

**PROCEEDINGS: *Advancing Research Priorities for Highly Pathogenic Avian Influenza H5N1 Through International Collaboration***



*Photo credit: Marcela Uhart, UC Davis*

**St. John's, Newfoundland and Labrador | June 27, 2025**

# Advancing Research Priorities for Highly Pathogenic Avian Influenza H5N1 Through International Collaboration

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Hosted by the Royal Society of Canada, in collaboration with the Forum on  
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## Background

Since 2021, resurgent inter-continental waves of highly pathogenic avian influenza (HPAI) – influenza A(H5Nx) clade 2.3.4.4b viruses [fb2.1]– have caused a panzootic (the animal equivalent of a pandemic). This has resulted in unprecedented mortalities in wild birds, domestic poultry, and marine mammals in all global regions except Oceania (Australia, New Zealand and the Pacific Islands). Well over 600 million domestic birds have died and/or been destroyed globally in an attempt to control the spread of HPAI H5Nx viruses, resulting in substantial global economic knock-on effects. The virus has impacted vast numbers of wild birds, with over 6,800 documented outbreaks in the last two years alone.<sup>1</sup> In addition, spillover to mammals has led to mass mortality events of marine mammals, particularly pinnipeds, raising substantial concerns for wildlife conservation.<sup>2</sup> Critically, the range of species infected by this clade of HPAI H5Nx is unprecedented, underscored by recent and sustained intra- and inter-species transmission involving dairy cows and other domestic mammals as well as wildlife.<sup>3-8</sup> The spread of HPAI H5Nx virus among wildlife, livestock and human hosts is a powerful example of how the health of all species is intertwined, highlighting the rapidly shifting paradigm that One Health is public health.

In June of 2023, building on the open call to develop a One Health approach and Action Plan for Canada issued in the article *Strengthening a One Health approach to emerging zoonoses*<sup>9</sup>, the Royal Society of Canada (RSC) hosted a national, inter-sectoral meeting entitled “H5N1: Evolving Situation, Evolving Research.” At this meeting, there was consensus that a One Health approach is essential to addressing gaps in science, prevention, and risk reduction related to HPAI H5Nx. As well, it was agreed that robust cross-sectoral connectivity is essential for health intelligence, policy, and research. Participants discussed the need for cohesive efforts to dismantle barriers to capacity building, enhance inter-sectoral communication and data sharing, and build research collaborations.

This meeting was followed by a focused inter-sectoral meeting in May 2024. At this meeting, participants affirmed that HPAI H5Nx remained a global One Health challenge, requiring international engagement and participation and they advocated for a One Health approach that would integrate all key aspects of biological, epidemiological, and behavioural research across wildlife health, veterinary medicine, and human health. Near term goals focused on the intersection of wildlife, livestock, and humans and the need for ongoing, cross-sectoral and multidisciplinary research collaboration and coordination through a One Health focal point. The One Health focal point would act as a coordinating structure responsible for developing robust research to (i) better understand viral ecology and biology, (ii) expand countermeasures, (iii) integrate behavioural science and outreach (to garner trust across sectors, communities, and the public), and (iv) inform policy. Existing national capacity would need to be leveraged, and additional capabilities advanced and coordinated. Furthermore, HPAI H5Nx remains a global One Health challenge, requiring international engagement and participation.

In light of the ongoing HPAI H5N1 virus panzootic threat to global animal and human health, the RSC and the Forum on Microbial Threats of the U.S. National Academies of Science, Engineering and Medicine (National Academies) co-hosted a meeting of experts adjacent to the 11th International Symposium on Avian Influenza (ISAI) in St. John’s, Newfoundland, Canada in June 2025. Meeting participants had the opportunity to discuss international research collaboration opportunities in response to, and in preparation for ongoing HPAI H5Nx activity.

## Purpose

This meeting aimed to explore opportunities for international research collaboration for readiness and response. Leading scientific experts and representatives from research organizations, the public sector, non-governmental organizations and other stakeholder groups aimed to outline how priority research areas on HPAI H5Nx can be addressed through international collaboration. Meeting participants considered practical steps toward an actionable framework for international research collaboration.

## Opening Presentation and Fireside Chat

This discussion focused on understanding the existing research response landscape, including the boundaries which mark distinct siloes, the importance of proactive collaboration, and building resilience. The different communities of practice around HPAI H5Nx in wild birds, poultry, mammalian wildlife, humans, and most recently, dairy cattle were discussed. Nonetheless, there are several examples where such siloes have been dismantled to allow for greater coordination and collaboration for mutual benefit. The OFFLU (<https://offlu.org/>) response has leveraged working groups across relevant species, disciplines, sectors, and countries; regional and global expansion of these efforts would build additional resilience at population and systems levels. Also, research collaborations coalesced around HPAI H5Nx in Antarctica, where mutual goals around wildlife health favoured collaboration, enabled by infrastructure for data sharing. Given the range of technical and other capacities at regional levels, collaboration remains a key to success and sustainability.

