How the School of veterinary Medicine at Penn fits within the national structure concerned with agricultural biosecurity

The School of Veterinary Medicine at the University of Pennsylvania is one of 27 schools of veterinary medicine in the United States. Our primary contribution to the national effort to maintain agricultural biosecurity involves training the veterinarians who will comprise the primary responders to any threat

to agricultural biosecurity and the research and service component of our work that is explicitly directed towards biosecurity issues (specific examples are listed below)

Our urban clinic, in the heart of the University City section of Philadelphia, draws an enormous caseload of varied small species. And our pastoral New Bolton Center, in Kennett Square, Chester County, 32 miles southwest of Philadelphia, on the edge of Lancaster County, attracts a large number of assorted large animals. During the 1998-1999 academic year, we saw 24,000 small animals and 6,000 large animals. The

core/elective curriculum allows students limitless choices. Seniors can select one of five distinct clinical areas: small animal, mixed (small and large) animal, large animal, equine, and food animal medicine. The huge biomedical research complex that comprises the University of Pennsylvania greatly enhances the teaching that students receive and their opportunity to participate in cutting-edge research in countless disciplines.

The School of Veterinary Medicine at the University of Pennsylvania graduates between 110-130 veterinarians each year. Not all of them will go into to food animal practice, but all of them have received extensive training in zoonotic infectious diseases and in the recognition and treatment of those infectious diseases that may compromise the safety of our food supply or imperil the productivity of our herds and flocks. Up to a third of any graduating class will also have been trained in the construction and use of mathematical models that inform policy decisions concerning the area-wide control of epidemic disease in domestic animals. Existing services offered by the School of Veterinary Medicine that advance biosecurity

within the agricultural sector The Salmonella Reference Center has become a valuable resource, not only for Pennsylvania farmers, but for other agricultural laboratories in the nation. The Center is part of the Pennsylvania Animal Diagnostic Laboratory System(PADLS); funding is received from the Pennsylvania Department of Agriculture, along with grants from USDA, the American Egg Board, and with revenue generated through client services.

The William B. Boucher Field Service provides routine and emergency health care for local dairy, horse, llama/alpaca and small ruminant clients. The dairy and small ruminant specialists offer consultation in production medicine as well as routine on-farm services

Pennsylvania is the nation's third largest chicken producer, primarily egg-layers, and New

Bolton Center is the diagnostic center of choice for many poultry farmers in the region.

The Commonwealth of Pennsylvania's Animal Diagnostic Laboratory System(PADLS), a third of which is housed at New Bolton Center, brings scores of cases annually for diagnosis. The laboratories of large animal pathology and toxicology, avian medicine and pathology, microbiology, and clinical laboratory or part of this tripartite laboratory system. Specimens are accepted 24 hours a day. The facilities are credited by the American Association of veterinary laboratory diagnosticians and offer state-of-the-art diagnostic services. A field studies unit at NBC is part of the PADLS. The field studies unit provides the academic and technical support to clinically investigate economically significant animal health and production problems in the Commonwealth of Pennsylvania. Information will be shared with other participants say the programmatic health-care interventions can be developed on a statewide basis.

The Center for Animal Health and Productivity focuses on improving the health of herds and flocks, not just individual animals. This food-animal program looks at the entire farm operation while considering economic, environmental and food-safety perspectives.

Emerging services and initiatives

1. Avian Influenza

(a) The importance of Geographical Information systems: Working with the Pennsylvania Department of Agri-culture and the poultry industry, the School of Veterinary Medicine at the University of Pennsylvania has been instrumental in developing and implementing a statewide avian flu surveillance program after an outbreak of highly pathogenic avian flu among Pennsylvania poultry in 1983-84 that resulted in the destruction of more than 17 million birds at a cost of nearly $65 million.

