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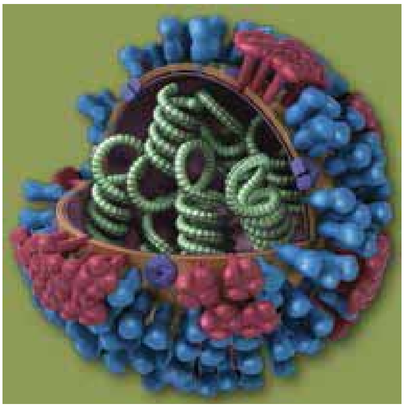

paper

LESSONS FROM HPAI

A technical stocktaking of outputs, outcomes, best practices and lessons learned from the fight against highly pathogenic avian influenza in Asia 2005–2011

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Contents

Foreword

Since 2004, the Food and Agriculture Organization of the United Nations (FAO) has been at the forefront of the global effort to fight H5N1 highly pathogenic avian influenza (HPAI), which emerged in Southeast Asia in 2003. At its peak, the disease affected 63 countries in Asia, Europe, the Middle East and Africa, and comprehensive strategies and systems for surveillance, detection, diagnosis and response were put in place at the international, regional and national levels. These strategies, which were developed in consultation with governments, regional organizations and non-governmental organizations – and were implemented by FAO in collaboration with international agencies such as the World Health Organization (WHO), the World Organisation for Animal Health (OIE) and the United Nations Children's Fund (UNICEF) – have begun to prevail. The disease has now been eliminated from most countries in the world, although it remains endemic in parts of Asia including China, Viet Nam, Indonesia, Bangladesh, and in large parts of eastern India. A number of countries in Asia, including Cambodia, the Lao People's Democratic Republic (Lao PDR), Myanmar and Nepal also experience regular sporadic outbreaks. In Africa, Egypt is the only country in which H5N1 HPAI remains entrenched.

Global efforts to address the problem of H5N1 HPAI have clearly yielded significant results. The understanding that a pathogen that predominantly causes losses in livestock can occasionally spread to humans and cause epidemics and pandemics has spurred politicians and decision-makers to invest in combating the problem of emerging infectious diseases (EIDs). The complexity of the drivers of infectious diseases that have such widespread impact has added impetus to incorporating One Health principles which promote a multidisciplinary and multisectoral approach to addressing the problem.

The central role played by FAO in the global efforts to control H5N1 HPAI has been explicitly acknowledged by major international agencies and by the donor community, particularly given FAO's broad mandate in the area of developing sustainable agriculture for food security, food safety and poverty reduction. The Emergency Centre for Transboundary Animal Diseases (ECTAD), an implementation platform created by FAO in 2004 to strengthen the organization's Emergency Prevention System for Animal Health component (established in 1994), combines the technical and operational expertise of the Animal Production and Health Division (AGA) and the Emergency Operations and Rehabilitation Division (TCE), respectively, and has maintained a strong focus on the control of HPAI. ECTAD's Regional office for Asia and the Pacific (ECTAD-RAP), which was established in Bangkok in 2005, responded to increasing poultry mortality and human infections resulting from HPAI in the region with a comprehensive and dynamic HPAI control programme in Asia. This included the establishment of a South Asia subregional ECTAD Unit based in Kathmandu (2007), and ECTAD units covering over 11 countries in South, Southeast and East Asia.

The success stories, challenges and lessons learned from these seven years of concerted programming in the region are helping to inform and shape the development of future programmes to combat HPAI and other EIDs. The information generated from isolation and genetic and antigenic characterization of a large number of viruses in Asia and other parts of the world, coupled with the information on disease outbreaks, has improved our understanding of the virus's evolution and the implications for its spread, infectivity and suitability for use in the development of vaccines.

In recent years the world has, regrettably, seen a progressive decline in funding to address the residual threats posed by continued H5N1 HPAI circulation. Political commitment has been on the wane, especially in affected and at-risk countries. This is worrying, as H5N1 HPAI continues to circulate in several countries, and is evolving in environments that present opportunities for the emergence of new variants that may have increased pandemic potential.

The disease is increasingly being under-reported, and efforts at surveillance are declining in most countries that are chronically short of financial and human resources. It is also clear that it would take several years for the endemic countries to eradicate the H5N1 virus from the poultry sector. In addition, a number of other new pathogens and diseases are emerging in the region in an environment where the interaction between livestock, wildlife and humans is increasing. It is, therefore, critical to put greater effort into raising awareness of the potential risks involved, particularly in light of the declining funds available for the control of HPAI and other high-impact diseases.

Over the last three to four years, FAO's role and priority has evolved from that of a predominantly emergency response to one of long-term capacity building to improve surveillance, early detection and response in HPAI-infected and at-risk countries. FAO has also broadened its HPAI programme to include other high-impact diseases and EIDs, and has adopted a One Health approach to promote greater multisectoral and multidisciplinary participation. This transition has provided an opportunity to reflect on the work done so far to control HPAI in the Asia region, and to identify its impact and achievements, success stories, challenges and lessons learned. The *Lessons from HPAI* report represents the outcome of this reflection and brings together in one place the knowledge, insights and recommendations of experts with first-hand knowledge and over eight years' experience of dealing with H5N1 HPAI in Asia.

30 October 2012

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ECTAD-RAP (FAO)

Abbreviations and acronyms

AAHL	Australian Animal Health Laboratory
ADB	Asian Development Bank
AED	Academy for Educational Development
AEGCD	ASEAN Expert Group on Communicable Diseases
AGA	Animal Production and Health Division (FAO)
AGAH	Animal Health Service
AHI	animal and human influenza
AI	avian influenza
AMS	ASEAN Member States
APEC	Asia-Pacific Economic Cooperation
APRC	Asia-Pacific Regional Conference
AREM	Annual Regional ECTAD Meeting
ASEAN	Association of Southeast Asian Nations
ASEAN+3	Association of Southeast Asian Nations plus China, Japan and Korea
ASWGL	ASEAN Sectoral Working Group on Livestock
AusAID	Australian Agency for International Development
AVET	Applied Veterinary Epidemiology Training
BSL	Biosafety Level (laboratories)
CAHW	community animal health worker
CBO	community-based organization
C&D	cleaning and disinfection
CDC	Centers for Disease Control and Prevention (USA)
CIRAD	Agricultural Research Centre for International Development (France)
CMC-AH	Crisis Management Centre – Animal Health (FAO)
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
CVO	Chief Veterinary Officer
DAH	Department of Animal Health (Viet Nam)
DIC	Disease Investigation Centre (Indonesia)
DLD	Department of Livestock Development (Thailand)
DVE	duck virus enteritis

ECTAD	Emergency Centre for Transboundary Animal Diseases (FAO)
EIDs	emerging infectious diseases
EMPRES	Emergency Prevention System (FAO)
EPT	Emerging Pandemic Threats programme (USA)
EU	European Union
FAVA	Federation of Asian Veterinary Associations
FMD	foot-and-mouth disease
FAO	Food and Agriculture Organization of the United Nations
FETPV	Field Epidemiology Training Programme for Veterinarians
GAINS	Global Animal Information System
GETS	Gathering Evidence for a Transitional Strategy project (Viet Nam)
GF-TADs	Global Framework for the Progressive Control of Transboundary Animal Diseases (FAO/OIE)
GIS	geographic information systems
GPS	Global Positioning System
GLEWS	Global Early Warning System
H1N1	subtype of influenza A virus
H5N1	subtype of influenza A virus
HPAI	highly pathogenic avian influenza
HPED	highly pathogenic emerging disease
IEC	information, education and communication
IGP	Indo-Gangetic Plain
ILRI	International Livestock Research Institute
IMCAPI	International Ministerial Conference on Avian and Pandemic Influenza
INGO	international non-governmental organization
IPC	Institut Pasteur in Cambodia
ISO	International Organization for Standardization
IVM	influenza virus monitoring
KAP	knowledge, attitudes and practices
KOR	Republic of Korea
LBM	live bird market
LL	leading laboratory
MoA	Ministry of Agriculture
MoH	Ministry of Health

NAHICO	National Avian and Human Influenza Coordination Office (Lao PDR)
NaVRI	National Veterinary Research Institute (Cambodia)
ND	Newcastle disease
NEIDCO	National Emerging Infectious Diseases Coordination Office (Lao PDR)
NGO	non-governmental organization
NSCAI	National Steering Committee for Avian Influenza (Viet Nam)
OFFLU	OIE/FAO Network of expertise on animal influenza
OIE	World Organisation for Animal Health
OSU	Oklahoma State University
PAHI	Partnership on Avian and Human Influenza
PCR	polymerase chain reaction
PDSR	Participatory Disease Surveillance and Response (Indonesia)
PPP	public-private partnership
PRK	Democratic People's Republic of Korea
PRRS	porcine respiratory and reproductive syndrome
PT	proficiency testing
QA	quality assurance
QM	quality management
RAP	Regional office for Asia and the Pacific (FAO)
RCM	Regional Coordination Mechanism
RDMA	Regional Development Mission for Asia (USAID)
RNA	ribonucleic acid
RT-PCR	reverse transcriptase polymerase chain reaction
RSU	Regional Support Unit
SAARC	South Asian Association for Regional Cooperation
SARS	Severe Acute Respiratory Syndrome
SEARO	South-East Asia Regional Office (WHO)
SEPRL	Southeast Poultry Research Laboratory (USA)
SMS	short message service
SOP	Standard Operating Procedure
TADs	Transboundary Animal Diseases
TCE	Emergency Operations and Rehabilitation Division (FAO)
TCP	Technical Cooperation Programme (FAO)
TOT	training of trainers

UN	United Nations
UNEP-CMS	United Nations Environmental Programme – Convention on Migratory Species
UNJP	United Nations Joint Programme
UNICEF	United Nations Children’s Fund
UNDP	United Nations Development Programme
UNSIC	United Nations System Influenza Coordination
UNTGH	United Nations Theme Group on Health
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VAHW	village animal health worker
VBEC	village-based biosecurity, education and communication
VVW	village veterinary worker
WAHIS	World Animal Health Information System (OIE)
WB	World Bank
WCS	Wildlife Conservation Society (USA)
WEE	wildlife, ecology and environment
WHO	World Health Organization
WILD	Wildlife Investigation in Livestock Disease and Public Health (FAO)
WPRO	Western Pacific Regional Office (WHO)

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The gathering of country-level and thematic data was managed by ECTAD-RAP's team leaders and their professional staff: Dr Mat Yamage (Bangladesh); Dr Allal Lotfi (Cambodia); Dr Vincent Martin, Dr Fusheng Guo (China); Dr Mandavi Subba Rao (India); Dr James McGrane, Dr Eric Brum, Dr Luuk Schoonman (Indonesia); Dr Tri Naipospos (Lao PDR); Dr Murray Maclean (Myanmar); Dr Mohinder Oberoi (Nepal); Dr Santanu Bandyopadhyay (Viet Nam); Dr Pawin Padungtod, Dr Wantanee Kalpravidh, Dr David Castellan and Dr Jan Hinrichs (Thailand). Additional inputs were provided by Dr Scott Newman, Dr Mia Kim, Dr Yoni Segal, Dr Nicoline de Haan, Dr Julio Pinto and Ms Ariella Ginni (Rome).

All data received from these sources were handed over to Dr Laurie J. Gleeson, FAO Consultant, who took notes during the discussions and question and answer sessions attended by veterinary professionals over the course of the three-day AREM meeting. Dr Gleeson subsequently collated, edited, revised and rearranged the data received, and then produced draft text for each chapter.

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Introduction

The emergence and rapid spread of a zoonotic H5N1 highly pathogenic avian influenza (HPAI) in Southeast Asia in 2003 and 2004 triggered worldwide interest and response, particularly owing to the ability of the H5N1 virus to kill large numbers of infected animals, thereby threatening food security and safety, and the livelihoods of millions of poor livestock farmers. By the time the disease appeared in Southeast Asia, the zoonotic potential of the virus was well recognized. Soon afterwards, a number of human cases and deaths were reported in Viet Nam and Thailand, coinciding with cases in domestic poultry. In 2005, when HPAI spread outside Southeast Asia into Russia, Europe and Africa, the potential for the huge impact of this disease on the global community was clear. This led to an unprecedented response from international organizations and donors to mobilize resources for containing and eliminating the disease.

While aquatic birds are the natural reservoirs of influenza viruses, it is well recognized that, from time to time, the viruses spread and adapt to domestic poultry and then to humans. During this process, influenza viruses increase in terms of their severity and, occasionally, cause influenza pandemics. A number of animal influenza viruses (subtypes H2, H5, H6, H7 and H9) have sporadically infected humans and are considered to have pandemic potential. Since the emergence of H5N1 in 2003, the virus has infected over 600 people worldwide and over half of the infected population have died from the disease. This number is still relatively low. At present, the virus is mainly confined to domestic poultry and

FAO/C.Y. GOPINATH

has not demonstrated that it can be transmitted effectively between humans. However, although human infections remain rare and sporadic, the potential for the emergence of pandemic human influenza from H5N1 still remains.

Since the emergence of H5N1 HPAI in 2003, the disease situation has evolved considerably. At the peak of avian influenza (AI) outbreaks in 2006, 63 countries in Asia, Europe and Africa were affected by the disease; it has now been eliminated from most of these countries. H5N1 is currently entrenched in a number of countries in Asia and the disease is endemic in China, Viet Nam, Indonesia, Bangladesh and large parts of eastern India. A number of countries in Asia, including the Lao People's Democratic Republic (Lao PDR), Cambodia, Myanmar and Nepal, also experience regular outbreaks.

The period 2004 to 2008 saw a steady decline in disease outbreaks in poultry. While there has been an apparent increase in outbreak numbers since 2009, the 2011/2012 HPAI season saw a significant decline in poultry outbreaks. The last newly-infected country was Bhutan; this outbreak took place in February 2010. However, the disease is known to be under-reported and there is increasing evidence that H5N1 HPAI has become endemic in some of the smaller countries in Asia that have relatively undeveloped poultry industries; such countries include Cambodia and Nepal. It is estimated that the disease has resulted in the loss of over 400 million domestic poultry and has caused economic losses of over US$20 billion.