Barriers to collaboration include limited cross-sectoral funding mechanisms, material and data sharing, including administrative and operational challenges associated with implementation of frameworks such as the Nagoya Protocol. There are also conflicting priorities and funding inequities within both academic and public sectors. Funding mechanisms, when not limited in amounts, are often siloed in other ways (jurisdictional, duration, operating vs infrastructure, etc.). In addition, although there is abundant goodwill among individuals who are often willing to share knowledge, expertise, and resources, trust among institutions and countries remains a critical issue. Mechanisms to overcome these barriers have been found through productive consortia including the well-established Centers of Excellence in Influenza Research and Response (CEIRR) Network (USA), a multidisciplinary and collaborative research network funded by the US National Institutes of Health, and more recently, the Kappa Flu Consortium (Europe), a multi-country, multi-institutional consortium funded by the European Union's Horizon Europe research and innovation programme, Innovate UK, and the Swiss State Secretariat for Education, Research, and Innovation. There are also a range of technical tools being advanced by members of the cross-sectoral research community that have the potential to bind collaborations (e.g. genotyping schemes, phylodynamics projects, standardized seroassays, environmental sampling efforts, collaborative novel vaccine approaches, mathematical and biological modelling, etc.). These also serve to balance descriptive and mechanistic research endeavours to ultimately generate evidence that is applicable to policy and decision-making across public (government and non-government) and private sectors. Critically, consortia and technical capacity-building also substantially strengthen resilience and enable proactive mitigation efforts, rather than relying on reactive approaches. This allows for more timely and relevant research responses that include a diversity of skills and perspectives and enables continent (rather than country) level responses.

HPAI H5Nx is a One Health challenge, and merits attention as such. This entails enabling research across species and sectors. Effective collaboration is strengthened by early and sustained involvement of researchers, decision makers, and stakeholders from poultry, wildlife, cattle, and human health communities of practice across a diversity of disciplines – diagnostics, virology, immunology, ecology, epidemiology, computational biology, social sciences, wildlife health, conservation, human and veterinary medicine, among others. This creates strong opportunities for interdisciplinary research collaboration and an effective One Health approach.

### Panel 1: Key Learnings and Knowledge Gaps

**Panelists were asked to identify key knowledge gaps and research questions that would benefit from multi-sectoral, multilateral, and international scientific collaboration.**

Panelists identified a range of gaps which included the persistence of research siloes and limited integration of expertise in social and implementation science, particularly at the human-animal interface. There was also a call to conduct research directed by the needs of producers, veterinarians, and others in the agricultural field, whose participation in research is critical. Strong cross-disciplinary relationships were built between researchers, public health practitioners and decision makers during the SARS-CoV-2 pandemic, and there are also well-established networks among veterinary and wildlife health researchers and policy-makers. However, historically,

there has been less direct, functional overlap between these human and animal communities of practice. There was substantive emphasis on strengthening a mindset that promotes prevention and preparedness, as well as response across One Health-related sectors.

**Knowledge and research gaps.** Discussion highlighted challenges in integrating data into decision-making for preparedness, including medical countermeasures, across wildlife, livestock, and human health sectors. Opportunities to exchange data, knowledge and expertise across sectors and disciplines remain limited.

While the ISAI meeting provided an important forum to address some of these gaps with broad disciplinary representation, gaps persisted in key areas of subject matter expertise including social sciences, economics and trade, geopolitics, health security. Gaps in geographic representation, including under-representation of participants from low-income countries and the Global South. The lack of Indigenous representation at the meeting was also acknowledged as a limitation.

Participants identified specific research gaps, including missed opportunities to better link field-based observations (“ground truth”) with basic science research, as illustrated by the following examples:

1. Understanding viral determinants of cross-species transmission
2. Understanding low pathogenicity avian influenza (LPAI) vs HPAI viral dynamics and reassortment
3. Knowledge of immune response and pathogenesis across species
4. Conducting serosurveillance across species (inclusive of wildlife-exposed humans)
5. Insights into the diversity of HPAI H5Nx genotypes circulating in Asia and other regions
6. Understanding the role of ecosystem health (e.g. water, food sources for wild birds, impact of climate change and land use change) on HPAI H5Nx dynamics
7. Understanding the impacts of HPAI H5Nx on biodiversity and ecosystems
8. Altered biosecurity and animal production in the context of a zoonotic
9. Understanding the impact(s) of livestock vaccination on viral ecology (including LPAI viruses) and diversity (including reassortment)

**Operationalizing a One Health approach.** That HPAI H5Nx research merits a systems approach was underscored by several panelists. While a One Health approach has been advanced by many, it has not been consistently operationalized, due in part to siloed government agency mandates and academic research funding structures. Addressing this would require coordinated priority-setting aligned with the strengths and capacities of individual researchers, consortia, and networks.

National multi-stakeholder organizations, such as Animal Health Australia and Animal Health Canada, have advanced cross-sectoral and cross-disciplinary engagement. Coordination efforts have also been developed, where federal and inter-agency mechanisms support One Health approaches to HPAI H5Nx. Through recognition that events occur at the agriculture-wildlife-human interface, there is robust inter-agency engagement. However, many of these efforts have largely operated at the national level, and inter-governmental and transboundary collaboration remains limited. Recent changes in federal capacity in the United States of America, including decreased funding, surveillance activities, and contributions to WHO and other international organisations, may have implications for both domestic and global efforts. Inter-governmental and transboundary initiatives still require further development (e.g. the WHO’s Global Emergency Corps, acknowledging that research is not the primary focus of this entity). The importance of synthesizing a consensus statement of primary goals was also raised.

**Costs and benefits of research and response.** The distribution of costs and benefits across sectors and populations was also discussed, with recognition that these dynamics affect livelihoods, communities, and trade at national and international levels. The value of involving policymakers and stakeholders such as producers in scientific discussions was emphasized as a means of supporting the translation of science into action. When key stakeholders understand how data can be used and the value-added by data sharing, trust can be strengthened. Greater consideration of private sector interests, including those of the livestock and biomedical sectors, was also identified as important. While vaccine manufacturers may develop countermeasures that are ultimately

approved, challenges remain in stockpiling, distribution, and implementation across different host species. Inclusion of perspectives from low- and middle-income countries was also emphasized.

