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"Stopping an Avian Influenza Threat to Animal and Public Health"

Introduction and Current Situation

Highly pathogenic (HP) avian influenza (AI) and the virus that causes it, avian influenza virus (AIV) is a major threat to the U.S. poultry food supply. While not a public health risk at present, the H5N2 HPAI virus is of concern. The current situation represents a new challenge to U.S. animal agriculture. Our country has not experienced an introduction of a HPAI originating directly from wild birds. Although the disease is now on the decline in the hard-hit Midwest region, through the efforts of many, we are faced with developing improved measures to more quickly recognize and respond to the disease to minimize its impacts.

HPAI has resulted in mortality in our wild waterfowl populations, certain species of which are known to harbor and spread the virus during their migrations along the Pacific, Central and Mississippi flyways. Only wild birds of the Atlantic flyway remain free of AI as far as we know at the present time. But predictions are that HPAI will come East during the southern waterfowl migration this Fall. Poultry are accidental hosts, becoming infected following direct or indirect contact with waterfowl or their droppings on land or contaminating water (ponds, wells, etc. used for poultry water sources). However, there is also a growing body of evidence suggesting terrestrial wild birds, which have not been consider conventional vectors in the past, may play a "bridging" role in the transmission of avian influenza into poultry farm facilities or perhaps to humans.

Since December 2014, USDA has reported H5 AI virus detections in 21 states in commercial poultry, primarily in egg layer type chickens and turkeys, privately owned backyard flocks, and wild birds.

Approximately 42 million commercial egg layer chickens on 210 farms have died from the disease or have been euthanized to end animal suffering and control the spread of the disease. In Minnesota alone, turkeys numbering more than 9 million on 108 farms have died. Numerous backyard poultry flocks have also been lost, representing additional financial and emotional stresses on small flock owners.

The H5N2 strain has evolved to become the predominant AIV responsible for the losses in the Midwest. However, earlier in the outbreak in the Western states, other H and N combinations (H5N8, H5N1) were involved, and molecular sequencing and

analysis of those other AI viruses demonstrated genetic interrelationships among all of the AI viruses. It is important to appreciate that AI viruses are adaptable and changeable. Career scientists studying AI know this better than anyone. AI virus does not follow rules so there are few clear-cut answers to some questions. This has theoretical implications and more importantly, practical applications. The good news is, we have many disease response tools already at our disposal that will hopefully provide the basis to successfully addressing HPAI control in the future.

Low Pathogenicity H7N2 Avian Influenza in Delmarva in 2004

Profitable Agriculture but Disease Risks

My experience with AI stem's from in Delaware and the larger Delmarva region, Delaware is the birthplace of the modern meat chicken (broiler) industry in the U.S., dating back to the early 1920s. Delmarva, consisting of Delaware (Del), the eastern shores of Maryland (mar), and Virginia (va) is one of the most productive and efficient broiler chicken production regions in the world. Approximately 20% of the broiler-finished product is exported from Delmarva and represents a significant portion of business profitability. At any point in time, approximately 100 million broiler chickens are being raised in the region. Sussex County Delaware is the most densely populated county in the U.S. Seventy percent of the farm income in Delaware is tied to poultry, including the production of corn and soybean for feed ingredients. Moreover, the so-called multiplier effect that accounts for direct and indirect infusions to the ag economy bring the annual value of poultry to $3.2 billion, and 13,500 jobs. All of this is impressive, especially for a state the size of Delaware, but it places great emphasis on preventing highly contagious diseases such as AI. AI is a potential business-ending event for farmers and poultry companies.

