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Opinion

Avian influenza and the Brazilian poultry production: Current situation and prevention strategies

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Abstract

Highly Pathogenic Avian Influenza (HPAI) presents a significant threat to global poultry, affecting trade and consumer trust. This analysis focuses on Brazil's preventive measures against HPAI to uphold its disease-free status recognized by the World Organization for Animal Health (WOAH). As of September 19th, 2023, Brazil confirmed 106 HPAI outbreaks, primarily in wild birds, with a few in backyard chickens. Despite most incidents occurring along the coast, a notable outbreak in Bonito-MS underlines the necessity for ongoing vigilance in key poultry regions. Brazil's HPAI prevention framework, initiated with the 1994 National Poultry Health Plan, has continually evolved. High biosecurity measures are emphasized in stringent regulations, surveillance, and rapid response strategies. The nation's vertically integrated poultry model supports centralized control, traceability, and consistent quality, fostering swift corrective actions and biosecurity guidelines. The private sector's commitment complements these efforts, often exceeding government regulations with rigorous biosecurity practices, highlighting Brazil's holistic approach to safeguarding its poultry sector from HPAI threats.

Keywords: HPAI, Poultry production, Brazil, Biosecurity, Brazilian legal framework

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Introduction

Highly Pathogenic Avian Influenza (HPAI) is caused by viruses in the Influenzavirus A genus of the *Orthomyxoviridae* family. These viruses are characterized by their two major surface glycoproteins: hemagglutinin (H) and neuraminidase (N). The influenza A viruses are further subdivided into different subtypes based on variations in these proteins (Gamblin and Skehel, 2010; Suarez, 2016; Kuhn et al., 2022). The H5 and H7 subtypes, in particular, have historically been associated with highly pathogenic strains, although not all H5 and H7 viruses are of high pathogenicity (Alexander, 2000). HPAI strains can cause severe disease in birds, leading to high mortality rates. The evolution and spread of these viruses are influenced by various factors, including migratory bird patterns, trade in poultry, and human interventions (Swayne et al., 2020). The emergence of HPAI in a country has profound and multifaceted repercussions, impacting poultry's health and the international trade dynamics of poultry products. From a poultry health perspective, the implications of an HPAI outbreak are dire. Strains of HPAI can cause severe diseases in birds, often leading to mortality rates that exceed 90%.

Furthermore, the rapid spread of the virus, especially in regions with high poultry density or those lacking stringent biosecurity measures, exacerbates the challenge of containment and control (Kapoor and Dhama, 2014). The ramifications on the trade of poultry products are equally significant. Upon detecting HPAI in commercial flocks, importing countries often swiftly implement trade bans to prevent the introduction of the virus to their domestic poultry (Wieck et al., 2012). Such bans can persist until the exporting country achieves an HPAI-free status, leading to a substantial dip in revenue. Beyond international trade, consumer confidence in poultry products can wane, driving down consumption and prices even within the affected country's domestic market. The associated costs of controlling and eradicating the virus, including measures like culling, disinfection, and surveillance, can weigh heavily on producers and governmental resources (Swayne et al., 2020).

This opinion paper was completed on September 20th, 2023, and considers the scenario surrounding the occurrence of H5N1 HPAI in Brazil up to the day before that (September 19th, 2023), details of which are described throughout the text. The article integrates a diverse set of resources, including regulatory guidelines, and combines them with the author's expertise in poultry health, biosecurity, and knowledge of the Brazilian poultry industry. This multifaceted approach allows for a comprehensive analysis of Brazil's current measures to prevent HPAI. From the perspective of the production sector, the article highlights the actions and initiatives undertaken by private producing companies and cooperatives. These efforts are framed within the context of government regulations and industry-developed protocols.

The role of the poultry production chain in the Brazilian economic and social landscape

The poultry production sector is pivotal in Brazil's economic and social landscapes. Economically, it is a significant contributor to the Gross Production Value (GPV),

accounting for 35% of the livestock GPV and 11% of the agribusiness GPV in 2021 (MAPA, 2022a), and Brazil is one of the world's leading exporters of poultry, particularly chicken (ABPA, 2023). This generates valuable foreign exchange earnings and creates numerous jobs, benefiting local economies. Socially, poultry farming provides livelihoods for small and large-scale farmers alike, improving rural income and food security. Thus, poultry production in Brazil is not merely an economic venture but a complex interplay of economic gain and social welfare.