## Panel 2: Opportunities to Address Gaps

**Panelists were asked to discuss strategies, research partnerships, and enabling infrastructure to address the key knowledge gaps identified during the symposium.**

**Research support in a changing world order.** Participants discussed evolving challenges related to shifts in government support for surveillance, reporting, research, pandemic preparedness, and vaccine development in several jurisdictions. It was noted that changes in the number of reported human and dairy cattle cases of HPAI H5Nx in the United States may reflect changing epidemiological patterns and/or limitations in testing and reporting. Broader shifts in government priorities were also identified as influencing support for science and public sector capacity. While changes in public sector engagement may create gaps, they may also present opportunities for new forms of leadership, including from underrepresented sectors, regions, and populations. For example, increased engagement from countries in the Global South, who represent the global majority, as equal partners in research, funding, and innovation was highlighted as an important opportunity. Participants noted the importance of diversifying leadership and funding models to support a timely and effective research response. In this context, private funders, professional societies, and international scientific bodies (e.g., the G7 Academies) were identified as potential contributors to strengthening collaborative research efforts.

**The value of surveillance.** In terms of potential opportunities and solutions, panelists underscored the untapped potential for knowledge which could be derived from surveillance data. A fundamental first step is to prioritize basic, field-level capacity including reporting systems, training for sample collection, and real-time response protocols. Strengthening mechanisms and enabling conditions for timely and transparent reporting of infections in a manner consistent with international animal health reporting frameworks was also highlighted as critical to maintaining situational awareness. Delays in data sharing or gaps in reporting can substantially limit the ability to assess risk and respond effectively at both national and international scales. For example, in 2023, South America accounted for 77% of global wild bird mortality, yet only 1% of publicly available viral genome sequences originated from the region. Similarly, for mammals in 2023, 80% of global mortality occurred in South America, but only 12% of sequences were from this region.<sup>10</sup> These discrepancies likely reflect a combination of factors, including differences in surveillance capacity, resources, access to sequencing infrastructure, and funding prioritization, which critically highlight opportunities to strengthen capacity in regions that are currently underrepresented in global datasets. While surveillance is infrequently framed as research, it often underpins hypothesis-driven, strategic approaches that both address key research questions and provide critical field-based evidence. Panelists underscored the gap between the importance of the sample collection, storage and analysis and the limited support for the extensive and challenging fieldwork on which the follow-on, hypothesis-drive research depends. There are emerging diagnostic and -omics technologies which offer opportunities to better integrate field and lab efforts and amplify the value of samples collected. Participants also highlighted opportunities to design surveillance more strategically to reduce bias in the data and more accurately reflect the situation on the ground, particularly in under-represented but highly affected areas. This could be partially achieved through strengthening local engagement, which would also lead to co-benefits including capacity-building, training, and infrastructure developments that support sustained participation.



Photo credit: Robert Ronconi, Environment and Climate Change Canada

**The value of collaborative centres of excellence.** In terms of programs, CEIRR was foregrounded by several panelists and participants as a highly successful program, in large part due to long-term funding which allows for building partnerships, trust, and an exceptionally well-trained workforce. Momentum is lost with shorter-term grants as capacity falters, requiring repeated re-establishment of resources and institutional memory.

*The concept of a federated CEIRR network was proposed.* This would entail establishing regional centres across global regions, underpinned by infrastructure for collaboration between centres and supported by long-term, sustainable funding for regional research and surveillance priorities. The success of this would be enabled through collective leadership to advance research on HPAI, overcome administrative barriers, and facilitate research with robust but enabling practices in biosafety and biosecurity. A CEIRR-type of network could also further a model for One Health collaboration by centering this approach to ensure integration of health research across species and ecosystems. Panelists drew attention to substantial efforts to assess risk, and map/implement mitigation activities, yet these activities have not been sufficient to stem HPAI H5Nx spread and evolution. Response networks may be too slow or fragmented, which may limit their ability to preserve ecological and food systems or protect agricultural workers. Participants highlighted the importance of reassessing both existing and emerging research and interventions.

**Connecting frontlines for an allied approach.** Connecting with the agricultural and wildlife frontlines would create opportunities to directly inform research priorities and support real-world applications. More equitable and inclusive collaboration was identified as an important consideration, including research conducted at both community and transboundary levels. Furthermore, partnerships with industry, including diagnostic and pharmaceutical sectors, along with the agricultural sector (swine, cattle, poultry) and trade organizations, are essential to implementing practical solutions. Strategies to build trust with these sectors as well as the public were highlighted as important for enabling relevant research and supporting effective outcomes.

**The role of the G7 Academies.** There is also an important role for the G7 Academies, which can help shape the scientific and policy landscape through engagement and collaboration. Some efforts already exist, which could serve as useful models for discussions on broader pandemic preparedness. For example, there may be opportunities for the G7 Academies to work together to convene leading experts to highlight key issues, share progress on data sharing and sample collection, address difficult research and policy questions, and inform decision-makers related to HPAI detection, mitigation, and long-term preparedness.

