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Review Article

Systematic One Health Approach for Control of Avian Influenza in Kerala

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ABSTRACT

Avian influenza outbreak has become an annual event in Kerala, especially at Alappuzha district, from last decade. Enough vulnerable birds and favourable factors are present for the avian influenza viruses to cycle in Kerala. Geographical location and the presence of migratory birds are suspected to be a major factor contributing to frequent avian influenza outbreaks in this region. Other factors suspecting to contribute to the outbreak are unorganized poultry production and marketing sectors and delay of timely preparedness and coordinated efforts among stakeholders. Some states face a lack of structured surveillance, insufficient laboratory capacity in handling the HPAI (high pathogenic avian Influenza) virus, lack of public outreach on risk communication that leads to specific constraints that add to the occurrence of HPAI and delay in control. The realistic goal for eliminating avian influenza outbreak based on Kerala experience is suggested in this study. In Kerala, control measures were achieved through early detection of viruses through thorough surveillance and monitoring, integrating and transforming poultry production in a more scientific manner, emphasizing biosecurity measures and establishing one health team and coordinating the efforts among all the stakeholders.

Keywords: *Avian Influenza, bird flu, Alappuzha, Kuttanad duck, One Health.*

INTRODUCTION

The poultry sector provides livelihood to many farmers of Kerala. Recent years have witnessed a huge demand for poultry products, resulting in a production boom in this sector. Avian Influenza, more popularly known as "bird flu or avian flu," has drawn the attention of the world community over the years due to its destructive effects on the poultry industry, farmer livelihoods, global trade, and the Health of wild birds.

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In India, the states of Maharashtra and Gujarat reported the first High Pathogenic Avian Influenza (HPAI) virus outbreak in February 2006, and the State of Madhya Pradesh reported the second outbreak in March 2006 (DAHD, 2015). Before 2012, most HPAI outbreaks in India were confined to eastern and north-eastern states; however, as time passed, HPAI outbreaks were reported from other states also (Govindaraj et al., 2017).

Kerala is the State from where most of the recent HPAI outbreaks in India are reported. It is an alarming fact that the frequency of such outbreaks has gone very high in Kerala, especially in the last quarter of the year. Including the recent H5N1 outbreak at Kozhikode, which led to the death of 1800 chicken and the culling of several thousands of other birds, in total, five outbreaks have been reported within the last three to four months from various regions of Kerala. The first significant HPAI outbreak in Kerala was in 2014 at the Alappuzha district itself (DAHD, 2015). In 2021, there were two HPAI outbreaks reported from the same region. In January 2021, bird flu caused by the H5N8 strain of the Influenza A virus was detected at several places of Kuttanad of Alappuzha (Anon, 2022). Towards the end of the same year, another bird flu (H5N1) outbreak was confirmed again at Kuttanad. The infections had caused the deaths or culling of tens of thousands of birds, mainly ducks (Shaji, 2021). In areas where outbreaks have occurred, it is generally the procedure to eliminate all the domestic birds, sick or healthy, in order to halt the spread of avian Influenza. Farmers used to suffer significant financial losses as a result, which had an ongoing effect on their way of life. Once the HPAI outbreak became an annual event at Kerala, many of the local duck farmers of the region moved on to other occupations (Govindaraj et al., 2017).

According to studies to date, individual birds do not maintain a long-term carrier state for H5N1 HPAI viruses (FAO, 2011). In warm tropical environments, the virus is unlikely to survive for longer than a few weeks and usually kills most non-immune birds (Alexander, 2008). Somehow, the H5N1 HPAI virus has survived in the Alappuzha region, which is home to year-round temperature and humidity, confirming enough vulnerable birds and favourable factors present for the viruses to cycle at Alappuzha.

Factors contributing to the recurrence of the HPAI outbreak in Kerala

FAO (Food and Agriculture Organisation) has identified three primary factors as barriers to the elimination of the HPAI virus in any areas with endemic infection. Those factors are the organization of the poultry sector, the quality of public and private veterinary and animal production services and level of commitment within the poultry sector (FAO, 2011). Although migratory birds are an important reason for the annual recurrence of the HPAI virus outbreak at Alappuzha, many least cared factors are also prevalent to impede the efforts to eradicate the HPAI virus in that region.

