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An HSI Fact Sheet: Biosecurity Challenges of Industrial Farm Animal Production

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Industrial farm animal production (IFAP) has become increasingly common throughout the world.[1,2] Worldwide, industrial systems now account for approximately two-thirds of poultry meat production and half of egg and pig meat production,[3] with developing countries already producing approximately half of the world's industrial pork and poultry by 2006.[4]

Inherent design and operational requirements of IFAP facilities can create biosecurity problems with both bioexclusion and biocontainment—efforts to prevent the respective influx and efflux of pathogens. These may help explain why large commercial flocks may be up to 10,000 times more likely to report outbreaks with pathogens such as highly pathogenic avian influenza H5N1 compared to small backyard flocks.[5]

Occupation exposure to zoonotic viruses and antibiotic-resistant bacteria poses significant risks to workers and their families. ©Erin Vanvoorhies/HSI

Feed input. The sheer number of animal in such facilities necessitates large material inputs. One cycle of a flock of 10,000 broiler chickens, for example, requires approximately 42 tons of feed and 100,000 liters of water.[6] The replacement of grazing and forage fodder with commercial feed that may contain animal by-products, waste, and antibiotics[7] increases risk of exposure to antibiotic resistant bacteria, prions, and other pathogens with human and animal health implication.[8,9,10,11,12,13,14,15,16,17] The worldwide dissemination of multidrug-resistant *Salmonella* has been blamed on the use of contaminated feed made out of farmed fish who had been routinely fed nontherapeutic antibiotics.[18]

Stocking Density. Pathogens can enter IFAP operations in a number of ways, including carryover from previous production cycles, from unrelated domestic or wild animal vectors, and through contaminated feed or water.[19,20] When such a breach of biosecurity occurs, pathogen spread, amplification,[21] and mutation is magnified by the large number and stocking density of confined, susceptible hosts.[22]

Occupational Exposure. The number and stocking density of animals in IFAP operations can increase the intensity of occupational exposure to pathogens. Inadequate protection of worker safety has been noted, including a frequent lack of protective clothing and on-site decontamination.[23] Numerous studies have noted a higher prevalence of zoonotic viral and antibiotic-resistant bacterial exposure and/or infections in farm workers and their families.[24,25,26,27,28,29,30,31,32,33,34] Smallholder herds and flocks present less of a risk for pathogen exposure and transmission due to reduced infectious loads and exposure.

Waste Output. The volume of excreta from IFAP operations presents a waste management challenge[35] compounded by the regional concentration of such facilities.[36] IFAP units can easily rival small cities in terms of waste production.[37] Smaller farming systems combine animal husbandry with crop agriculture, thereby balancing the number of animals with crop nutrient needs. At IFAP facilities, the amount of manure produced typically exceeds the capacity of the surrounding land to absorb it. Waste from industrial swine and poultry production is often stored in massive manure pits[38,39] that have been known to leak and break, contaminating nearby water sources with manure pathogens[40,41,42,43,44,45] that can survive up to a year in the case of bacteria and up to seven years in the case of helminths.[46] Unlike human waste, raw animal waste may be sprayed on nearby fields untreated, potentially contaminating water, soil, and air.[47,48] Spilled feed in disposed poultry waste can attract wild birds[49] and creates a likely mode of avian influenza transmission to these wild birds,[50,51,52] who can then transport it to other susceptible domestic flocks.[53] Additionally, workers involved in the transportation, disposal, and spreading of this mass accumulation of biosolids may face a much higher level of exposure to zoonotic pathogens.[54]

Insect Vectors. The concentration of animal waste, decaying organic material, and cesspit standing water at IFAP operations may result in infestations of insects[55] implicated in the spread of *Escherichia coli,*[56] *Staphylococcus aureus,*[57,58] multi-drug antibiotic resistant bacteria,[59] cholera,[60] *Shigella*,[61] *Salmonella*,[62] *Campylobacter*,[63] highly pathogenic avian influenza (HPAI),[64] West Nile virus,[65] St. Louis encephalitis,[66] equine encephalitis,[67] malaria,[68] yellow fever,[69] and dengue fever.[70] Contaminated and/or infected insects can enter and exit IFAP operations via high-volume fans needed to control the heat and humidity created by concentrating so many animals in a confined space.[71,72] A study examining the spread of *Campylobacter,* a bacteria that causes millions of cases of foodborne illness every year, found that as many as 30,000 flies may enter a broiler facility during a single flock rotation.[73] The necessity of high volume ventilation[74] undermines the perceived biosecurity and biocontainment advantage of indoor confinement.

Geographic Consolidation. Mechanically ventilated IFAP facilities and their attendant waste may introduce pathogens into the surrounding environment more than smaller naturally ventilated farm animal populations.[75,76,77] Biocontamination risk is amplified by the international trend towards geographic consolidation of IFAP.[78,79] When facilities are situated in close proximity to one another, pathogens may spread through the wind,[80,81] a mode of transmission thought to play a role in a 2004 outbreak of HPAI in Canada between multiple IFAP operations positioned several hundred meters apart. A million-fold increase in aerosolized dust has been noted in the air surrounding IFAP units.[82]

Vertical Integration. IFAP operations may vertically integrate different stages of farm animal production (breeding, supply of young animals, feeds, animal husbandry, slaughter),[83,84,85,86] which can facilitate the spread of pathogens into multiple IFAP operations. Suppliers that deliver to multiple IFAP operations can also carry pathogens between facilities.[87]

Live Transport. The geographic concentration of IFAP facilities specific to different stages of farm animal production has increased average distances for animal transport.[88] In 2005, for example, more than 25 million live pigs were traded internationally.[89] In 2007, investigations of an avian influenza outbreak in the U.K. revealed the movement of birds four times between Hungarian and U.K. facilities within one enterprise before the final product reached retail.[90] Trucks and shipping containers used to transport farm animals can be contaminated with pathogens,[91,92,93,94] which are increasingly shed by animals stressed by transport.[95] Given that a single gram of feces can contain as many as 10 billion infectious particles, small amounts of residual fecal matter can infect susceptible groups of animals[96] and transporting animals in unenclosed trucks and trains also allows for the spread of pathogens into the surrounding environment.[97] Smallholder farms do not require the shifting of animals between stages of production and eliminate the need for mass long distance live animal transport. Without the spatial dissemination of swine flu progenitor strains associated with long-distance commercial transport,[98] the 2009 H1N1 pandemic might have been averted.

Biosecurity Noncompliance. IFAP risks can be mediated with strict biosecurity protocols, but producers are often unwilling to adhere to such standards due to the associated financial expense.[99] For instance, large poultry operations may reduce the amount of time between flocks and neglect to clean poultry houses between production cycles in order to cut costs.[100] Commercial IFAP operators consistently require neither footbaths nor a change of clothes.[101] The U.S. Supreme Court has had to intervene and mandate compensation for employees' time spent donning protective clothing.[102] Public health experts fear the increasing number of IFAP operations worldwide may lead to an international decline in standards of biosecurity and biocontainment.[103] Even with full compliance with established protocols, the delineated risks inherent to industrialized animal agriculture may pose unacceptable human and animal health risks.

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