Broiler production can significantly impact the Human Development Index (HDI) of cities in Brazil. For example, cities like Lajeado (Rio Grande do Sul state), Toledo (Paraná state), and Concórdia (Santa Catarina state) are not only known for their strong poultry sectors but also boast high HDI rankings within Brazil. These cities are the 6th, 7^{th,} and 8th municipalities in the Brazilian HDI ranking, respectively (ABPA, 2023). The poultry industry creates employment opportunities, directly affecting the income parameter of HDI. These jobs can result in better access to education and healthcare, as families have more financial resources to invest in human capital. Additionally, revenue generated through poultry production often leads to improved public services and infrastructure, further boosting the HDI. The influence of a robust broiler industry in these cities radiates through the various HDI parameters, underscoring the interconnectedness of economic prosperity and overall human development.

Brazil's broiler production industry has been consistently on the rise over the past few years, reinforcing its position as one of the world's leading poultry producers. The country produced around 14 million tons of broiler meat annually, accounting for 14% of the world's production in 2022. Brazil has been exporting approximately 4.8 million tons of chicken meat annually, 35% of the world's export market in 2022, valued at around $6-9 billion USD. The top destinations for Brazilian chicken exports included countries in Asia, the Middle East, and Africa. The trends generally indicated robust growth in volume and export revenue. This has been underpinned by an increasingly efficient production chain, growing international demand, and Brazil's reputation for high-quality poultry products (ABPA, 2023).

Maintaining the status of Brazil as free of HPAI in commercial poultry is critical for several reasons, especially in the contexts of economic and social well-being presented above.

Economically, an outbreak of HPAI could devastate the poultry sector, leading to mass culls, production halts, and the closure of export markets. Given Brazil's role as a leading global poultry exporter, this could result in significant economic losses, affecting GPV, foreign exchange earnings, and the job market. A drop in employment could then adversely affect human development indices in cities heavily reliant on poultry production, as job losses would lead to reduced income, less access to education, and poor health outcomes. Socially, the ripple effects would extend to the rural and urban communities that depend on the industry for livelihoods. Reduced income could exacerbate poverty levels and limit access to essential services. In a very pessimist scenario, the reputation of Brazilian poultry products would suffer globally, possibly taking years to recover.

HPAI incidence in Brazil

The first-ever confirmed outbreak of HPAI was reported on May 15th, 2023, in wild birds. The first outbreak of backyard chicken was reported on June 27th, 2023. As of September 19th, 2023, Brazil has confirmed a total of 106 outbreaks of HPAI. Most outbreaks, 103 to be precise, have occurred among wild bird populations, while three instances were reported in backyard chickens (Figure 1). Importantly, all of these cases have been successfully resolved and were confined to coastal regions of the country, except one case reported in backyard chicken in the city of Bonito (Mato Grosso do Sul state) (Figure 2). No outbreak was reported on commercial birds. The outbreaks spanned eight states, underlining a geographical concentration and suggesting the risk is not limited to a single area (MAPA, 2023b). This information indicates that while Brazil has experienced several HPAI outbreaks, effective containment and management measures have prevented wider spread and commercial impact. It also emphasizes the need for ongoing vigilance to maintain Brazil's poultry production capabilities and international trade status, particularly in coastal regions and across multiple states.

The risk of HPAI varies across Brazil's leading table egg-producing states – São Paulo, Minas Gerais, Espírito Santo, and Rio Grande do Sul – which comprise about 55% of the country's commercial laying hen population. Minas Gerais is a lower-risk area, with no reported HPAI cases, while São Paulo and Rio Grande do Sul have had cases that were distant from their main egg-producing regions. Conversely, Espírito Santo's primary egg-producing area is near the coast, where HPAI has been confirmed, making it a higher-risk zone requiring enhanced biosecurity measures.

In the context of Brazil's broiler industry, 64% of production and 79% of exports are concentrated in the southern states of Paraná, Santa Catarina, and Rio Grande do Sul. Most commercial operations are inland, particularly in western regions. Given the geographical separation from the coastal areas where HPAI has been reported, the immediate risk to these critical broiler production zones appears to be lower.

