Cornell University

Department of Crop & Soil Sciences

Cornell Waste Management Institute

Rice Hall
Cornell University
Ithaca, NY 14853

Telephone: 607-255-1187
Facsimile: 607-255-0238
E-mail: cwmi@cornell.edu
http://cwmi.css.cornell.edu

Summary of Avian Influenza

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What is AI?

Avian influenza (bird flu) is caused by avian influenza viruses that are carried by wild waterfowl and shed in the saliva, nasal excrements and feces. Domestic poultry get the disease when they come in contact with the viruses either directly from waterfowl (drinking from contaminated water, foraging in places where waterfowl have been), or from contact with other infected domestic birds, cages, feed, feces or workers that may be carrying the virus on their clothes or vehicles. Domestic poultry can become very sick and die when infected.

There are three types of influenza viruses: A, B and C. Although humans can be infected by all 3 types, birds are only infected by type A. While avian influenza rarely affects humans, people who work in close contact with infected birds are at some risk.

Type A influenza viruses are further divided into strains, which are constantly evolving. There are two ways these viruses change; either through antigenic drift, or antigenic shift. Antigenic drift is small, permanent, ongoing alterations in the genetic material of the virus. Each new strain, being slightly different from the old, is not completely susceptible to antibodies from the old strain. Antigenic shift is when Influenza A subtypes from different species trade and/or recombine genes. The result is a new strain that is different from either parent virus. Since there would be reduced natural immunity to this type of virus, it can spread very quickly. If the new virus causes illness in people and can be easily transmitted from person to person, an influenza pandemic can occur.

Avian Influenza can be classified into two forms based on the severity of illness they cause in birds. Low pathogenic avian influenza (LPAI) causes only mild symptoms such as ruffled feathers and a drop in egg production or may not cause any illness at all, and thus may go undetected. It is rarely transmitted to humans and is not life-threatening. Highly pathogenic avian influenza (HPAI) causes serious illness and death in infected birds, often within 48 hours of onset. As with LPAI, it is easily spread through a flock by contact among birds and through litter, cages, equipment and air (particularly within poultry houses). Transmission to humans occurs rarely and is usually associated with high levels of exposure to infected birds. It is a serious, often deadly, disease if contracted by people. It is not known to be transmitted from person-to-person.

Only certain avian influenza viruses are known to cause the highly pathogenic form. Some LPAI viruses, when allowed to circulate in poultry populations, can mutate, usually within a few months, to the highly pathogenic form.

AI and Human Health

The concern for human health is that HPAI may create conditions leading to a pandemic. Pandemics can start when three conditions have been met:

- A new influenza virus subtype emerges;
- It infects humans causing serious illness; and
- It spreads easily and sustainably among humans.

The HPAI virus currently circulating in Asia has met the first two conditions. It can meet the third if it mixes with a human virus (this would result in rapid spread), or if it gradually adapts to bind to human cells (there would be small clusters of cases at first). According to the US Center for Disease Control, "Each additional human case gives the virus an opportunity to improve its transmissibility in humans, and thus develop into a pandemic strain. The recent spread of the virus to poultry and wild birds in new areas further broadens opportunities for human cases to occur."

The AI Cycle

The cycle for AI (Figure 1, page 6) is transmission of LPAI from wild birds to domestic flocks that can then circulate in the flock and be transported to other flocks. LPAI may undergo mutation into HPAI that can circulate in the flock and be transported to other flocks. Control of LPAI can thus help to prevent creation of HPAI. Once a flock has contracted LP or HPAI, preventing off-site movement of birds, litter and contaminated equipment is important. Composting of dead birds and litter can control the viruses.

Prevention of LPAI is a step in preventing HPAI from occurring and thus preventing outbreaks or a pandemic. This is best done through biosecurity for poultry flocks: no contact with wild birds or water sources where wild birds congregate; essential personnel only in poultry facilities; clean/disinfect clothing, equipment, tires, etc.; and no contact with other poultry or live bird markets. If flocks are infected, and LPAI mutates into HPAI, disposal of dead birds and infected litter becomes an issue. Moving birds offsite for disposal can easily spread the disease. The virus is killed by heat (56^{o}C [133^{o}F] for 3 hours, 60^{o}C [140^{o}F] for 30 minutes), and with common disinfectants such as formalin and iodine compounds, but remains viable indefinitely in frozen material and for weeks at moderate temperatures. Since properly managed composting meets these time/temperature requirements, static pile composting provides a tool to manage infected birds on site and kill the virus, reducing the risk of spreading disease

Effectiveness of Composting

According to the United States Environmental Protection Agency (USEPA), "On-site composting has been proven effective in deactivating avian influenza virus. On site composting limits the risk of groundwater and air pollution contamination, the potential for farm to farm disease transmission, and transportation costs and tipping fees associated with off-site disposal. Also, there is the benefit of producing a usable product."