**The value of inter-governmental organizations.** Meeting participants considered the value of organizations collectively endorsing scientific priorities and highlighting opportunities for the WHO, other inter-governmental agencies, and nation-states to consider adopting or revising guidance to better enable data- and sample-sharing, which remain substantial barriers for HPAI research. Such an approach could help address inefficiencies arising from different data and sample sharing policies across countries and organizations. For example, studying more than one type of pathogen from the same sample may require entirely different sets of approvals. There are also substantial difficulties associated with moving and retaining wildlife samples due to different regulatory frameworks. Strong, consensus statements from the scientific community articulating this work as a One Health, conservation, and public health priority could help inform national policies and support momentum toward more efficient and transparent collaboration between countries, institutions, and researchers.



Photo credit: Marcela Uhart, UC Davis

## Breakout Groups

Five breakout groups of 10-12 individuals with diverse regional and disciplinary representation were formed to address the following questions:

*What are the top 2-3 research questions or knowledge gaps related to H5N1 that would most benefit from international coordination, and why?*

*What could successful international collaborative research look like?*

*What are the most critical barriers—political, logistical, technical, or otherwise—to this kind of collaboration, and how might they be addressed?*

*What concrete next steps should be taken to move this forward—including priority actions, key stakeholders to engage, and how we can sustain momentum beyond this meeting?*

A collation of breakout group discussions is compiled by theme below:

## Life Sciences

A cohesive global approach is essential for prioritizing shared research goals, coordination of efforts and enabling scientific progress and knowledge mobilization. The implementation of standardized methodologies and nomenclature would provide means to compare and integrate data from experimental work and computational analyses to inform risk assessments and the development of countermeasures.

1. What are the drivers of viral evolution and genomic and antigenic shifts across regions and species? An understanding of these determinants from molecular, individual host and population and ecosystem levels is needed to gain insights informing surveillance, control, and medical countermeasure development.
2. There are major knowledge gaps around host species susceptibility and response, and risk to health and conservation across different emerging HPAI viruses globally.
3. Integrated risk assessments for novel genotypes remain critical to anticipating risk of spillover and virulence. Composite data around host immunity, transmission, host-pathogen interactions and disease in pertinent host species and the identification of species-specific determinants of tolerance vs disease will inform risk.
4. There are also questions around understanding the establishment of novel viral reservoirs, particularly among mammals in remote or under-sampled regions that merit attention.

5. Extending relevant lessons from seasonal influenza viral evolution and response to vaccination may inform vaccine research for avian influenza. This includes applying predictive modeling approaches, genomic interpolation of antigenic mapping, and integrating signals across populations. These may address specific questions such as which viral clades are likely to expand and possibly dominate, and implications for transmission and disease.
6. Participants also underscored the importance of advanced research in vaccine development including novel platforms such as mRNA and self-amplifying vaccines, the use of adjuvants, and characterization of host response and protection across species, and that efforts would be strengthened through coordinated vaccine trials.

## Behavioural Sciences

Behavioural and communication sciences are critical to understanding drivers and enablers of viral spillover, as well as optimizing the implementation of effective pharmaceutical and non-pharmaceutical countermeasures.

1. What are the behavioural and social drivers of transmission dynamics across different species? This entails understanding barriers and enablers of behavioural change, including those related to livestock supply chains, animal movement, on-premise husbandry, and biosecurity and biosafety practices.
2. How can behavioural sciences be integrated into outbreak analyses to better understand drivers of individual outbreaks and inform behavioural interventions.
3. What are the determinants of vaccine acceptability and uptake? Addressing this key issue can support efforts to mitigate negative perceptions related to safety and effectiveness.

## Ecosystems and Economics

While these topics were identified by workshop participants, it is essential to also solicit research priorities from a broader range of stakeholders across human, livestock and wildlife sectors and across global regions, to enable engagement and address host, ecosystem, and economic considerations across borders.

1. Understanding HPAI virus impacts on wildlife populations and ecosystems, and determinants of species and population recovery following declines, would benefit from an integrated approach spanning health, ecology, conservation and environmental sciences. This includes improving understanding of upstream drivers to help mitigate risks to wildlife and ecosystems.
2. Key global policy questions related to biosecurity, trade, and governance would benefit from a systems-based approach that integrates health, economics, political, behavioural and implementation sciences.
3. Foodborne risk pathways merit further study, particularly as they relate to animal movement and trade, product distribution, and at a more granular level, infectivity of specific food products.
4. There are major gaps in understanding the economic impacts of the HPAI panzootic. While poultry depopulation data may provide a baseline estimate, knock on economic effects including those related to dairy herd outbreaks, food security, employment, and trade remain incompletely characterized.

## Transdisciplinarity and Collaboration

Despite the global nature of the problem, the absence of a coordinated global research framework has contributed to a fragmented research response. Such a framework could support integration across disciplines (biology, ecology and behavioural sciences) and sectors, linking academic research with public health and industry needs, while facilitating coordination without being overly prescriptive. It could also help alleviate the substantial barriers related to the movement of samples, viruses and data, for example through the development of trusted, curated international data sharing platforms across relevant species.

1. Successful international collaborations can be supported through enabling infrastructure that facilitates coordination while minimizing administrative burden. The CEIRR network was again raised as a potential model, which enables research to be carried out across multiple sites, based on regional priorities, but supported by a common funding pool. This approach would facilitate shared activities such as integrated risk assessment, while building in sufficient redundancy and minimizing unnecessary overlap.