We have a comprehensive strategy that includes constant education and reminders about biosecurity practices, monthly surveillance testing of blood or eggs, regular reviews and updates to our response plans, and ensuring that we have the most advanced technology in our arsenal," she explains. "This includes Geographic Information System (GIS) technology, which is one of the most powerful weapons we have to control diseases and minimize economic loss. Pennsylvania was one of the first in the poultry industry to develop GIS. Since 1998, the School has been using GIS technology to map the location of commercial poultry flocks, feed mills, processing plants, rendering plants, hatcheries, and components of the live-bird market system throughout the Commonwealth. GIS also can be used to create buffer zones around infected flocks for increasing surveillance testing or possible quarantine purposes. The School has proven the value of this state-ofthe-art technology. In 1997, just before we began using GIS, there was an outbreak of avian flu in Pennsylvania. Despite a rapid diagnosis of the problem, it took several months to contain the outbreak and cost the Commonwealth of Pennsylvania $3.5 million. In 2001, we experienced another outbreak: with GIS in place and fully functional, we were able to quickly identify where the flock was, where surrounding flocks were, which ones we had to monitor, and which routes trucks should use to avoid infected flocks, among many other applications. GIS gave us the ability to respond very quickly and make very quick decisions. As a result, we had the outbreak under control within one month at a cost of only $400,000, nearly 90 percent less than the cost of the 1997 outbreak.

(b) The importance of rapid diagnosis: The School's ability to respond rapidly to avian influenza was dramatically enhanced in December 2004 with certification by the National Veterinary Services Laboratory to use a new real-time preliminary chain reaction (PCR) test based on technologies similar to human DNA testing used in criminal cases. The real-time PCR takes just a few hours to complete in comparison to tests used previously that take several days. This rapid test enables us to get on top of the situation much faster and, as a result, decrease the cost of outbreaks.

(c) The importance of mathematical modeling to inform policy decisions concerning the control of avian influenza: In December 2005, the School of Veterinary Medicine received almost a million dollars in federal funding to continue our work on mathematical models on avian influenza in poultry flocks. These models are used to explore and rank in order of effectiveness putative strategies for defending against the natural or deliberate introduction of avian influenza virus into poultry flocks in Pennsylvania and adjoining states. As a result of this award, the research group in the Section of Epidemiology and Public Health has become a member of the National Institutes of Health "Models of Infectious Disease Agent Study" (MIDAS) and, as such collaborates in this effort with research groups in the USA (at the Pennsylvania State University, for example) and abroad (the University of Warwick, UK). MIDAS is a collaboration of research and informatics groups to develop computational models of the interactions between infectious agents and their hosts, disease spread, prediction systems, and response strategies. The models will be useful to policymakers, public health workers, and other researchers who want to better understand and respond to emerging infectious diseases. If a disease outbreak occurs, the MIDAS network will be called upon to develop specific models to aid public officials in their decision-making processes.

2. Surveillance

Surveillance is the bedrock upon which rest all of our strategies to maintain agricultural biosecurity. The Primary Animal Health Care Specialist Training Program is designed to train those actually working on dairy farms to recognize diseases and conditions that may affect productivity or portend some serious breakdown of biosecurity. This new program is funded by the private sector (Pfizer) and is a collaborative effort between the Center for Animal Health and Productivity at the School of Veterinary Medicine and Delaware Valley College. The idea is to increase the pool of well-trained first responders and to buttress that training with substantial internet resources for diagnosis and the exchange of information. Areas where additional work is needed and obstacles to progress.

(a) The importance of spatial heterogeneity and the particular problem of applying spatial models in the USA:Mathematical models of infectious disease transmission dynamics inform policy decisions about disease control. The models for SARS and BSE(Mad Cow Disease) transmission dynamics provide two recent examples. A decade ago, most infectious disease transmission models were deterministic, mean-field models that took little account of spatial and stochastic events. Despite the success of these deterministic, mean field models it became apparent that there were situations in which spatial heterogeneities in transmission were important prognostic factors with respect to control - and that these heterogenieties required explicit representation. A burgeoning literature setting out the ways in which such problems could be dealt with in a modeling context and the need to address urgent contemporary problems that clearly involved spatial components has led to the development of a large number of spatial, stochastic models. Examples of these include the several models of Foot and Mouth Disease that were used to inform and examine policy during and after the 2001 FMD outbreak in Great Britain and models of Foot and Mouth Disease in the US. These spatial, stochastic models have been spectacularly successful. Not only do they provide a good representation of an observed outbreak, but they provided an ideal vehicle for comparing and contrasting putative control strategies. What all of these models had in common (both in the UK and in the US) was that they absolutely depend upon accurate maps of farm locations and good information concerning the size and type of each farm. In Britain, such information was available on a national scale: agricultural Census included the easting and northing coordinate of the farm-house together with the numbers of pigs, cattle, sheep, goats and deer present on each farm at the data of the census.

