How Research Can Support Efforts to Control Avian Flu in Developing Countries: First Steps toward a Research Action Plan

Report of an international consultation—*The Research Community's Response to Avian Influenza, with Special Reference to the Needs of Developing Countries,* held 14-16 June 2006 in Nairobi, Kenya—organised by the International Food Policy Research Institute (IFPRI) and the International Livestock Research Institute (ILRI).

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Foreword

The possibility that the highly pathogenic form of avian influenza—as yet a disease mostly affecting chickens, ducks, and other poultry—might create a lethal human pandemic has become the year's hottest international health issue. Less well known is that the poultry disease itself, and the measures used to prevent or control it, are major concerns in developing countries. The threat of avian influenza looms large over hundreds of millions of small farmers and marketers who make their livelihoods out of poultry.

We need to control highly pathogenic avian influenza (HPAI) in the developing world to reduce both the possibility of a potential global human pandemic and the socio-economic damage bird flu is already causing the world's poorest people. Developing countries still have largely rural populations practising mixed crop-and-livestock farming. In many of these countries, poultry roam freely, many birds are marketed live, and veterinary services, public institutions and infrastructure need strengthening. Given this context, bird flu may become endemic in some regions, offering ideal conditions for the feared mutation to a deadly strain transmissible between humans. We must urgently address this challenge while ensuring that the livelihoods of developing country populations, especially the poor, are not compromised. It profits all of us to consider the health and policy implications of this and to employ the best of science to support these countries in their work to control this disease.

The most recent efforts in fighting bird flu have been front-line emergency actions. It is an opportune time for the research community to step back and consider lessons learned: what worked, what didn't, and why? How can we translate these lessons into better control efforts and policy actions in the future? What are the longer-term research needs and how can the international research community help? Many aid agencies are eager to fund research to help developing countries battle bird flu but need guidance as to the research areas that should take first priority.

The International Livestock Research Institute (ILRI) and the International Food Policy Research Institute (IFPRI), two of 15 centres supported by the Consultative Group on International Agricultural Research (CGIAR), are facilitating an international consultation to help address this need. We see this consultation as the beginning of a bigger process that will help investors and decision-makers make better-informed decisions.

The Research Community's Response to Avian Influenza with Special Reference to the Needs of Developing Countries, held in Nairobi 14-16 June 2006, brought together experts from a range of institutions involved in fighting avian influenza. The information compiled here is preliminary**.** We are sharing it in view of the fast developments in this field of research. We are confidant that the participants of this consultation and the wider e-mail consultation that follows it will help inform collective research and policy actions needed to ensure that the global fight against bird flu is equitable as well as effective. In this way, the research community can help protect the livelihoods of the world's poor as well as lives worldwide.

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Acknowledgements

The information contained in this report was generated during a consultation, organised and hosted by ILRI and IFPRI and attended by a broad range of participants from around the world. A full list of participants can be found in the Appendix. The consultation organisers would like to thank all participants for finding the time to attend the consultation and for their generosity in sharing their expertise, ideas and experiences.

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Disclaimer

This report is a record of a brain-storming consultation by an international group of experts on how research organisations can better support developing countries in their efforts to combat bird flu. The consultative process is continuing via a facilitated email discussion with a broad group of stakeholders working to control bird flu in the developing world. The purpose of the email consultation is to produce an action plan representing a consensus of the research community.

1. INTRODUCTION

The International Livestock Research Institute (ILRI) and the International Food Policy Research Institute (IFPRI) jointly convened a consultation entitled *The Research Community's Response to Avian Influenza, with Special Reference to the Needs of Developing Countries,* held in Nairobi, Kenya from 14-16 June 2006. The consultation was attended by a broad range of interested partners from the international research community. During the consultation, a total of more than 50 participants brainstormed on how research could support efforts to control highly pathogenic avian influenza (HPAI), with special reference to the needs of developing countries and the poor. The consultation was a response to several requests ILRI and IFPRI have received from donors who wish to prioritise and better target their investments in HPAI research for the benefit of Asia and Africa.

1.1—Objectives

The consultation had four main objectives:

1. To share the experiences of those from the avian influenza 'front-line' to provide a realistic, objective, and up-to-date background for the consultation.
2. To identify immediate service needs that the research community can provide in support of preparedness and emergency responses.
3. To identify medium- and long-term research needs.
4. To develop an action plan and consider the way forward, including the possibility of forming an inter-institutional task force.

In addition, two 'embedded' journalists attended the consultation (Mike Shanahan of SciDev.Net and Georgina Smith of WREN*media*) with the objective of raising awareness amongst a broader constituency about HPAI in the developing country context and of the role of research. [1]

Service needs were defined as actions, other than research, that the research community can undertake in the immediate term to support emergency response efforts in developing countries where outbreaks are occurring or preparedness efforts where outbreaks are anticipated.

Medium and long-term research needs were considered to involve anticipating and addressing 'second generation' issues associated with HPAI in developing countries. Such issues might include, for example, requirements for improved diagnostics and vaccines for developing country poultry production and marketing systems and understanding the transmission of the disease in these systems, amongst many others.

1.2—ILRI and IFPRI's Role

The role of ILRI and IFPRI was to convene, organise, host, and fund the consultation and provide background materials to stimulate thought and discussion. The purpose of the consultation was **not** to draw up an HPAI research agenda for ILRI and IFPRI.

[1] See www.scidev.net and www.wrenmedia.co.uk for media outputs associated with the consultation.

2. THE CONSULTATION PROCESS

The consultation is part of a three-stage process designed to draw up and make widely available a comprehensive action plan for the research community. The stages are:

1. Consultation to draw up draft lists of research needs.
2. Email-based validation of draft list of research needs.
3. Distribution of finalised list of research needs—formulated as an action plan—to interested parties, including donors.

This report describes stage one only—the consultation held in Nairobi from 14-16 June 2006. Over a period of two-and-a-half days, the consultation participants worked through a facilitated process, which included:

Scene-setting interviews: selected participants who had first-hand experience of HPAI were interviewed in front of the consultation audience as an alternative to more conventional presentations. The interviews were video-taped and a DVD containing edited versions of these interviews is an integral part of this report.