Research in many states indicates composting is effective in inactivating the avian influenza virus (AIV). Lu, et al, studied AIV resistance to different environmental factors. AIV was mixed with different types of chicken manure and incubated at several different temperatures. Controls of AI virus alone were also incubated at the same temperatures. The manure was from field chickens, and also from specific pathogen free (SPF) chickens. These particular SPF chickens, as their name indicates, are guaranteed to be free of the AIV being used. The field manure/AIV mixture lost its infectivity after 15 minutes at 56^{o}C (133^{o}F), 24 hours at 30-37^{o}C (86-99^{o}F), and 2 days at 15-20^{o}C (59-68^{o}F). The SPF chicken manure/AIV mixture lost its infectivity after 20 minutes, 36 hours and 6 days, while AIV alone (no manure) took 90 minutes, 12 days and 32 days, respectively. AIV mixed with field chicken manure lost its infectivity about 5 to 10 times faster than unmixed AIV control. In comparison of chicken manure source on AIV inactivation, it can be concluded that field chicken manure had a quicker inactivating effect over the SPF chicken manure. Field chicken manure that naturally contains microorganisms or their digestive enzymes or by-products has the ability to destroy AIV in less than a week under field conditions at ambient or higher temperatures.

Senne, et al, ran an experiment using a 2 stage bin composting procedure to determine the survival of HPAI. They used the H5N2 virus that was isolated in the Pennsylvania outbreak in 1983. SPF chickens that had been received at one day old and raised to 8 weeks in isolation were inoculated with 10^{7} EID_{50} (a dose that results in infection in 50% of the eggs) HPAI virus and either died, or were killed after 5 days. They were placed in both the upper and lower layers of the bins (along with bags of tissue for sampling) that had been layered with carbon rich material and manure. The bins were allowed to compost for 10 days and samples were taken out for analysis. The remaining bags were removed so that the compost could be manually turned then the bags were returned to the same spots. The bins were allowed to compost an additional 10 days. No virus was isolated from the tissues of the composted birds within the bags inoculated with HPAI virus after 10 or 20 days of composting.

Glanville, et al conducted a three year study to examine the feasibility, performance, environmental impacts and biosecurity of composting as a disposal method should a livestock or poultry disease outbreak occur in Iowa. They ran 6 seasonal field trials in which they looked at several different cover materials for composting cows. Among other parameters, they implanted and retrieved samples of vaccine strains of 2 common avian viruses (avian encephalomyelitis [AE] and Newcastle disease virus [NDV], both of which are highly representative of other viruses, such as influenza viruses) to evaluate the potential of emergency composting procedures to inactivate viral pathogens, and did blood sampling and serum testing of SPF poultry housed in cages near selected composting test units to assess the potential of the composting operations to retain live viruses. Both AE and NDV were inactivated during the composting process. When just subjected to heat, survival time ranged from 2 days to 4 weeks for NDV and one to 7 weeks for AE. When subjected to heat plus other stress factors in the composting pile, both types were inactivated within one week regardless of the season or type of cover material. This implies that other factors, besides heat alone, play important roles in pathogen reduction during composting. Negative serum antibody test results for 71 of 72 SPF poultry housed in cages located within a few feet of the composting test units indicate that the birds were not exposed to the live AE and NDV viruses applied to the carcass surfaces when the piles were constructed. This suggests that the composting process deactivated the viruses. When the virus was applied to the external surface of the windrows, there were 6 of 22 positives, indicating that contaminated material should not be used in the outer envelope of the compost pile.

In Virginia, in 2002, an AI outbreak on the Delmarva Peninsula was successfully confined to only 3 farms despite the high density of poultry farms in that area by the use of in-house composting of the 5 pound broilers. However, it was unclear if it would work with larger birds. Therefore, in the fall of 2004, several Virginia state agencies conducted a research and demonstration project to evaluate the effectiveness of in-house composting of turkeys (17 – 40 lb birds) as a means of disease containment and disposal of catastrophic losses. Windrows were set up with several types of carbon materials and birds were placed as either whole, crushed or shredded. All were effective in composting the turkey mortalities, but those with whole birds took more time to compost than those with crushed or shredded carcasses. Temperatures of 60oC (140^{o}F) were achieved within 5 days for crushed carcasses, and 16 days for whole ones.

In 2007, routine pre-slaughter testing of a turkey flock in West Virginia showed a positive test for LPAI H5N2. Since USDA policy is to eradicate LPAI with subtypes H5 and H7 to ensure they don't mutate into HPAI, the turkeys were depopulated and 1,022,400 lbs of turkey carcasses, as well as 20 tons of feed and 350 tons of litter needed to be disposed. Composting was selected as the disposal method. The birds were euthanized with fire fighting foam which added a significant amount of water to the mix and created a challenge to the composting. The piles were constructed in-house, then removed and turned 3 weeks later to compost to a finished product. After 3 weeks, carcass decomposition was about 95%, and there was no ammonia or rancid smell. Internal windrow temperatures in the 1st 3 weeks ranged between 43-57^{o}C (110 and 135^{o}F). All samples of the compost material taken for virus isolation tested negative. Land application of the finished material as a soil amendment will occur after 12 months of composting.