The discovery of an HPAI case in backyard chickens in Bonito-MS alters the context previously discussed. This is the first inland report, including wild birds, in a region pivotal to the country's poultry production. While this raises the area's risk, measures are underway to contain the outbreak. These efforts will be detailed in subsequent sections of this paper.

Brazilian legal framework and government role in HPAI prevention and control

Brazil has a robust legal framework for preventing and managing HPAI, with regulations evolving over several years to meet new challenges. The first foundational regulation was the National Poultry Health Plan, implemented in 1994, which laid the groundwork for avian health standards across the country (MAPA, 1994). In 2002, Technical Directive 32 (Instrução Normativa 32) was established, setting the technical standards for the surveillance of Avian Influenza and Newcastle Disease (MAPA, 2002). Four years later 2006, Technical Directive 17 (Instrução Normativa 17) was approved, which formalized a prevention plan for Avian Influenza and Newcastle Disease (MAPA, 2006). The most recent significant update came in 2013 with the publication of the first National Contingency Plan for Avian Influenza and Newcastle Disease (MAPA, 2013). This plan underwent revision in July 2023 to adapt to current needs and challenges (MAPA, 2023a). Additionally, in 2022, the Avian Influenza and Newcastle Disease Surveillance Plan

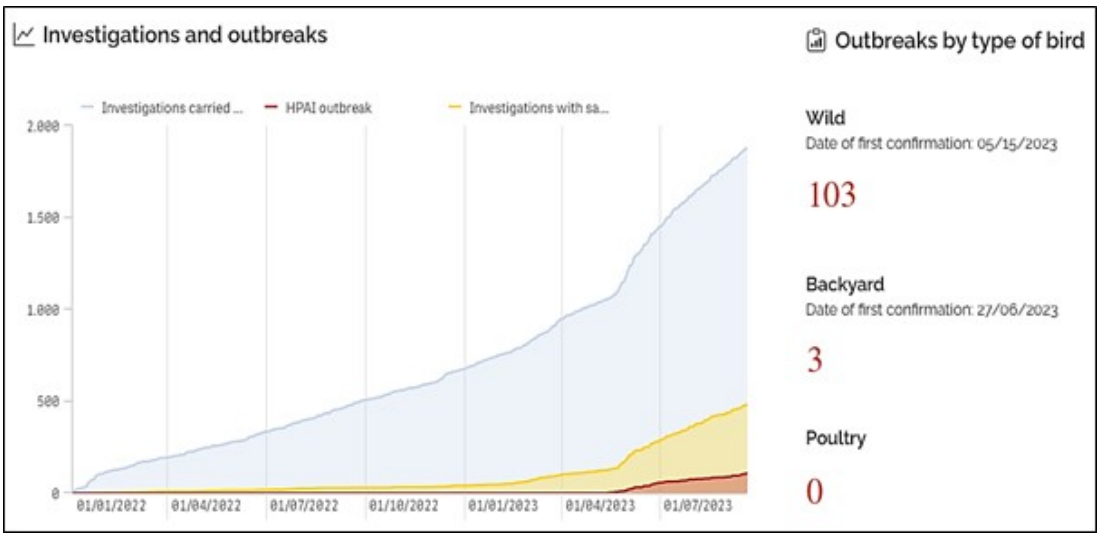

Figure 1: Frequency of investigations (grey area), investigations with sample collection (yellow area), and confirmed outbreaks (red area) of HPAI in Brazil until 09/19/23 (MAPA, 2023b).

was published (MAPA, 2022b). This evolving legislative landscape underscores Brazil's commitment to maintaining high biosecurity measures, which is essential for safeguarding its crucial poultry sector.