Interviewees:

- *Santanu Bandopadhyay*, Animal Husbandry Commissioner, Department of Animal Husbandry & Dairying, Ministry of Agriculture, Government of India
- *Robyn Alders*, International Rural Poultry Centre/KYEEMA Foundation, a specialist on veterinary service delivery in smallholder poultry systems
- *Daniel Adene*, Ahmadu Bello University, Zaria, Nigeria; has the distinction of diagnosing the first case of bird flu in Africa.
- *El Hadji Fallou Guèye*, Editor-in Chief of the International Network of Family Poultry Development (INFPD), and Coordinator, Animal Production Programme, Senegalese Institute of Agricultural Research
- *Joyce Wanjohi*, Chair of National Task Force responsible for overseeing the activities of prevention and control of avian influenza in Kenya
- *Celia Abolnik*, Ondersterpoort Veterinary Institute (OVI), South Africa; responsible for avian influenza diagnostics
- *Adam Lagerstedt*, World Bank, Kenya; handles the Bank's support to avian influenza preparedness and control efforts in eastern Africa.

Identification of issues and lessons emerging from the interviews: As a warm-up activity prior to focusing on the specific objectives of the consultation, participants worked in small groups to identify the main issues and lessons emerging from the scene-setting interviews.
Focus on service needs: Service needs were defined as functions and roles that the research community can immediately provide to support front-line national and international agencies in implementing their response to the HPAI threat, such as developing preparedness plans or executing control measures in the face of outbreaks. Selected participants from the HPAI front-line first gave their impressions of the role of research organisations in this context. Participants then worked in small groups to identify these service needs and these were later shared and discussed in plenary.

Focus on research needs: Research needs were defined as those questions and data that could contribute to a better understanding of the dynamics of the disease and its impacts, and how its control might be improved. Participants worked in one of three small groups to consider research needs: epidemiology; genetics, vaccines, and diagnostics; and socioeconomic and communication aspects. This session formed the heart of the consultation and was the activity to which most time was allocated.

*Way Forward – **A common vision**:* Participants worked in small groups to develop a vision that addressed the questions: where do we want the process we have started this week to lead to and what difference do we want to make? Each group's visions were then shared and, through a process of negotiation, the whole group generated a common vision with which it was comfortable. Participants then moved on to consider how the vision could be realised.

Need for an international task force: In plenary, participants considered whether an international task force was the best way to achieve the vision and to carry forward the research needs identified during the consultation.

What needs to be done to make the vision happen?: Having reached consensus that an international task force was indeed the way forward, participants next considered a series of questions:

- What are the roles and responsibilities of the international task force?
- How should this be established, organised and run?
- Who should lead the process?

Immediate priority actions: Drawing on the consultation, participants considered the immediate necessary follow-up actions:

- How do we finalise and market the outputs of this consultation?
- How should the prioritisation of service and research needs be carried out? Is an email-based exercise involving consultation participants and invitees who could not attend the best approach?
- Do we know what research is already being done or planned? Is there a need for a survey to avoid duplication of effort? If so, how should it be done?
- What are other priority actions?

3. CONSULTATION OUTPUTS I: FOCUS ON SERVICE NEEDS

As an introductory exercise prior to pinpointing service needs, several participants from the HPAI front-line in China, India, and Kenya were interviewed about their experiences regarding how the research community supported their preparedness, diagnostic, or control operations. Participants were reminded that service needs are defined as actions (other than research) that the research community can undertake immediately to support emergency response efforts in developing countries where outbreaks are occurring or to support preparedness efforts where outbreaks are anticipated. The participants then split into four small working groups, each containing a broad range of geographical and disciplinary experience and expertise. First, the

broad headings under which service needs would be considered were briefly discussed. It was agreed that these should be: 1) information brokering, 2) training, 3) capacity development, and 4) capturing lessons learned.

Working groups then considered service needs under these four headings. For each need identified, a card was written. Later, in plenary, the cards were shared and clustered under the appropriate headings. Below are the raw, unsynthesised outputs of this session. All cards presented by the working groups have been included: as a result, there is some duplication, as different groups identified similar needs.

3.1—Information Brokering

Issues:

- Impact assessment
- Geographical Information Systems (GIS)
- Informed public: seminars, website
- Informed farmers: leaflets
- Research into what is the best way to disseminate information
- Science should come not only from:
    - Communication
    - Smallholder production systems
    - Farming systems and participatory specialists
- Two-way reliable communication is needed: grassroots↔ research
- Research can contribute significnatly in management of data, information, and knowledge
- Information brokering:
    - Good sources of information (quality, relevance)
    - Clear, consistent, credible information
- Information, education, and communication
- Information systems:
    - Need to centralise data collection and dissemination
    - Data bank
- Synthesis of information to inform stakeholders
- Synthesis of lessons learned from other experiences
- Researchers come to table asking for cash, rather that research information
    - Going for solutions to aid in emergency response
    - Politics of different experts preventing effective information

Information content:

- Recommendations adapted to local conditions
- Lessons learned from elsewhere
- Research contributing to information systems that is credible, up-to-date, reliable, supported by scientific information, and dynamic
- Laws and regulations:
    - Enforcement
    - Present
    - Provides reporting
- Demystification through production of extension publicity based on science, e.g. relating to egg and poultry consumption and recommended precautions.

Who To?