The H5N1 virus itself has evolved progressively in Asia. Between 2003 and 2007, the H5N1 clades 1 and 2 were the most common. The latter clade progressively replaced clade 1 and, by 2005, it had become the dominant strain globally. Clade 2 has evolved rapidly and has generated a number of subclades in different epidemiological situations in Asia. Of the H5N1 clade 2 viruses, clade 2.2, found in the Indo-Gangetic Plain (IGP) area including Bangladesh, Nepal and India, has been the most common. In Indonesia, only the subclade 2.1 has been found. In Southeast Asia, the viral clade situation has been more complex and heterogenous, while in northern Viet Nam the subclade 2.3.4 has been predominant, replacing the previously dominant clade 1 and the newly introduced clade 7. In southern Viet Nam only clade 1 has been observed and it continues to be the most important strain of virus present. Cambodia shares the same epidemiological environment and clade as southern Viet Nam. Lao PDR and Myanmar have had multiple incursions of H5N1 viruses with outbreaks caused by clades 1, 2.3.4 and 2.3.2 in the former, and 7, 2.2 and 2.3.4 in the latter. Thailand, which is now free of H5N1 HPAI, has had two incursions, one with clade 1 and the other with 2.3.4.

Since late 2010 and 2011, there has been evidence that clade 2.3.2.1 is emerging as the most dominant strain in Asia. By early 2011, several countries in Asia had experienced outbreaks of HPAI caused by this clade, which seems to have evolved in domestic poultry in China and also appears to possess altered characteristics with high pathogenicity to wild birds. This virus has been known to spread widely in Asia through infected wild birds, and has affected Bangladesh, India, Japan, Myanmar, Nepal and the Republic of Korea (KOR). Clade 2.3.2 in its various forms exists in China together with clade 2.3.4.

The information, generated from isolation and genetic and antigenic characterization of a large number of viruses in Asia and other parts of the world, coupled with the information on disease outbreaks, has improved our understanding of the virus's evolution and the implications for its spread, infectivity and suitability for use in the development of vaccines. The current trends in evolution present a number of concerns, which include the emergence of second-, third- and fourth-order clades, demonstrating rapid evolution and rapid replacement of virus strains in some endemic regions, and the emergence of antigenic diversity, including changes in receptor binding capacity and the ability to break through existing vaccine strains.

THE GLOBAL RESPONSE

As part of the global effort to control AI and reduce the risk of a human pandemic, a series of high-level international ministerial conferences on avian and pandemic influenza (IMCAPI) were organized by international technical organizations and the donor community. These consultations, held in Beijing (2005), Bamako (2006), New Delhi (2007), Sharm el Sheikh (2008) and Hanoi (2010), have consistently acknowledged that the risk of pandemic influenza can only be reduced by controlling the disease at source in poultry. In this regard, major international agencies and the donor community have recognized the important role of the Food and Agriculture Organization of the United Nations (FAO) in controlling this disease, particularly given FAO's broad mandate related to the development of sustainable agriculture for food security, food safety and poverty reduction. The IMCAPI meetings have also been influential in generating political and financial support for addressing the HPAI problem.

FAO'S RESPONSE

FAO has played a central and leading role in global efforts to control H5N1 HPAI. In 2004, FAO created the Emergency Centre for Transboundary Animal Diseases (ECTAD), an implementation platform for addressing the global issues of HPAI as an operational support for its Emergency Prevention System for Animal Health component (established in 1994). ECTAD was born out of a partnership between FAO's technical expertise, embodied in the Animal Production and Health Division (AGA), and its emergency operations expertise, represented by its Emergency Operations and Rehabilitation Division (TCE). ECTAD's Regional office for Asia and the Pacific (RAP) was established in Bangkok in 2005 in response to increasing poultry mortality and human infections due to HPAI in South, Southeast and East Asia. By 2007, FAO had a large HPAI control programme in Asia, with a South Asia subregional ECTAD Unit based in Kathmandu, and country ECTAD units covering over 11 countries in South, Southeast and East Asia. Driven by a clear, decentralized chain of command from the FAO Chief Veterinary Officer (CVO), in his role as the Head of ECTAD, through to the Regional Manager and the country Team Leaders, and supported by clear and synergistic global, regional and national strategies for HPAI control, the ECTAD platform provided an effective model for emergency implementation of a high-impact emerging disease control programme.

FAO's principal role in using the ECTAD platform may be broadly grouped under two headings: coordination and technical support. The coordination role has been significant in forging productive partnerships with national governments, regional organizations, national non-governmental organizations (NGOs) and international non-governmental organizations (INGOs), national and international research institutes, other international developmental and technical agencies and the international donor community. FAO's formal relationship with ministries of agriculture in respective member countries has enabled the rapid development, establishment and implementation of national HPAI programmes. The technical expertise has fostered programmes to improve the capacity to quickly detect, diagnose, report and respond to a disease emergency. Through its technical advice and support, FAO has enhanced regional cooperation and has promoted greater transparency in sharing disease information through the establishment of regional diagnosis and surveillance networks in collaboration with regional organizations. FAO has also been able to form and mobilize multidisciplinary teams, including communicators, socio-economists, wildlife experts, epidemiologists, virologists, molecular biologists and public-private partnership experts, to address an extremely complex disease problem of global significance.

Global efforts to address the threats and impact of H5N1 HPAI have yielded significant results. The understanding that a pathogen that predominantly causes losses in livestock can spread to humans and cause epidemics and pandemics has spurred politicians and decision-makers to invest in combating the problem of emerging infectious diseases (EIDs). The complexity of the drivers of infectious diseases has stimulated the development of a One Health approach that promotes multidisciplinary and multisectoral collaboration in addressing the problem. When pandemic H1N1 influenza emerged in 2009, two factors that prompted the well-coordinated global response by various countries and international and regional organizations were increased awareness of such high-impact global problems and enhanced capacity to address them.

WHY THIS REPORT?

FAO continues to play a key role in the global response to HPAI. At its peak, the ECTAD programme comprised 168 donor-supported projects, of which 64 remain active, more than half of them in Asia. From 2010 onwards, there has been a progressive decline in funding

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for HPAI, coupled with clear evidence of declining political commitment among affected and at-risk countries. This is a worrying trend, as H5N1 circulates and evolves in six endemic countries, posing the risk that new variants with unexpected outcomes could emerge unexpectedly. The disease is under-reported, and efforts at surveillance are declining in most countries that are chronically short of financial and human resources. The FAO publication *Approaches to Controlling, Preventing and Eliminating H5N1 HPAI in Endemic Countries* (FAO 2011) has noted that factors such as the nature of the poultry sector, the quality of veterinary services and the level of commitment from the public and private sectors will play an important role in determining the rate of progressive control of HPAI. It is also clear from the current situation that it would take several years for endemic countries to be free of the H5N1 virus. In addition, a number of new pathogens and diseases are emerging in the region in an environment where the interaction between livestock, wildlife and humans is increasing. It is, therefore, important to put greater effort into raising awareness of the potential risks involved in reducing funds for the control of HPAI and other high-impact EIDs. Given the scenario outlined, it was considered important that an attempt be made to reflect on the progress achieved thus far in the control of HPAI in the Asia region. In late 2011 and early 2012, an initiative was launched by ECTAD-RAP (ECTAD's Regional office for Asia and the Pacific) to gather information from the ECTAD Regional Programme for Asia, with the broad objective of taking stock of the HPAI programme between 2005 and 2011.

In order to collect this information, a structured process, with a set of key questions to create a common framework for reporting, was adopted and coordinated by ECTAD-RAP. The questions included: a) What was the situation at the outset in 2005? b) How had this changed by 2011? c) What are the quantifiable outputs and outcomes? d) What practices were successful, what were the lessons learned? e) How many of the outputs are sustainable, how many require a little support, and for how long?

Staff in the regional office, country units and in FAO headquarters were requested to provide information on the ongoing HPAI programme using a template of questions, under the following thematic areas:

- coordination and partnership;
- surveillance, epidemiology and information management;
- laboratory capacity;
- disease prevention (vaccination);
- disease prevention (biosecurity);
- socio-economic capacity and disease control;
- strategic communication and advocacy;
- wildlife health and ecosytems.

The information gathered was shared with participants at the 6th Annual Regional ECTAD Meeting (AREM) held in February 2012, and validated through further discussions. The resulting output was collated in the form of this report, *Lessons from HPAI.*

It is envisaged that this report will be used primarily by FAO AGAH and ECTAD staff as an internal aid to designing and developing future programmes to combat HPAI, transboundary animal diseases (TADs) and EIDs by drawing on the last seven years' experience of tackling HPAI in Asia. The report may also be used to generate communication and advocacy materials for garnering continuing support for the HPAI programme and further investment from the international donor community. It is also expected that the report may serve as a resource for other key donor partners for eliciting information on the impact of their investment in FAO to control HPAI in Asia. It is important to note that this report neither purports to be a comprehensive account of the activities of FAO in the HPAI arena, nor does it provide detailed lists of outputs, outcomes, impact and gaps. However, the stocktaking process effectively captures the key experiences and challenges of addressing a complex disease problem such as HPAI.

Coordination

FAO has played a central role in forging and coordinating partnerships between players and stakeholders involved in the control of HPAI and other high-impact emerging and re-emerging infectious diseases. These have included partnerships with national governments, NGOs, donors, national and international research institutes, regional organizations and other international development and technical agencies. With the exception of Singapore and Brunei, FAO is represented officially in all countries in South, Southeast and East Asia, and it enjoys formal relationships with ministries of agriculture or their equivalents in these countries. This enables FAO to undertake projects at the national level without the need to develop additional memorandums of agreement. FAO also hosts the biannual Asia Pacific Regional Conference (APRC) for ministers of agriculture and regional organizations, where regional priorities and policy issues are discussed and important decisions are made. In addition, FAO has formal collaborative agreements with the Association of Southeast Asian Nations (ASEAN), the South Asian Association for Regional Cooperation (SAARC) and other UN and international agencies including the World Health Organization (WHO), the United Nations Children's Fund (UNICEF) and the World Organisation for Animal Health (OIE), as well as multilateral donors such as the World Bank (WB) and the Asian Development Bank (ADB).

All global activities relating to HPAI and other high-impact infectious diseases were led by FAO and were conducted under the umbrella of ECTAD, the internal mechanism established in 2004 by the Director General of FAO in response to the crisis caused by the

FAO/K. WONGSATHAPORNCHAI

emergence and spread of HPAI in Southeast Asia. ECTAD, which is a unique partnership between FAO's technical and operational arms, was established to manage and deliver an emergency programme across the Asia-Pacific region.

FAO has managed major projects funded by a large number of donors, including ADB, the Australian Agency for International Development (AusAID), the German Government, the Japan Trust Fund, the United States Agency for International Development (USAID), the Avian Influenza Facility of the WB, and the European Union (EU). Funding has also come through the multidonor-funded UN Joint Programme (UNJP) in Viet Nam. Many governments have established mechanisms to coordinate the public health and animal health aspects of their overall response to HPAI, and FAO has remained closely and continuously involved with the functioning of these mechanisms, either through the ECTAD team or through the FAO representative. FAO has worked as a neutral broker within the government systems of its member countries, ensuring that the government's interests receive due priority from a large number of national, regional and international partners. While this may have presented a challenge at the outset, over time FAO has become a trusted partner delivering efficient technical approaches and advocating policy issues that support HPAI control in the interests of the international, regional and public good. By adhering to its core principles, FAO has been increasingly effective as a coordinator and partner, and has also played a consistent role in the functioning of the UN's country-level coordination mechanism.

In 2004, just as HPAI was beginning to sweep across the region, FAO and OIE, representing animal health interests, worked with WHO to develop the *FAO/OIE Global Framework for the Progressive Control of Transboundary Animal Diseases* (FAO/OIE 2004), a document which articulated the principles for collaboration on priority infectious diseases of livestock. An important initiative in this framework was the establishment of a global early warning system (GLEWS) for animal diseases, which operates as part of the FAO Emergency Prevention System (EMPRES) programme.

In 2006, ECTAD-RAP helped to develop *A Strategic Framework for HPAI Prevention and Control in Southeast Asia* (FAO 2006), the first joint strategy against HPAI in Asia and the Pacific. Using this strategy as a springboard, FAO, which already had strong links with the ASEAN Sectoral Working Group on Livestock (ASWGL), helped to develop the *Regional Framework for the Control and Eradication of HPAI in ASEAN* (FAO 2006), an initial set of guidelines for HPAI control in ASEAN member states. Early FAO workshops on epidemiology and laboratory standards also included ASEAN representation.

FAO and OIE developed the *Guiding Principles for Highly Pathogenic Avian Influenza Surveillance and Diagnostic Networks in Asia* (FAO 2004) and made significant contributions to the evolving global response through collaboration with the UN System for Influenza Coordination (UNSIC). In addition, FAO has been a central advisor, coordinator and participant in the six IMCAPIs that have been held since late 2005.

SITUATION IN 2005

Although the ECTAD mechanism, which was created to deliver FAO's global HPAI emergency programme, was already in existence, it was not until late 2005, when the global fund for avian and human influenza became available, that ECTAD-RAP was established in Bangkok. Until then, FAO had been deploying its core funds through Technical Cooperation

Programmes (TCPs) at both national and regional levels in Asia in order to coordinate with and support countries in their HPAI control efforts. For example, in 2005, a regional TCP helped to establish diagnostic laboratory and surveillance networks for HPAI in many countries in Southeast Asia. It was these early emergency missions and TCPs that gave FAO the basis for working with donors in 2005 to prepare national and regional project proposals. By early 2006, funding was in place and activities were initiated in Cambodia, Indonesia, Lao PDR and Viet Nam.

SITUATION IN 2011

International partnerships

Under the leadership of ECTAD-RAP, several country ECTAD units were quickly established in the Asia-Pacific region to manage multidonor-funded country programmes. ECTAD-RAP played a key role in the overall UN system response and had a collaborative alliance with OIE, WHO and UNICEF; the latter received special funding to develop a communication programme to prevent and control HPAI in humans.

Close coordination on animal health technical matters with UNSIC, and also with WHO and UNICEF, helped to broaden understanding of the issues at the source of the disease and to synchronize messages across the UN system.