The legal framework governing biosecurity in Brazilian poultry farms is quite detailed and comprehensive, aiming to ensure a high animal health standard and mitigate risks of disease outbreaks like HPAI. One cornerstone of this framework is the "Technical Directive 56" (Instrução Normativa 56), which establishes protocols for registering, inspecting, and controlling poultry establishments involved in reproduction, commercial activities, education, or research. This policy underpins the country's approach to maintaining stringent biosecurity conditions within its poultry sector, and the next paragraphs describe a summary of the minimum biosecurity requirements in poultry farms based on this particular legal instrument (MAPA, 2007):

1. One of the primary requirements stipulated by the legal framework involves physical barriers. Poultry establishments must have a perimeter fence of at least one meter in height alongside mesh screens on the side of the barns with gaps no larger than 2.54 cm. These barriers serve the dual purpose of keeping unauthorized humans out and preventing the entry of wild birds, which could be potential carriers of diseases like HPAI.
2. Control and monitoring of vehicle and human movement into and out of poultry establishments are also heavily emphasized. Farms are required to maintain a meticulous log of all such activities and are mandated to display warning signs aimed at deterring unauthorized entries. These measures contribute to a secure environment, minimizing the risk of the introduction of pathogens into farms.
3. On a similar note, robust protocols are in place regarding cleaning and disinfection. The legislation demands that farms establish operational flows and hygiene measures on access roads to avoid contamination of clean and disinfected materials used in production. Vehicles entering and exiting poultry farms must undergo specific disinfection procedures, creating another layer of biosecurity.
4. Furthermore, personal hygiene measures are also well-defined for farm employees. Clean clothing and footwear are mandatory, reducing the risk of transferring pathogens into the production areas. This seemingly simple yet crucial step aligns well with the overall strategy of maintaining a biosecure environment.
5. Waste management and disposal are also given due importance in the guidelines. Establishments must adopt appropriate procedures for the disposal of used water, deceased birds, discarded eggs, litter, and packaging. This ensures that waste products do not serve as a medium for the spread of diseases. Additionally, each farm is required to develop and implement a cleaning and disinfection program to be executed in barns after the exit of each poultry flock.
6. Also, compulsory chlorination of water used in the farm is required, with a minimum active chlorine level of 3 ppm. Also, meticulous records of pest control programs must be maintained to ensure that storage and production areas are free from pests like insects, rodents, and wild or domestic animals.

The Brazilian Government plays a crucial role in preventing and controlling HPAI through a multifaceted approach to minimize the risk of outbreaks. One of the key components is border enforcement and surveillance of national and international transit points, including roads, ports, and airports. This helps regulate the movement of birds and related products, limiting the potential for disease transmission. Active surveillance is another cornerstone, with authorities rigorously monitoring commercial flocks by collecting thousands of samples annually for testing. Similarly, backyard and wild bird populations are also subject to active surveillance through extensive sample collection, ensuring a comprehensive understanding of the disease landscape across different bird communities. In addition to these proactive measures, the Government employs passive surveillance methods in commercial flocks. This is usually triggered by a report from a responsible technical veterinarian who may suspect an outbreak. This multi-layered approach, combining active and passive surveillance with stringent border controls, illustrates the Brazilian government's commitment to maintaining a high biosecurity standard to safeguard its vital poultry sector (MAPA, 2022b).

Role of the private poultry sector in HPAI prevention and control

In Brazil, the table egg production industry is distinct from the broiler sector in terms of organization and biosecurity measures. While a portion of the egg production chain is integrated, much comprises independent producers. Unlike the fully vertically integrated system observed in broiler production, even the integrated part of the egg production sector is not organized fully vertically. This creates variations in the uniformity of protocols and practices across the production chain.

Generally, the average level of biosecurity in the table egg production sector is lower than in broiler production, meaning layer farms usually comply with the minimum requirements but without applying any additional measures. Additionally, exports are not an important part of this market, accounting for less than 1% of the total amount produced. However, it's important to note that the industry is actively engaged in efforts to prevent the occurrence of HPAI in commercial flocks. Although the system's fragmented nature might challenge the standardization of biosecurity measures, there's a collective push within the sector to raise biosecurity standards. This reflects an understanding of the critical role that biosecurity plays not only in animal health but also in the economic sustainability of the industry.

The broiler and turkey production industry is highly organized through a vertical integration system, which allows for streamlined operations, efficient resource allocation, and consistent quality control. In this system, a company or cooperative owns the birds and orchestrates the entire production process from start to finish.

