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Mycoplasma hyopneumoniae eradication in a large system: strategies and techniques

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The breeding stock that fueled the growth of the western Canadian swine industry in the 1980's and 1990's came from a small number of genetics companies. Most of these companies and thus the majority of commercial production they supplied shared similarities such as predominately British-based female lines and, core to this discussion, freedom from several significant diseases including *Mycoplasma hyopneumoniae*.

Many of these commercial herds continue to remain free of *Mycoplasma hyopneumoniae* infection. However as the industry grew, new farms were established in close proximity to each other and to existing *Mycoplasma hyopneumoniae* positive farms. With more densely pig-populated areas, disease spread among farms within areas became an issue.

This was true for farms in the Elite Swine system. The pig flow in their 3-site system relied on flexibility in commingling weanling pigs from several sow barns. But, when a sow herd in the network broke with *Mycoplasma hyopneumoniae*, it could not continue to contribute pigs to the network. The options were to leave the system or depopulate-repopulate. An adaptation of the *Mycoplasma hyopneumoniae* eradication protocols developed in Europe (Baekbo, Zimmerman) made it possible to eliminate the activity of *Mycoplasma hyopneumoniae* in herds without depopulating the sow herd and rejoin the *Mycoplasma hyopneumoniae*-free producer network.

This eradication procedure relies mainly on two techniques: 1) closing the breeding herd to new animal introductions for a period of time and 2) partial depopulation, which usually involves the removal of all animals on site except the breeding herd.

Eradication requirements

The first requirement is to ask some fundamental questions concerning cost and risk of the disease compared to cost of the eradication procedure. What is the current cost of the disease in terms of losses and control costs? What is the cost of the eradication? The answers to these two questions can be used to calculate the pay back period of the disease eradication procedure. Certainly the longer the herd remains free of the target diseases post-eradication, the greater the financial advantage. But what is a realistic estimate of a financial return for an eradication procedure? To answer that we need to consider: What are the odds of success? Are secure sources of replacement stock free of *Mycoplasma hyopneumoniae* available? Are the sources genetically similar or superior to the current stock in the herd? Can the farm maintain adequate farm biosecurity to minimize the risk of reacquiring the disease? Does the barn design and condition allow a reasonable chance of eliminating the organism from the barn environment in a short period of time? Can we achieve immunological stability within all of the animals retained on farm to assure elimination of the disease or, at least, stop the risk of pathogen shedding and transmission?

Replacement stock free of *Mycoplasma hyopneumoniae*

Today there are many options for replacement stock free of economically important pathogens. If nucleus and multiplication herds that were established *Mycoplasma hyopneumoniae*-free are located away from hog dense areas and have maintained a sufficient biosecurity program, they can remain *Mycoplasma hyopneumoniae*-free for long periods of time. There are examples of this in Western Canada where herds established in the early 1980's are still *Mycoplasma hyopneumoniae* negative. Of course when looking for *Mycoplasma hyopneumoniae*-free breeding stock the proper due-diligence is needed. Consultation with the source herd's veterinarian, a review of the source herd disease monitoring procedures with the historical results of this monitoring and an assessment of the biosecurity (including transportation) are required before choosing replacement stock.

Farm biosecurity

A thorough review of all aspects of the farm's biosecurity is needed with a focus on the most probable ways that *Mycoplasma hyopneumoniae* had infected, or potentially could infect, the farm. *Mycoplasma hyopneumoniae* is not recognized as a disease that can be readily moved around on fomites. It is not regarded as a particularly robust organism and is prone to drying. Survival outside of host animals is longest if the organism is intimately associated with organic matter but even with that, survival in the environment is reported to be not much longer than a

week. So any standard biosecurity measures designed for more robust organisms such as TGE virus will certainly protect from any tracking of *Mycoplasma hyopneumoniae* on fomites.