2. Another model discussed involved bilateral collaborations. However, these can be influenced by differing funding structures, variations in partnership terms, and constraints related to duration, scale, and coordination.
3. Existing models are often limited geographically and may not consistently include low- and middle-income countries (LMICs) as primary partners. Strengthening linkages with existing public health infrastructure across jurisdictions, including LMICs, could help promote more equitable collaboration. Prioritizing trust-building in impacted communities through early and sustained engagement was also identified as an important component of effective collaboration.
4. From a technical perspective, collaborations to adapt existing influenza models to avian influenza would extend the existing toolbox of mathematical, *in vitro*, and *in vivo* and other systems.
5. Research and development for cost-effective, point of need/field-ready diagnostic assays would also be of substantive use to enable strategic surveillance. In addition, shared, curated data and intelligence sharing for international surveillance could be integrated within a CEIRR network, and incentivized by the same mechanism.

## Funding Gaps

This remains the most significant impediment to a cohesive and collaborative approach for HPAI research.

1. Ways and means of sustainable funding by the global community (e.g. GLOPID-R, existing and new partners) is essential. Grant review by diverse and expert panels is ideal but may be challenging given the limited size of the research community.
2. Representation across sectors and from people with lived experience (e.g. affected producers, hunters and harvesters) is important. Private sector (agricultural, pharmaceutical, diagnostic) partners are also essential and should be fully engaged.
3. Critical barriers include funding constraints, including a cost paradox whereby reagents can be more expensive in LMICs. International funding mechanisms remain limited and can present management challenges.
4. Sample, reagent and data sharing are influenced by regulatory and policy frameworks, including instruments such as the Nagoya protocol and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), as well as differing institutional or stakeholder priorities and potential conflicts of interests which may affect collaboration.
5. **The administrative burden associated with conducting research was identified as a growing challenge, which can influence how research activities are prioritized and implemented (e.g., decisions that can be driven by administrative feasibility, rather than driven by science).** These barriers also affect skilled workforce development and retention, particularly in LMICs.
6. Incentives for research remain a challenge. These tend to focus on individual career advancement rather than broader public health or societal outcomes. Clinical practitioners, responders and government scientists often face competing priorities, particularly during health emergencies. These factors can influence the timeliness of research needed to inform public health and may limit opportunities to investigate livestock and wildlife health.
7. Trust-related challenges remain within and across sectors, between researchers and stakeholders, and at broader geopolitical levels, which may further affect progress in the research response.

## Insights and Recommendations

Research gaps that merit **immediate attention through international collaboration** include (but are not limited to) the following areas:

- Advancing virus detection, genomics, phenotyping and serosurveillance across wildlife, livestock and human hosts and regions
- Understanding viral ecology, dynamics, reassortment and adaptation between HPAI and LPAI viruses across host species

- Understanding viral and host determinants of disease severity and inter-species transmission at the virus-wildlife-livestock-human nexus
- Understanding adaptive and innate host responses, and tolerance vs. disease across all host species
- Advancing understanding of the upstream ecological and anthropogenic drivers of HPAI virus emergence and spread, alongside the impacts of HPAI on biodiversity and ecosystem health
- Enhancing understanding of how livestock production systems and biosecurity practices shape HPAI virus introduction, amplification, and control at the wildlife-livestock interface
- Understanding contributing human factors and identifying solutions informed by behavioural sciences

There are limited opportunities, such as the ISAI meeting, for researchers focused on HPAI to convene and develop collaborations. Establishing a forum focused on HPAI research that also includes knowledge users from health and private sectors across global regions would substantially strengthen the value of research enterprises.

There was consensus among participants that barriers to material and data sharing persist as major challenges for international research collaboration. These challenges are influenced by inter-governmental agreements and would benefit from coordinated international efforts to effectively and urgently address them. **The CEIRR Network was highlighted as a potential model for broader, international collaboration**, with a sustained track record of supporting effective research partnerships. Expanding or adapting this model internationally could help address the research and operational gaps identified; **scaling this model globally would represent a concrete mechanism for action**.

## Summary

This summary table has been adapted from the framework described in the *Quadripartite One Health Joint Plan of Action, Action track 2: Reducing the risks from emerging and re-emerging zoonotic epidemics and pandemics*<sup>11</sup> post hoc, to reflect the workshop’s focus on research. Some subtracks have been collapsed together thematically to reflect workshop discussions and for the sake of brevity.

Research and Related Activities	Gaps	Actions
<b>Action 2.1. Understand the drivers of emergence, spillover and spread of zoonotic pathogens</b>		
Develop guidance and conduct coordinated, harmonized and systematic data collection, operational and behavioural research and risk assessments (biological and epidemiological) on the drivers, processes, pathways and impacts of zoonotic disease emergence, spread and persistence	There are major knowledge gaps around (but not limited to): <ul style="list-style-type: none"> <li>• drivers of virus evolution and spillover and phenotypic</li> <li>• characterization of emerging genotypes</li> <li>• host species susceptibility, immune response, and disease</li> <li>• risk to population health and conservation for wildlife</li> <li>• ecological, epidemiological and biological risks associated with novel genotypes across host species</li> </ul>	Establish a global CEIRR-like network of national centres, underpinned by infrastructure for collaboration between centres and supported by long-term, sustainable funding for regional research priorities; <p>Galvanize and fund collaborations among researchers from wildlife, poultry, cattle, and human health communities of practice involving a range of disciplines, including (but not limited to) diagnostics, virology, immunology, ecology, computational biology, and mathematical modelling, epidemiology, behavioural sciences, economics and policy.</p>

