Development and Evaluation of a Herd Health Monitoring System for Swine Operations[1]

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Introduction

In today's intensive pork production systems, herd health is a major factor determining the profitability of the business. Among the economically most important diseases in the Midwest are porcine reproductive and respiratory syndrome, pseudorabies, transmissible gastroenteritis, swine influenza and pneumonia caused by *Mycoplasma hyopneumoniae* and *Actinobacillus pleuropneumoniae*. Several studies have evaluated the financial impact of acute outbreaks of these diseases in swine operations (Miller & Kliebenstein, 1985, Mullan et a. 1994, Poulson et al., 1993, Rougoor et al., 1996). However, the predominant problem in many swine operations is a subclinical infection of the herd rather than acute outbreaks of diseases. Infected pigs are not obviously sick or die, but perform poorly. The economic consequences of subclinical infection can be slow growth, decreased feed efficiency, low fertility, increased numbers of abortions and stillbirths, and smaller litter sizes (Baysinger et al., 1997). For farms operating on an 'all in, all out' basis, the difference in weight gain between infected and non-infected pigs can be an additional problem, because finishing pigs do not reach market weight at the same time.

The objective of our study was to develop a herd health monitoring system to detect subclinical disease at an early stage. The ability of this system to detect changes in herd health status was evaluated. We also determined the magnitude of the impact of infection with different pathogens on weight gain, carcass quality and reproductive performance. On the basis of this information, the costs and benefits of specific intervention measures (e.g. vaccination, test-and-removal, antibiotic treatment) can be evaluated. This will assist farm managers in decisions on disease management.

Materials and Methods

In 1996, the first year of this two year study, three university farms were monitored. Farm 1 was a pasture operation. On farm 2, the sows and nursery pigs were kept indoors and the grower and finisher pigs outdoors. Farm 3 was a complete confinement operation. Each farm was visited four times, with a 6-8 week interval between visits. On every visit blood samples **were obtained from** 90 pigs of different age groups. On these samples serological testing was performed to detect antibodies to porcine respiratory and reproductive syndrome virus (PRRSV), transmissible gastroenteritis virus (TGEV), swine influenza virus (SIV) and *Actinobacillus pleuropneumoniae* (APP). These infectious agents were chosen for monitoring because of their potential economic impact and at least one of the farms had a recent diagnosis of infection with these pathogens. Each

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farm had two cohorts of 30 pigs followed from nursery to slaughter. Individual pigs in the cohort were identified with ear tags. At each visit, pigs were weighed to monitor weight gain. Serum samples were collected to monitor changes in antibody titers. Figure 1 illustrates the sampling scheme on each farm for the first project year.

At slaughter, carcasses were examined for gross pathology: the skin was evaluated for mange, the snout for atrophic rhinitis, the lungs for pneumonia and the liver for parasite infestation. In order to evaluate carcass quality, back fat and loin eye area were measured and color, firmness and marbling of the loin eye were scored. To determine the association of subclinical infection with reproductive performance of sows, the farrowing interval, number of liveborn, number of stillborn and weaning weights were recorded. The influence of seropositivity on weight gain in nursery to finisher pigs and on productivity in sows was evaluated using a multiple linear regression analysis.

Visit	Nursery	Grower	Finisher	Sows
1	30			30
2	30	30	30	
3	30	30	30	
4	30		30	30

Figure 1. Sampling scheme for farm visits in 1996. Numbers indicate number of pigs sampled from each age class on each visit. Arrows indicate individually identified pigs followed longitudinally.

Results

In all of the three university herds PRRSV was endemic in the sow herd with seroprevalence rates of 11.7%, 6.7% and 51.7% respectively. TGEV infection was prevalent in all herds throughout the year; 18.3% to 56.7% of the sows were seropositive. However, grower and finisher pigs were seropositive for TGEV only sporadically. On all three farms seroprevalence rates were the highest for SIV, with averages of 63.9%, 59.7% and 63.3% respectively. Only one farm had APP seropositive animals during a limited period of time. The surveillance system was effective in detecting changes in disease prevalence $\geq 15\%$ ($\alpha=0.05$, power=0.80). Figure 2 shows the prevalence of antibodies against PRRSV, SIV, TGEV and APP on each farm. Figure 3 indicates the prevalence for each age group across farms.