The biggest biosecurity risks are from carrier swine and area spread. Area spread has become a concern in my practice area. In western Canada, we historically had a "one mile" rule based on our low relative humidity and smaller size of farms and lower density of production. We observed that farms more than a mile from Mycoplasma hyopneumonae positive farms would stay free of the disease for a period of time usually in excess of five years versus farms situated within one mile of positive farms. However with the growth of the industry, we are faced with more farms within a region and also the advent of larger units. These factors have created the scenario where closed *Mycoplasma hyopneumoniae* naïve farms 2 miles from positive farms have broken with the disease. Process of elimination would indicate that the most probable route of disease introduction for many of these breaks was via area spread. So in contemplating farm eradication, an assessment of the number and size of *Mycoplasma hyopneumoniae* positive farms in the area, and the distance from each, needs to be done to evaluate the risk of a rebreak and the estimated payback period.

Elimination of the organism from the farm environment

For any eradication procedure, the target organisms must have short natural environmental survivability. If not, we must be able to successfully eliminate the organisms from the farm by some means such as a targeted sanitation program.

The first questions to ask is: Given the environmental conditions that would exist in the barn over the depopulation period, how long will the organisms survive? Survival will vary with the nature of the organism and the barn and climatic conditions.

The second question is: Knowing the answer to the first question and based on the length of time of the partial depopulation, what is the chance that organisms will still be present and viable when susceptible pigs are once again on the farm? Susceptible pigs could be piglets that are not protected from infection by maternal immunity, pigs that become susceptible after losing their maternal immunity, or naïve herd replacement stock. *Mycoplasma hyopneumoniae* fits the profile well for an organism that can be eliminated from the barn environment. Away from the host under typical barn conditions it is unlikely that it would survive more than a few days. Nonetheless our eradication protocols require a thorough washing of all barn areas to remove organic material and a general disinfection with a mild disinfectant (animal safe) such as an iodine or quaternary ammonia. This is to ensure that no organic material, that would prolong *Mycoplasma hyopneumoniae* survival, remains in any area where pigs can contact it. Also, all refrigerated areas such as dead stock coolers and medication fridges should be warmed up, cleaned and disinfected. We utilize seasonal environmental conditions to improve the odds of a rapid die off of the *Mycoplasma hyopneumoniae* in the environment. Cool moist conditions are conducive to survival so we try to target summer months for eradications when we have warmer temperatures and higher ventilation rates that aid in drying.

Elimination of the target pathogens and/or shedding from the animals in the production groups that will be retained on the farm.

Zimmerman (1990) was able to eradicate *Mycoplasma hyopneumoniae* from herds by removing all animals less than 10 months of age. The mature animals appear to be able to mount an immune response that may eliminate the organism (sterilizing immunity) or at least prevent shedding of the pathogen. Using this principle, our approach to eradication is to close the breeding herd to all introductions until the youngest gilts and boars are at least 10 months of age. The point where the group is deemed stable is the point where the last animal ceases to shed the pathogens. Prior to closing the herd we will try to overstock the herd with replacement breeding stock to help compensate for normal herd attrition during the closed period. If this stock is from a *Mycoplasma hyopneumoniae*-free source, these naïve animals must be housed with the existing herd to allow ample exposure to positive stock to ensure early exposure and seroconversion. There is the question of how early in life gilts and boars must be exposed to *Mycoplasma hyopneumoniae* to ensure they can build sufficient immunity to establish the immunity to eliminate or prevent shedding of the bacteria. All of our eradications involved the introduction into the positive breeding herds of 5 - 6 month old *Mycoplasma hyopneumoniae* naïve gilts from our regular breeding suppliers. Then the herd is closed until after the youngest of the introduced animals are 10 months of age. So the usual exposure time from entry to eradication is about 4 to 5 months. This has proven adequate for us.

We have also utilized vaccination of the entire retained breeding herd to promote total immunity of the group. This is considered "insurance" since initially we have conducted successful eradications without the use of vaccination.