Research and Related Activities	Gaps	Actions
Develop a One Health indicator framework to monitor the health of humans, wildlife, domestic animals, and the environment	Data from human health, livestock and wildlife sectors are not harmonized in how they are supported, generated or shared	Reduce barriers (technical, regulatory, administrative) to materials and data sharing;  Support existing infrastructure for monitoring HPAI across species and global regions where it exists <b>and</b> expand where it is needed.
Support science-policy interfaces ensuring scientific knowledge is translated into action	There are limited opportunities for productive and sustained interactions between scientists, policy makers and stakeholders across sectors  There are limited opportunities for research directed by the needs of producers, veterinarians, and others in the agricultural field	Strengthen existing bodies such as ISAI organisers, the scientific Academies, OFFLU, and the Quadripartite to enable engagements around science and policy;  Integrate key stakeholders in research collaborations to inform, participate in, and benefit from the research
Identify One Health research gaps and priorities, develop a research agenda and advocate for funding	Current pathways are often fragmented and siloed in many jurisdictions. Funding is often too limited and short-term, which can affect sustained impact. As a result, momentum may be difficult to maintain, with capacity needing to be re-established over time, including workforce and institutional memory	Enable a global research network based on the CEIRR model as an approach to support the development of a coordinated research agenda;  Coordinate funding agencies, private funders, professional societies, and the G7 Academies to play an expanded role in supporting engagement and funding timely research efforts
<b>Action 2.2. Identify and prioritize targeted, evidence-based upstream interventions to prevent the emergence, spillover and spread of zoonotic pathogens</b>		
Support joint One Health risk assessments and mapping, incorporating land-use planning	These efforts are not well coordinated across sectors or jurisdictions, and there are important gaps in understanding the role of anthropogenic change in HPAI ecology and evolution	Establish an international network to develop an integrated research plan of action at the virus-host-population-ecosystem nexus, spanning scales of work from the microscopic (molecules) to macroscopic (environments), with an emphasis on interactions
Establish standards and raise awareness among stakeholders for the management of ecosystem processes, including mainstreaming habitat degradation prevention	There is limited knowledge around the impact of HPAI on biodiversity and ecosystems	Integrate subject matter experts in landscape ecology, environmental sciences, land use planning and policy in research collaborations through an international, CEIRR-like network
Engage with local communities, including Indigenous Peoples, to conduct participatory and gender-based research to identify behaviours, acceptance, and feasibility of risk mitigation measures	There is limited integration of expertise in social and implementation science, particularly at the human-animal interface	Develop initiatives to support local and community engagement to enable more strategic surveillance, reduce bias in data, and better reflect ground truths more accurately. Incorporating community benefit sharing (eg. capacity-building, local training, or infrastructure improvements) may further support participation within international research networks

Research and Related Activities	Gaps	Actions
Support global strategies on zoonotic diseases and ensure synergy and cohesiveness at global, regional, and national levels	The full range of private sector interests, including the livestock industry, and biomedical sectors are inadequately integrated with research programs, yet bear significant roles around prevention, response and specific operations including biosecurity and the stockpiling, distribution and administration of countermeasures across different host species	<p>Build a CEIRR-like network with consortia inclusive of</p> <p>1) expertise and stakeholders capable of advancing pharmaceutical and non-pharmaceutical (e.g. biosecurity) capacity-building and innovation to substantially strengthen resilience and enable proactive mitigation efforts. Promote allied approaches conducting research at both community and transboundary/multinational levels, and</p> <p>2) Academic, public sector and industry experts from the Global South, to lead regional and global research and innovation efforts</p>
Conduct analysis of existing legislation, and economic analyses relevant for each sector	<p>There are gaps in understanding the economic impacts and legislative levers associated with HPAI, partly reflecting limited integration of relevant subject matter expertise (e.g. social sciences, economics and trade, geopolitics, health security) and geographic representation, including from the Global South</p> <p>There are inconsistencies in the distribution of costs and benefits across sectors and populations and disproportionate impacts on livelihoods, communities, and nation-states through trade</p>	<p>Integrate research aims and expertise around policy/legislation, social sciences and economics in research efforts;</p> <p>Highlight opportunities for the WHO, other inter-governmental agencies, and nation-states to adopt or revise guidance to better enable data- and sample-sharing, which remain substantial barriers to HPAI research</p>
<b>Action 2.3. Strengthen national, regional and global One Health surveillance, early warning and response systems</b>		
Develop tools and resources for surveillance and data sharing at human-animal-ecosystem interfaces	There are gaps in serosurveillance across species and an understanding of viral determinants of cross-species transmission, LPAI and HPAI viral dynamics and reassortment, and the diversity of HPAI genotypes (including non-clade 2.3.4.4b) circulating in Asia and other regions	<p>Establish surveillance across species as an essential activity, supported in a fundamental, sustained and harmonised manner. A fundamental first step is to prioritize basic, field-level capacity: reporting systems, training for sample collection, and real-time response protocols;</p> <p>Maximize the value of surveillance data through follow-on analyses and research to translate data into actionable knowledge</p> <p>There should be clear, strong links between the conduction of surveillance and scientific and policy-oriented use and uptake of those outputs</p>