In February 2004, the University of Delaware (UD) Poultry Diagnostic Laboratory at Georgetown received a call from a poultry farmer reporting unusual mortality in his flock near Harrington. Our UD staff veterinarian obtained samples and real time RT-PCR testing was used for the first time during an outbreak to identify AI, in this case a H7 virus. The farm was immediately quarantined by the Delaware State Veterinarian to restrict all movement of poultry, people and equipment. As per USDA protocol, the diagnostic samples were sent to the USDA National Veterinary Services Laboratory in Ames, Iowa. The Delmarva emergency incident command system (ICS) was activated on Day 2 to implement the Delmarva emergency response plan. The H7 findings were confirmed the next day and the virus was further identified as H7N2, and was suspected to be low pathogenicity (LP). The flock was humanely depopulated on Day 3 using the USDA-approved carbon dioxide gassing method, and the chickens were composted inside the AI positive poultry houses to prevent possible spread to nearby AI-free farms. Meanwhile a second chicken farm 5 miles from the index farm was found AI positive, quarantined and depopulated on Day 5. Region-wide AI surveillance testing of approximately 2000 poultry farms, performed by UD and USDA identified one additional farm on the eastern shore of Maryland about one month after the index case. The on-farm

response was identical to the other two AI positive farms, and no further cases were ever detected. The origin of the LP H7N2 AI viruses was determined to be the live poultry markets in the metropolitan New York City area. Wild waterfowl were not implicated in the outbreak. Epidemiological evidence showed the index case in Delaware and the 3rd case in Maryland both had ties to these markets. Restrictions by several countries were levied for several months against poultry exports from Delaware and Maryland as a result of the LPAI event.

Lessons Learned in 2004

Biosecurity, Biosecurity, Biosecurity…

According to Wikipedia, "Biosecurity" as a term was coined first by the agricultural and environmental communities. It is defined as a "set of preventive measures designed to reduce the risk of transmission of infectious diseases in crops and livestock…Another site, horseandrider.com goes further and states that "People can spread diseases as they move within a facility and from one facility to another." Indeed, humans are highly efficient transmitters of disease by carrying AI virus on our clothing and shoes, farm equipment and other vehicles that become contaminated with wild bird or poultry droppings. AI virus may be present in manure at high concentrations and be viable for days to weeks depending on ambient temperatures and relative humidity. Unfortunately, biosecurity practices are not consistently applied on farms where animals and crops are produced. This is a major gap that must be addressed by farmers and the animal production companies. There are many aspects to improved biosecurity; having farm-dedicated clothing and shoes for farmers, limiting visitors to essential personnel, and mandating clean clothing including the use of disposable plastic shoe covers. Poultry litter and manure management, and dead poultry disposal are also critical elements of biosecurity programs.

The ICS leaders in 2004 identified several areas of improvement. Two specific areas that were particularly emphasized were…

Although the rapid depopulation (within 48-72 hours) of AI positive flocks was thought to be a critical element in the successful outcome, the need for faster depopulation procedures with a consistent goal of 24 hours after presumptive identification of an AI positive farm was recommended.

Also recommended was to take actions based on the local diagnostic lab positive findings, without waiting the additional 24 hours for the USDA NVSL findings to be reported.

Consideration of the use of a total depopulation strategy restricted control (quarantine) zones in areas with high farm densities. In this scenario, all farms, even those testing AI negative in the same zone with one or more AI positive farms,

would be depopulated to reduce risk of spread outside the zone. ICS leaders were particularly supportive of the approach in the event of a HPAI outbreak.

Seek an insurance program that would specifically benefit poultry farmers that suffer AI losses.

Please see section "*Potential Action Items for 2015 and Beyond*" for details.

Current Avian Influenza Programs at UD's Avian Bioscience Center (ABC)

The mission of the ABC is to support poultry production nationally and internationally through teaching, research and outreach. ABC scientists address real-world practical avian influenza (AI) needs by collaborating with USDA, poultry non-profits, U.S. states, and countries around the world to share information. I also oversee our University of Delaware Poultry Health System that is a member of USDA's National Animal Health Laboratory Network (NAHLN). Our diagnostic lab is responsible for ongoing AI virus surveillance testing and reporting.

Below are some of the AI programs of the ABC.