- Targeting information to different stakeholders
    - Farmers, researchers, etc.
- Gender relationship in communication
    - Role of women

Methods:

- Communication mode:
    - Radio
    - Posters
    - Use of reference persons
    - Leaders, MPs, ministers
    - Civil society: useful link between research and policy.
- Types of research expertise
    - Communication experts
    - Media's role
    - Vets/technical are limited

Challenges:

- Veterinary services downsised in most countries
- Conflicting, unclear, and wrong information
- Sustainability of reporting systems
- Fear of litigation
- Indecision of line personnel

Potential lead suppliers of information content: OIE, FAO

3.2—Training

Issues:

- Debate over 'proper procedure'
- On-job training
- Centers for Disease Control and Prevention (CDC) ended up doing a lot of backstopping
- Use of diagnostic tools and human capacity development
- Outbreaks management
- Impact assessment
- Use of Geographical Information Systems (GIS)
- Collection of epidemiological data
- Field diagnosis
    - Proper collection/transport of samples
- Standardisation of techniques (sample collection, testing, etc.) for technology transfer to regional labs, etc.
- Training is a cross-cutting issue, e.g. how to use information systems

Types of activities:

- Training group in the emergency response team
    - Use of personal protective equipment
    - Case definition
    - Tracing back

- Risk analysis/management
  - Have a strategy
  - Basic tools
  - How you go about doing a field investigation
- Recognise multi-media approach to training, e.g. use:
  - Radio (national/vernacular)
  - Print
  - Electronic, etc.
  - Train groups to understand multidisciplinary approach of what could cause spread of HPAI
- Epidemiology
  - Molecular
- Animal health workers:
  - Animal hygiene
  - Minimising contact
  - Personal protective equipment
- Training in use of diagnostics:
  - PCR
  - HA/HAI
  - IFA
- Train in the field
- Research input into the collateral infections and epidemiology
- Extension service research on HPAI in rural locality
- Train traders in live bird markets:
  - To understand the diseases birds could bring
  - To have well-coordinated live bird markets
  - To dispose of clothing of workers in infected areas (train workers)
- Community people on the ground through
  - Churches
  - Provincial administration
  - Community leaders
- Train owners of fighting cocks to vaccinate their birds
- Aircraft swill
  - Train workers in safe disposal
  - Farmers trained also on disinfection of waste from birds
- Train general public on dangers of smuggling poultry products across borders
  - Must include people manning border points
- Train in use of poetry, music, etc to spread HPAI messages
- Communication
  - Need to train scientists, e.g. education for decisionmakers
  - Train journalists to communicate science
- Training implementation
  - Need to point out what the protocols are and how to use them
  - Training and standardisation
- Train risk communication
  - Should include all stakeholders, e.g. lab scientists, social scientists
- Training in case of recognition
  - Necessary to prevent infection
  - Change attitude of workers (some are lax, hence posing danger)
- Train as to why stamping-out may be important
  - Government personnel
  - Communities

- Should involve compensation plan
- Traders and food handlers
- NGOs

Possible lead suppliers of training: National research institutions/universities, reference laboratories, CDC, WHO, OIE, FAO, UNICEF, EU, USAID.

3.3—Capacity Development

Issues:

- Strengthening labs' diagnostic capacity
- Capacity development for diagnosis (sampling) and response
- Capacity to understand what are the best strategies (vaccines, systems, diagnostics, strategies, biodiversity)
- Sharing expertise
- Standardising laboratories: diagnostics and sample collections (including wild birds) using evidence-based evaluations
- Capacity for what?
  - Diagnostic
  - Culling
  - Clean-up
  - Keeping internal SPF flocks
- Transportation systems: role of couriers need agreement at higher level
- Ensure samples of adequate quality
- Research can improve decisionmaking capacity by synthesising information and providing tools
- Research must address capacity needs at all levels
- Appropriate capacity building: generic capacity building to maximise value for money
- Capacity to implement using physical and human resources from research
- Research can help
  - Capturing lessons and sharing them.
  - Sharing protocols, e.g. Holland manual steering committee
- Capacity for accessing and generating basic research (epidemiology, geographic, and demographic), data and samples, need to build sustainable strategic research, not fire-fighting research
- Research should focus on generic capacity building
- Put in place diagnostic capacity
- Develop infrastructure
- Stockpile: protective gear reagents, diagnostic kits
- Research into vaccines: participation of researchers, efforts to stamp-out an outbreak
- Capacity and training for diagnosis and sampling development
- Demand for action in a crisis not always compatible with research
- Existing research labs, etc. to backstop national labs
- Share equipment, supplies
- Quicker diagnostic methods
- Cost-effective laboratory test

Prevention, Impact, and Control Options:

- Epidemiology
  - Surveillance
  - Control

- Genetics
- Virus
- Poultry
- Diagnostics and vaccines
- Socioeconomic
- Communication

3.4—Capturing Lessons Learned

Issues:

- Creation of multidisciplinary and research services teams
- Identification of gaps in complying with or attaining international standards in veterinary services (sanitary and phytosanitary standards: SPS), including administrative, research, and diagnosis
- Impact assessments in interventions in past outbreaks:
    - Review processes used
    - Review respective activities
- More effective response mechanisms, e.g. funding mechanisms and processes for assessing the funds
- Role of research organisations in supporting diagnostic services, e.g. Nigeria
- Role of research community to document and use lessons learned to improve efficiency of interventions
    - Monitoring and evaluation: put log frames
    - Impact assessment
    - Synchronising information
    - Communicating the information
- Identification of research questions and needs arising during Implementation.
- Evaluation
    - Mid-stream assessment for contingencies and response modification
    - Term collation of experiences and data for publication and learning

Planning:

- Involvement of international and national communities in planning, especially in accessing knowledge and skills
- Involvement of social scientists in planning and response
- Input from evaluation of previous experiences
- Budgetary
- Setting up of priorities
- Biological research needs
- Environmental management and social research
- Options on command chains and networks for emergency preparedness and response
- Organisational researchers and management researchers
- Compensation
    - Input on community response
    - Resource for compensation
    - Mode of disbursal of compensation: cash, kind, rehabilitation
    - Assessment of direct/indirect losses
    - Nature of losses suffered by various stakeholders
- Impact assessment on smallholders and industry as a whole
- Various responses by communities.