Regional partnerships

At the regional level, ECTAD-RAP engaged strategically with ASEAN by establishing the ASEAN HPAI Task Force and developing the ASEAN HPAI Roadmap 2020. With significant technical inputs from FAO, this roadmap for an HPAI-free ASEAN community by 2020 was endorsed at the 32nd Meeting of the ASEAN Ministers on Agriculture and Forestry held in October 2010. ECTAD-RAP's engagement has since developed into a fully-fledged collaboration, and its activities have broadened from TADs to include high-impact emerging and re-emerging infectious diseases of significant socio-economic impact in the ASEAN and ASEAN+3 member countries. ECTAD-RAP's expertise contributed to finalizing the ASEAN priority animal diseases and priority zoonotic diseases, which allowed FAO to actively engage at a practical level with the ASEAN Expert Group on Communicable Diseases (AEGCD), the organization's human health arm. The establishment of the ASEAN Regional Support Unit (RSU) in 2011 in Bangkok marked a significant step in ECTAD-RAP's regional coordination role. The process for establishing a regional coordination mechanism with the proposed name ASEAN Coordination Centre for Animal Health and Zoonoses had already been endorsed by the Preparatory Senior Officials Meeting at the 33rd Meeting of the ASEAN Ministers on Agriculture and Forestry held in October 2011, thereby demonstrating FAO's alignment with the direction of ASEAN's policy.

ECTAD-RAP's Subregional Coordination Unit for SAARC, established in Kathmandu, has stimulated effective regional coordination and has delivered particularly good outcomes from the South Asia cross-border project. Project management and coordination mechanisms included technical and policy-level committees, meetings, workshops and information bulletins, with SAARC engagement in both regional and global meetings. Between May 2009 and October 2011, 15 issues of a bimonthly information bulletin were disseminated to ECTAD members, donors, countries, and other stakeholders. Between

April 2009 and May 2010, four meetings of technical and policy-level committees to review project progress were held in Kolkata (India), Dhaka (Bangladesh), Pokhara (Nepal) and New Delhi (India). These meetings have contributed to filling significant gaps in technical capacity within the SAARC Secretariat.

FAO also helps to coordinate the Tripartite mechanism, which was established in early 2010 as an intersectoral platform for dialogue around One Health and for collaboration between FAO, WHO Southeast Asia Regional Office (SEARO), the Western Pacific Regional Office (WPRO) and OIE. The mechanism incorporates the recommendations from the 2010 IMCAPI in Hanoi, where the One Health approach was strongly endorsed, thereby highlighting the importance of strengthening partnerships and intersectoral cooperation. The 2010 IMCAPI noted the need to move beyond disciplinary insularity so as to ensure that the One Health approach would be successful. This involved broadening the scope of the mechanism to include ministries of environment or natural resources in addition to ministries of agriculture and health. In August 2011, countries in the region developed their first drafts of advocacy action plans to promote One Health in their country settings; in this endeavor they were guided by *The One Health Action Plan of FAO's Animal Health Service* (FAO 2011), which recognizes advocacy as a key activity. FAO is coordinating the creation of comprehensive, intersectorally-developed One Health strategies at country levels. Bangladesh's One Health country strategy and action plan document is now nearing finalization, and includes a number of ongoing One Health-related activities.

Country partnerships

In order to ensure effective coordination of technical areas in countries in the region, the Subregional Coordination Unit developed a strong, synergistic multidisciplinary team of experts in epidemiology, laboratory methods, legislation, socio-economics and communication. By the end of 2011, FAO had helped to manage donor inputs in Bangladesh, Cambodia, China, India, Indonesia, Lao PDR, Malaysia, Myanmar, Nepal, the Philippines, Timor-Leste and Viet Nam, thereby covering key countries that were at major risk of H5N1 HPAI infection in South, Southeast and East Asia.

Indonesia: FAO's largest project investment was in Indonesia, where FAO was embedded in the government structure and implementation mechanism. This put FAO in a pivotal position to gather and disseminate information about the national programme through its interactions with industry stakeholders on behalf of the government, and its engagement with international agencies such as WHO, OIE and UNICEF. FAO's regular coordination meetings with the government and with key stakeholders and donors – including the International Livestock Research Institute (ILRI), USAID, AusAID and the Indonesia Dutch Partnership Project – contributed to harmonizing the programme. FAO served as a bridge between the Indonesian Government and Indonesia's large international NGOs which were not embedded in the government system; it was also heavily involved in helping the WB to establish a project to support the Indonesian Government. FAO established quarterly HPAI technical briefing meetings with donors and technical partners, in order to support the Directorate General of Livestock and Animal Health Services. This support was extended in 2011/12 to providing technical donor coordination support to the Director of Animal Health on issues of animal health, which involved mapping the animal health activities of donors, technical agencies and INGOs, in addition to defining a donor coordination strategy.

Viet Nam: FAO's second largest investment was in Viet Nam, where it also worked closely with government structures and mechanisms to deliver assistance to the Ministry of Agriculture. The Vietnamese Government established a National Steering Committee for Avian Influenza (NSCAI) chaired by the Ministry of Agriculture (MoA). FAO provided advice and advocacy to this committee through the Department of Animal Health (DAH). FAO also had inputs into Viet Nam's all-important, so-called 'Green Book' – *Viet Nam Integrated National Operational Programme for Avian and Human Influenza 2006–2010* (Viet Nam 2006). FAO used this publication as a guidance tool for implementing donor assistance.

Viet Nam's Partnership on Avian and Human Influenza (PAHI), established in November 2006, was signed by 26 partners including the Government of Viet Nam and other national organizations, the UN System, the WB, international donors, NGOs, research organizations and other stakeholders. FAO was closely involved with PAHI's annual plenary meetings, which provided a forum for updating the disease situation, for joint monitoring and delivery of overall financial commitments, and for policy discussions and sharing of experiences.

FAO also played an important role in UNJP, which managed funds provided to the trust by a number of donors. In addition to coordination with WHO, FAO had considerable interaction with UNICEF and others in relation to the UNJP-funded communications strategy. As in Indonesia, FAO played a bridging role between the national animal health services and several INGOs working with USAID support to implement activities at the grassroots level. Relationships between partners, including the United States Centers for Disease Control and Prevention (CDC), OIE and the United States Department of Agriculture (USDA), were strengthened at annual retreats organized by FAO to discuss programme progress and plans.

China: FAO ECTAD's coordination role in China has been recognized by both national and provincial partners in Hunan, Yunnan, Guangxi and Chongqing at centrally administered municipality (provincial level) and also by beneficiary countries in the region. Over the past five years, this has helped to build cohesion in the national programmes, has strengthened links between FAO and the national government, and has enhanced partnerships between stakeholders such as the Ministry of Agriculture and the State Forestry Administration. FAO also established partnerships with the city administration in Guangzhou municipality to facilitate work in markets. As the focal point and knowledge hub for TADs within FAO and the UN family in China, FAO ECTAD China plays a leading role in the coordination of the national and local government with other stakeholders and with the outside world. This is achieved through the provision of science-based technical advisory inputs by FAO, continuous communication within its mandate areas, and through the development of proposed solutions to address issues and challenges ahead. Under the umbrella of the UN Theme Group on Health (UNTGH), FAO ECTAD China organized meetings of the subworking group on diseases at the human-animal interface in 2010/12; these meetings have helped to promote the use of an ecosystem health approach to address EIDs. FAO ECTAD China also extends its technical assistance and expertise through the facilitation, design and implementation of TCPs in Mongolia and the Democratic People's Republic of Korea (PRK), with a special focus on foot-and-mouth disease (FMD).

Myanmar: In Myanmar, FAO was able to integrate diverse components into one programme with notable results. In 2005, when there were no coordination structures, FAO began to develop an Integrated Programme on Avian Influenza. This programme coordinated inputs from three funding sources – AusAID, USAID and the WB – while reporting to each donor separately and holding consultations with the National HPAI Steering Committee. FAO also conducted cooperative interactions with stakeholders such as the Myanmar Livestock Federation and independent livestock associations, and coordinated another project with WHO.

Lao PDR: In Lao PDR, FAO established the National Avian and Human Influenza Coordination Office (NAHICO), later renamed as the National Emerging Infectious Disease Coordination Office (NEIDCO) in line with its broadened responsibility beyond influenza. NEIDCO coordinates the implementation of the National Work Plan for EIDs and Public Health Emergency for Lao PDR (2011–2015), which includes FAO's avian influenza (AI) project. Through this mechanism, FAO has shared active and passive surveillance information on priority zoonotic diseases and emerging disease events. The mechanism also allows for joint investigations and risk assessments which can lead to coordinated responses to zoonotic disease threats and joint risk-reduction activities. Structures have been set up for intersectoral coordination and the development of a national integrated work plan. The process has fostered communication between appointed officials at policy, implementation and supervisory levels, and has reduced inconsistencies in responses between different agencies.

In other countries, ECTAD-RAP linked itself with national efforts through National HPAI committees that included representation from the health and agriculture sectors at both national and international levels, as well as other stakeholders such a UNICEF and poultry industry representative bodies.

Donor partnerships

ECTAD-RAP engaged closely with donors in establishing both regional and national projects. FAO had a strong partnership at international, regional and national levels in particular with USAID, the single largest donor to the global programme. Wherever the WB has funded HPAI control programmes, FAO has been involved at varying levels, although contractual difficulties caused by differences in institutional arrangements have posed a challenge. Nevertheless, this has neither hampered the partnership nor impeded coordinated inputs from the WB and FAO into the country programmes. The partnership with the ADB was particularly important, as it supported the regional coordination role of ECTAD-RAP as well as some key technical positions and regional communications activities. Significant support also came from the Japan Trust Fund, which is used to bolster FAO field support in ASEAN Member States. AusAID provided valuable support to the programme in Indonesia and Myanmar - a partnership that has proved to be effective. Smaller amounts of support were provided by a number of donors including Germany, Sweden, the Netherlands, China, New Zealand, Ireland and France.

Other partnerships

FAO's strong partnership with the technical arm of USAID, particularly in the Bangkok mission, has led to deep discussions about project design and has also led to some interaction with US-based technical officials. The latter was especially true of the programmes in Indonesia and Viet Nam. In addition, ECTAD-RAP played a key role in organizing many workshops and review meetings together with USAID's Regional Development Mission for Asia (RDMA) office. Apart from USAID, FAO has collaborated with technical experts from the Commonwealth Scientific and Industrial Research Organization (CSIRO), the Australian Animal Health Laboratory (AAHL), the CDC in Atlanta, CDC experts stationed in several Asian countries, and the United States Department of Agriculture (USDA) – both the Southeast Poultry Research Laboratory (SEPRL) in Atlanta and its regional office in Bangkok. The French Agricultural Research Centre for International Development (CIRAD) was another technical partner that collaborated with FAO on HPAI.

OUTPUTS

- Donor inputs were coordinated through FAO partner involvement in several key meetings of national steering committees or similar bodies.
- Technical aspects of the HPAI control programme were coordinated through over 200 workshops and meetings at regional or national levels.
- Active and productive regional networks were established for HPAI diagnostic laboratories and veterinary epidemiology.
- The ASEAN RSU was established at the FAO RAP, and a process for developing the ASEAN Coordination Centre for Animal Health and Zoonoses was initiated.
- The ECTAD Subregional Coordination Unit for South Asia, and subsequently the RSU for SAARC, were established.
- Global, regional and national plans and guidelines for HPAI control were drawn up in collaboration with other agencies and donors.
- Two real-time evaluations were coordinated by independent reviewers of the FAO-executed HPAI programme in Asia.
- Mobilization of resources was facilitated through the coordination of five IMCAPIs, held in Beijing, Bamako, New Delhi, Sharm el Sheikh and Hanoi, respectively.
- A meeting of high-burden HPAI countries was coordinated for sharing experiences and best practices for controlling HPAI in humans and animals.
- Two global and regional HPAI strategy documents and a One Health strategy document were developed.

OUTCOMES

- Significant progress was made in relation to HPAI control across public health and animal health sectors in the region, primarily as a consequence of FAO's effective coordination and collaboration with governments, regional organizations, donors and partners, and also as a consequence of strong contributions at global, regional and national fora on HPAI control.
- One Health initiatives were developed at the national level, facilitated by FAO's efforts to link the public health and animal health sectors.
- Cooperation between neighbouring countries has increased, and understanding of transboundary issues has improved, as a result of regional activities coordinated by FAO. Such activities include building and strengthening laboratory and epidemiology

networks. This has led to better information-sharing between countries, as well as in the region and internationally.
- The capacity of ASEAN and SAARC to control HPAI and highly pathogenic emerging diseases (HPEDs) has improved because of FAO's capacity building initiatives, supported by the European Union's (EU) Highly Pathogenic Emerging Diseases (EU-HPED) project.

SUCCESSFUL PRACTICES

- Opportunities for intersectoral collaboration between the human health, animal health and wildlife sectors are now explored and promoted during different stages of project design, and also during the development of action plans.
- Experts from diverse technical, sociological, economic and other fields participate in planning and review meetings, as well as research and field activities, in order to generate richer insights through greater interdisciplinary collaboration.
- UN agencies such as UNSIC, WHO and UNICEF have developed closer coordination on animal health technical matters, in order to broaden understanding of issues around HPAI and synchronize messages across the UN system.
- FAO has maintained a development perspective while working in emergency modality, in order to transform the scope and perspective of disease control, and broaden the focus to include livelihoods and socio-economic factors, nutrition and other development aspects. This approach has, in turn, helped to foster a spirit of professional partnership and collaboration between FAO, donors and governments, based on an acknowledgment of comparative advantages.

SUSTAINABILITY

Networks: Active technical support for networks requires external assistance. Over time, this function could be subsumed into ASEAN's regional activities, provided that the political commitment to sustain it is maintained at the regional level.

RSUs: The ASEAN and SAARC RSUs will be transferred gradually to the respective regional organizations. The ASEAN RSU transfer will be in line with the comprehensive proposal for the establishment of a Regional Coordination Mechanism (RCM) on Animal Health and Zoonoses. This mechanism will empower ASEAN to coordinate activities related to animal health and zoonoses more effectively at the regional level among ASEAN Member States (AMS), and between AMS and development partners. The SAARC RSU will provide ASEAN with a robust model for addressing many other regional technical issues in South Asia.

Coordination mechanism: Sustainability in the medium and long term is also closely linked to the development of stronger working relationships between the government and the commercial poultry sector in the spirit of public-private partnerships, and is based on the premise of trust and respect for each other's capabilities. In the short term, this will continue to require resources, support and advocacy.