Figure 2: Prevalence of PRRSV, SIV, TGEV and APP on the three university farms

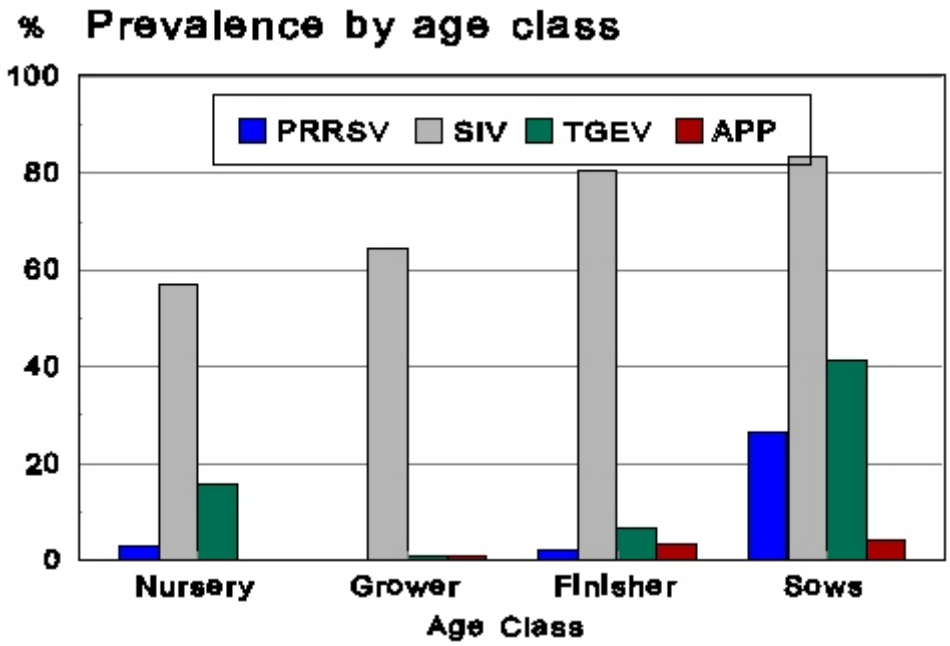

Figure 3: Prevalence of PRRSV, SIV, TGEV and APP in different age groups

A multiple linear regression model was used to evaluate the influence of seropositivity on weight gain. The outcome variable was average daily weight gain (in grams) between the first farm visit (6-8 weeks of age) and the last farm visit (22-24 weeks of age). The mean average daily weight gain (± standard deviation) on farm one was 820 (± 97) grams per day, on farm two 651 (± 65) grams per day and on farm three 738 (± 75) grams per day. For the regression model farm and cohort effects were coded by orthogonal contrast coding. On each farm the two cohorts were compared among each other. The pasture farm was contrasted to the other two farms and the farm that raised finishers outdoors was compared to the complete confinement operation. Other variables included in the original model were age at first bleeding and weighing, sex, positive antibody titers for each of the four diseases at each of the three bleedings and gross pathology at slaughter. A significant influence (at α=0.05) on weight gain was found for farm and cohort effects and age at first bleeding and weighing. Sex was not significant at an α level of 0.05 (p=0.085), but was forced into the model as females have been shown to have a slower weight gain if no split sex feeding is practiced. Nursery pigs with positive titers for SIV at 6-8 weeks of age gained an average of 27 grams per day more than pigs without maternal antibodies at that age. Antibodies for PRRSV in the nursery increased the weight gain by 73 grams per day. The six pigs that seroconverted for PRRSV in the finisher stage had a significantly lower weight gain (-46 grams per day) compared to the negative pigs. Of the findings at slaughter only lung pathology influenced average daily weight gain significantly. For each percent increase in lung tissue with pneumonia, weight gain was decreased by 5 grams per day. Pigs that showed fibrous scars in the lung tissue gained 23 grams per day less than pigs without visible signs of having had pneumonia at an earlier age. In table 1 the variables that remained in the final multiple regression model and their associated β, t, p and sr^2 values are listed.