- Surveillance
  - Inputs from research institutes
  - Development of models: sampling frame, mode of analysis
  - Medical epidemiologists/eco-system specialists
- Assist in drafting a generic compensation manual

4. CONSULTATION OUTPUTS II: FOCUS ON RESEARCH NEEDS

Process

Participants were first reminded that research needs were defined as those questions and data that could contribute to a better understanding of the dynamics of the disease and its impacts, and how its control might be improved. They were then asked to join one of three working groups to which their expertise and experience could best contribute:

1. Research opportunities and needs in molecular biology and genetics
2. Epidemiology and control issues
3. Socioeconomics and communication.

Each group then considered research needs under their respective headings in some detail: one entire day was devoted to this activity. Having identified the research needs, the groups were then asked to consider what timeframe was required for each identified need. One group also considered at what level the research should be done. Each working group nominated a rapporteur who wrote up the group's findings: these are reproduced—unedited—below.

4.1—Research Opportunities and Needs in Molecular Biology and Genetics

4.1.1 Virus research

<u>–Identification and definition of circulating strains</u>

a. There is a basic and high-priority requirement to define the viruses present in each country in wild and domestic species. This definition should be for neuraminidase and hemagglutinin antigens, but also at other loci and should be ongoing and is important for:
   - Tracking movement of virus and identifying the appearance of new strains.
   - Assessing whether re-assortment may result in virus with increased risk of human infection and transmission.

b. The creation and maintenance of regional databases will facilitate:
   - Improved monitoring and lead to better models to predict risk
   - Tracing the origins of new strains

c. Feed could be the source of infection in poultry, screening of feed (and manure) for AI virus may identify infection sources:
   - Requirement for development of suitable screening methods to identify presence of virus/ presence of viable virus, to distinguish infectivity from vaccination

Priority: high
Timeframe: short/immediate and ongoing
Research level: local

<u>–Factors influencing the conversion of LPAI to HPAI</u>

a. While LPAI is constantly present, the virus can change in virulence as a result of minor changes in the RNA genome. Co-infection can result in re-assortment of the RNAs to create a virus with

increased virulence. Research is required to define the loci and sequences that control transmission across species and virulence in original and new hosts:

1. Viral genome
    i. Definition of genotypes of highly virulent strains
        - Identification of loci responsible for host specificity
        - Virulence in different hosts
    ii. Need for strain information generated above
    iii. Analysis of sequence similarities with HPAI strains
    iv. Predictions of mutation events necessary to convert LPAI strains present to HPAI

Timeframe: short
Research level: local

2. Host genetics
    Identification of genetic factors in the host that influence mutations in the virus

Timeframe: short
Research level: international

3. Other contributing factors that may influence changes in the virus and appearance of new strains. This may include research on response of the virus to*:*
    i. Vaccination
    ii. Immune response
    iii. Concomitant infection (which could be a unique feature in Africa)

Timeframe: short/medium
Research level: local/international

–Viral persistence in the environment

The major infection risks are associated with direct contact with birds or animals carrying the virus via aerosols, but there is also significance risk from virus in the environment following shedding by infected individuals. The persistence of viable virus in different environments, waste (e.g. manure) or feed is largely unknown.

1. The survival of viable virus in different environments/manure/feeds can be easily tested and the risks associated with African environments predicted
2. Factors to be considered could include:
    i. Feed: storage conditions, feed types, and content
    ii. Soil types
    iii. Humidity
    iv. Manure–sterilisation treatments
    v. Local factors such as antiviral activities of plants and micro-organisms
    vi. Stability of different subtypes should also be addressed

Priority: high
Timeframe: short/medium
Research level: local

–Determinants affecting virulence

a. It is not known whether AI viruses attenuate/adapt to the host. This is important information in developing control strategies and developing models to predict the course of outbreaks.
b. Attenuation itself should be studied: does this occur, in what circumstances and to what extent?
    1. Do all HPAI strains attenuate?
    2. Is it host dependant?
    3. What are the viral determinates that change (if not Ha and Nu)?

Timeframe: medium
Research level: international

4.1.2 Host research (domestic species)

–Susceptibility/response of the host

a. It is likely that the genetic background of the host influences the outcome of challenge with AI. Somewhat circumstantial evidence suggests that chicken from SE Asia are more susceptible that those from the Indian subcontinent: this should be formally tested, and is best achieved by controlled experimental challenge:
    1. The role of specific candidate genes, and variations within these genes could be addressed, especially:
        i. The Mx gene,
        ii. Receptors
        iii. Immune genes
        iv. Genes with antiviral/antiviral inducing activity (INF…)
    2. The role of genetic background
        i. SE Asia vs. "Indian" origins
        ii. Hybrids (commercial)
b. Factors to be considered in this study would include:
    1. Host vs. AI strain interactions (is a resistant genotype for one strain also resistant to others?)
    2. Phenotypes (susceptibility where animals die rapidly would be better than animals that are asymptomatic and shed virus)
    3. Likelihood of transmission between birds
    4. Influence of host genotype on viral mutation

Priority: high.
Comment: costly and logistically complex study.
Timeframe: medium/long
Research level: international, but could also address local populations

–Role of prior infections on disease response

The controlled challenge is required to understand the host/virus interaction. In the farm environment, however, there are many factors that may influence the outcome of AI challenge. Various scenarios can be imagined that could affect the predicted responses of the host and should be addressed, including:

1. If an animal has been infected (sub-clinically) and recovers, how does this affect subsequent infection?
2. Does infection with other viruses (Newcastle) affect the outcome of AI infection?
3. Do either of the above affect viral conversion LPAI/HPAI?