- USDA supports the ABC Emergency Poultry Disease Certificate course that has trained 121 participants from 64 countries from 2009 - 2015.
- In conjunction with the U.S. Poultry and Egg Association, UD's Dr. Benson and Professor Alphin sponsored a series of web-based training sessions this year on topics including "On Farm Biosecurity", "Guidelines for Depopulation" and "Foam Depopulation". Over 500 participants took part in these trainings.
- Benson, Alphin and now retired UD scientist George Malone developed the foam-based technology for emergency poultry depopulation several years ago. This technology was approved by USDA and is widely used in the U.S. for floor-reared poultry.
- Since 2013, Benson and Alphin have trained over 80 USDA contractors in the "3D's" - depopulation, disposal, and decontamination. These activities require rapid deployment of response personnel and equipment to affected locations. The 3D response is part of the USDA National Veterinary Stockpile program.
- Since 2006, the ABC has cooperated with the Delaware Department of Agriculture to provide training for emergency depopulation of poultry to state participants in Delaware, Maryland, Virginia, West Virginia, Pennsylvanian and the state of Washington.
- This year, UD extension agent William Brown with assistance from University of Maryland Extension, and regional poultry company

veterinarians, hosted a series of On-Farm biosecurity seminars for poultry farmers in Delaware and Maryland.

- My research group, working in collaboration with Dr. Erica Spackman of the USDA Agricultural Research Service (ARS) showed that testing one larger pool of specimens from individual poultry for AI was as sensitive testing two smaller samples per flock. The research lead to reducing the cost of AI molecular testing by approximately 50% per flock.

Potential Action Items for 2015 and Beyond

1. Develop and implement educational outreach biosecurity programs designed to help farmers prevent and respond to avian influenza (AI) on their poultry farms.

Poultry farmers are on the front line and prevention of all diseases is a major goal. Their ability to recognize the symptoms of AI and initiate biosecurity measures is crucial.

The educational programs should have web-based, as well as face-to-face delivery options. Initial focus to be on programs for commercial poultry farmers, followed later by development of programs for backyard and hobby flock owners.

Suggested Elements of the Program

- Implement improved "everyday, non-emergency" biosecurity programs to limit exposure to all "off farm" infectious disease threats including AI. The effort will pay dividends by reducing the introduction infectious diseases of all causes.

- Recognize potential foreign animal diseases, AI and virulent Newcastle Disease (VND), at the earliest stages and report suspicions to a resource person (state animal health official, poultry company representative, farmer's consulting veterinarian, university extension agent, etc.). AI control may be viewed as similar to successful cancer outcomes. Early recognition by the farmer is key to successfully controlling AI.

- Define and implement an "emergency" biosecurity plan following recognition of AI. The plan must be well conceived and practiced in advance. All movement of people and animals coming on and off the farm must cease immediately, including farm equipment and other vehicles. Visitors, contractors, and their vehicles must not be permitted on the farm. "No access" signage should be posted and farm gates, if available, must be closed to restrict access. Additional instructions will come from the state animal health official's office on further farm actions and procedures.

- Facilitate collection, and handling of affected poultry for purpose of obtaining high quality diagnostic samples for testing by a U.S. Department of Agriculture (USDA) National Animal Health Laboratory Network (NAHLN) laboratory. Fresh dead poultry mortalities to be placed in double plastic sealed bags and deposited in a clean, labeled trash can with secure lid at the end of the farm driveway. A trained AI surveillance sample team will collect specimens and take them to the lab for testing. Farmer is responsible for disposal of remaining contents of the trashcan in a biosecure manner.

2. Revise federal emergency response plan to more effectively and successfully control HPAI and thus limit exposure of healthy poultry and humans to virus.

- Allow "presumptive" AI testing results generated by local USDA National Animal Health Network Laboratories (NAHLN) to be the official USDA basis for initiating the depopulation of AI positive flocks. AI infected flocks release massive quantities of AI virus via the respiratory and fecal routes. Transmission to nearby AI-free farms is a high risk as long as poultry are alive. At present, the timing of decisions to depopulate positive flocks and to later indemnify farmers, or the companies that own their poultry, rest with the "confirmation" of the local lab test results by USDA's National Veterinary Services Laboratory in Ames, IA. In reality, delaying depopulation presents an unnecessary, risky practice that can tip the scales towards transmission to nearby farms, other animals and humans.

- Depopulate HPAI positive flocks within 24 hours of a presumptive positive result by the local NAHLN lab to limit transmission for reasons stated previously. Of particular concern are large commercial farms using power ventilation (fans) to maintain air quality, but this in itself can aid transmission. Preferred procedures for emergency depopulation of commercial farms include the use of carbon dioxide (CO2) gas or foam. In the event of limited resources to perform depopulation with CO2 or foam, other means of depopulation may need to be used.