The cycle begins with the company or cooperative providing contracted farmers with day-old chicks. Alongside the chicks, they supply all necessary inputs for successful poultry rearing, such as feed, vaccines, and other essential products. Technical assistance is consistently offered to the farmers to ensure adherence to best practices in poultry health and biosecurity.

Once the production cycle is complete, the farmers return the mature birds to the company or cooperative for processing. This includes slaughtering, packaging, and eventually selling the meat in various markets. The farmers are not involved in selling but are financially compensated for their role in the production cycle. This compensation accounts for the farmers' labor, their land and facilities use, and utilities like energy and water consumed during the production process.

This vertical integration model ensures that the company or cooperative controls every production stage, from breeding to marketing. For the farmer, this translates into reduced financial risk and consistent support, while for the company, it ensures a stable supply and quality control. Overall, this system allows for the efficient production of broiler meat, meeting both domestic and international demand.

The vertically integrated structure of the poultry production industry offers distinct advantages for developing, implementing, and overseeing biosecurity protocols, a critical factor in preventing HPAI in commercial flocks. One primary benefit is the centralized control that the company or cooperative has over all stages of production, from breeding to market. This unified command structure allows for quickly formulating and disseminating biosecurity guidelines based on scientific evidence and best practices. Since a single entity controls multiple stages, there is greater uniformity in the protocols applied, thereby reducing variability that could lead to weak links in biosecurity.

Additionally, the vertical system's inherent oversight mechanisms facilitate rigorous monitoring and quick corrective action. Technical assistance is usually provided to the contracted farmers throughout the production process. This direct line of communication ensures that farmers understand and implement biosecurity measures effectively,

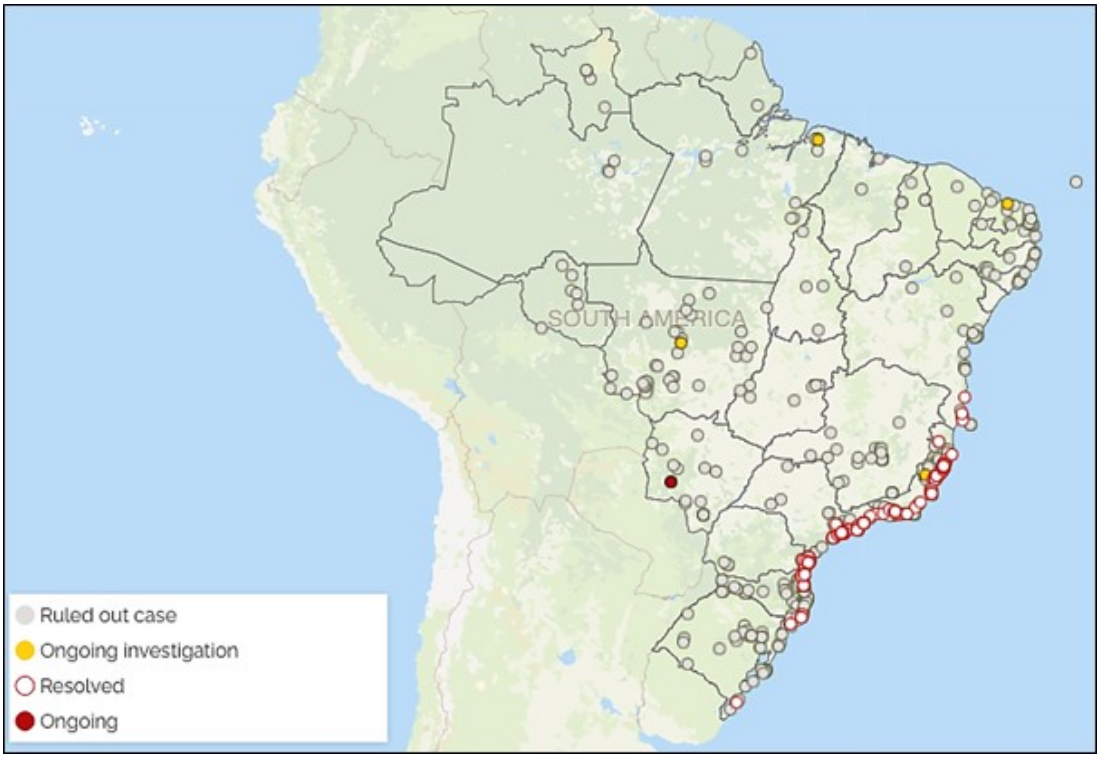

Figure 2: Distribution of the 106 confirmed outbreaks (red dots), ongoing investigation (yellow dots), and ruled-out cases (grey dots) of HPAI in Brazil from the first report on 05/15/23 until 09/19/23 (MAPA, 2023b).

and any lapses can be quickly identified and corrected. Frequent inspections and audits also mean that compliance can be closely tracked, allowing for real-time adjustments and preventing the spread of potential diseases like HPAI.