THE FUTURE

Regional organizations are demonstrating greater capacity to provide technical leadership for HPAI and other priority diseases and will therefore assume a greater coordination and support role in the future. FAO will continue to take the stance of the neutral agency and to support strategic efforts to institutionalize the One Health approach to infectious diseases. Long-term plans will need to be drawn up to strengthen animal health services in the region and to devise strategies for addressing gaps in technical capability and capacity that constrain the implementation of One Health approaches in the livestock sector. In this, the introduction of a development perspective to the overall coordination of international inputs would help a great deal.

Surveillance

The availability of timely and accurate information about disease occurrences continues to be a priority for global, regional and national communities owing to its critical importance in implementing effective HPAI control programmes in domestic poultry. The key to achieving this is the capacity to detect disease outbreaks, and then to manage, report and analyse outbreak information. In the context of HPAI the objectives are twofold: to reduce the economic impact of the disease in the poultry sector by facilitating timely detection and control, and to inform public health authorities of the risk to human populations. It is difficult to define the scope and boundaries of disease surveillance in the context of rapidly evolving disease dynamics under different epidemiological environments. The constant question faced in Asia is: How much surveillance activity does a disease control programme need when the cost of each step in the process is weighed against the effectiveness of the approach? Although international experts differ among themselves as to the best structure and the desired outputs of an effective surveillance system, one important principle that must remain in the forefront is 'fit for purpose'. An important consideration for ECTAD is that the surveillance system must inform and enable a successful disease control programme at the national level. There should also be a timely flow of information to international reporting systems to enable the broader analysis of disease information to assess regional and global risks to livestock as well as to public health.

FAO/T. MCCRACKEN

Disease in poultry has been detected in different ways since the HPAI epizootic began in Southeast and South Asia. In the early stages, one of the most common detection methods was reporting by poultry owners to local authorities, sometimes augmented by reports from concerned community members. Disease was also detected when there were outbreaks of H5N1 influenza in humans, generally causing mortalities, which triggered searches for sources in poultry. While in the later stages there were specific, active surveillance programmes to detect infection or disease, it has generally continued to be the case that financial stakeholders in a poultry value chain who are concerned about loss of income or personal safety will alert authorities about outbreaks. They are generally motivated by personal benefit rather than by any concern for the common good. Rumours at ground level, or reported in the media, also sometimes constitute indirect surveillance triggers.

Notably, no country has established a formal mechanism for joint public health-animal health surveillance, although in some places community-level programmes using community health workers (i.e. public health) to report on poultry health status have been initiated. In addition, joint outbreak investigations, a form of surveillance, have sometimes been conducted.

Surveillance has often been hampered by the reluctance of stakeholders to cooperate because of perceived disincentives, some of which involved the administrative authorities. For example, the negative impact of disease control measures such as stamping out, coupled with insufficient compensation, created a disinclination to report outbreaks, even among those who might have complied with disease control authority regulations. This, in turn, led to reduced levels of reporting by those with an economic interest in the poultry production system, which was under pressure. Other more mundane factors that discouraged reporting, both at the national level and to the international community, were fatigue with HPAI by government animal health services, and habituation at the community level. A reluctance to report was also observed in district authorities, who feared that their superiors might perceive a disease outbreak as a black mark against them, or who were disinclined to implement unpopular and difficult control measures. Equally, this antipathy to reporting could stem from concern about the impact of a disease outbreak on the province's trading rights for poultry and poultry products. Reluctance to report or under-reporting also occurred at the national level for political reasons.

While the emphasis in the early stages of the regional effort was on active surveillance, it became clear that this expensive method was not cost-effective. As the incidence of disease decreased, it became more viable to gather information using passive or targeted approaches. Given that most surveillance information should emerge as a result of the engagement of stakeholders in routine activity, their lack of involvement was a significant constraint. In order to overcome this problem, emphasis was placed on strategic communication, better incentives and the economics of value chains, and an effort was made to incorporate these elements into surveillance structures. An effective surveillance system would also yield information about risk factors that influence disease occurrence and the effectiveness of disease control measures. The application of epidemiological analyses can also challenge some prevailing practices. Resistance to changing paradigms or policies because of political interests should not be underestimated.

Another form of surveillance that has increased in line with support from the international community is the isolation and characterization of H5N1 viruses from disease outbreaks in order to monitor genetic changes and enable adjustments to be made to vaccines that are compatible with circulating viruses. Other important activities have included post-vaccination monitoring of antibody responses to vaccines as a measure of vaccination effectiveness, and the targeted searching for viruses that might be present in vaccinated populations.

It is not realistic to expect a surveillance structure to detect every single instance of H5N1 infection. It is expected, however, that when a disease outbreak occurs, it will be reported to the authorities, and the required disease control measures will be implemented. Where the disease is endemic, the combination of surveillance and control measures is expected to keep its incidence to an acceptably low level which, in the case of H5N1, is related to the concurrent incidence of human cases and the production impact on the poultry sector. Where the disease is sporadic, the surveillance system is expected to detect an incident or incursion quickly enough to pre-empt a large focus of secondary cases and to help eliminate the disease locally.

The role of FAO in surveillance programmes has varied considerably across the region covered by ECTAD-RAP, with deeper involvement in the national surveillance structure in some countries. Other than in a few countries, FAO officers do not get directly involved in outbreak investigations and surveillance.

SITUATION IN 2005

Three FAO documents provided the conceptual basis and principles for the early detection, rapid response, prevention and control of HPAI. In 2004, FAO and OIE signed an agreement setting up the *Global Framework for the Progressive Control of Transboundary Animal Diseases* (FAO/OIE 2004), better known as GF-TADs. Two other documents were *Guiding Principles for Highly Pathogenic Avian Influenza Surveillance and Diagnostic Networks in Asia* (FAO 2004) and *A Strategic Framework for HPAI Prevention and Control in Southeast Asia* (FAO 2006). Efforts to initiate more structured surveillance were under way in the region, but the existing infrastructure and capacity limited early detection and response. At the beginning, before national contingency plans were developed, surveillance was implemented through short-term missions carried out mainly by consultants with back up provided by regional staff. Initial fears about the pandemic potential of HPAI H5N1 promoted early reporting from communities, within the constraints for recognizing differential conditions such as Newcastle disease (ND) and duck virus enteritis (DVE). Cases were mostly reported passively through voluntary submissions.

Field and laboratory components required for surveillance were nascent and disconnected. Few countries had epidemiology units within their animal health services and national epidemiology capacity was low or non-existent. In addition, laboratory capability and the capacity to support control activities in the field were severely lacking. Initial efforts to establish laboratory capability and capacity were gradually augmented by field training programmes to teach disease recognition, reporting and sample collection methods to staff. Post-outbreak surveillance predominated, and serological surveys were conducted in many countries to determine the prevalence of infection in both chickens and ducks.

In its role as FAO's main implementing platform in the region under GF-TADs, ECTAD-RAP was perfectly placed to identify and take advantage of an extraordinary network of partners and expertise at the global, regional and national levels. ECTAD-RAP helped to link individual countries to global tools and platforms for surveillance, diagnosis and data sharing. Among these were the Global Early Warning System (GLEWS) for major animal diseases including zoonoses; EMPRES for transboundary plants, pests and animal diseases; the Crisis Management Centre – Animal Health (CMC-AH); and the OIE/FAO network of expertise on animal influenza (OFFLU). Despite having access to these tools and platforms, none of the affected countries reported H5N1 HPAI outbreaks or any other disease-related events. The only data on disease events came from official reports provided to OIE.

Mass vaccination began in Indonesia in early 2004 and in Viet Nam in late 2005, in response to pressure from the human health sector/industry. However, planning for field virus surveillance and post-vaccination monitoring continued to lag behind. Vaccination had got under way in China before 2004, when it was officially sanctioned; in the interim, post-vaccination monitoring and virus surveillance had become routine.

SITUATION IN 2011

Global perspective

By 2011, significant integration of the surveillance outputs from country programmes into global reporting systems had been achieved. The reporting outputs from GLEWS and EMPRES had been greatly enhanced by the improved quality of information provided by the country surveillance programmes. At FAO headquarters disease intelligence analysis capability had improved as a result of the establishment of a core GLEWS team with responsibility for disease tracking, data integration, analyses and monitoring for early warning purposes. The number of countries reporting HPAI H5N1 outbreak data had increased by 2011 to encompass all affected countries in South and Southeast Asia, including endemic countries such as Viet Nam, Egypt, Indonesia and Bangladesh. The quality of disease information directly feeding into GLEWS and EMPRES had also improved.

In keeping with prevailing public health practice, rumour-tracking and event-based surveillance has been established by GLEWS at FAO headquarters in Rome, at ECTAD-RAP in Bangkok, and at the RSU in Kathmandu, in order to share early signals of potential outbreaks through formal and informal information generated by communities and reported by media. The EMPRES-i and EMPRES-i Asia platforms have been made operational to upload and disseminate information to participating authorities. Current inputs to the system derive from more than 70 authorized users, including national veterinary services, FAO field officers and reference laboratories. Apart from inserting details of disease events, authorized users can utilize spatial analysis tools and discussion forums, and they can also access additional documents in the repository. Since the system went online in April 2010, over 1 500 disease outbreak events have been reported through this system. Of these 1 500 events, 300 were additional to those reported through OIE's World Animal Health Information System (WAHIS) in Asia. The general public can access disease event information, disease mapping tools, the document library and a directory of animal health personnel. A link has been made between genetic and epidemiology data in EMPRES-i. In addition, spatial analyses of disease occurrences have been undertaken within EMPRES-i Asia. Countries were assisted with strengthening their disease information management through the provision of TADinfo®, FAO's open-source database/mapping software for national disease information.

Regional perspective

Since late 2005, when it was set up, ECTAD-RAP has coordinated country activities in field and laboratory preparedness and response, including the provision of technical backstopping and the establishment of regional networks. ECTAD-RAP has always viewed strengthening the capacity of the regional laboratory system as key to building national and regional surveillance capability. Its epidemiologists have conducted training at the national level, sometimes in conjunction with other players such as OIE, the Australian Animal Health Laboratory (AAHL), the Centers for Disease Control and Prevention (CDC) and the United States Department of Agriculture (USDA). ECTAD-RAP epidemiologists have also supported regional workshops to standardize and harmonize surveillance methods. The establishment of the regional Field Epidemiology Training Programme for Veterinarians (FETPV) in collaboration with Thailand's Department of Livestock Development (DLD), together with the development and support of epidemiology training programmes in China, Myanmar and Viet Nam, represent a major step forward. Regional workshops have emphasized the standardization of outbreak investigations, including the importance of defining the geographic location of disease outbreaks, epidemiological units, case definitions, the number of events and their time span, forward tracing and backward tracing, reporting, and the collection and dispatch of biological samples.

The development of cross-border collaboration, including sharing surveillance information, has sometimes involved coordinated activities with public health partners. Coupling cross-border risk assessments with socio-economic market chain studies has improved current understanding of trade, its drivers and related disease risks. Interdisciplinary collaboration characterizes interventions, and surveillance in the region is increasingly conducted using a One Health approach to address human, animal and wildlife health.

Country-level perspectives

Surveillance efforts in countries were dictated to some extent by the level of H5N1's endemicity and the capacity of the animal health services. Cambodia and Lao PDR do not have veterinary schools. Consequently, they suffer a general shortage of qualified personnel who have little or no prospect for continuing professional education. In countries that do have veterinary schools, the curricula have not evolved to provide appropriate epidemiology training. Building capacity within such a diverse range of settings has required surveillance structures that can be tailored to 'fit for purpose'. In Indonesia, where the disease was well entrenched, the Participatory Disease Surveillance and Response (PDSR) system was introduced (Alders *et al.,* 2009; Azhar *et al.,* 2010; and Brum *et al.,* 2008). In countries with small numbers of trained veterinarians and no veterinary education system, the emphasis was on strengthening existing grassroots animal health extension services that were supported by community-based animal health workers (CAHWs), village veterinary workers (VVWs) or village animal health workers (VAHWs) in order to increase surveillance networks.

In Viet Nam, considerable resources were expended to monitor the mass vaccination programme. While post-vaccination monitoring is more closely aligned to disease control, the programme also contained an element that focused on virus monitoring of target markets in an area post-vaccination.

Countries such as Bangladesh have exploited mobile telephone technology and short message service (SMS) gateways for sharing disease information in a surveillance network.

Cambodia, Indonesia and Lao PDR have established hotlines to give the public ready access to the animal health reporting channel. Countries in the region have strengthened their capacity for ownership of, and leadership in, surveillance as a result of developing locally-relevant models and approaches based on needs. Decision-makers in the region are beginning to appreciate the usefulness of a strong surveillance structure, not only for AI, but also for other animal diseases.

The model of surveillance best suited to a particular setting and situation is determined by a number of converging factors, such as the prevalence of disease, the structure of government services, the availability of trained personnel, the cost-effectiveness of any particular approach in the local poultry production environment, and public health considerations.

Grassroots surveillance models

Grassroots surveillance models require the cost-effective training of a large number of individuals in a relatively short period. Rather than producing a poultry diseases specialist, training aims to increase the disease recognition and reporting capacity of VAHWs, VVWs or CAHWs, who have been active as, or previously trained as, extension workers or paraveterinarians. However, these individuals, who play a key role in the formal animal health structure, are not part of the official veterinary service and, as a result, this creates significant reliance on the quality of upstream officials and the quality of their engagement with village-level workers.

Another grassroots issue is the quality of the cascade training system used and the ability of the trainers themselves. Training that tends to emphasize disease recognition results in village-level practitioners making diagnostic decisions about disease incidents, leading to information flows being filtered at the very first step in the process. Further filtering can occur at the next level (usually district level) if the outbreak is judged to be a common endemic problem rather than a disease incident requiring investigation. For example, while it was recognized that ND was endemic and caused losses, outbreaks were rarely investigated to see if they were linked to HPAI. The broader capture of HPAI-compatible incidents imposes a financial burden, some of which has been borne by the volunteers themselves, thus leading to a decline in their enthusiasm for the process over time.

On balance, however, such grassroots systems may be the only viable option in several countries with relatively sparse human and poultry populations, and undermanned and under-resourced animal health services. The challenge is to maintain the networks, with related efforts bolstered in some areas by the ability of a number of village-level volunteers to derive some income from providing simple services to livestock producers. Initiatives are also under way to formally register these paraveterinarians within national regulations.

