have done the procedure much sooner”

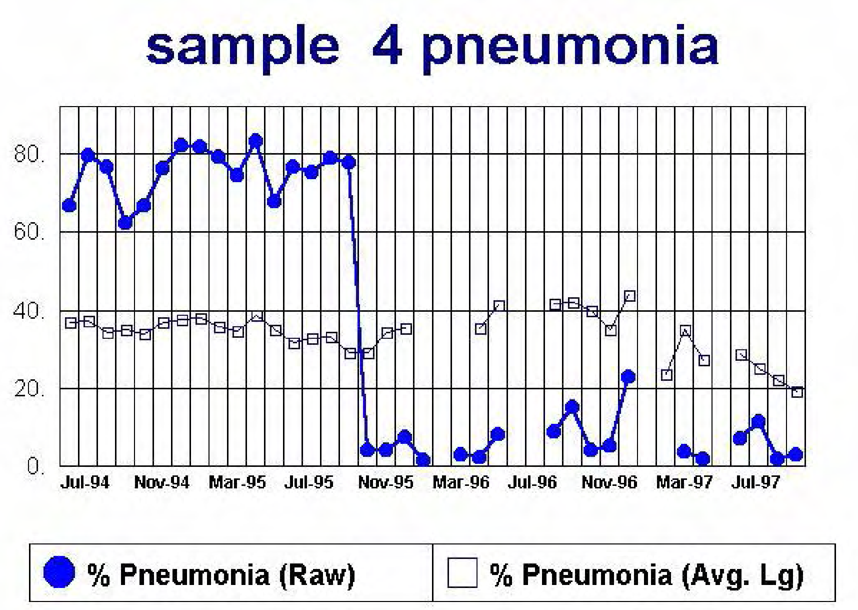

Figure 2 Many producers have chosen to eradicate *Mycoplasma hyopneumoniae* as it provides a permanent control strategy. This graph of lesions at slaughter shows that a farm can eliminate lesions and losses if the pathogen in removed.

Eradication without depopulation

Mycoplasma
In the 1990, Zimmerman reported the eradication is possible without depopulating the whole herd. This has become known as the Swiss method of mycoplasma eradication. The program has been used in Europe extensively to control Mycoplasma hyopneumoniae infection in both commercial and breeding herds. The basis of the program is as follows:

- All young animals (weaners, growers, finishers) are removed from the infected herd
- Only Breeding animals **older than 10 months** remain in the herd
- There is no farrowing allowed for 14 days
- During the 14 days the whole herd is medicated with Tiamulin (120ppm)
- During the 14 days, the whole barn is cleaned and disinfected

This program is believed to work because older breeding stock that does not shed the pathogen, and piglets born in the herd after the 14 day window will not pickup the pathogen. If the program is successful, these piglets when they grow up will not carry *Mycoplasma hyopneumoniae* nor will they be seropositive for the agent.

Using this method in small herds in Norway and Switzerland, the success rate appears to approach 100% [12]. In Denmark modifications have been made where farrowing has not been interrupted and instead the piglets were injected with Tiamulin. As well the age limit was lowered to 8-9 months in some cases. Their estimated success rate under field conditions appears to be 80-90%[12]. Other diseases such as mange and swine dysentery can also be eliminated if medication is strategically applied during the eradication.

We have used the method in several herds where Mycoplasma hyopneumoniae appeared and no other diseases were present. These herds wanted to sell Mycoplasma negative animals and did not want to depopulate fully. To increase the odds of success we made the following modifications to the original Swiss method.

- The age limit was increased to 12 months
- Replacement gilts were purchased early to ensure they were 12 months old at eradication time
- Remaining breeding stock were vaccinated with a *Mycoplasma hyopneumoniae* vaccine two times prior to the eradication process
- The herd was medicated with a combination of Tiamulin (100 ppm) and Chlortetracycline 330gm/tonne) during the 14 day down time.

The success rate has been 100%, based on serologic and slaughter examination, up to 3 years after the eradication. The herds have sold pigs to other herds that have remained consistently negative for *Mycoplasma hyopneumoniae* by clinical examination, slaughter examination and serologic testing.

The reasoning for the modifications were to reduce the risk of failure. The increase of the age limit is to ensure that full immunity was present and risk of shedding was eliminated. If purchased gilts are used enough time needs to elapse so that full immunity develops. Vaccination may or may not help in the procedure, but the vaccines are safe and will stimulate greater immunity towards mycoplasma hyopneumoniae. In larger herds the risk of failure may be greater as the likelihood of one carrier animal remaining in the herd increases with herd size. In multisite production where pigs are weaned early and to an offsite location, a condition close to a Swiss eradication may occur[3]. This leaves in my opinion an intriguing possibility to remove mycoplasma hyopneumoniae form Multisite production systems.

The herd criteria that are used to select herds for a mycoplasma eradication program are as follows and greatly increase the odds of success:

- A clean mycoplasma hyopneumoniae negative source of gilts needs to be available
- The farm people needs to be motivated to follow through on all the details of the eradication program
- An offsite facility to growout the contaminated feeder pigs needs to be available
- the biosecurity of the herd needs to be tight enough to prevent re-infection once the herd is clean.