Geographical location and the presence of migratory birds

Migratory wild birds, especially waterfowls, are the natural host and reservoir of avian influenza viruses (Zanaty et al., 2019; & Yehia et al., 2018). They transport and exchange various virus strains along their migration routes, resulting in antigenic drift, antigenic shift and the emergence of novel HPAI viruses (Blagodatski et al., 2021). A frequent occurrence of avian Influenza in Alappuzha has been attributed to the geographic location and the presence of migratory birds in that region, but there is a lack of scientific evidence to confirm this. The locations where the presence of the HPAI virus was verified are not so far away from Kumarakom bird sanctuary. All through the year, a number of migrating species visit that sanctuary. The second-largest wetland ecosystem in India, Vembanad lake, contains numerous parts of Kuttanad islands and attracts migrating birds on a regular schedule (Mathew & Alias, 2020). According to the duck farmer whose flock was affected by the recent outbreak in Kuttanad, he

had been taking the ducks to forage in paddy fields and water bodies where the presence of migrating water fowls were also common just before the outbreak has occurred. He also reported that his ducks have shared water bodies with those migratory birds (Anon, 2022). Therefore, it is essential to consider the migratory birds visiting Alappuzha as a potent source for that region's annual HPAI virus outbreak.

Unorganized poultry production and marketing sectors

Duck farming in Kerala is a highly complex sector with the adoption of several unorganized production and marketing chains. The majority of the duck population and a larger portion of the chicken population of Kerala are concentrated at Alappuzha district. Hogerwerf et al. (2010) in their study on some of the agro-ecological parameters, identified numerous factors that seem to be connected to avian influenza endemicity. The density of agricultural population and the number of ducks is important in the epidemiology and evolution of HPAI H5N1 viruses (Hulse-Post et al., 2005; Gilbert et al., 2006; & Hogerwerf et al., 2010). Infection flare-ups are influenced by chicken density (Slingenbergh & Gilbert, 2008). In regions where both hosts function synergistically, the product of chicken by duck density seems to be most significant (Hogerwerf et al., 2010).

The persistence and transmission of the avian influenza virus can also be significantly impacted by poorly managed live bird markets and traders' yards, particularly if poultry remain in the market for longer than 24 hours, creating opportunities for transmission within market stalls (Wang et al., 2006; & Martin et al., 2006). This significant discovery was made by FAO (FAO, 2011), who asserted that Hong Kong was the place where they first acquired this lesson, which has now been proven in other Asian countries as well as Egypt. In Alappuzha, many duck farmers are actually paddy farmers who follow a mixed farming system combining paddy cultivation and duck rearing (Govindaraj et al., 2017; Jalaludeen, 2011; & Blagodatski et al., 2021). They rear ducks in paddy fields during intercropping intervals. Another type common in Alappuzha region is Nomadic type of duck rearing (Jalaludeen, 2011). With thousands of native duck breeds like Chara and Chemballi, duck farmers move to the village in search of paddy fields and water bodies where the flocks can forage (Jalaludeen, 2011; John & Reghu, 2009; & Blagodatski et al., 2021). The intensive and scientific type of commercial duck rearing is very rare in this area (John & Reghu, 2009; & Blagodatski et al., 2021). Production and market chains are complicated and poorly linked, and a large percentage of ducks are raised and sold in settings that offer minimal protection from influenza viruses (John & Reghu, 2009). The duck rearing is typically growing unchecked in the region where Influenza is recurring. As FAO pointed out, the unorganized production and marketing chain of ducks in Alappuzha cannot be left uncounted as a potent source for HPAI virus outbreak in that region.

Need for preparedness and coordinated efforts

The route map of the migratory birds visiting Kerala seasonally is important for identifying areas that require intensive preparation (Kuriakose, 2018). Furthermore, a detailed epidemiological study about the HPAI outbreaks in Kerala is required. According to FAO, critical gaps in epidemiological information and methods are suggestive of a lack of coordination among stakeholders and a lack of skilled human resources or facilities to conduct effective epidemiological studies (FAO, 2011). Systems for tracking diseases rely on reports from farmers, who are frequently sceptical about mass culling or because of inadequate compensation for the forced culling of birds and destroying eggs (Govindaraj et al., 2017). The farming community has felt the need for sensitizing through information, education, and communication (IEC) strategies to raise awareness of the avian flu before every anticipated season of the outbreak (Anon,

2022). The effectiveness of veterinary services needs to be extended to border checks as well as large farms of the State. For quick and precise diagnosis and for prompt control activities, avian influenza diagnostic facilities need to be established with all containment facilities (Pantin-Jackwood & Swayne, 2009; & Kuriakose, 2018). The lack of structured surveillance, delay in the development of laboratory infrastructure and laboratory capacity in the HPAI entrenched regions, lack of public outreach on risk communication are specific constraints to HPAI control and elimination, however Kerala has been able to address the issue well with limited resources by adopting One Health approach. An example of the approach is detailed below.