Passive surveillance and conventional veterinary services

Most countries in the region where FAO has managed donor-funded HPAI control programmes have a conventional veterinary services structure with a strong vertical line of command down to operational interactions with producers. Two such countries, Thailand and Malaysia, have been successful in eliminating incursions of the disease. However, in countries where animal health services are decentralized, management and reporting lines are constrained, and are difficult to overcome. Strong advocacy campaigns are needed to make local authorities aware of the need to use the linkages inherent in an animal health structure and to support greater interaction between central departments and local animal health services. Most veterinary services structures in the region rely on community-level contacts to acquire early information about disease incidents. In more conventional structures, these individuals are paid a small stipend and are part of regular training and monitoring procedures. A producer will generally report to authorities if he or she believes that some benefit will accrue from it, either by way of inclusion in a compensation process, or through some useful input and advice from the animal health service. Concerned community members may also report outbreaks, either because they recognize the threat to their enterprise or because of their concerns about public health risks. It is not possible to fully estimate the efficiency of the various passive surveillance approaches for HPAI.

Active surveillance models

Some early attempts at active surveillance were not cost-effective, with the considerable inputs required to achieve relatively meagre outputs contrasting sharply with the level of outputs achieved in an adequately supported and well-managed passive surveillance structure. For example, the Participatory Disease Surveillance and Response (PDSR) model in Indonesia found that it was less cost-effective to conduct widespread disease searching than it was to support the same network in its efforts to react to voluntary reports of disease from owners. The success of this passive surveillance system in Indonesia was most likely the result of the strong links that the participatory model forges between poultry holders and the local animal health service, coupled with the limited culling that is carried out when participatory surveillance confirms a focus of disease. Viet Nam and Lao PDR had similar experiences with active surveillance which targeted provinces, with an historically higher risk of outbreaks and the presence of risk factors such as market hubs and significant duck populations.

Active surveillance using the SMS gateway in Bangladesh detected about 80 percent of outbreaks in 2011, and reduced the time between detection and response from an earlier average of 4.5 days to 1.8 days, although a supporting factor may have been the increase in the compensation paid. Nepal has carried out active surveillance in designated high-risk areas with greater efficacy than that of other active programmes elsewhere, probably owing to the network of about 1 250 contact persons who were visited weekly for information. One example that did not involve FAO inputs was the so-called X-ray surveillance in Thailand which was used to detect disease in chickens and was then followed by local culling. This active programme contributed to the eradication of HPAI, especially in non-commercial poultry.

Viet Nam recently launched a pilot study using active surveillance to monitor the presence of viruses in live bird markets (LBMs) and especially in ducks, to determine whether this methodology could be used to set a baseline for virus load. An increase in the virus load could point to a virus buildup in the general poultry population, and serve as a proxy for the risk of human cases. Early findings suggest that this is a useful adjunct to other surveillance systems, particularly now that the government-supported vaccination programme has been significantly reduced.

Since 2009, LBM surveillance for tracking H5N1 has been carried out in the greater Jakarta metropolitan area of Indonesia through the collection of environmental swabs using a consistent protocol. This has demonstrated seasonal fluctuations in virus levels and has also suggested a decline in the amount of virus present. In addition, the longitudinal study has established a useful system for determining baseline levels of virus appearing at a certain point in a value chain, and has shown that it may be used as a proxy for overall viral circulation in the sector involved in the chain, and as a measure of effectiveness of a control measure applied to the value chain. LBM surveillance was also used recently in Bangladesh, and was responsible for identifying high levels of environmental contamination with H5N1 virus in all LBMs located in and around Dhaka.

In January 2011, FAO, working with Cambodia's National Veterinary Research Institute (NaVRI) and the Institut Pasteur in Cambodia (IPC) conducted a joint environmental surveillance for H5N1 in four main LBMs (FAO/IPC 2011). Of the total of 502 specimens (145 water, 120 feather, 117 faeces and 120 mud/soil), 90 (18 percent) tested positive for H5N1 virus and, of these, 10 specimens (2 percent) tested positive after inoculation into embryonated chicken eggs. The virus was successfully isolated from 8 water specimens (5.5 percent) and 2 soil/mud specimens (2 percent). The overall positivity rate of H5N1 virus ribonucleic acid (RNA) detection by reverse transcriptase polymerase chain reaction (RT-PCR) is approximately 20 percent in all types of specimens except for the faeces samples, where the RNA was detected less often (6 percent).

FAO's engagement with surveillance in China has been building slowly, in part due to the size of the country and the autonomy of the animal health services at the provincial level. LBM sampling has been modified as a result of inputs from FAO. The outcomes of surveillance and social network analysis are described in the Socio-economics chapter of this report.

Participatory surveillance

Participatory interactions with the community (Brum *et al.,* 2008) are understood to be integral to all good epidemiological work, and there has been emphasis on training veterinary services in using participatory methodologies to engage with stakeholders in the HPAI control programmes, especially in Indonesia, where considerable investments were made to embed participatory community engagement principles in the routine activities of the animal health services. Initially, relationships with Sector 4 poultry holders in village communities were built within active surveillance activities. However, it soon became clear that, where active participatory methodologies were being used, 95 percent of disease outbreaks detected were as a result of voluntary reporting to the district animal health service. An important feature of the PDSR approach is the use of an HPAI case definition and a rapid diagnostic test (Robyn *et al.,* 2012; Loth *et al.,* 2008) to detect HPAI, based on which local control measures can then be decided. Analysis of the results of PDSR surveillance has identified a number of determinants of H5N1 HPAI outbreaks in Indonesia (Farnsworth *et al.,* 2011). The success of the PDSR approach depends on having a critical mass of staff with veterinary or paraveterinary qualifications at the field level. PDSR is now being embedded in the local veterinary services, thus building capacity and long-term viability for this methodology, not only for HPAI but also for other priority animal diseases (Siregar *et al.,* 2008).

Targeted surveillance studies

Targeted field surveys have been carried out in Bangladesh, Cambodia, Indonesia, Lao PDR, Myanmar and Nepal, to increase knowledge about the prevalence of infections in ducks and to determine if there are links to outbreaks of disease in chickens. These surveys have provided policy-influencing information about the potential role of ducks in the introduction and maintenance of H5N1. The information also provides a link between the problems facing production systems in each country. Recently, ducks have been targeted in surveys carried out in a number of selected markets in Viet Nam, and this approach might be used to monitor virus levels in poultry in the future. In addition, surveys of wild captured birds have been carried out in markets in Cambodia and Viet Nam, but have not generally detected H5N1 in such birds.

Risk-based surveillance

Risk-based active surveillance has had varying degrees of success. Viet Nam's efforts to base village-level surveillance on various risk factors did not yield the returns expected. Lao PDR had a similar experience, where populations believed to be at risk were sampled regularly. A more intense system put in place to detect sporadic events in Nepal seems to have been more effective, although the reasons for this are not clear. Cross-border studies have helped animal health services in Myanmar to identify the areas where increased efforts are required to detect early incursions of H5N1 along trading chains. Agro-ecological studies in China, Thailand, Bangladesh and Indonesia (Loth *et al.,* 2011) have added to a better understanding of risk-based surveillance through risk mapping at the interface of farming and natural environments. China, which is considering a transition from mass vaccination to targeted vaccination as is now implemented in Viet Nam, requires a risk-based surveillance strategy to inform modifications to the mass vaccination regime.

Field diagnosis of disease

The use of field diagnostic kits by surveillance teams has been a somewhat vexing question for animal health services. While the practice, in combination with a HPAI case definition, has proven successful in Indonesia's PDSR programme, central administrations in other jurisdictions have preferred to leave diagnostic decisions to the central laboratory; this is a reasonable position in settings where disease occurs sporadically and accurate diagnosis is important.

Integration of value chains, strategic communication and surveillance

It is clear that value chains have much to do with the circulation of viruses within countries and into farms in the region (Martin *et al.,* 2011). Investments in this area have started to reap good returns in terms of understanding disease epidemiology and how to allocate resources in a way that helps achieve the maximum benefits. While some of the attendant risks of virus incursion and spread are dealt with through the application of measures such as biosecurity and disinfection, more needs to be done to monitor the actual presence and movement of viruses along value chains.

Epidemiology capability and capacity

FETPV and the Applied Veterinary Epidemiology Training (AVET) are making significant contributions to developing epidemiology capacity, with an emphasis on operationalizing surveillance through training for local staff and frontline workers. For example, the success of the FETPV programme established in China is evident in the improved quality of field reports emanating from well-executed disease outbreak investigations that increase understanding of disease dynamics and help identify risk factors for outbreaks. Joint interdisciplinary training with public health and wildlife professionals is improving the breadth and depth of surveillance capacity in the region.

By 2011, every country in the region had staffed an epidemiology unit. In Myanmar, where the epidemiology unit's staff has grown from 3 to 11 since 2006, surveillance has evolved from a reactive, general sero-surveillance approach in chickens and ducks to a risk-based approach that includes targeting high-risk subpopulations such as domestic ducks. In some settings in Myanmar, more advanced technologies for epidemiological analysis such as geographic information systems (GIS) have been introduced, and the use of a Geographic Positioning System (GPS) has become standard in surveys and investigations.

OUTPUTS

- Several thousand grassroots animal health workers were trained in H5N1 detection, reporting and communication.
- In Indonesia, a large network of people is reporting on the outcomes of participatory methodology for obtaining information about HPAI in small-holder poultry systems. Over 2 500 local government livestock and animal health services staff were trained in the PDSR approach.
- A significant body of data was submitted for analysis. In several countries, data on virus loads were submitted from market surveillance.
- In Viet Nam, 1 678 people were trained in epidemiology and surveillance, and 2 535 CAHWs in five pilot provinces were trained.
- FETPV course curricula were prepared and delivered, along with epidemiology training material for courses in veterinary schools, in ten countries in South and Southeast Asia, including Cambodia, China, Indonesia, Lao PDR, Malaysia, Mongolia, Myanmar, the Philippines, Thailand and Viet Nam. Ten students have now completed the course, and a further eight are currently attending it.
- Two weekly, disease-scanning reports were generated by the RSU epidemiology staff in Bangkok and Kathmandu, and have been disseminated to country teams and partners.
- Local staff from countries in the region were trained to conduct surveillance for H1N1 in pigs and to undertake cross-sectional and longitudinal surveys of duck populations.

- Regional molecular epidemiology patterns are reported regularly to country teams and partners.
- Meetings were held with tripartite (FAO/OIE/WHO) as well as national partners to promote joint and coordinated surveillance pilot studies for rabies, Ebola Reston, H1N1 and H5N1 HPAI.
- Two EMPRES-i training workshops were conducted for the Asia region.
- Training, hardware and software have been provided to improve animal health data management.
- Training in the use of TADinfo®, a web-based national disease information system, has been provided to national veterinary institutes in several countries in South and Southeast Asia.

OUTCOMES

- Across the region, the response to disease trends, new events and disease emergence is better coordinated and more timely. Molecular analysis informs national and regional strategies for future prevention and control of HPAI and other EIDs.
- National animal health staff, armed with new and transferrable skills in surveillance, are responding to the increasing challenge of other emerging and re-emerging diseases such as porcine respiratory and reproductive syndrome (PRRS), foot-and-mouth disease (FMD), anthrax and brucellosis.
- FETPV has been accepted in the region as a good model for building epidemiology capacity at the field level for veterinarians. The programme has been modified for local application, as in the case of AVET in Viet Nam. FETPV and AVET graduates are contributing to better quality epidemiological investigations in the field.
- More countries in the region now share data with each other and are supported by EMPRES-i Asia training. Information flows regularly into the central database, fed in part by the large network coverage obtained with PDSR in Indonesia.
- In Indonesia, LBM market surveillance has contributed to better understanding of HPAI risk along the market chain, and has highlighted the need for cleaning and disinfection (C&D) interventions to reduce the risk of HPAI transmission both back to the farm and to consumers.
- Information for reporting and analysing trends and risk factors for disease is retrieved more quickly, as a result of improved data management. Spatial and network analysis of surveillance data has delivered valuable insights into linkages between outbreaks, the likely role of value chains in distributing viruses, and other risk factors for disease outbreaks.

SUCCESSFUL PRACTICES

- Field and laboratory personnel were trained in the design and analysis of surveillance data. This led to improved coordination at country and regional levels, including between FETPV and the laboratory and epidemiology networks.
- The adoption of the in-service training approach in FETPV, coupled with surveillance/survey studies, has demonstrated the value of the programme to local authorities and has also fostered collaboration between the public health and animal health sectors.

- The adoption of participatory approaches that acknowledge the concerns and understanding of communities regarding HPAI has resulted in closer links between animal health services and community members, thus making passive surveillance more effective.
- Investing in the participatory programme in Indonesia has resulted in a surveillance network that provides a robust watch on the HPAI situation in smallholder poultry populations across most of the country.
- Targeted surveillance of particular populations or species, such as ducks, has provided policy-makers with key information about HPAI.
- Environmental surveillance and markets surveillance have helped to monitor the presence of viruses in poultry value chains and may provide a useful baseline for monitoring the overall effectiveness of control measures.
- Risk-based surveillance of value chains, especially of cross-border chains, has helped animal health services to focus scarce resources on high-risk areas.
- Developing linkages with national animal health services and grassroots animal health worker systems has helped to build large surveillance networks over relatively short periods.
- Analysis of Chinese surveillance data by FAO ECTAD China, coupled with the development of epidemiology capacity through the support of regional FETPVs, have resulted in promoting greater data sharing and transparency between China and FAO.

LESSONS LEARNED

- Targeted surveillance can be useful for detecting the virus in healthy birds, but systems of tracing to source are not yet reliable. More effort is required in order to understand how to monitor the levels of virus in the population, how to measure the impact of control measures and how to get early warning of an upsurge in virus activity.
- Passive surveillance can be unreliable, especially when commercial operators conceal outbreaks because the compensation offered does not fully cover their economic losses. Proxy indicators of disease outbreaks, such as market prices, also need to be monitored, so as to detect hidden problems.
- Awareness campaigns do not necessarily result in behaviour change or improve passive surveillance reporting by poultry producers.
- Animal health epidemiology needs to be linked to functions with strategies that are more politically sensitive and relevant than the status of endemic animal diseases. Epidemiological units established in the past have been allowed to deteriorate because of lack of routine funding from government budgets.
- Active surveillance can stimulate greater passive surveillance when relationships are established with communities. Participatory approaches such as PDSR in Indonesia have successfully demonstrated this.
- Training in basic epidemiology and in the proper collection, storage and submission of samples needs to be provided for field veterinarians.
- More epidemiology expertise needs to be developed at the provincial or state levels. Many countries do not have enough epidemiologists in central departments to meet individual country requirements.