Timeframe: medium/long
Research level: international

–Investigating natural infections

While the analysis of information from AI outbreaks is confounded by many factors, valuable lessons related to host response to infection could be learned and built into epidemiological models:

1. In order to access and use this information it is important to develop suitable infrastructures to capture research materials, namely:
    i. Samples from infected animals: viral and host
    ii. Samples from survivors
    iii. Phenotypes: clinical signs, virus levels, etc.
2. Database required to centralise information

Timeframe: short/ongoing
Research level: local/international

–Genetic markers to define populations

Genetic markers exist and these need to be used to define and document the diversity of chicken populations:

1. To define origins and movements of poultry
2. To manage the restocking post-AI cull
3. To assess the impact of culling on diversity
4. To include genetics of host in epidemiological models of outbreaks and spread of disease

Timeframe: short/medium
Research level: local

–Markers to track poultry movement

Genetic markers can be used to identify origins of birds, at least at the broader geographical level:

1. Research is required to examine diversity in African poultry to define how precisely origins can be defined geographically.
    i. Tracking movement of birds in Africa and worldwide
2. This technology could be used in risk assessment and verification of authenticity (i.e. not from infected areas) and be applied to:
    i. Live birds
    ii. Carcasses
    iii. Meat products

Timeframe: short/medium
Research level: local

–Susceptibility in other species

Different species show differing responses to infection: generally turkeys show high mortality, while ducks are tolerant (but shed virus):

1. Determine the factors that control differing responses between species and see if this can be used to select desired genotypes/responses?
2. Exploration of the mechanisms of shedding (worst situation)

Timeframe: medium/long
Research level: international, but could also address local species, e.g. guinea fowl

–Model species

Is there anything to be learned from model species, e.g. mice?
Identification of candidate loci to examine in target species?
Timeframe: medium/long
Research level: international

4.1.3 Host research (wild species)

–Genetic markers

a. Genetic markers can been used to define populations of wild birds:
    1. To track origins and better define flyways
    2. To predict risks of transmission from infected areas
b. Need to develop markers, collect datasets, and establish databases

Timeframe: short/medium
Research level: local

–Susceptibility

Susceptibility to infection should be explored in migratory populations, and in local static populations which may represent vectors that transmit infection from migratory species to domestic fowl:

1. Measurement of natural infections in wild species
2. Examination of genotypes at candidate susceptibility loci
3. Strains supported:
    i. Are these the strains to which domestic populations are most susceptible?
    ii. Are there likely to be HPAI/ HPAI-related strains (sequence similarity)?

Timeframe: medium/long
Research level: international

4.1.4 Vaccine development

<u>–Conventional vaccine improvement</u>

a. A large part of the reason vaccination is not considered as a preventative measure arises from deficiencies in the vaccines currently available. Research activities could be targeted at vaccine improvement:
    1. Thermostable vaccines
    2. Overcoming strain specificity
    3. Vaccines that offer more rapid protection:
        Containment of virus by vaccination is not an option if immunity takes three weeks to develop
    4. Full protection on primary immunisation
    5. Sterilising immunisation
        Vaccination is not appropriate if vaccinated birds continue to shed virus

Timeframe: medium/long
Research level: international

b. Development of permissive cell lines for vaccine production to avoid bottlenecks in vaccine production

Timeframe: medium
Research level: international

<u>Designer vaccines</u>

a. Sub-unit vaccines could be more predictable than inactivated virus, but currently are generally not persistent: research into mechanisms of protection could improve sub-units vaccine design:
    1. Transcriptomics/proteomics could be used to define cellular responses associated with maximum protection:
        Sub-unit components could then be identified that are required to generate more sustained response
    2. Such designer vaccines may overcome strain specificity

b. Development of marker/subunit vaccines designed to distinguish vaccination response from infection

Timeframe: medium/long
Research level: international

<u>Wildlife vaccination</u>

Wildlife could be a reservoir for infection and some wildlife species that may be susceptible are important in the local economy, such as large cats for tourism. Research activities could address:
1. Feasibility of vaccination
2. Development of suitable vaccines
3. Methods for vaccine delivery

Timeframe: short/medium
Research level: local

4.1.5 Human aspects

While work on human response to infection is an immense topic, there are some researchable issues that have a particularly African relevance:

1. What is the infection rate (to LPAI), in African populations and is this similar to or different from other populations? This may give clues regarding possible genetic difference and hence potential for differing responses to infection:
   Monitoring of infection by presence of antibody
2. Are there higher risks associated with presence of other infections, e.g. HIV?

Timeframe: short/medium
Research level: local

4.2—Epidemiology and Control Issues

Underlying principles

- Multi-disciplinary and trans-disciplinary research
- Research into issues where research will make a difference – actionable and action research

4.2.1 Disease epidemiology

[No time frame required]:

Understand the basic epidemiological factors specific to developing countries, including composition and density of poultry flocks; contact rates (direct and indirect) between poultry and certain wild bird species; flock management; poultry movements; survival and persistence of the virus in the environment (e.g. water and faeces, sewage); local, national and international avian trading pathways; and the risk factors of the introduction of H5N1 into poultry flocks.

Bring together multidisciplinary teams (epidemiologists, ornithologist, virologists, molecular biologists, social scientists, etc) to generate qualitative and quantitative data for transmission patterns and parameters in Asian and African contexts for use in transmission and spatial models

Improve the understanding of the distribution of Highly Pathogenic Avian Influenza (HPAI) strains (including the H5N1 strain) in the mix of poultry, waterfowl, migratory, and indigenous wild birds found in developing countries.

Understand the structure of the poultry industry within developing countries in terms of numbers and spatial distribution of high-input large-scale and small-scale producers aligned to the more formal sector versus low-input small-scale and backyard producers aligned to the informal sector—how the structure is changing and how these changes affect the provision of veterinary care.

Understanding movements of poultry and their products along the variety of poultry supply chains in developing countries, and how they relate to different types of producers (backyard, contract producers, etc).

4.2.2 Risk assessment

[No time frame required]:

Conduct a risk assessment of the likelihood of entry HPAI into developing countries given the various pathways that HPAI might spread to poultry from different vectors or anthropogenic processes such as from migratory birds, commercial trade in breeding stock, veterinary inputs, live animals, and transportation of infected equipment, or soils. This assessment should incorporate the

fluid and dynamic nature of disease epidemiology of this highly mutable virus as it adapts to new hosts or conversely loses virulence.

Understand the role of migratory flyway, the role of wetlands in such migrations, and the role these factors play (or do not play) in the spread of specific strains, and map such outcomes so as to increase understanding of the spatial spread mechanisms for various strains of HPAI. Understand the local, regional, national, and international trading pathways (legal and illegal) for poultry and exotic bird breeds. Investigate the spatial spread of HPAI via market mechanisms to trace potential transmission pathways through local trade and commerce, and combine that information with the above and develop models capturing these mechanisms using GIS data.