Case Scenario: Avian Influenza outbreak was confirmed in Kerala state on 23/11/2014 and mortality of nearly 17,000 ducks was reported in Central Kerala. Bhopal-based National Institute of High-Security Animal Diseases has confirmed H5N1. The H5N1 strain of the virus is pandemic and contagious to human beings. It was not just the duck farmers, but also the ancillary industry which was hit due to this outbreak. The outbreak also had its impact in the broiler sector and its consumption has drastically reduced in Kerala.

One Health approach in Kerala:

Animal Health Sector: The veterinarians played a major role in adopting preventive operations as defined in the National action plan for Avian Influenza (MoFAHD, 2021); this also included securing and culling affected birds, 24-hour control rooms at various areas, distributing protective clothing to the public in the affected areas, providing prompt treatment to disease suspected birds in other adjoining districts, conducting awareness camps etc. The veterinarians developed and released awareness videos on social media to reduce the panic among the public. A three-tier awareness programme was implemented for local body representatives, farmers and the public. The team of veterinarians frequently visited the affected areas to take necessary measures to contain the spread of the disease. The teams monitored the dead birds in water bodies and dead birds lying unnoticed in the fields. Surveillance had been stepped up around 10 km of the areas from where the mass death of ducks had been reported. Also surveillance was carried out in all other districts of Kerala with special importance to places where migratory birds are present.

Human Health Sector: Health professionals played an important role in providing proper prophylaxis among prone individuals. The flu drug was promptly dispensed to individuals for prophylaxis. Physicians also regularly checked the duck farmers, their families, and the neighbourhoods, including the rescue teams. Public health personnel's ensured biosecurity measures and Personal protective equipment.

Environment and other allied Sectors: *The wildlife and forest department* played a crucial role in reporting any unusual deaths among wild birds and conducting post-mortem examinations of wild birds if any were found dead. *Laboratory workers* had a role in diagnosing disease conditions in all the avian species. *The Government* played the role to offer compensation to farmers for culling their birds. A *central government* team also visited the sites to probe the death of hundreds of birds in that area. *The tourism department* was on alert and helped reduce panic among local and foreign tourists present at the area at the time of the outbreak. *Media* had an important role in updating the bird flu status and spreading awareness and alert to inform about risks & prevention measures. *Food Safety officers* provided information on how to properly cook poultry products to make them disease-free and not pose a food safety risk for consumers.

Outcome: During mid of December 2014, the Kerala government lifted all restrictions imposed on the movement of poultry following the successful containment of the H5NI virus in the affected areas.

Systematic approaches to eliminate recurring HPAI outbreak in Kerala

It is nearly impossible for any endemically infected countries to eliminate H5N1 HPAI within five to ten years because it will take

many years to overcome all constraining factors and implement universal preventive measures. However, Kerala being the smallest land with the advantage of its globally recognized health management system, it is possible to establish infection-free zones and compartments and confirmation of its status through ongoing surveillance studies and disease investigations. Parts of Indonesia and the People's Republic of China have already done this. The systematic approaches to eliminate avian Influenza from Kerala are briefed below in table 1 and is summarised in figure 1.