- Viruses from field outbreaks must be regularly isolated and characterized. This has been well recognized in Indonesia, where a problem with poor vaccine efficacy was recently rectified by incorporating into the vaccine a virus strain compatible with the viruses circulating in the field.
- Monitoring and characterizing field virus isolates for changes in behaviour may help in signalling vaccine failure and the possible spread of new outbreaks of disease. The H5N1 subclade 2.3.2.1, a genetic variant of the clade 2.3.2.1, was able to cause infections despite the vaccine being used in Viet Nam. The increased susceptibility of wild birds to the subclade 2.3.2.1 has resulted in the spread of the virus in Bangladesh, India, Japan, the Republic of Korea and Nepal.

SUSTAINABILITY

Providing personal and professional rewards to those who have acquired skills and have amassed some experience under the HPAI programme is an important component for sustainability. People trained to provide professional inputs may start to feel disillusioned when they realize that the overall service management is poor or that resources to act on findings are not available.

As some surveillance activities are expensive, and require extra effort from staff at all levels, external inputs are needed in order to maintain the momentum. The animal health services in some countries have bridged a 50-year performance gap in four to six years. As it will be some time before such a leap is matched by funds from national budgets, there is a distinct danger of regression or stagnation.

THE FUTURE

The effort to build epidemiological expertise in the region must continue, placing an emphasis on practical aspects such as the design of surveillance activities, data management, sample analysis and the maintenance of regional and international networks, coupled with conducting high-quality outbreak investigations and ensuring intersectoral collaboration where possible. Each of the countries in the region has questions about disease epidemiology that can be answered by studies. Research studies should be supported with the requisite resources, because building research capability can help sustain existing epidemiological capacity. Training should be institutionalized, especially in countries with large domestic production of livestock for national food supplies. Some production systems are extremely wasteful and effective epidemiological services can make a positive difference to this situation.

The experiences of coordination between animal health and human health authorities in dealing with HPAI have laid the foundation for expansion into other zoonotic diseases, and for collaboration on possible EIDs. Growing understanding and acceptance of the One Health approach in the region's animal health services has also improved the prospects for developing it further.

The FAO/OIE/WHO four-way linking project, which connects at least four information streams – epidemiological and virological, each from animal health and human health – is critical to assessing the public health risk of influenza at the human-animal interface. This project supports countries in developing a better understanding of national risks from H5N1 influenza viruses by building a framework for strengthening systems to collect and link national data and by facilitating national-level risk assessments and risk communication. The project is being piloted in H5N1-endemic countries such as Viet Nam, Bangladesh and Indonesia. A complementary linkage which also needs to be strengthened is that between field and laboratory data across both the animal health and public health sectors.

Institutionalizing the role of epidemiology in animal health services without creating inflexibility among epidemiology units at the field level is an area requiring further advocacy. One way of achieving this might be to make epidemiology training a necessary qualification for being appointed as the head of Provincial Veterinary Services, along with a demonstrated capability to apply the theoretical training to field work. A veterinary epidemiology network is required at national and regional levels to keep such individuals informed of developments and to enable the sharing of experience and problems.

There is an emerging view that the number of viruses which are sequenced, as well as their geographic representation, needs to be greatly increased, and that the time between virus isolation and sequence information being made available needs to be greatly reduced. The unsatisfactory state of surveillance could be turned around rapidly by, for example, creating a network of sentinel sites that would collect isolates and sequence them in real time; this process would involve focusing on the countries and regions most at risk. Such a network, it is argued, would probably cost even less than the fragmented and uncoordinated surveillance efforts in place today.

Recent experience with H1N1 influenza has highlighted the need for increased monitoring of influenza viruses circulating in the large concentrations of pigs in several countries. This would seem to be particularly important in Asia, where H5N1 circulates in poultry populations, and large duck populations mingle with wild birds, presenting pathways for new viruses to enter pigs via poultry. Longitudinal virological surveillance, not only in poultry but also in other livestock, is now considered to be a prerequisite for assessing the evolution of the virus and the risk for pandemic influenza. FAO is beginning to do this through the Emerging Pandemic Threats Plus programme.

Laboratory capacity

Diagnosing infection quickly and accurately is a key element of any disease control programme. In the case of H5N1 HPAI, there is also the imperative to ensure a safe and secure working environment. When the major international effort to control HPAI first got under way, laboratory capacity for accurately diagnosing the infection across the region varied considerably. Safety standards were rudimentary and there was no programme for checking the proficiency of laboratory testing. In some countries, laboratory capacity existed in a separate or autonomous research division or institute, as opposed to being an integral part of the animal health services.

International donors have traditionally been supportive of animal health laboratories. The common model is that of the laboratory which provides comprehensive services. However, this soon leads to dilapidated facilities, and staff who are disillusioned by the lack of mentoring, inadequate budgets and poorly maintained equipment. The effort to upgrade laboratory capacity to fight H5N1 HPAI was the first regional initiative supported by local, political and international donors to address the constant demand for diagnostic services; this initiative had a particular focus on providing equipment, training and reagents. Increasing engagement with international reference laboratories has led to mentoring in laboratory techniques and laboratory safety, the provision of technical reference services, and the establishment of laboratory proficiency testing programmes.

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This alignment of interests created an opportunity to develop and improve laboratory services and, despite some residual problems, animal health laboratories now support the field programme by providing competent and reliable diagnostic services. Increasing numbers of laboratory staff have received postgraduate training and are expected to become the laboratory system leaders of the future. The key challenges ahead are maintaining the skill base and applying generic technologies to new diseases. The One Health approach calls for increasing attention to strengthening laboratory capacity, but without increasing their dependency on external resources. It is therefore becoming important for laboratories to develop business plans that will enable them to generate income for maintaining their reagent supplies and equipment.

A telling statistic of the regional laboratory capacity building effort is that not a single scientist has fallen ill from H5N1 infection. Had that happened, it would have resulted in heavy fines being imposed on laboratory operations and it also would have exerted serious constraints on the field programme by restricting diagnostic throughput.

The most significant technological leap made since 2005 has been the establishment of the complex diagnostic procedures that are now routinely carried out in national laboratories. While this is a considerable achievement, the situation is still somewhat precarious, as staff do not always have the in-depth technical understanding needed to solve problems or troubleshoot the systems with which they are working.

SITUATION IN 2005

In 2005, few countries in the region had the capacity to diagnose HPAI at their own national facility. In some of these countries, the facilities did not report directly to the animal health services. With the exception of Thailand, national laboratory systems did not have a strong link to the poultry sector, and the majority of laboratories had low capacity for HPAI diagnosis. As diagnostic systems evolved, with support from many different sources, each laboratory began using its own testing protocol. No mechanism existed for standardizing and verifying testing procedures, and little attention was paid to laboratory quality assurance (QA) and biosafety, as a result of limited knowledge and lack of laboratory equipment. Proficiency testing was never carried out either regionally or nationally and, consequently, evaluating test outcomes and laboratory performance posed certain difficulties. Laboratory environments lacked biosafety, biosecurity training programmes and Standard Operating Procedures (SOPs), and were therefore less than ideal for handling zoonotic pathogens. There was usually no prophylaxis programme for staff, and waste disposal systems left much to be desired. Communication between laboratories in the region was poor, and disease diagnosis information and reagents were seldom shared between key laboratories. While a few laboratories enjoyed collaboration with some reference laboratories, most were not internationally connected.

SITUATION IN 2011

By 2011, laboratory capacity in every South and Southeast Asian country involved in ECTAD-RAP's laboratory capacity development programme had been strengthened using a progressive approach involving equipment and reagent supply, basic biosafety and technology training, the writing of SOPs for local use, standardization of test procedures, the introduction of QA systems, and review and assessment of performance. Inappropriate procedures for molecular diagnostic testing, which had been set up previously by international experts who had research backgrounds but little diagnostic experience, led to the development of lax laboratory habits. As a result, while initial virus detection and confirmation was possible, the procedures were not robust enough to be adopted by less technically adept national staff, and problems arose with contamination in these systems. Considerable work was required in order to establish proper work flows and undo some of the inappropriate and careless habits that had evolved.

Diagnostic capability

All countries in the region now have at least one central laboratory that can detect and identify H5N1 HPAI and can also conduct appropriate serological tests. In most instances the test of choice for virus detection is the polymerase chain reaction (PCR) and, while some laboratories use the real-time technology routinely, others prefer to run the conventional PCR in order to save on reagents. However, in the long term, real-time PCR is the recommended and preferred technology for a wide range of virus detection tests.

A set of guidelines for HPAI diagnosis has been endorsed and ratified by animal health laboratory services from the eight FAO Member States in ASEAN which are members of the regional laboratory network. The guidelines are living documents that should be regularly reviewed and updated to ensure maximum diagnostic sensitivity and specificity based on current circulating viruses.

Many laboratories have the capacity to perform virus isolation using embyronated chicken eggs to confirm PCR-positive results. One of the issues for virus isolation has been the difficulty in testing and certifying biosafety cabinets. In the early stages of the programme, cabinets for which no recent appraisal of safe performance existed were already in use.

Serological procedures have also been established for detecting prior exposure to wild type virus, especially in ducks and, most importantly, for monitoring vaccination responses. The serological testing of ducks, although more complex, can now be conducted with consistent performance.

An HPAI-negative result is not helpful to the animal health field services and the poultry owner if some other serious disease problem remains undetected. To this end, there is now expanded differential diagnosis for other avian disease agents such as the ND and DVE viruses. The expansion of this range of diagnoses is now viewed as being important, as it improves the service and thereby strengthens the links to the producer.

Laboratory quality management and proficiency testing

Significant progress has been made in improving the quality and reliability of laboratory diagnostic test results, and many laboratories are now able to apply elements of a laboratory quality management (QM) system to HPAI diagnostics. National laboratories in Thailand and Viet Nam have been accredited to the International Organization for Standardization (ISO) laboratory standard ISO 17025 for HPAI diagnostic assays, and others have established practices needed to obtain accreditation, such as the documentation of internal quality controls required for tests. National laboratories in the Philippines have undergone major renovations in 2011, and a new laboratory building has recently been completed in Lao PDR.

The ASEAN-designated leading laboratory (LL) for HPAI in Malaysia has recently constructed a Biosafety Level 3 (BSL) facility, which is expected to be operational and accredited shortly.

Regional proficiency testing (PT), implemented since 2007, provides external validation of the accuracy of testing and it also helps regional organizations to understand how reliable the diagnostics are in indicating the presence or absence of disease.

Laboratory biosafety and biosecurity

At the beginning of the programme, there were worrying gaps in workplace safety in the handling and generation of infectious materials. As a result of workshops conducted to help national laboratory services develop SOPs for laboratory biosafety and biosecurity, all national laboratories now operate at BSL2 for HPAI diagnostic procedures. Class II biosafety cabinets have been calibrated and recertified in order to improve laboratory safety standards. Laboratories have been encouraged to implement procedures for improving the safety of biological waste disposal.

Regional laboratory networks

The FAO/OIE regional laboratory networks have facilitated capacity building, communication and harmonization among ASEAN and SAARC Member States. The progressive establishment of regional laboratory networks has improved the level of laboratory engagement with the improvement programme, and the degree of information sharing in regional and international networks. The strengthening of regional leading laboratories has improved services such as reagent supply, test harmonization, and training and reference activities, and has also reinforced relationships with the OFFLU network and the collaborating and reference centres of FAO, OIE and WHO. These developments have led to an overall improvement in technical practices and a fuller understanding of HPAI viruses.

OUTPUTS

- Laboratory capacity was strengthened in every South and Southeast Asian country involved in the programme, using a progressive approach involving equipment and reagent supply, basic biosafety and technology training, the writing of SOPs for local use, standardization of test procedures, the introduction of QA systems, and review and assessment of performance.
- At least one central laboratory that can detect and identify H5N1 HPAI, and conduct appropriate serological tests, was established in every country in the region.
- Guidelines were established for HPAI diagnosis by animal health laboratory services in the eight FAO ASEAN Member States which are members of the regional laboratory network.
- Serological procedures were established for detecting prior exposure to wild type virus, especially in ducks and, most importantly, for monitoring vaccination responses.
- Expanded differential diagnosis was introduced for other avian disease agents such as the ND and DVE viruses.
- National laboratories in Thailand and Viet Nam were accredited to ISO 17025 for HPAI diagnostic assays.

- National laboratories in the Philippines were renovated, a new laboratory building was completed in Lao PDR, and a BSL3 facility was constructed by an ASEAN-designated leading laboratory for HPAI in Malaysia.
- Regional proficiency testing was implemented since 2007. This has provided external validation of the accuracy of testing and it also helps regional organizations to understand how reliable the diagnostics are in indicating the presence or absence of disease.
- SOPs were developed for laboratory biosafety and biosecurity in national laboratory services. All national laboratories now operate at BSL2 for HPAI diagnostic procedures. Class II biosafety cabinets have been calibrated and re-certified to improve laboratory safety standards.

OUTCOMES

- The submission of viruses to international reference laboratories has improved, leading to deeper understanding of viral strains in circulation.
- The quality and reliability of laboratory diagnostic test results has improved, and many laboratories are now able to apply elements of a laboratory quality management system to HPAI diagnostics.
- Many laboratories have the capacity to isolate viruses using embyronated chicken eggs to confirm PCR-positive results.
- Increased harmonization and communication has been achieved among ASEAN Member States. The progressive establishment of regional laboratory networks has increased the level of laboratory engagement with the improvement programme and the degree of information sharing in regional and international networks.
- Services such as reagent supply, test harmonization, and training and reference activities have been improved, and relationships with the OFFLU network, as well as with the collaborating and reference centres of FAO, OIE and WHO, have been reinforced.