During the period of time that the breeding herd is closed, any clinical signs of *Mycoplasma hyopneumoniae* usually disappear. If they do not, this indicates that the herd is not stabilizing and the eradication needs to be postponed.

Another aspect of herd closure is the control of the litters born during what I call the "intensive eradication period". The European protocols ceased breeding to allow for no

farrowings for a 2- week period at the point of time when the entire breeding herd is greater than 10 months of age. I call this 2-week period the intensive eradication period and instead of a cessation of farrowing, we continue the farrowings but wean litters off-farm at 12 days of age or less.

The partial eradication protocols for *Mycoplasma hyopneumoniae* eradication that were developed in Europe also used mass medication of the group during the intensive eradication period. We have continued this practice. Although the question can be asked – Is medication necessary? No program can guarantee total elimination of *Mycoplasma hyopneumoniae* from all animals. It is the immune stability in the closed group that is the key to a successful eradication.

Nursery and grow-finish

By definition, partial depopulation requires the removal of all groups of animals where shedding and transmission of the pathogen can't be stabilized. For *Mycoplasma hyopneumoniae* elimination usually means that the nursery and grow/finish areas of production are totally depopulated. Typically it is in the nursery and grow/finish areas where the disease can cycle from the older animals to the younger (naïve) animals. However, where a nursery/grower pig flow is established that enforces strict age segregation, e.g. weekly All-In-All-Out (AIAO) batches, this pig flow can effectively break lateral transmission of the target diseases among the different age groups. Then *Mycoplasma hyopneumoniae* can be "stepped" out of the production flow without depopulating the entire nursery and grow-finish population on a site. The ESI system is set up with nursery and grow-finish sites of 1 to 6 barns per site. On any site the barns are separated by a minimum of 400 feet between barns. With this barn spacing, we have successfully kept nursery or grow-finish barns filled with *Mycoplasma hyopneumoniae* naïve animals free from disease spread from other positive barns on the site. Success is contingent on a few essential conditions such as true AIAO and the ability to minimize shedding of *Mycoplasma hyopneumoniae* from the infected groups by vaccination and medication.

Cost of partial depopulations

This cost can vary considerably depending on typical system pig flow which determines whether or not the nursery & grow-finish sites need to be totally depopulated. It also depends on the economics of alternate markets for weanling sales over the depopulation period or, if growers are retained, the cost of raising them off-site. For the breeding herd, the capacity to overstock gilts is an asset because the breeding herd attrition and the cost of holding on to poorer performing sows to maintain breeding inventory numbers are major cost of this process. Another cost would come if the farm elects to rent off-farm facilities to allow them to continue to introduce and breed the regular number of herd replacements (the *Mycoplasma hyopneumoniae* naïve gilt replacements) during the time that the breeding herd is closed. **Table 1** gives the partial depopulation costs that were incurred by a 3000 sow, farrow-to-wean barn in the ESI system. Based solely on the cost of the ongoing grower pig *Mycoplasma hyopneumoniae* vaccination program and medication costs, the payback period was 1 year.

Post-eradication verification of success

Certainly the appearance of clinical signs in grower pigs born post-eradication or in naïve replacement stock and verified by PCR as *Mycoplasma hyopneumoniae* signifies

Table 1: *M. hyopneumoniae* partial eradication costs – 3000 sow farrow-to-wean herd