3. Provide an insurance program for poultry farmers who contract with poultry companies to raise their flocks.

The insurance program would compensate contract farmers for losses due to AI and VND. USDA has hired the consulting company, Watts & Associates, to explore possible creation of a Business Interruption Insurance Program for farmers who lose income because of disruptions to their businesses, because of AI and another foreign animal disease known as exotic Newcastle disease. In the event a farm is confirmed as HPAI positive, a government order is issued to destroy the poultry to eradicate the virus. Indemnity is paid by the federal government to the owners of the birds, the poultry company, not the contract farmer who raises them. The poultry company may make some partial payment to the farmer for the time he or

she raised the birds, but nothing is guaranteed. Moreover, cleaning and decontaminating the farm will take a month or longer before the next flock of poultry is delivered so the farmer can be without income for an extended period of time.

4. Vaccination for controlling AI in poultry requires careful, in depth consideration of the pros and cons.

The poultry industries in the U.S. are divided on the vaccination issue. On one side, the hard-hit layer and the turkey companies in the Midwest are leaning towards favoring vaccination. The broiler companies, which has not yet suffered losses, are against vaccination because more of their business is export dependent. Many countries will restrict import of U.S. products even if poultry products come from unaffected, AI-free states.

Pros
AI vaccination will reduce losses due to HPAI, by preventing serious disease and mortality in infected flocks. However, the efficacy of AI vaccination is limited, as discussed below.

Cons
Restricted export trade has already been an economic consequence of AI in the U.S. The fear is that vaccination will not improve the likelihood of the removal of these restrictions.

Research has demonstrated AI vaccines are only partially effective, not unlike human influenza vaccines. While AI vaccines reduce mortality, they do NOT prevent infection with the virulent HPAI virus that may be present on the farm. So over time, vaccines place selective pressure on virulent HPAI viruses to cause them to further mutate and circumvent the immunity provided by vaccine. As this happens, vaccines become less effective.

An added cost of poultry production accompanies the use of AI vaccines. Development manufacturing, purchasing and administration add obvious production costs. Additional costs of monitoring vaccine usage via blood testing to determine if the vaccinated flock has or has not been infected with the virulent HPAI virus are required. These costs will likely be passed on to the consumer.

Farmers may become complacent with their biosecurity efforts when vaccines are used, because mortality and severe disease will be reduced or eliminated. Meanwhile, the virulent HPAI virus may still be infecting the flock and could potentially spread to and cause mortality on a farm that is not using AI vaccination.

How will the American consumer react? Will meat or eggs from HPAI farm be labeled differently from other poultry products? If HPAI virus was zoonotic, what

impact would this have? There is a risk that consumers will find other sources of meat protein and forgo poultry products.

5. Research on terrestrial wild birds and AI – Understanding the potential role of terrestrial wild birds in AI and evaluating ways to reduce their contact with poultry.

Suggested Elements of the Program:

- Raise all commercial poultry indoors at all times to limit exposure to wild birds and AI virus exposure. Most commercial poultry are raised in indoor facilities. However, poultry in organic production programs must be given access to outdoors where the risk of Ai exposure is greater.

- Facilitate controlled laboratory research to determine the susceptibility and shedding patterns of terrestrial wild bird species to the H5N2 HPAI virus to assess their possible role as carriers and transmitters of the HPAI using the currently circulating H5N2 virus. If lab research shows specific terrestrial species are susceptible and can transmit the virus to uninoculated cage mates, field surveillance studies targeting those species could be performed to further identify risk.

  Terrestrial species are often observed in poultry houses. Their role in introducing and transmitting AIV to poultry and possibly humans or other hosts is unknown. There is a limited body of evidence suggesting these birds may play a role in disease transmission. Published research has shown certain species of finch, sparrow, as well as starlings and parakeet can be experimentally infected with a specific low path (LP) and HP AI viruses. Further research using the currently circulating AIV H5N2 strain and perhaps other American AIV strains is needed to define the risk.

- Facilitate research using safe bird deterrent products. Wild bird deterrents might be useful to reduced terrestrial birds intrusion into poultry houses.