Another advantage is resource allocation. In a vertically integrated system, the company or cooperative is often better positioned to invest in high-quality biosecurity measures because it controls the financial aspects and can allocate resources where they are most needed. Investments can include anything from state-of-the-art disinfection systems to advanced diagnostic tests and employee training programs, all of which contribute to the early detection and prevention of diseases like HPAI.

Also, the tight control of inputs and outputs in a vertically integrated system makes it easier to trace back any incidence of disease to its point of origin. If an outbreak were to occur, the system's traceability would make it easier to identify the infected flock, the farm where they were raised, and even the specific inputs that might have been contaminated. This capability is crucial for rapid containment and eradication of diseases, including HPAI, thereby preserving both the flock's health and the economic viability of the enterprise.

The private sector is indispensable in preventing HPAI in Brazil, primarily through strict adherence to the country's comprehensive legal framework for biosecurity. By following established protocols, such as physical barriers, vehicular and personnel hygiene, and waste management, companies and cooperatives create a strong line of defense against potential outbreaks. In doing so, they protect their assets and contribute to the overall public health effort against HPAI. This aligns the private sector's interests with broader national and public health objectives.

The centralized and vertically integrated nature of Brazil's poultry industry allows for easier dissemination and enforcement of biosecurity measures. Given that companies or cooperatives often own the animals and provide resources—like day-old chicks, feed, and technical assistance—there is a level of control and standardization that might not be present in less integrated systems. This enables the rapid implementation of preventative measures and, when necessary, quick responses to any biosecurity threats, thus fortifying the industry against diseases like HPAI.

It's worth noting that the private sector's compliance with regulations such as disinfection protocols, perimeter security, and water chlorination isn't just a legal necessity but also a business imperative. Companies and cooperatives know that an outbreak of HPAI could have catastrophic financial implications, including loss of livestock, reduced productivity, and potential closure of international markets. This adds an additional layer of motivation for the private sector to maintain and even exceed the regulatory requirements set by the Brazilian government.

The private sector often goes beyond government guidelines by investing in research, innovation, and education to further strengthen biosecurity. This can include anything from developing more effective disinfectants to training programs for farm workers on best biosecurity practices. The private sector's proactive role thus serves as an additional bulwark against HPAI, reinforcing government agencies' efforts and contributing to Brazil's poultry industry's overall resilience and sustainability.

In Brazil, private poultry companies often go beyond the mandated biosecurity measures laid down by the government to ensure the health and safety of their commercial flocks. These additional precautions include extended quarantine periods for people, supplies, and equipment that are scheduled to enter poultry farms. Moreover, the companies employ stringent cleaning and disinfection protocols that exceed standard requirements, thereby adding an extra layer of protection against potential outbreaks of diseases like HPAI.

Another noteworthy aspect is the identification and isolation procedures for backyard chicken coops that are located near commercial poultry farms. Companies establish protocols to isolate these areas to minimize the risk of contact between backyard chickens and personnel working in commercial poultry operations or with the immediate surroundings of the commercial farms. The protocols for isolating backyard chicken coops near commercial poultry farms in Brazil are comprehensive, incorporating several proactive measures to minimize disease transmission risks. Firstly, companies actively inform and train their employees about the importance of avoiding contact with backyard chickens. This training is crucial in preventing the inadvertent transfer of pathogens from less controlled backyard environments to commercial operations. Additionally, access routes to the farms are strategically planned to circumvent areas with backyard chickens. This routing helps limit any potential interaction between commercial poultry operations and nearby backyard flocks. Another critical measure is the implementation of additional physical barriers, such as double perimeter fences. These fences not only prevent the entry of backyard chickens but also create a restricted movement area for personnel who are in direct contact with the farm's birds. Furthermore, companies often engage in community agreements, providing or donating food products like eggs, chicken, or pork to neighboring communities. In return, these communities agree not to raise backyard chickens. Such agreements benefit the farms and the local residents, ensuring a safer environment for commercial poultry while supporting community needs. These examples collectively illustrate the thorough and community-inclusive approach adopted by Brazilian companies to ensure biosecurity and mitigate the risks of disease spread from backyard to commercial poultry operations.