Research and Related Activities	Gaps	Actions
Develop guidance and capacity for biosecurity, controls and management pathways, regulatory frameworks and resource sharing	There are gaps in coordination of key research question development and mechanisms to address this, including research around biosecurity and animal production in the context of a panzootic	Support collective leadership to advance research on HPAI, including through international engagement to address challenges related to material transfer and to support enabling biosafety and biosecurity practices in both laboratory and agricultural settings.
Establish frameworks and technical networks for surveillance and predictive health intelligence at human-animal interface	In some jurisdictions, levels of surveillance characterization (e.g., whole genome sequencing) remain limited relative to virus activity , particularly in regions with more constrained capacity, including parts of the Global South. Operational infrastructure across regions is also not consistently integrated	Strengthen mechanisms and enabling conditions for timely and transparent reporting of detected infections - consistent with international animal health reporting frameworks
Use pandemic risk assessment tools (eg TIPRA) to proactively identify pre-pandemic vaccine candidates	There are numerous gaps in the use of existing risk assessment tools (e.g. limitations around biocontainment capacity), and the tools which exist focus on human health, thus lacking elements around livestock health, viral ecology, and viral pathogenesis and host response in non-human hosts	Integrate existing risk assessment tools in research initiatives and expand these to include risk assessment for non-human hosts. This entails generating composite data that include host immunity, transmission, host-pathogen interactions and disease in pertinent avian and mammalian host species and the identification of species-specific determinants of tolerance vs disease to inform risk
Leverage innovations and new technologies in disease surveillance, rapid response and control	There are siloed funding opportunities, particularly across species, leading to opportunity costs around research innovation	Advance emerging technologies which could bridge the field and the lab and amplify the value of samples collected; technical tools have the potential to bind collaborations around: <ul style="list-style-type: none"> <li>▪ diagnostic innovations for surveillance, case identification, outbreak management and clinical trial support;</li> <li>▪ multi-omics for pathogenesis, and host response;</li> <li>▪ structural and systems biology for targeted/rationally designed pharmaceutical countermeasures;</li> <li>▪ novel vaccine platforms</li> </ul>

In summary, participants identified several near-term opportunities including: 1) build on this meeting and the 11th ISAI by holding the 12th ISAI within the next 2-3 years, 2) galvanize the international funding community around a sustainable model for collaborative avian influenza virus research, and 3) establish an actionable international research collaboration based on the CEIRR Network model. These opportunities may be particularly timely and relevant in the context of evolving funding landscapes across regions.

## References

1. WOAHA High Pathogenicity Avian Influenza Situation Report 78. <https://www.woah.org/en/document/high-pathogenicity-avian-influenza-hpai-situation-report-78/>.
2. Leguia, M. *et al.* Highly pathogenic avian influenza A (H5N1) in marine mammals and seabirds in Peru. *Nat. Commun.* 14, 5489 (2023).
3. Alkie, T. N. *et al.* Characterization of neurotropic HPAI H5N1 viruses with novel genome constellations and mammalian adaptive mutations in free-living mesocarnivores in Canada. *Emerg. Microbes Infect.* 12, 2186608 (2023).
4. Jakobek, B. T. *et al.* Influenza A(H5N1) Virus Infections in 2 Free-Ranging Black Bears (*Ursus americanus*), Quebec, Canada. *Emerg. Infect. Dis.* 29, (2023).
5. Burrough, E. R. *et al.* Highly Pathogenic Avian Influenza A(H5N1) Clade 2.3.4.4b Virus Infection in Domestic Dairy Cattle and Cats, United States, 2024. *Emerg. Infect. Dis.* 30, (2024).
6. Garg, S. *et al.* Highly Pathogenic Avian Influenza A(H5N1) Virus Infections in Humans. *N. Engl. J. Med.* 392, 843-854 (2025).
7. Jassem, A. N. *et al.* Critical Illness in an Adolescent with Influenza A(H5N1) Virus Infection. *N. Engl. J. Med.* 392, 927-929 (2025).
8. Einfeld, A. J. *et al.* Pathogenicity and transmissibility of bovine H5N1 influenza virus. *Nature* 633, 426-432 (2024).
9. Mubareka, S. *et al.* Strengthening a One Health approach to emerging zoonoses. *FACETS* 8, 1-64 (2023).
10. Ralph E. T. Vanstreels, R.E.T. *et al.* Differences in surveillance and reporting among countries may distort our understanding of the impacts of HPAI on wildlife in the Americas. 11th International Symposium on Avian Influenza. June 24 - 26, 2025. St. John's, Newfoundland, Canada.
11. One health joint plan of action (2022-2026): working together for the health of humans, animals, plants and the environment. <https://www.who.int/publications/i/item/9789240059139>.

## Appendix 1 | Participants

Tamiru Alkie, Canadian Food Inspection Agency  
Anna Bellos, Public Health Agency of Canada  
Yohannes Berhane, Canadian Food Inspection Agency  
Elizabeth Billington, Animal and Plant Health Agency (Rapporteur)  
Juliette Blais-Savoie, University of Toronto (Rapporteur)  
Andrew Bowman, The Ohio State University (Panelist)  
Rick Bright Bright, Global Health (Moderator)  
Joseph Cavallari, Canadian Institutes of Health Research  
Marisa Creatore, Canadian Institutes of Health Research  
Emily Denstedt, Wildlife Conservation Society (Panelist)  
Meagan Dewar, Federation University Australia (Discussion Lead)  
Titus Divala, Wellcome Trust  
Lori Engler-Todd, Office of the Chief Science Advisor  
Ron Fouchier, Erasmus MC (Panelist)  
Alice Fusaro, Istituto Zooprofilattico Sperimentale delle Venezie (IZSVe)  
Jolene Giacinti, Environment and Climate Change Canada (Organizing Committee, Discussion Lead)  
Murray Gillies, Atlantic Veterinary College  
Amy Greer, Trent University (Panelist)  
Jean-Luc Gu erin, IHAP - National Veterinary School of Toulouse and INRAE  
Gordon Hickman, Head of Exotic Disease Control Policy, Defra, UK  
Sarah Hill, Royal Veterinary College  
Chelsea Himsworth, BC Ministry of Agriculture  
Marcel Klaassen, Deakin University  
Keith Klugman, Gates Foundation  
Mahesh Kumar, Zoetis  
Andrew Lang, Memorial University of Newfoundland (Discussion Lead)  
Michelle Lavery, Open Philanthropy  
Kara Lee-Aves, Novo Nordisk Foundation Initiative for Vaccines and Immunity  
Jasmina Luczo, CSIRO Australian Centre for Disease Preparedness  
Russel MacDonald, Royal Society of Canada  
Katharine Magor, University of Alberta  
Finlay Maguire, Dalhousie University  
Angela McLaughlin, Guelph University (Rapporteur)  
Christine Middlemiss, Department for Environment Food and Rural Affairs