Factor	Total Cost
Breeding herd attrition	$52500
Cull Sow Productivity	$3250
Vaccinations	$3900
Medications	$18600
Cleaners and disinfectants	$1010
Labor	$4000
TOTAL	$ 83,260
Notes on costs	
Breeding herd attrition	No gilts for 4.5 months – 450 gilts – Were able to put an extra 200 into the herd and retained 100 culls so short production from 150 animals - 10 pigs at $35/pig = $350 per sow X 150 = $21,000
Cull Sow Productivity	100 sows at .5 pig = $17.5 (half value) X 100 = $1750.00 plus feed & semen on another 50 = 50 X $12 + $18 = $1500.
Vaccinations	$1.30 X 3000 = $3900
Medications	$6.20 X 3000
Cleaners and disinfectants	$1010
Labour	2 extra people for 2 weeks plus overtime = $12X $1000 + $1000 = $2000 x2= $4000

failure. However low prevalence herds, as would be the case where *Mycoplasma hyopneumoniae* remained after the eradication attempt, exhibit no clinical signs. Or these herds can have a vague pattern of very mild and sporadic signs of respiratory disease. This is especially true in herds that remain closed to introductions or those with excellent environmental conditions.

To verify success in a herd absent of clinical signs we look for:

- Absence of seroconversion in replacement stock (if unvaccinated)
- Absence of seroconversion in grow/finish pigs born after the eradication. Ensure that sampling is done in animals that have do not have maternal antibodies remaining in their sera. Maternal antibodies to *Mycoplasma hyopneumoniae* will persist in animals born to seropositive mothers for varying lengths of time but have not been reported to last longer than 150 days of age.
- Absence of any PCR positive lungs from suspicious deaths.

Conclusion

A complete protocol for eradicating *Mycoplasma hyopneumoniae* is given in Appendix A.

Over the past 10 years we have attempted this eradication procedure in 20 sow herds. All have been deemed successful in that weanlings and feeders from the eradicated farms could be commingled with *Mycoplasma hyopneumoniae* naïve pigs with no need of vaccines and medications and with no clinical signs developing in the groups from weaning to slaughter. We have had 6 farms where the disease has returned to the pig flow with an average time from eradication to re-emergence of *Mycoplasma hyopneumoniae* clinical signs of 22 months.

There is an interesting side benefit to closing the herds to *Mycoplasma hyopneumoniae*. Other diseases such as neonatal diarrhea decline in incidence and the staff note a general lift in herd health and performance. This "honeymoon period" lasts about 8 months after normal herd replacement flows resume. This lift in the health of the pigs and the improvement in the environment from the thorough "top to bottom" cleaning of the barn often create a motivational lift for the staff. And with a typical payback period of 8 to 12 months (which for us is based on the savings from the elimination of all *Mycoplasma hyopneumoniae* vaccine programs and other costs of disease control), this process will continue to be utilized in our system.

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Appendix A

Mycoplasma pneumonia eradication plan

This is the general plan used by ESI farms. The plan requires that the herd be closed to new breeding stock replacements and that all animals in the breeding herd reach a minimum age of 10 months at the start of the eradication phase. As many gilts as possible are brought into the herd to help the breeding herd inventory from dropping too far below normal target levels. The breeding herd is vaccinated at least twice with a *Mycoplasma hyopneumoniae* (MH) vaccine before the start of the eradication phase. The breeding herd is started on medication just prior to the eradication phase. All grower pigs over 11 days of age are removed from the farm. During the eradication phase the medication continues, litters are weaned at 12 days of age or less, and the entire barn is washed and disinfected. On some projects, the barn has not chlorinated pits as outlined below.

Pre-eradication phase

About 5 months pre-eradication

Gilts and boars are brought onto the farm to overstock the inventory, and the herd is closed to new introductions. The age of the youngest gilt or boar is found and the date when that animal is 10 months old is determined. This date will be the targeted Day 0 of the eradication plan.

6 weeks pre-eradication

Vaccinate the entire breeding herd for MH. Arrange for the depopulation of all grower pigs and shipment of early-weaned litters.

3 weeks pre-eradication

Vaccinate the entire breeding herd for MH.

No fostering that would put older piglets into a younger litter is allowed.