The Virginia Department of Environmental Quality (VA DEQ) has prepared recommendations regarding the most appropriate waste management responses to disposal of entire flocks of poultry after an outbreak of AI. They state that on-site management using good management practices is preferred over off-site management. The preferred order of disposal methods lists in-house composting first, followed by out-of-house composting on-site, other on-site methods as available, landfill off-site, rendering, incineration or composting off-site, and finally burial on-site under emergency permit. On-site composting is practical and economical. The process temperatures destroy the AI virus in a short period of time. It has the highest level of biosecurity as no material leaves the farm. It can be used to treat carcasses as well as infected litter using equipment normally available on the farm, and requires no DEQ permit.

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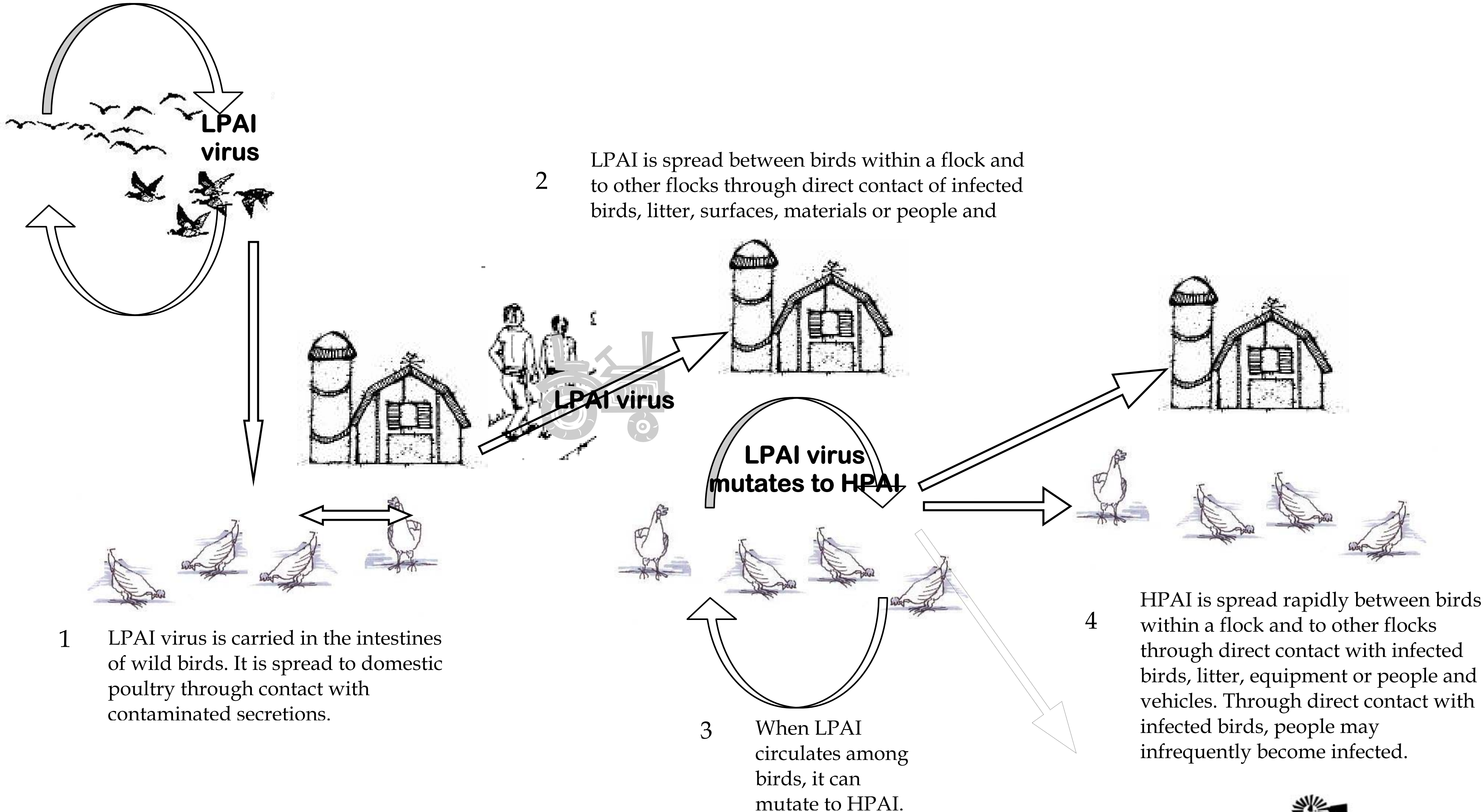

Figure 1. Avian Influenza Evolution and Transmission