The major benefit of an eradication program is that it is cheaper than a full depopulation and offers a high probability of success. In our hands, it has been a valuable tool for farms where control of Mycoplasma hyopneumoniae has been needed.

PRRS

The mycoplasma protocols outlined above will work quite well for PRRS. In my experience, we did not incorporate PRRS vaccination in the process. Other authors use mass vaccination of the sow herd and unidirectional flow away from the sow herd with success.

Because the PRRS virus is not shed as long as mycoplasma, nursery depopulation has been reported to work quite well. The procedure is as follows:

- Plan a break in pig flow so nurseries are empty for a minimum of two weeks
- Move existing nursery pigs off site for finishing
- Start to refill the nurseries with weaned pigs after two weeks downtime
- If the sow herd is stable and not shedding the virus, the virus will be removed.

Good diagnostics are needed to verify the sow herd is stable

Farrow to wean herds

In production systems with sow herds that raise pigs only to weaning age. These herds can achieve PRRS elimination if:

- Herds are closed (up to 200 days - no new naïve or positive gilts are introduced) – length of time is commensurate with herd diagnostics and how much risk the producer is willing to take.
- Diagnostics to verify no virus is circulating (use sentinel pigs, and/or test outgoing weaner pigs)
- Initiate replacement gilt flow from a PRRS negative source
- Semen from PRRS negative boar stud

Mange Eradication

- Treat all sows simultaneously with an injectable mange treatment
- Repeat in 14 days
- Treat all nursing piglets
- Keep all treated pigs physically separated from others in the herd.

Because mange needs skin to skin contact to transmit, a physical separation of treated pigs from untreated is all that is needed. Once all untreated pigs go market and only treated pigs remain, *Sarcoptes scabei* will be gone, unless some pigs mixed. The cost of treating all the sows twice 14 days apart is equavelent to the normal treatment cost spread out over a year, thus no additional cost is required for eradication. For this reason, most farms that have the disease have long ago opted for this option

Swine Dysentery Eradication

The use of antibiotics to which *Brachyspira hyodysenteriae* is sensitive can eliminate the organism from those treated animals. If mass treatment is initiated along with rigorous cleaning and elimination of rodents, the bacteria may die out. As for Mange, the medication cost may be equivalent to ongoing maintenance cost, thus most producers have eradicated *Brachyspira hyodysenteriae*; those that haven't, have been eradicated by the disease.

Actinobacillus Eradication

Several methods have been attempted for APP eradication notably:

- Test and remove
- Segregated early weaning
- Strategic medication

None have given consistent results, and in some cases created pockets of naïve animals which when mixed with infected pigs created clinical outbreaks of disease. The most consistent control APP program has been a full depopulation-repopulation program. Often APP is found with other diseases and many of the advantages of a full depop-repop program can be realized if implemented. Because APP can cause explosive, high mortality, there is a high motivation for a permanent solution. The most crucial element to a successful elimination program is access to high health APP negative replacement gilts or weaners.

Examples of Costs of Eradication Programs

	Depopulation -repopulation	Closure (off-site breeding)
Investment $/sow US	228.00	42.59
Proportion of costs		
Cost of gilts - Cull sows	39%	28%
Off-site breeding	28%	61%
Interest on gilts	2%	2%
Diagnostics and testing	1%	8%
Down time (lost pigs)	30%	0%

Source : Adapted from Yeske (2010)

Other new costs sometimes need to included in cost evaluation. To lower the risks of PRRS recontamination, the farms may need to implement new biosecurity measures along with the eradication program. These biosecurity measures increase the costs above those given, but should be implemented in both cases. Biosecurity measures such as HEPA filters can add significantly to costs.

Disease costs can be quite variable between farms so an important step in the cost analysis of the eradication is an evaluation of the specific health status and the financial impact diseases to a farm. For that, production and financial reports can be used. Costs have to be evaluated herd by herd because each system or farm is unique. Opportunity costs represent the expected gain from a successful eradication, both from higher income or lower production costs. Yeske, estimated opportunity costs to range from 10.34 US $/pig sold to around 12.50 US$/pig sold

These factors can be used to make a cost-benefit analysis, to determine the return on investment or a payback period. For example, it is of value to estimate how long the farm must remain targeted disease free to ensure a return on investment. A herd closure with an offsite gilt developer had the shortest period disease free run with 1.6 month needed to ensure a return. Depopulation-repopulation had the longest, with 10.9 months needed, which can be attributed to the fact that it is the costliest method (although it is the most likelihood of success).

Factors to success of an eradication program can be based on the following elements:

- Cost-benefit analysis
    - Opportunity costs (disease cost & genetic improvement)- (Investment costs)
- Risk of failure, either from failed process or recontamination
- Staff motivation
- Sufficient financial resources to manage cash-flow demands

A regional approach

The largest risk for a failure of an eradication program is odds of becoming re-infected. Re-infection generally is a proportional to the disease pressure in the regional pig community. In pig dense regions or areas with high disease pressure, it may be of value for producers to pool their eradication efforts to mutually reduce the risk of re-infection. Regional control efforts are presently under consideration in the US for PRRS, and a coordinated mycoplasma partial depopulation program nationwide has given good control of mycoplasma infections in Switzerland. A coordinated regional approach to disease control is the next frontier in control of swine disease, but will challenge our knowledge of the social sciences to ensure full participation among the farming community.