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Farrowing rooms can be set up as "clean" rooms as they are emptied and refilled. The standard wash and disinfection program is sufficient. The clean rooms need to be segregated with their own boots and coveralls, and equipment. They are to be the first rooms to go to in the day, and people need to wash hands before re-entering the rooms and touching the boots and coveralls for that room. Sows moving into the farrowing rooms need to have manure crusts and wet manure washed from their skin and each sow wetted down with a quaternary ammonia disinfectant. This washing of sows won't be necessary after wash and disinfection of the gestation and breeding barns.

Do not foster any pigs back into these clean rooms.

Feed all sows in these rooms 1-rounded tablespoonful (15 grams) of feed grade tiamulin per day until they are on the feed medication indicated below. If possible use the medicated ration indicated below for these animals.

The feed grade tiamulin refers to Denagard Medicated Premix containing 17.8 grams of tiamulin (as hydrogen fumarate) per Kg of product.

1 week pre-eradication
The entire breeding herd is started on medication in the feed. This will be 5.62 kg of Denagard and 2 kg of chlortetracycline 100 (440 grams of chlortetracycline) per tonne. If any animals are not eating normally, they will need to be injected daily with tylosin (4 cc per 100 pounds), and Oxytetracycline hydrochloride (e.g. an oxytetracycline LP – 4 cc per 100 pounds) injected at the same time but with separate syringes. These medications should be given for 5 days, then 5 days with no injections, and then 5 more days of injections.

Note: The tiamulin level is for set up to deliver 100 grams of tiamulin per Tonne of feed. This level in the feed is designed to deliver a minimum of 250 mg of tiamulin per sow per day assuming a minimum daily feed intake of 2.5 Kg of feed per gestating sow.

1 to 5 days pre-eradication
Preclean barn. Scrape and clean areas where manure accumulates and where deep crusting is evident.

Eradication phase

Day 0
First day of the eradication phase – All animals in the breeding herd should be 10 months of age or older. All grower pigs older than 8 days of age are removed from the farm. Be sure that all dead stock, placentas, mummies, stillborns, etc. are disposed of. Cold rooms, freezers, refrigerators, including the one in the kitchen need to be defrosted, and wiped or sprayed with disinfectant.

Day 0 to Day 4
Start washing and disinfecting all of the chronically moist areas of the dry sow, breeding barns, farrowing rooms (if they haven't already been cleaned), nurseries and grower barns (if applicable), load-outs, all hallways, offices, and storage areas. Be sure to soak slat areas very well with disinfectant. Use a quaternary ammonia disinfectant that has a dual detergent and disinfectant action and is safe to spray on and around animals. Be sure that clothing, boots, and all equipment that has had direct pig contact (such as syringes, needles, crowding boards, hog catchers, etc.) are disinfected.

Chlorinate the water lines at this time - 4 ounces of Javex (5% sodium hypochlorate) per 128 ounces of medicator stock solution. Run this for 5 days. Or if the barn has a chlorinator ensure it is functioning properly and that the free chlorine at the end of the line is at least 1 ppm.

These procedures should be completed within 4 days of the start of the eradication phase.

Day 3
(Assuming weaning every 3 days – if a longer or shorter weaning interval, adjust weaning age accordingly) Move all piglets older than 9 days off farm. This weaning schedule will continue every 3 days for 15 days. Where a Sunday weaning would occur, this should be done 1 day earlier, and then continue on the original schedule. More frequent weaning will allow for an older minimum weaning age. The goal is not to allow any piglets older than 12 days to stay on farm.

Day 15
Feed medication program ends.

Post-eradication phase

Gilts and boars can move onto the farm. All new breeding stock needs to be pre-vaccinated with 2 doses of a MH vaccine at 4 and 2 weeks pre-entry for a period of 6 months.

Weaning age can return to normal.

Give MH vaccinations to all sows 2 weeks prefarrowing until the testing for the presence of MH is complete. If the barn is considered in a moderate to high risk location then the sow vaccination program should continue indefinitely.

For a period of 1 month after the eradication phase, any piglets weak at birth that you think did not get much colostrum needs to be killed immediately.