SUCCESSFUL PRACTICES

- Technical working relationships with national laboratory staff have been established and these staff are now closely monitored.
- Closer relationships with laboratories have been developed as a result of carrying out visits, providing on-site technical support, conducting capacity building workshops and liaising with regional organizations. In addition, the global OFFLU programme's strong technical engagement in the region has helped to spread technical advances and strengthen connections between national laboratories and the global network.
- Experts 'in-residence' help with the process of introducing new technology into laboratory systems speedily; they also help national staff set up equipment, establish tests and prepare SOPs. In addition, they facilitate on-site training.
- A national-level network linking laboratory scientists to epidemiologists in the field has been established. This has helped to improve the outcomes of diagnostic efforts.

LESSONS LEARNED

- On-site training is important because training is an iterative process. It is also important to review the outcomes of this training in follow-up sessions, and to mentor closely in order to prevent staff from becoming overwhelmed.
- The establishment of 'lab-epi' networks helps to reduce the gap between the two arms of the animal health service and to improve overall disease control. The lack of effective relationships between the laboratory and field services at the national level often results in failure to provide a full diagnostic service. Laboratories also function as testing centres and do not extend services beyond the HPAI project requirements; this reflects gaps in laboratory management capacity and the absence of a case management approach to diagnostic submissions. Failure to adopt a more service-oriented approach can lead to difficulties in maintaining support for laboratories within the animal health system. Insufficient training in proper sample submission leads to loss of quality and effectiveness in laboratory submissions.
- Reference laboratories should understand fully the expectations of the submitting agency in respect of turnaround times and subsequent publication of data. At times, there have been long delays in obtaining permission to upload sequence data from such submissions, thereby resulting in frustration on the part of the international agency and the reference laboratory.
- Separating the key national laboratory from the animal health services can lead to obstacles in establishing or upgrading diagnostic facilities, and it may also impede the flow of key information. Similar issues arose when international research institutes brokered arrangements with national laboratories to obtain virus isolates for research purposes.
- Working with inappropriate technology or insufficient training can erode a national laboratory's performance and can negatively affect the attitudes of senior officials. For example, gene-sequencing equipment was provided to some national laboratories without sufficient training, maintenance and the requisite reagent supplies.
- Good laboratory practices can be difficult to implement in laboratories that already have an anomalous, long-established work culture. In addition to the key issue of laboratory safety, good laboratory practice also includes following SOPs, keeping proper laboratory records, and prohibiting the consumption of food in the laboratory environment. There is no immediate solution in sight: inappropriate practices are often associated with the laboratory management team's reluctance to take disciplinary action against the perpetrators.
- Animal health services can, on occasion, overstretch themselves and undertake more than they can manage effectively with the laboratory facilities at their disposal. Some countries have tried to set up BSL3 laboratory facilities in settings where the power supply was erratic, manpower numbers were insufficient and personnel lacked the requisite skills and knowledge. This has led to challenges in both maintenance and sustainability despite the fact that, on paper, these countries were identified as having BSL3 facilities.

SUSTAINABILITY

Sustaining and expanding the laboratory capacity built up during the HPAI programme is of great importance for the entire region, as the emphasis expands to include emerging and re-emerging infectious diseases. Linking laboratories to either routine disease control efforts or new initiatives under One Health projects will be essential to sustaining momentum, technical expertise and user confidence in the services.

The prospects for sustainability vary significantly between countries, depending on their level of reliance on external funding to conduct surveillance. At one end of the spectrum are countries which are wholly dependent on external support, for example, Bangladesh, Cambodia and Lao PDR. At the other end of the spectrum are countries such as India, Thailand and Viet Nam which have almost reached self-sufficiency with the support of government funding.

Although they depend on political will, regional networks are far more sustainable platforms, as they are tied to the economic community's efforts. To this end, working closely to expand the understanding, capacity and strategies of regional organizations such as ASEAN and SAARC is vital to the regional sustainability of these initiatives.

Within the laboratory system there is limited capacity as well as lack of experience and knowledge about strategic planning and the process of developing a strategic plan. As a result, many countries within the region do not have strategic plans specific to the national animal health laboratory or the national system of laboratories. This affects the sustainability of the considerable gains made.

THE FUTURE

While postgraduate degrees can cultivate in-depth understanding of the fundamental science that underpins diagnostic tests and their interpretation, there is also a need to build hands-on experience with quality control systems and to foster stronger collaboration with field staff in implementing disease control activities arising from diagnostic results.

Laboratories in the region need the resilience to cope with surges in samples submitted during multiple concurrent outbreaks. Young laboratory staff should be trained in, and given the technical authority to take over, mid-level management functions in order to maintain uninterrupted diagnostic services in the absence of senior staff members. They should also be able to move to other sites on a temporary basis and fit seamlessly into operations there. Introducing a culture of documented management systems, as used under ISO standards, would be beneficial, especially where hierarchical structures pose challenges.

There is a need to foster research projects in order to build technical and scientific expertise. These projects would require international collaboration in the medium term to attract funding and to improve success rates. Encouraging laboratory staff to engage in research could create an additional avenue for recognizing and rewarding effort, and there is also a need for similar mechanisms in the diagnostic services.

Laboratories may need longer-term mentoring and guidance to bring their services to the private sector and meet the needs of commercial livestock production. Progress in this area could be stimulated by investment in laboratory management, business planning and strategy development.

Vaccination

The objectives of HPAI-related activities carried out by national governments have been to achieve better control over the disease or the risk of disease, to protect public health and to safeguard the economic interests of commercial poultry producers from the threat of H5N1. While the various elements of the control programmes have combined to limit the impact of disease, specific elements within them deal with the prevention of, response to, or recovery from disease outbreaks. In the area of disease prevention and control in particular, two distinct technical aspects are relevant, namely vaccination and biosecurity.

The number of reported disease outbreaks does not always reflect the amount of virus in circulation. However, such reports are currently the best proxy measure of disease control available to national programmes. For example, one country in the region estimated that no more than one in every 2 000 flock disease infection events was reported over an 18-month period. Most countries have experienced a steady decline in the number of cases and this is, arguably, due primarily to HPAI control measures. Much of the discussion in this chapter is a description of the vaccination programmes developed and implemented by the national animal health services themselves. FAO's principal role in these programmes has been to provide support on technical issues, as opposed to providing vaccines.

SITUATION IN 2005

By December 2005, HPAI had been officially reported in ten countries in Southeast Asia, including China, Cambodia, Lao PDR, Indonesia, Japan, Malaysia, Mongolia, Republic of

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Korea, Viet Nam and Thailand. Vaccination against H5N1 was adopted to meet acute economic and public health demands and pressures. Because of the scale and structure of their poultry production and markets, China, Viet Nam and Indonesia undertook vaccination programmes, whereas other endemic countries such as Bangladesh and India did not. At that time, no country had any experience of deploying vaccination in the face of an outbreak. As a result, procedures implemented against HPAI in the early stages were derived from best practices in preventing or managing other diseases.

The first international guidance documents on vaccination were not developed until 2006, after vaccination had already been initiated (FAO/OIE 2006). At the time, the scale and scope for undertaking vaccination was unprecedented, particularly in relation to widespread endemicity. With the exception of data on how the issue was addressed in Hong Kong in 2003, there was little documented experience about the use of AI vaccines for disease control. While HPAI is not a new disease, large-scale vaccination programmes are a recent phenomenon, beginning in Italy in the late 1990s in relation to notifiable H7 and, later, in relation to H5. Since 2004, Pakistan has also used vaccination against H5 and H7 subtypes to a limited extent. Vaccination against H9N2 has been reported in Afghanistan, Bangladesh, China, Egypt, Jordan, Republic of Korea, Hong Kong, Germany, India, Iran, Iraqi Kurdistan, Israel, Nepal, Pakistan, Saudi Arabia, Tunisia, the United Arab Emirates and Viet Nam (EMPRES-i; Nagarajan, 2012; Saif, 2008).

By 2003, it was a requirement that all poultry imported from China be vaccinated with an approved vaccine. In 2004, government-sponsored mass vaccination got under way in China. However, unsanctioned vaccination that was neither coordinated nor monitored officially was already taking place by then. Vaccine production was limited to a select group of manufacturers, all of whom were subject to quality control procedures. In the first year after the disease was detected in Indonesia, the government agreed to vaccinate to control the outbreak and also address public health issues as well as the economic impact of the epidemic. The commercial poultry industry in Indonesia commenced vaccination of chicken breeder and egg layer flocks; in addition, the central government procured limited vaccine stocks for distribution to selected local governments for district-level application. A number of different vaccines had been imported through private channels from international sources, including China, and QA data was not always available. Local vaccine production was started in order to complement the imported vaccine supply. However, initially, there were no standardized approaches used for assessing the quality of locally produced vaccines.

Despite the challenges and constraints associated with immunization in developing countries, the government supported vaccination of ‘backyard’ poultry, but not meat broilers or ducks. The commercial sector attempted to manage its problems through vaccination, with little interaction or exchange of information with the government veterinary services.

Vaccination against HPAI got under way in Viet Nam in late 2005, because the control measures being applied to poultry (stamping out, movement controls and, in some cases, closure of LBMs) were not effective in controlling the epidemic, and also because there was a steady and alarming increase in the number of human cases. In Hanoi, vaccination was combined with market closures to mitigate the risk of virus transmission within market systems. In this case, quality-assured vaccine from China was deployed for use in a twice-yearly, calendar-related mass vaccination effort which focused on the higher risk areas of the Red River and Mekong deltas. One of the campaigns aimed at creating a relatively immune poultry population around the time of the Lunar New Year (Tet) holiday period. While twice-yearly campaigns were also applied to village poultry in China, Indonesia did not introduce similar, calendar-based campaigns.

SITUATION IN 2011

In 2009, an international meeting of animal health officials and researchers developed the Verona recommendations (FAO/OIE 2007), a guidance document for countries either involved in, or considering the introduction of, vaccination programmes against H5N1. While the recommendations were technically sound, some countries found it difficult to apply them successfully. There were a number of reasons for this, including technical issues of vaccine efficacy as well as effectiveness related to species, logistics and cold chain delivery, limited veterinary capacity to conduct surveillance and virus monitoring, and a general lack of a structured vaccination strategy.

At the global level, FAO has been a strong champion of properly implemented vaccination programmes with a clearly defined exit strategy – as an adjunct to other control measures when the disease has become endemic, and as a temporary measure to enable animal health services to contain severe outbreaks or to protect valuable commercial, genetic or conservation resources. The Verona recommendations for vaccination programmes, which were drawn up by an international conference on vaccination in Verona (FAO/OIE 2007), have served as guidelines for FAO, and have been modified over the years based on field experience. At the regional level, FAO has provided advice and technical input to governments, and has participated in national-level meetings to review information and practices related to vaccination. In particular, FAO, by utilizing operational research, is helping governments to develop robust plans to move away from mass vaccination to more targeted and risk-based strategies that will pave the way for a phased reduction from this financially draining control measure. The notion of an exit strategy is seen as a gradual process for each country situation rather than as an all-or-nothing option.

China: An ECTAD office was established in China in 2006. This office has provided limited technical inputs to the vaccination programme, as China has been at the forefront of HPAI vaccine development. FAO provides China with epidemiological training as well as advice on assessing vaccination, including risk-based vaccination. FAO also gives advice on the vaccination exit strategy. China has a mass vaccination programme, through which more than ten billion doses of vaccine have been delivered annually since 2005. Large numbers of serum samples – over three million in 2008 – have been tested to monitor vaccine efficacy. However, the surveys are not probability-based and do not represent overall flock immunity; rather, they represent responses from purposefully selected groups. In addition, large numbers of swab samples collected in markets have been tested for virus (over 100 000 per year between 2007 and 2009, and over 500 000 in 2008). The discrepancy in monitoring results shows 90 percent protection at farm level and 30-40 percent protection at market level. Consistent monitoring, coupled with isolation and characterization of field virus strains, have enabled the national authorities and researchers to modify vaccines that are compatible with the circulating viruses.

The national authorities have also genetically engineered vaccines through reverse engineering from field isolates, and have deployed them for use in the mass vaccination campaigns. While the campaign has the full commitment and financial resources of the government, there are still constraints to achieving sufficient coverage of poultry raised in rural smallholder communities and areas where ducks abound. In addition, there has been an historical overdependence on vaccines for animal disease control and this has probably affected the development of other traditional disease control measures and epidemiological assessments of the outcome. Two issues of concern are related to the widespread-use vaccines and the generation of novel genotypes through immune pressure, and the potential for suboptimally immunized poultry to create a population of virus carriers with subclinical infections. The latter concern stems from the fact that although there are many proficient operators in the commercial sector who probably have sufficient biosecurity to avoid infection, some of these continue to vaccinate in order to avoid the economic losses associated with an outbreak. China is now seeking to develop more tactical, risk-based vaccination, in order to reduce costs and increase the efficiency of the overall programme. FAO will continue to support these new strategies to the extent that its funding allows.

Indonesia: FAO's strong and persistent advocacy with the Indonesian Government, coupled with steadfast technical support for government initiatives, has been responsible for catalyzing some important changes to the vaccination programme. By 2006, the widespread government-sponsored vaccination programme had to be restricted to 12 high-risk provinces because of resource constraints. However, it had become evident that the use of sponsored vaccines in the so-called Sector 4 – extensively-raised, scavenging poultry that are used for household consumption – was not delivering the expected results. Consequently, a specific operational research project was conducted in collaboration with the International Livestock Research Institute (ILRI) to investigate the effectiveness of vaccination in this sector. Anecdotal evidence from the early stages of the outbreak indicated that vaccination teams might have been responsible for spreading the disease. The research yielded evidence (Bett *et al.,* 2012; McLaws *et al.,* 2012) that led to the near cessation of vaccination in Sector 4. Another operational research project, investigating the efficacy of the cold chain in vaccine delivery, revealed serious defects in the management of delivery through to grassroots level.