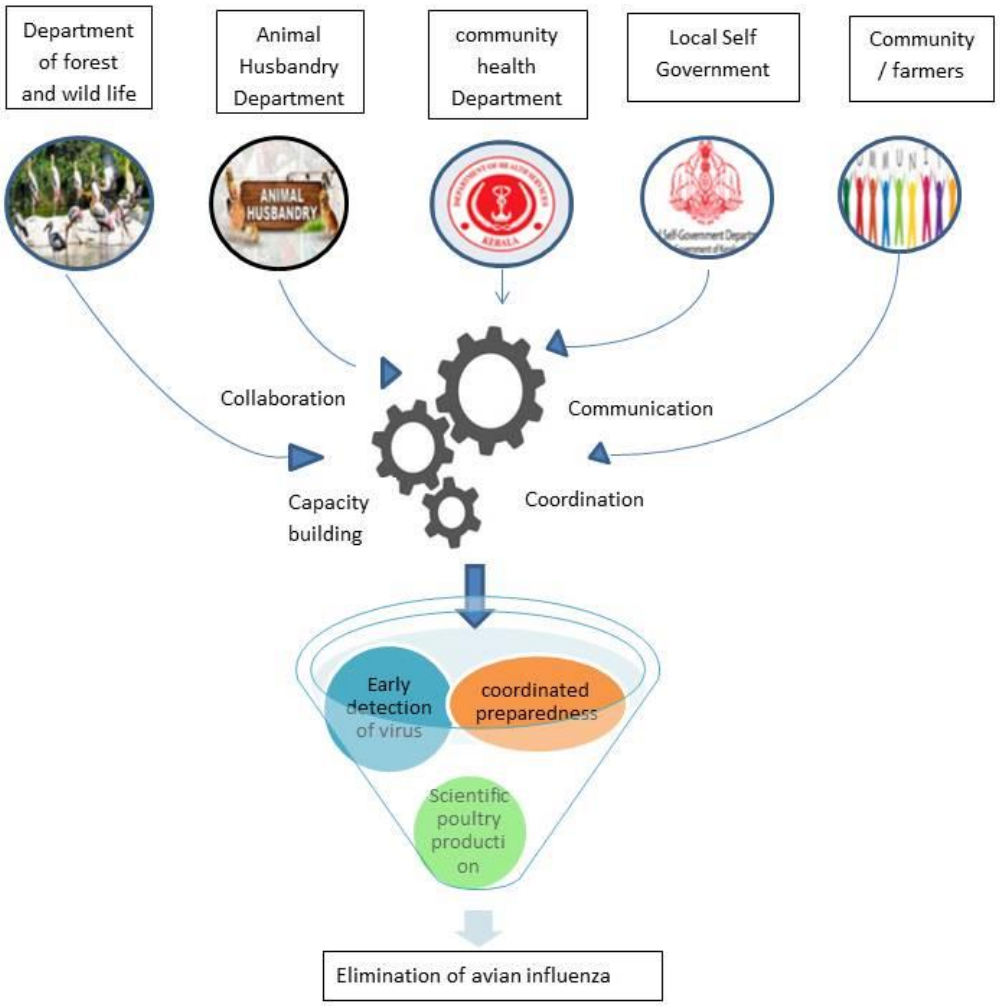

Fig 1. One health approach to eliminate avian influenza outbreaks from Kerala

Table 1. Objectives and expected outcomes of various systematic One health approaches suggested for controlling avian influenza outbreaks in Kerala

Objective	Expected Outcomes
Poultry integration for good production practices	
Modernization of poultry production: Integration of various poultry industry components, including hatcheries, farms, feed production units, meat shops, and rendering facilities, by the Government acting as an integrator and farmers acting as contractual farmers. The prime focus should be on farm biosecurity measures. With this, no farmers will be stepping out in the fear of economic loss as the compensation of the loss during the outbreak will be catered by the Government if proper biosecurity measures are in place	• Transforming the unorganized poultry production sector especially duck rearing into an organized sector. • Implementation of scientific intensive or semi-intensive production system with proper biosecurity measures. Farmers should not feel that investment in bio-security is costly, impracticable, inconvenient and cause personal discomfort: Neither will they be rebuked or ridiculed when they take precautions during times with no avian flu outbreak • Developing coordinated efforts among farmers and the Government • Farm registration and reporting of selective infectious diseases can be made mandatory

