SWINE HEALTH INFORMATION CENTER
FINAL RESEARCH GRANT REPORT FORMAT

Project Title/ Project ID no: Development of regional surveillance systems for emerging and foreign animal diseases of swine (#18-198)

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Industry Summary: Effective surveillance should efficiently collect data for production and/or business planning, document freedom from specific pathogens, and guide a rapid, effective response to emerging and/or FADs. Current on-farm or regional surveillance programs routinely fail to meet these targets. In part, this is because the industry has changed over time and no longer conforms to the assumptions under which our surveillance systems were originally designed. As a result, surveillance either is not done or is done ineffectively.

<u>On-farm surveillance</u> The statistical theory on which on-farm surveillance was originally based assumes: (1) subjects (pigs) are independent, (2) all pigs have an equal probability of being selected, and (3) the farm has a stable, homogenous pig population. Traditional farms fit these assumptions - hence the "30 sample" approach worked in the PRV eradication program - but current swine production systems do not. Why?

Contemporary production systems differ from traditional farms in ways that are incompatible with traditional surveillance: (1) Pigs no longer run free in pastures or feedlots. Iowa farms averaged a total inventory of 250 animals in 1980 (Flora et al., 2007) versus 3,250 in the 2012 Census of Agriculture. Management of large populations requires physical segregation by age and stage into buildings and pens. (2) Swine populations on modern farms experience rapid turnover of animals and frequent introduction of new animals - often of a different disease status. (3) Current production systems rely on extensive movement of pigs, people, trucks, and feedstuffs between sites. This connects distant places/populations and facilitates the rapid movement of pathogens between them.

In NPB #13-157 (Rotolo et al., 2017), we showed that disease on contemporary farms moved in a spatiotemporal fashion (non-random) and developed new surveillance guidelines based on spatial (non-random) sampling. This "fixed spatial sampling" approach is being used in the U.S. and elsewhere.

<u>Surveillance at a regional level</u> Efficient regional surveillance is fundamental to detecting the incursion of new pathogens and in monitoring regional disease control/elimination projects. Thus, the current project moved surveillance to the regional level with the objective of developing more efficient regional surveillance methods (fewer samples, but better detection).

In this project, we tested the hypothesis that disease exhibited a spatiotemporal pattern of spread at the regional level (just as we saw on farms). The emergence of PEDV in April 2013 provided the opportunity to examine this question. Using PEDV testing results from the ISU VDL (at the county level to protect client confidentiality), we found a spatiotemporal pattern of PEDV spread. This means that, just as for on-farm sampling, the assumptions upon which regional surveillance was based do not hold in today's world. Thus, new guidelines for regional

surveillance should be developed using statistically-appropriate modelling to account for the spatial and temporal correlation in disease spread. We have also shown that spatially balanced sampling through generalized random–tessellation stratified (GRTS) provides a higher power of detection than traditional simple random sampling (SRS) using simulation studies mimicking real PEDV data.

In conclusion, this research provided producers and swine veterinarians with a better understanding of the spatiotemporal nature of disease spread. From a pragmatic perspective, application of a spatially balanced sampling design was shown to improve the power of disease detection and the efficiency of the disease surveillance. Surveillance designed using this approach can achieve better detection at a lower cost.

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