Table 1: Final multiple linear regression model for average daily weight gain in nursery to finisher

pigs. R^2=0.74; F(12,121)=29.13; p<0.0001

	Effect on ADG	β g/day	t	p	sr^2
first vs. second cohort farm 1		-27.3	-1.25	0.2121	0.0033
first vs. second cohort farm 2		-9.1	-0.87	0.3849	0.0016
first vs. second cohort farm 3		-45.5	-2.94	0.0040	0.0183
pasture farm vs. indoor farms		227.3	7.43	0.0001	0.1174
indoor vs. partially outdoor farm		81.8	-4.57	0.0001	0.0444
age at first bleeding		-4.5	-2.72	0.0076	0.0157
SIV positive at 6-8 weeks (0=no; 1=yes)	higher	27.3	1.75	0.0411	0.0065
PRRSV positive at 6-8 weeks	higher	72.7	1.89	0.0305	0.0076
PRRSV positive before slaughter	lower	-45.5	-1.69	0.0468	0.0061
% of lung pneumonic at slaughter	lower	-4.5	-2.32	0.0111	0.0114
scars on lung tissue (0=no; 1=yes)	lower	-22.7	-1.68	0.0474	0.0060
sex (0=male; 1=female)	male>female	-13.6	-1.38	0.0851	0.0040

To evaluate the impact of subclinical disease on sow productivity, multiple linear regression models were performed with the farrowing interval, number of liveborn piglets, number of stillborn (including mummified fetuses) and weaning weight as the outcome variables. The weaning weight and the number of liveborn piglets in a litter were not associated with any of the monitored diseases. The mean (± standard deviation) farrowing interval was 149.1 (± 4.7) days on farm one, 146.0 days (± 22.3) on farm two and 135.8 (± 12.7) days on farm three. The farrowing interval was increased by 7.1 days in APP positive sows (p=0.023). Sows vaccinated and seropositive for TGE had a 25.9 days shorter farrowing interval (p=0.006). Vaccinated TGE positive sows also had a smaller number of stillborn or mummified piglets in the litter. The average number of dead pigs in the litter was 2.7 on farm one, 0.9 on farm two and 1.8 on farm three. A positive vaccination titer for TGE decreased this number by 0.6 (p=0.045). The number of stillborn piglets in sows seropositive for SIV was increased by 0.9 (p=0.018). None of the sows were vaccinated for SIV. Seropositivity for PRRSV did not influence any of these measures of reproductive performance.

Discussion

The herd health monitoring system was effective in detecting changes in herd health status on the three farms monitored during the first year of the study. In the multiple linear regression model for average daily weight gain of nursery to finisher pigs antibody titers were responsible for only a small part of the variation in weight gain. Most of the variation in weight gain could be attributed to farm and cohort effects. Of the total variation in weight gain, 1.41% could be explained by antibody titers

at 6-8 weeks and 0.61% by seroconversion for PRRSV in the finisher phase. This could mean that subclinical disease has only a small impact on performance compared to feeding, genetics and management factors. However, the farms chosen for this study represented a broad range of management types from a pasture operation to complete confinement. Therefore the high variation between farms is expected. Antibodies for SIV or PRRSV at 6-8 weeks of age had a positive effect on average daily weight gain. This indicates that the titers measured are from maternal antibodies rather than from infection. Most of these seropositive pigs were seronegative at the second bleeding at 16 weeks of age. There was also a positive correlation between antibody titer and weight in 6-8 week old nursery pigs.

Of the subclinical diseases monitored, only antibodies for PRRSV had a significant impact on average daily weight gain. However, in the groups monitored, the prevalence of antibodies for TGEV and APP were too low to detect an impact of these diseases on weight gain. More than 80% of the finisher pigs seroconverted for SIV. Thus a moderate decrease in weight gain due to this infection may have remained undetected because the sample size of seronegative pigs was too small. The second year of this study includes a greater number of farms as well as a slightly increased cohort size. Therefore the evaluation of the magnitude of the impact of TGEV and SIV on weight gain will be facilitated. The prevalence of APP was low on all farms, it might not be an important pathogen for subclinical infection in the area we were doing our research in.

Fertility in sows was significantly decreased by several of the monitored diseases. While litter size and weaning weights were not affected, the number of stillborn and mummified piglets as well as the length of the farrowing interval were influenced by the health status of the sows. Positive titers in unvaccinated sows increased the number of stillborn piglets and increased the farrowing interval. Positive titers from vaccination, on the other hand, improved reproductive performance. It was surprising that positive titers for PRRSV did not have an effect on fertility in the sows monitored in this study. Sows can remain seropositive for PRRSV for a long time after infection. The data that we evaluated included only the last farrowing before our visit to the farm. Therefore an earlier infection with persistent antibodies might not have an impact on reproductive performance during our measuring interval. However, Baysinger et al. (1997) observed a decrease in reproductive performance that lasted for one year after infection with PRRSV. For the continuation of the project in 1997, the sows are identified individually and blood samples are collected twice in a 6 month interval. Thus, we will be able to evaluate possible changes in serological status over time.

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