In addition to government-mandated biosecurity measures, companies and cooperatives in Brazil take rigorous steps to control access to their poultry farms, implementing multi-tiered protocols to prevent contamination at the farm level. These procedures often start at the farm entrance, requiring anyone who enters to undergo a series of steps, such as showering, changing clothes or putting on specialized coveralls, and changing or sanitizing shoes. These procedures are not just one-off requirements upon entry but are repeated each time someone moves from one barn to another within the same farm.

Hand hygiene is also given significant emphasis. Washing and sanitizing stations are typically set up at various points, ensuring workers cleanse their hands thoroughly before touching equipment, feed, or animals. This meticulous level of biosecurity serves to prevent potential vectors of transmission for diseases and reflects the commitment of the private sector to uphold the highest standards of animal health and food safety. By implementing these enhanced biosecurity measures, private poultry companies in Brazil are taking a collaborative and responsible role in disease prevention and control. This complements the existing

legal framework and creates a more robust biosecurity system, collectively reducing the risks associated with avian diseases like HPAI.

As stated above, the integrated and vertical structure of poultry production in Brazil allows for more effective control over the entire production system, including biosecurity practices. This organizational framework ensures that biosecurity measures can be consistently applied and monitored throughout the chain, from breeding to broiler production. In this closely managed system, biosecurity requirements are tailored to different stages of production, with higher-level biosecurity measures applied to grandparent and great-grandparent flocks, followed by slightly less stringent requirements for parent stock and, subsequently, for broilers. This tiered approach to biosecurity makes practical sense, given each group's role in the production cycle. The grandparent and great-grandparent flocks are essentially the foundation of the entire operation, and a disease outbreak of any kind at this level could have a catastrophic impact downstream. Therefore, these birds are subjected to the most stringent biosecurity protocols. As we move down the production hierarchy to parent stock and then to broilers, the biosecurity requirements may be scaled down but remain robust enough to mitigate the risk of disease transmission, safeguarding both animal health and food safety.

To illustrate the proactive measures taken by Brazil's private poultry sector, consider their recent response to two outbreaks of HPAI in backyard flocks. Companies with poultry farms near these outbreaks voluntarily took immediate steps to mitigate the virus's spread. They expedited the slaughtering of their commercial birds to reduce the number of potential hosts for the HPAI virus, aiming to decrease the risk of further transmission and safeguard their commercial stocks.

This voluntary measure emphasizes the private sector's sense of responsibility and initiative in addressing biosecurity threats. It demonstrates their dedication to animal health and public safety and highlights a larger, strategic focus on taking quick and decisive actions to prevent wider outbreaks. By reducing the density of potential hosts, these companies effectively add an extra layer of defense against HPAI, exemplifying the private sector's significant role in disease prevention and control.

Public and private sectors working together on HPAI prevention and control

In conclusion, the private sector and government in Brazil both play crucial roles in preventing and controlling HPAI in commercial poultry flocks, often working in tandem to ensure effective measures are in place. The government provides a strong regulatory framework, ensuring standardized biosecurity protocols, which are then meticulously followed and often exceeded by companies in the private sector. The private sector, in turn, goes beyond compliance by implementing additional biosecurity measures and swiftly taking proactive actions during outbreaks to limit the spread of the virus.

This collaborative approach between the private sector and the government forms a comprehensive, multi-layered defense against HPAI. While the government lays down the foundational guidelines and oversees their enforcement, the private sector adds an extra layer of vigilance and innovation, exemplifying a commitment to public safety and animal health. This synergy amplifies the effectiveness of Brazil's strategy against HPAI, enhancing both the sustainability of the poultry industry and the safety of the country's food supply.

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