Create risk assessments for developing countries requires epidemiological information that is specific to that country or region, since such information may vary widely between Asia and Africa.

Identify the likelihood that HPAI can spread to and among poultry and humans (poultry workers and their families) from all the potential pathways (identified in research in section 1). Evaluating how these pathways may differ in terms of short- and long-distance spread.

Assess the economic consequences of control strategies, e.g. regarding compliance with culling, movement restrictions, and compensation, given resource constraints and delays in diagnosis and appropriateness of control strategies in terms of cost-effectiveness, acceptability, sustainability, impact on vulnerable groups, and other concerns.

Identify cost-effective disease-control measures appropriate to the scale and location of poultry producers.

Characterise risk of exposure to HPAI in the different poultry production and marketing systems as occupational hazard.

[Medium-term time frame:]

Model population dynamics of people, poultry, pigs, wild birds, and other animals susceptible to influenza; understand contacts, networks, transmission and risk factors. Identify critical control points where transmission can be blocked.

Identify the strains of LPAI circulating within countries and their movements in space and time.

Carry out risk assessments to give decisionmakers and resource-allocators state-of-the-art estimations of HPAI impact on human and poultry health with associated uncertainties.

4.2.3 Surveillance

[Short-term time frame]:

Carry out a critical review of existing surveillance systems and make recommendations for their appropriateness under different circumstances. Research what makes surveillance systems effective, affordable, and sustainable. Carry out epidemiological critiques on the type of data currently collected and advice on data type and minimum quality needed for credible analysis.

Review and disseminate information on how to do HPAI epidemiological work-ups in developing countries with emphasis on quality-controlled data. Ensure that other essential studies (economic, social etc.) have access to basic epidemiological inputs.

Critique and review the ability of existing surveillance systems to capture developing-country specific types of information (e.g. sociocultural practices) and ability to capture information in low-trust environments. Develop and validate epidemiological investigation techniques appropriate to developing countries.

Critically review existing tests for influenza— develop guidelines on what tests are appropriate under what circumstances (screening, confirmatory). Based on this, develop evidence-based guidance on appropriate action after positive screening tests given specificity, sensitivity and prevalence.

[Medium-term time frame]:

Conduct action research of simple, sustainable surveillance models appropriate for developing countries. Evaluate models of multi-issue surveillance (flu-like bird diseases, other animal diseases, other crises….)

Develop and validate syndromic surveillance and participatory epidemiology tools for HPAI surveillance. Research the credibility, cost, and usefulness of non-traditionally generated epidemiological data.

Research how to develop ways of monitoring wild birds in developing countries that are practicable and affordable.

4.2.4 Control

[No time frame required]:

Understand the options for policymakers to assess and choose between alternative mitigation strategies that could improve smallholder participation in poultry markets for developing countries under the threat of HPAI and use an innovation systems approach to aid, making appropriate policy recommendations at local, national, regional, and international levels. Evaluate innovative sustainable community-based surveillance systems to strengthen conventional veterinary services. Identify sustainable options for strategically recapitalising public veterinary services.

Assess the economic implications of various compensation schemes and identify the optimal compensation package needed to get smallholders to comply with eradication measures and prevent problems of moral hazard while also protecting the livelihoods of smallholders.

Understand the implication of vaccination policies, such as whether a combination of culling and vaccination in developing countries is optimal when resource constraints limit ability to undertake widespread culling. Assess the likely success of post-vaccination monitoring for efficacy and preventing the re-emergence of disease.

Understand the impact of alternative short-term and long-term disease-control strategies identified for controlling the spread of HPAI, depending on the specific vector or anthropogenic processes responsible for the spread of HPAI.

Look into whether joint health and veterinary action reduces costs, particularly for rather costly interventions (e.g., mass vaccination in rural zones) and determine if such an approach is feasible in different contexts.

Identify the cost-benefit or cost-effectiveness of disease-control strategies (culling, vaccination, movement restriction, information provision, etc). Analyse how strategies may differ depending on the specific vector or anthropogenic processes responsible for the spread of HPAI in the short- and long-term.

Identify sustainable options for strategically re-capitalising public veterinary services.

[Short-term time frame]:

Critically review the control of HPAI in developing countries with recommendations. What have we learned and what are the implications for developing countries with and without HPAI? How does control differ in developing countries as opposed to developed countries? Why do countries

respond differently to HPAI and how does this affect the subsequent management of disease? What is the role of inter-institutional collaboration in mounting an effective response?

Research the long-term control/management of avian influenza in countries with large small-scale poultry operations. Model and compare different control strategies and different production systems from the perspective of their impact on small-scale production. Validate control innovations before the epidemic arrives.

Research the control delivery mechanisms: review and compare systems including private sector, civil society, community-based workers, and other sectors.

Review how stakeholders are involved or excluded from HPAI control, the implications of this and the mechanisms that increase stakeholder competence and ownership (emergency preparedness exercises).

Review the vaccines available, their cost-effectiveness, advantages, disadvantages, and applicability for countries with different epidemiological conditions.

Review vaccination experiences in developing countries; based on this, evaluate currently used vaccines and delivery systems, and draw-up guidelines for matching vaccination and surveillance.

[Medium-term time frame]:

Look into expanding the repertoire of disease control by novel "outside the box" control strategies. Not just culling and vaccination but … (insurance, changing production systems, genetically resistant birds, accelerated marketing…)

Collaborate with economic research to understand how the likely impacts on human health should, and do, affect the veterinary control of HPAI in poultry and other animals.

Make evidence-based recommendations on the combination and phasing of different control strategies (vaccination, culling, etc) and the trip-wires for strategy switches.

Research the failure of surveillance and control. Retrospective studies on the factors that are associated with success or failure of surveillance and control? How to combine flexibility with direction?