There are two important facts here: first, the easting and northing coordinates which constituted the unique farm identifier for census purposes also provided a good measure of each farm's location, and, second, the census data for each farm were available to the modelers. Similar information is not in the public domain in the United States, nor(in the opinion of the writer) is it ever likely to be. Issues of confidentiality confound and impede all efforts to gather and to use such information in the United States. The arguments regarding individual and corporate rights to privacy are quite proper but an unintended consequence of these arguments is to deprive the nation of a proven means of defense against the consequences of catastrophic epidemic disease. There very few states in the US where good maps exist for more than just a few. Thus, the US is at a considerable defensive disadvantage.

(b) The importance of a national animal ID system

On 30 Dec 2003, the USDA announced additional safeguards to further minimize the risk for human exposure to BSE in the United States. Among these it was stated that A To enhance the speed and accuracy of the response to animal health threats such as BSE, APHIS is working to implement a national identification system to track animals of various species through the livestock marketing chain.

The projected time lines for the establishment of a National Animal Identification System (NAIS) in the draft documents issued by USDA/APHIS (May 2005) propose requiring stakeholders to identify premises and animals according to NAIS standards by January 2008.

Requiring full recording of defined animal movements is proposed by January 2009. These same documents acknowledge the very considerable concern voiced by stakeholders and it is clear that many producers are fearful about what might happen should a NAIS become mandatory(there are some voluntary programs currently). For example in March, 2004, the California Cattleman's Association stated that they "will continue to work closely with NCBA and CDFA to ensure that the implementation of any national animal identification system does not impose unreasonable costs to producers and limits the liability of individual producers and others in the production chain. Of particular significance is determining how best to protect the confidentiality of producer records".

"Trace Back" and Trace Forward" methodologies are crucial components of any attempt to curtail and investigate epidemic disease. An effective NAIS would dramatically enhance our nations ability to deal with natural and deliberate introductions, but this writer expects that the legal challenges to such a system will be such that the time lines proposed by USDA/APHIS cannot possibly be satisfied. Good maps and an effective animal identification system will probably not be available in the short term, so what can we do instead?

(a) Maps and models

If we cannot use existing spatial models (which depend upon accurate mapping of the location of individual farms) can we use spatial models that operate at lower resolutions and still answer worthwhile questions about disease control? This is the problem of granularity. One possible solution might be to turn to the public domain data made available by the US Census. Using census data, it may be possible to map, by zip code, the number of farms of a given type. A number of research groups (include the modeling group in the School of Veterinary Medicine at Penn) have proposed to investigate the utility of metapopulation models as a replacement for detailed spatial models in the design of disease control strategies. The essential insight of metapopulation modeling is that populations exist in "patches@ and that we cannot predict the dynamics of the metapopulation as a simple function of the local dynamics within patches because the larger scale processes of migration and colonization, as well as the regional distribution of patches, determine metapopulation dynamics. The models take explicit account of the spatial relationship of the patches and the number of susceptible units in each patch but they do not require any information about the location of each unit within the patch. Thus if we were to define patches in terms of zip codes and infectious units in terms of farms within zip codes, we do not need to know the exact location of each farm. Given that metapopulation models have provided useful insights into observed epidemic patterns in human populations it seems reasonable to hope that the zip-code information contained within the Census of Agriculture could provide the basis for similar metapopulation models of infectious diseases in farmed animals in the US. The funding for this work should reasonably come from state and federal government.

(b) Maps, Animal ID systems and "Trace back":

One problem with maps is that they have to be maintained. Another is that it is very difficult to construct maps of farm enterprises from the supplied address because the address often does not correspond to where the animals are actually located. Farms also go out of business or change the nature of their business. Some of these difficulties might be overcome by "Real Time Mapping" in which patterns of commerce are recorded using geographical positioning instruments permanently fixed in bulk milk tanks (for example). The patterns recorded by such a system could be used as a surrogate for maps of farm locations and have the distinct advantage that they reflect actual current farming practice (and the amount of milk collected used as an index of herd size). Such a system would require that private sector trucking companies and feed mills (for example) collaborate with information integration centers located in universities or state agriculture departments. Although the examples used here deal with dairy farms, it is not difficult to imagine that the same system could be used to monitor the swine or poultry industries too. Funding would reasonably be the responsibility of state governments.

Respectfully submitted

Gary Smith, January 5th, 2006.