Samira Mubareka, University of Toronto (Organiser)  
Mitchell Mumby, Western University (Rapporteur, Organizing Committee)  
Martha Nelson, National Institutes of Health  
Stephen Ostroff, Ostroff Consulting (Panelist)  
Rokshana Parvin, Bangladesh Agricultural University  
Gounalan Pavade, World Organisation for Animal Health  
Daniel Perez, University of Georgia (Discussion Lead)  
Anne Pohlmann, Friedrich-Loeffler-Institut | Federal Research Institute for Animal Health (FLI)  
Kerry Robinson, Public Health Agency of Canada  
Nadine Sicard, Public Health Agency Of Canada  
Anthony Signore, Canadian Science Centre for Human and Animal Health, National Centre for Foreign Animal Disease  
Heather Smith, Fisheries and Oceans Canada (DFO)  
Clare Stroud, National Academies of Sciences, Engineering, and Medicine (Organiser)  
Tina Thorslund, Novo Nordisk Foundation  
Mia Torchetti, USDA-APHIS, National Veterinary Services Laboratories  
Marcela Uhart, UC Davis One Health Institute, Karen C. Drayer Wildlife Health Center (Panelist)  
Bryce Warner, Vaccine and Infectious Disease Organization (Panelist)  
Richard Webby, St. Jude Children's Hospital, WHO Collaborating Centre for Studies on the Ecology of Influenza in Animals and Birds (Moderator)  
Michelle Wille, University of Melbourne (Speaker, Panelist)  
Frank Wong, CSIRO Australian Centre for Disease Preparedness  
Yan Zhou, Vaccine and Infectious Disease Organization



# Advancing Research Priorities for Highly Pathogenic Avian Influenza H5N1 Through International Collaboration

## Sheraton Hotel Newfoundland | June 27, 2025

JUNE 27, 2025 | 8:00 – 15:00 NDT

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### Purpose

In light of the ongoing HPAI virus A (H5N1) panzootic threat to global health, we aim to discuss opportunities for international research collaboration for readiness and response to highly pathogenic avian influenza (HPAI). Leading scientific experts and representatives from research organizations will outline how priority research areas on HPAI can be addressed through international collaboration. We aim to identify the first steps toward developing an actionable framework for international research collaboration.

**7:30 AM**      **Arrival (30 min)**

*Light breakfast and coffee available in lobby*

**8:00 AM**      **Opening Remarks (10 min)**

**Samira Mubareka**, University of Toronto

**Clare Stroud**, U.S. National Academies of Sciences, Engineering, and Medicine

**8:10 AM**      **Opening Presentation & Fireside Chat (30 min)**

Moderated by **Richard Webby**, St. Jude Children's Hospital

**Michelle Wille**, University of Melbourne, Centre for Pathogen Genomics

**8:40 AM**      **Panel 1: Key Learnings & Knowledge Gaps (60 min)**

*Synthesis of the symposium & articulation of knowledge gaps that emerged from the week's discussions*

Moderated by **Richard Webby**, St. Jude Children's Hospital

**Andrew Bowman**, The Ohio State University

**Amy Greer**, Trent University

**Bryce Warner**, Vaccine and Infectious Disease Organization, University of Saskatchewan

**Michelle Wille**, Centre for Pathogen Genomics, University of Melbourne

**9:40 AM**      **Break (20 min)**

**10:00 AM**      **Panel 2: Opportunities to Address Gaps (60 min)**

*Discussion of strategies, research partnerships, and enabling infrastructure to address the key knowledge gaps identified during the symposium. The focus will be on gaps that can be addressed through collaborative research.*

*Moderated by **Rick Bright**, Bright Global Health*

***Emily Denstedt**, Wildlife Conservation Society (WCS)*

***Ron Fouchier**, Erasmus MC*

***Stephen Ostroff**, S Ostroff Consulting*

***Marcela Uhart**, One Health Institute, University of California, Davis*

**11:00 AM**      **Perspectives from Centre for Research on Pandemic Preparedness and Health Emergencies (15 min)**

***Marisa Creatore**, Centre for Research on Pandemic Preparedness and Health Emergencies (CRPPHE)*

**11:15 AM**      **Lunch (60 min)**

**12:15 PM**      **Breakout Groups (90 min)**

*Identify priority questions to address through international coordination. Begin to map out a potential action plan for collaborative research, identifying barriers or questions that need to be addressed to implement the action plan*

*Refine elements of proposed action plan, identifying key stakeholders and additional interested parties that should be part of collaborative efforts going forward.*

**1:45 PM**      **Break (15 min)**

**2:00 PM**      **Report Back (45 min)**

**2:45 PM**      **Closing Remarks**

**ADJOURN**