Research the role of promotion of indigenous poultry as a control strategy, taking into account susceptibility, survivability and other characteristics. Research the best way of conserving indigenous genetic poultry resources in situ as a means of preserving valuable genetic resources.

Conduct case control studies on the factors associated with establishment or non-establishment of HPAI. Historical studies of outbreaks in this and the last century. What is the natural course of HPAI epidemics? How does this differ in different farming systems and ecosystems? What, if anything, is different about the current poultry pandemic?

4.2.5 Zoonotic/pandemic potential

[No time frame required]:

Understand, in the context of developing countries, human susceptibility (genetically, immunologically) to current and emerging strains in order to estimate the impacts of a future pandemic.

Develop appropriate, affordable, and sustainable monitoring and surveillance systems for zoonotic disease. Designing efficient (and early) human case detection for developing countries—and this in the face of high prevalence of other, often deadly morbidity (e.g. HIV/AIDS and malaria)—in light of dispersed and remote small-scale and backyard poultry farms and of poor coverage by primary and secondary public health services.

Understand why human cases have been reported in Egypt but not in Nigeria—do Egyptians have closer contact to poultry, is the infection pressure higher, or does Nigeria simply not detect it human cases? And understand whether the African population is more or less susceptible (genetically, immunological) to current H5N1 strain than the Asian population?

Understand if subclinical infection (including shedding) is possible and if it changes the mutation rates of the virus or allows adapting more easily to the human body.

Determine what are the other circulating HPAI strains in Asia and Africa, especially those with the potential of causing human disease, such as H7 strains.

4.3—Socioeconomics and Cooperation

4.3.1 Understanding spatial and cultural conditions linked to emergence & spread of AI:

- Understand the conditions (spatial, cultural, market, lack of education, investment in science) that have allowed bird flu to become the problem it is; what are problems of smallholders and industrial production mixing? Identifying failures market or farming systems causing diseases to go undetected
  Timeframe: short
- Determine what is preventing veterinary services from reaching the poor
  Timeframe: ongoing
- Ascertain the regulatory and pecuniary measures to get people to comply
  Timeframe: short
- Conduct a literature review to avoid duplication of research
  Timeframe: short
- Determine why production practices that are not good are still being used – why are lessons not being learned?
  Timeframe: medium
- Understand how changes in trade regimes due to sanitary and phytosanitary standards (SPS) are affecting less developed countries
  Timeframe: short
- Develop a better understanding of smuggling and how the industry reduces its losses
  Timeframe: short
- Look at pharmaceutical companies' practices regarding vaccine strains, effectiveness, etc.
  Timeframe: short
- Determine what lessons can be learned from SARS, HIV/AIDS, etc and apply them to efforts to deal with HPAI
  Timeframe: short
- Identify the factors affecting whether AI or other diseases are more of a problem: modelling / cost-benefit analysis
  Timeframe: short/medium
- Learn why zoonotic diseases are emerging where they are
  Timeframe: short/medium
- Understand how international/regional trade affects the spread of disease, and determine how to make those responsible accountable
  Timeframe: medium

4.3.2 Communication

- Tidy up websites (OIE, FAO, WHO) so they are credible, effective and that out-dated information is removed
  Timeframe: short

- Make sure research toolbox is made available
  Timeframe: short

4.3.3 Preparedness

- Look at smallholder networks and see how to mobilise those involved to get them involved in research on small farms
  Timeframe: short
- Develop strategies to deal with lag time between suspect cases and definitive diagnosis— a prerequisite for compensation
  Timeframe: short
- If AI is a serious international problem, determine how to create action and sanctions to encourage best practices in the short term so it does not become a pandemic in the long term
  Timeframe: short and ongoing
- Focus on developing mechanisms to improve food security for all
  Timeframe: long
- Ascertain the advantages of looking beyond HPAI and how efforts could boost animal health in general
  Timeframe: medium
- Work to improve transparency
  Timeframe: short

4.3.4 Preparedness and impacts

- Review OIE standards regarding different categories of farmers and determine whether they are appropriate
  Timeframe: short
- Ascertain at what point will stakeholders start caring about this issue
- Research the role of micronutrients/animal protein from poultry on the health (and susceptibility to disease) of small children/pregnant women and others
  Timeframe: medium

4.3.5 Impacts

- Understand the complex market chains— from producer through middlemen to consumers
  Timeframe: short
- Understand the risks associated with AI in general
  Timeframe: short
- Determine the impacts AI could have on tourism
  Timeframe: short/medium
- Determine the impacts of loss of animal protein/eggs on consumer health and producer income in general— particularly for those who previously relied on such cheap products
  Timeframe: medium
- Determine the impacts of AI on other hosts and their role in transmission
  Timeframe: medium/long
- Determine the agro-ecological impacts of removing poultry from farming systems, e.g. loss of control of crop pests
  Timeframe: medium/long
- Understand the multiple roles poultry plays in rural livelihoods and in different production systems, including ceremonial roles and values ascribed to these
  Timeframe: short

- Understand the preservation role of poultry for the rural poor

4.3.6 Impact and control

- Determine the socioeconomic constraints in setting up optimal compensation plan
  Timeframe: short
- Determine the nutritional and other impacts of stamping out, and the risk-risk trade-offs of eating sick poultry
  Timeframe: short/medium
- Investigate what alternative animals can be raised (or other livelihood options) and the associated costs (financial, labour, land, etc)

4.3.7 Control

- Understand the socioeconomic impacts of control methods
  Timeframe: short/medium
- Understand the interaction of combination of control methods and their acceptance, and ability to comply
  Timeframe: short/medium
- Develop effective (i.e. pre-tested) education, information and communication materials and ensure appropriate delivery and revisions as needed
  Timeframe: short
- Ascertain the socioeconomic factors affecting adoption of control methods
  Timeframe: short
- Research the historical spread of disease through trade: is AI something different?
  Timeframe: short
- Determine what sociocultural practices should change or improve regarding common use by poultry, wild birds, and people of water—or of people living with poultry/marketplaces
  Timeframe: short