	• It is important that laws and guidelines should be farmer friendly, hence, the introduction of certification and gradation schemes will be good.
Channelizing live bird marketing	
Establish a strategic poultry marketing strategy that will be profitable based on business models.	By successfully balancing public and private interests, providing good bird rearing practises, focussing on welfare and consumer protection.
Improve the biosecurity and hygiene of live bird markets and understanding of risk factors along market chains	• Develop a tracking system for poultry and poultry products by combining the findings of market chain studies with surveillance programmes targeted at live bird markets
Vaccination strategy	
Effective vaccination programmes	Give decision-makers evidence-based information to review the bulk immunization plan and switch to targeted vaccination
Boost the process for determining vaccination effectiveness.	Complete documentation of the impact of vaccination
Boost the monitoring of vaccine effectiveness	Assure compulsory vaccination and establish avian influenza vaccine quality control system
Establishing One Health team by involving various stakeholders	
Form a One Health team	Apart from public health, veterinary, and wildlife departments, there should be involvement of Civil-administration involving the District Collector (DC), Revenue Officers, District Magistrate, Chairman and members of Panchayati Raj Institutions/ Municipality/ Local bodies, Officers of Health and other line departments
Enhance the communication channels between animal husbandry departments, health service, community health, forestry, local self-government, and the general public.	Establish a platform for information exchange between the general public, the public Health, veterinary, and wildlife departments.
Improve the internal vertical governance of services (nodal agency for One Health), upgrade the disease flow of information, and involve media to create awareness.	Establish internal coordination mechanisms and a clear and effective chain of command for most activities. Ensure transparency and disease data sharing Media to develop liaison with nodal agency to report confirmed new to avoid panic as well as to educate public
Disease surveillance and monitoring	
Enhance knowledge of disease dynamics and transmission cycles at the interface between domestic poultry, humans, and wildlife	Optimizes the use of results from various surveillance programmes conducted and conduct risk analysis, modelling and communication
More accurate data analysis from the active surveillance system	Create risk models utilizing surveillance data for various compartments. Disease management can be improved by accurately reporting the disease situation and giving thorough information about the local situation. Use risk modelling or risk mapping to accurately anticipate the level of risk by eco-geographical zones.
Outbreak reporting system	
Implementing a robust outbreak reporting system between sectors Improve the incentive system to encourage reporting outbreaks	Develop a proper disease reporting system at the government level and incentivizing reporting system at the farmers level. Samples are usually sent to to national labs for confirmation of outbreak. National labs (NIHSAD) communicates the results of testing of samples to the Secretary (AHD), Animal Husbandry Commissioner (AHC), Joint Secretary (Livestock Health) of the Department of Animal Husbandry and Dairying, Govt. of India, the Chief Secretary and Director, Animal Husbandry of the State concerned. Focus on timely diagnosis of Avian Influenza in birds, Isolation of the affected and exposed birds and prompt communication to the animal husbandry department for further reporting and action (MoFAHD, 2021)
Action on reporting	
Role of AHD & Public Health Departments of Kerala	Includes setting up of a control room in the State, constitution of Rapid Response Teams (RRTs), setting up of infected zone of 1 KM of radius from epicenter, surveillance zone of 1-10 KM radius of epicenter with details of population of birds involved in 1 KM radius for culling operations and 1-10 KM for surveillance zone, medicines/ disinfectants, Personal Protective Equipment (PPE) kits, health check-up and supply of oseltamivir/any other antiviral drugs (MoFAHD, 2021)
Laboratory capacity building	
Setting up of a BSL-3 avian influenza laboratory facility in Kerala	Quick diagnosis of the presence of virus

Improve the quality of existing laboratories.	Ensure standardization of sample collection, diagnostic procedures and data reporting Increase the accuracy and consistency of diagnostics among different institutes or agencies
Improve the ring test among laboratories.	For outbreak management
Capacity building	
Expand the pool of knowledgeable field epidemiologists to carry out efficient research on disease outbreaks and epidemiological studies	• Provide local epidemiologists with basic knowledge and skills through training. • Organize training of senior and key technical staff in advanced disease analysis and modelling techniques.
Provided sustainable capacity building program on epidemiology with respect to emerging disease control	Establish a national training curriculum on epidemiology to control of emerging diseases and conduct trainings involving cross sector.
Capacity building of farmers	Farmers need to be sensitized on Avian Influenza and should be able to answer the following questions: How serious is the Avian Influenza outbreak? What are the most significant risk factors in the Avian Influenza outbreak? What is a major concern in an Avian Influenza outbreak situation?
Collaborative research	
Veterinary, medical and Forest research institutes can collaborate and conduct research	• To undertake effective and appropriate surveillance of AI, particularly in the wild/migratory bird so for the forest areas and also recording of route map to notified water bodies, bird sanctuaries in the State regularly visited by wild and migratory birds • Research to learn more about the virus, for example, where they spread, how they spread, and what kinds of disease they cause. This includes antigenic characterization, antiviral resistance, genetic characterization, serology and assessment of bird flu viruses' ability to cause disease and spread in animal models • Research on vaccines

CONCLUSION

The most crucial requirement for preventing outbreaks is the early detection of viruses. Robust implementation of disease surveillance plans at the risk areas helps in early virus detection. HPAI surveillance in migratory birds could provide an early warning system that, when combined with the integration of poultry production and introduction of biosecurity practices could result in effective influenza control in Kerala. Further contributing to this is the coordinated efforts among the various stakeholders. Coordinated efforts of the departments like animal husbandry, health service, community health, local self-government system, farmers community and the general public is mandatory to prevent and control the outbreaks, and Kerala has been to achieve it successfully through the One health approach.

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