4.3.8 Cross-cutting

- Determine what is the optimal delivery of information to all stakeholders
  Timeframe: short
- Generate a scientific consensus on all aspects of AI
  Timeframe: medium
- Determine how to best mobilise research to focus on socioeconomic concerns
  Timeframe: short/ongoing
- Understand the political issues affecting action—how have things changed since emergence of AI?
  Timeframe: short
- Determine whether smallholders are really the cause of the spread of the disease
  Timeframe: not specified
- Understand the roles of the different players in the poultry sector in the spread of disease
  Timeframe: short/medium
- Consider how to integrate socioeconomic concerns into decisionmaking
  Timeframe: medium
- Consider how to bring community participation into prevention and control
  Timeframe: short
- Model options for prevention/preparedness: (a) do nothing, (b) surveillance for HPAI, (c) surveillance + efficacy of vaccination against endemic killer diseases— e.g. Newcastle disease and Gomboro disease, (d) surveillance + efficacy of vaccination against endemic killer diseases— e.g. Newcastle disease and Gomboro disease + mounting vaccination campaigns against ND in priority smallholder

areas
Timeframe: short

- Determine how to best translate research results into policy decisions that take into account all socio-economic issues
  Timeframe: ongoing
- Understand the poultry systems—production and marketing chain— to identify critical control points
  Timeframe: short/medium
- Understand the role of gender, and other societal categories surrounding poultry
  Timeframe: short/medium
- Identify the appropriateness of different control methods in different production systems
  Timeframe: short
- Research the spatial dynamics of disease outbreaks in relation to birds, people, urban centres, etc
  Timeframe: short

5. CONSULTATION OUTPUTS III: WAY FORWARD

Process

After dividing into small working groups, participants were first asked to draft a vision statement that addressed the questions: where do we want the process we have started this week to lead to and what difference do we want to make? Each group in turn shared their vision statement with all participants and, through a process of facilitated negotiation; a common vision statement was derived that was acceptable to all participants. Next, after some discussion, the participants agreed that the best way to make the vision happen would be to form a taskforce. Having reached this point, participants formed three working groups, each of which considered a series of questions related to the taskforce, the outputs of the consultation, and related follow-up activities. Ideas and suggestions were captured on cards, which were then shared with the larger group and clustered under the appropriate questions. The unedited outputs of this process are reproduced below.

5.1—Common Vision

The common vision of the consultation participants was to:

Target research to help provide solutions for avian influenza prevention and control to improve health and livelihoods in the developing world.

5.2—Implementation

By consensus, the consultation participants agreed that a taskforce was the best way to make this happen. They suggested it should be multi-institutional, multidisciplinary, and multinational (with an emphasis on African representation), and should include donors and representatives of international and subregional organisations.

Participants provided the following answers to a series of questions related to implementing the vision. There is some duplication and alternative suggestions as participants worked in three sub-groups:

What are the roles and responsibilities of the international task force?

- Form a consortia to implement the activities identified
- Develop proposals targeted to donors/investors
- Sensitise
- Explore and facilitate funding
- Coordinate research agendas
- Identify, prioritise, and set research agenda
- Find funds to implement agenda
- Conduct complementary research
- Communicate research
- Identify group leader
- Clearly establish research responsibilities
- Group leader ensures broader input by individual researcher
- Set priorities
- Identify capacity
- Seek source funding
- Taskforce to coordinate the focus on Africa
- Consortia to work closely with other international consortia
- Develop research proposals specific to Africa situation

How should the task force be established, organised, and run?

- Interested individuals and institutes informally linked later—formal secretariat?
- Group leader (heading multidisciplinary task force) with institutional support
- Virtual consultation among stakeholders
- Domain within CG system
- Stakeholders must bring in existing poultry networks

How should this be organised and run?

- Through a small high powered group
- Secretariat (joint)
- Run electronically
- Occasional face-to-face meeting
- Advisory group to guide the taskforce

Who should lead the process?

- FAO?
- ILRI?
- IFPRI?
- UN?
- An authoritative/respected body
- Initially IFPRI/ILRI
- Once taskforce formed and ToRs established, lead institution will be determined
- Platform needs to be established as soon as possible to keep discussion alive and produce a tangible report and actions from outcomes meeting and other issue that became apparent

Any other issues/points

- Sustainability?
- Duration of the taskforce?

- Link with regional organisations, e.g. AU-IBAR
- Serve any other emerging disease (only potential to serve)

5.3—Immediate Actions

How do we finalise and market the outputs of this consultation?

- ILRI and IFPRI to finalise document (in consultation with participants)
- Synthesise output and research gaps
- Distribute paper to participants and also a press release
- Get/develop proposals
- Get paper out as soon as possible and develop website
- ILRI leads prioritisation exercise
- Conduct thorough, formal and grey literature review, and talk to donors and potential researchers of ongoing research
- Get money and resources to run taskforce
- Generate local and international press releases emphasising gaps that were identified
- E.g. CNN, SciDevNet
  - Syndication— high impact
- Produce written document reporting the outputs of the meeting (electronic and hard copy)
- Investigate recent and planned research
- Investigate potential funders and their funding interests
- Remain responsive, fast,and flexible
- Issue meeting report within one to two weeks
- Form taskforce/network and identify task leaders
- Task force to draft a research priority list and circulate widely
- Open the network and include all interested parties
- Conduct consultation to identify other players
- Identify literature and network of participants
- Develop concept note for Africa (validate and dissemination) to use as marketing tool to raise initial fund

How should the prioritisation of service and research needs be carried out? Is an email-based exercise involving consultation participants and invitees who could not attend the best approach?

- Expert consultation
  - With one-to-one interviews
- Coordinating body to identify the key research gaps and approach interested research groups and source funding
- Email consultation consortia to provide initial prioritisation taskforce

Do we know what research is already being done or planned? Is there a need for a survey to avoid duplication of effort? If so, how should this be done?

- No, we don't know (active/planned research)
- Yes, a survey is essential. Need consultation with experts to aid this.

APPENDIX:

Participants List

Avian Influenza Consultation Participants List

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