The work carried out under the OFFLU project in Indonesia has also been essential in assisting the government with technical decisions about vaccine strains, and it has built capacity and ownership for monitoring vaccine field strain fits using a new computational technique called 'antigenic cartography'. The OFFLU project has been successful in encouraging collaborative characterization of H5N1 viruses and in placing sequences in the public domain. The FAO ECTAD team has begun engaging with the commercial sector in vaccine testing trials and has applied participatory approaches to gain insights into problems with the application of vaccines in the commercial sector. FAO has also worked with other collaborators such as the USDA and the Government of the Netherlands to help develop QA procedures, and it has convened several technical meetings to bring various players, including industry, to the table. In recent times, FAO has advocated for administrative procedures to enable more rapid approval of vaccine strains and for the registration of reverse genetics vaccines, which, in Indonesia, are more tightly regulated than conventional vaccines. in Indonesia. Commercial poultry farmers are responsible for vaccinating their poultry at their own expense and vaccination is not typically closely monitored by government, making it doubly important to maintain industry as a stakeholder in the HPAI control programme. While the government has invested in the vaccination programme, it has equivocated on its commitment to a fully coordinated, national approach; however, some progress has been made in sharing virus isolates through the work of FAO and OFFLU.

Viet Nam: Extensive consultations involving FAO and OIE preceded the Vietnamese Government's adoption of vaccination. The initial biannual government-sponsored vaccination was carried out in most areas, except in remote locations where the risk of disease occurring was considered to be low; government-sponsored vaccination was then further limited to 32 designated high-risk provinces. The criteria adopted to assess high risk included previous occurrence of outbreaks; poultry density; human population density; poultry movement; poultry species, especially ducks; nature and location of markets; production practices, and proximity to borders where cross-border trade in poultry was common. Some provinces that were not designated high risk opted to continue vaccinating using their own resources. FAO has supported the Vietnamese Government in conducting an annual review of prevention and control measures, to which national and international participants are invited. A number of studies were conducted to inform the development of new vaccination policies, including cost-benefit studies, strategic vaccination and modelling of vaccination options. Considerable funding was provided for post-vaccination monitoring, using both serological and virus sampling.

To help the Government of Viet Nam with the logistics of implementing vaccination, a number of cold stores were established at the provincial level. However, there has not been a systematic investigation of the management of the vaccine delivery system, and breaks in the cold chain might explain some of the variations seen in antibody titres detected by post-vaccination monitoring. Results from the Gathering Evidence for Transitional Strategy (GETS) project indicate an association between low vaccine coverage and H5N1 infection at the district level, suggesting that vaccination has been quite crucial in controlling H5N1 in some districts.

Important contributions, much welcomed by the government, were the potency testing of vaccines against local field strains and studies of the various vaccination schedule options, especially for young ducks. Technical support on vaccination culminated in the GETS project findings in early 2011, which provided additional evidence for the broader application of a targeted vaccination programme focused on age-based and risk-based vaccination of ducks in Viet Nam. Other findings of the GETS project included:

- All districts and provinces in the study demonstrated a wide variability epidemiologically between and within north, central and southern study sites.
- Under-reporting of H5N1 outbreaks is widely prevalent. As few as one in 2 000 disease events are being reported.
- Vaccination has been effective at the district level in the Mekong and Red River deltas.
- Mobile ducks may be associated with increased risk of H5N1 outbreaks at the commune level.
- Current vaccination coverage in five GETS provinces is estimated at 65 percent.

- The Red River Delta is subject to virus incursions through trade; the risk is higher in districts with lower vaccination coverage.
- GETS led to improved immunity of adult ducks in the Mekong River Delta.
- H1 titres are related to H5N1 and spurious seroconversion is related to other exposures.
- Market surveys were ten times more sensitive than sentinel surveys for detecting H5N1.
- Vaccination withdrawal should be gradual, particularly in the Red River and Mekong River valleys.

By late 2011, the Vietnamese Government had suspended all vaccination related to the appearance of one particular subtype of clade 2.3.2.1. Around the period when the annual ECTAD meeting took place in February 2012, there was some discussion about reintroducing risk-based vaccination for ducks in the Mekong Delta. Since 2.3.2.1 virus is very restricted within Viet Nam, the government is considering reintroducing public sector funding for routine vaccination in northern and central Viet Nam. In addition, the private sector can continue to use the licensed vaccine.

Regional considerations

In China, Indonesia and Viet Nam, FAO has solidly put into practice the Verona recommendations (FAO/OIE 2007) related to the review and reiteration of strategies. One issue that has arisen across these three countries concerns the role of so-called vaccinated older 'spent' layer hens in the maintenance and spread of viruses. It is clear that inadequate flock immunity enables and allows the development of subclinical or mild infections, and consequently the propagation of the virus in such birds, which is referred to by some national partners as 'duck equivalents'. Cross-border or local trade in these birds, which may either enter market chains when they are already infected or may contract infection along the way due to suboptimal immunity, has been implicated as a source of outbreaks, making compliance with, and proper adherence to, vaccination protocols and schedules important for long-lived layer birds. The issue of vaccine-associated falls in production negatively affects producer compliance. Again, the matter of low-impact vaccination is important for the production cycle.

The triggers for the investigation of disease syndromes in vaccinated flocks need to be altered, as clinical signs are modified by partial immunity. Such enhancement of passive surveillance has been supported in all three countries by the use of active measures to quantify virus circulation in LBMs. This is a productive, though expensive, approach.

Studies that have attempted to investigate the economics of vaccination in the control programmes have concluded that the benefits of vaccination could not be isolated from the benefits of the other measures being applied. The most useful economic analysis of disease control is likely to be a comprehensive analysis of the overall programme rather than one that distinguishes between the measures implemented. However, this does not preclude undertaking financial analysis of different vaccination options.

The vaccination of village poultry remains an important aspect of disease control, protection of household livelihoods and even food security. For the time being, this measure is considered to be too difficult to promote and manage, and is not regarded as an efficient use of money and manpower because of its low potential for eliminating disease.

Across the region, there continue to be serious constraints surrounding the use of vaccines in ducks, especially meat ducks. Most vaccines are formulated to optimize protection in ducks and there are still gaps in scientific evidence about the protective post-vaccinal antibody titre. There is a need to explore the development of a vectored vaccine, based on the duck enteritis herpes virus, in order to give dual protection to ducks, thereby providing an additional incentive for producers to vaccinate.

OUTPUTS

A summary of findings and best practices from the Viet Nam GETS project has been presented earlier in this chapter, providing the rational basis for the broader application of a targeted vaccination programme focused on age-based and risk-based vaccination of ducks in Viet Nam.

OUTCOMES

- There has been a reduction in the number of human cases in the region (with the proviso that in China no human cases had been recorded prior to vaccination).
- There has been a decline in the number of poultry outbreaks in China, Indonesia and Viet Nam (with the proviso that better control as a result of vaccination in the commercial sector has resulted in fewer outbreaks in Viet Nam, and that the outbreak numbers in unvaccinated village poultry are not increasing).
- The GETS project in Viet Nam produced evidence-based recommendations regarding the intensive vaccination of ducks and gradual withdrawal of vaccination from chickens; targeted, age-based vaccination in ducks (high-risk, silent carriers); vaccination coverage of mobile duck flocks via enforceable legislation; replacement of the current biannual vaccination schedule with age-based vaccination; matching of vaccine to circulating virus found in market surveys and outbreaks, and adoption of a staged removal of vaccination from poultry that do not act as silent carriers.
- The environmental load of virus for poultry and humans has declined, primarily as a result of the vaccination programme.
- Vaccines of assured high quality are now available as a result of antigenic, molecular, post-vaccination seromonitoring and challenge studies.
- Greater collaboration and information exchange is now common between countries engaged in programmes to vaccinate against HPAI.
- The detection of new virus strains has improved and response to outbreaks of new virus strains is quicker.
- The sharing of information on new virus strains circulating in the field has improved.

LESSONS LEARNED

- Mass vaccination campaigns for smallholder poultry are difficult to apply effectively. Because owner cooperation is not assured, the capture of free-range poultry is difficult, and therefore vaccinators quickly tire of the task. Rapid turnover in the population means that flock immunity levels wane quickly.
- Vaccination programmes that interfere with production cycles such as broiler and meat duck production have a smaller chance of being implemented; as a result, vulnerable populations increase in low biosecurity systems. Risk reduction has to be achieved either through strengthened exclusion measures or with improved vaccines.

- Duck farmers are less interested than other farmers in HPAI prevention and do not see the need to vaccinate ducks as, in general, there is limited discernible clinical disease or mortality arising from infections.
- Commercial operators are not forthcoming about problems that occur in their systems in relation to vaccination programmes. In spite of the information available concerning proper application of vaccine regimens, some commercial operators do not adhere to instructions. Technical support for companies from government and industry is limited, thus leading to vaccine failures.
- The view of some critics that vaccination results in endemicity and increases the likelihood of virus mutation must be dealt with using advocacy and communication strategies. In Asia, vaccination was implemented reactively only after the virus was already well established in the poultry population, and when there was sufficient scientific evidence to suggest that vaccination places selection mutation pressure on field viruses. There is an urgent need to review and revise vaccination guidelines and recommendations from international animal health organizations, and to develop a vaccination planning tool to support decision-makers in countries that are considering vaccination as an additional tool to manage their HPAI problem.
- Field strains are evolving as predicted, making it necessary to check vaccine suitability regularly. National authorities want to have the capability to check vaccine efficacy, especially that of imported vaccines. It has been necessary to support this process and to build capacity in this area.
- The introduction of technology to monitor vaccines has proved effective as a way of informing national partners and has increased the credibility of the support effort with the partners. This type of technical support is a factor for any animal health programme where vaccination is being considered.
- Surveys do not accurately indicate vaccination coverage at the population level, as post-vaccination monitoring is generally conducted by the jurisdiction responsible and is frequently biased. There is no incentive to change to more population-representative sampling; thus greater advocacy is needed in order to promote epidemiologically sound practices.
- As there is considerable cross-border trade, particularly of spent hens, through the shared border between China and Viet Nam, the lack of coordination between the two countries' respective vaccination programmes poses some challenges while developing a regional disease control strategy.
- The notion of an exit strategy is confusing for some authorities who cannot understand why they should expose their countries to the large risk implied in exiting a vaccination strategy designed to combat a virus that has become endemic in some populations. FAO recognizes that it will be some years before the virus circulation is reduced to the point where elimination can be considered. Any moves to change vaccine programmes are best undertaken in a gradual, iterative manner at country level.
- The vaccines that are presently available can be difficult to use under current field conditions, even if they can be shown to be effective under experimental conditions. New vaccines are needed to overcome technical, economic and logistical challenges, and provide incentives for producers to use them.

- The ideal vaccination protocols use two vaccinations for meat birds and three to four vaccinations for breeder and layer birds. The use of a single vaccination for meat ducks did not provide consistent immunity and protection, especially in the presence of maternal antibodies.
- There is still no systematic guidance document on vaccination policies based on sound theory and proven practices available to countries for reference purposes. FAO has developed a draft vaccination planning tool to support countries considering vaccination as an intervention.

SUSTAINABILITY

The vaccination programme in China is already fully funded by the government, and there is no indication that this support will be reduced. There is also good collaboration between the commercial sector and the Chinese Government, as the vaccination programme is being regulated and the government leads the development of new vaccines. In Indonesia, the commercial poultry industry uses locally-produced vaccine through self-funded programmes and, given the endemic status of the virus, this should be encouraged.

The initiatives put in place by FAO, in partnership with governments and other collaborators, are not fully sustainable by individual governments alone, and until there are stronger connections between the public and private sectors driven by mutual benefit from collaboration, these initiatives are vulnerable to stagnation and eventual dissolution. The signs are encouraging but the relationships are still delicate and the levels of trust are relatively fragile. In Viet Nam, the government has to deal with financial constraints in assigning a priority level to the continuation of the vaccination programme. It is likely, however, that if there were an upsurge in human cases, the programme would assume higher priority. It is unlikely that the virus and vaccine testing would continue without international technical support.

THE FUTURE

For endemic countries, vaccination and virus monitoring remain valuable tools to keep virus levels in poultry in check while other control strategies are being developed and applied. The H5N1 virus will remain a part of the global infectious agent landscape for some years to come. The low-grade circulation of H5N1 with other co-circulating subtypes in poultry considerably increases the possibility of human infections. This, in turn, increases the risk of the emergence of a virulent strain of H5N1 capable of efficient transmission from human to human. However, there are limits to the levels of financial and other resources that can be made available to eliminate a pathogen with, at present, limited virulence for man. There is also a parallel risk that a pandemic may arise from another source, as happened with H1N1.

There is a compelling need to support monitoring programmes for influenza and other viruses at the human-animal-ecosystem interface.

The development of a vaccine that is effective, affordable and easy to administer for both ducks and chickens is a challenge. The option of a vectored vaccine using DVE virus as a delivery vehicle has potential, and carries the benefit that many duck farmers already vaccinate against DVE using a modified live virus vaccine. A similar opportunity might be available with the Marek's disease herpesvirus of turkeys being used as the vector for

H5N1 genes. Again, this strategy provides for ease of vaccination of day-old chicks. A new generation of vaccines against influenza and other important, related poultry pathogens needs to be developed, and this will require support from the international community and the private sector.

The application of surveillance to vaccination programmes, based on sound principles and rigorous epidemiological analysis, will continue to inform disease-control strategists and policy-makers of the most effective ways to target vaccine resources.

Operational research at country level related to vaccination and other disease control strategies needs to be supported.

A review and revision of vaccination guidelines and recommendations by the international animal health organizations is also needed.

The challenges that face smallholder producers in their efforts to control HPAI are likely to continue. However, if vaccines are more easily administered and induce longer-lived immunity, it might be possible to have them administered by local animal health workers in a more age-based schedule as part of regular flock health programmes, thereby reducing losses and virus loads. Until there is a significant change in the structure of the poultry sector in these countries, it will not be feasible to rely on the principles of biosecurity to eliminate virus. This is especially true for free-range ducks. However, the gradual improvement in the education and understanding of poultry raisers, and advances in practices related to LBMs, will also exert pressure on the virus and contribute to a reduction in its environmental load.

Biosecurity

The unprecedented spread of H5N1 HPAI virus in the Southeast Asia region was the result of the alignment of a number of key factors, including rapid, largely unregulated growth of the commercial poultry industry throughout much of the region; the preponderance of LBMs with relatively poor management and low hygiene standards; low standards of husbandry within the small-scale entrepreneur segment; large numbers of ducks being traded through markets in close contact with chickens; complex and unregulated market chains; and, at the end of the process, probably the large numbers of poultry kept for home consumption in rural communities. The overall production system was very "open" as many operators relied on vaccines to control endemic poultry diseases. It would appear that, in some locations, once the amount of virus reached a certain threshold, it spread across the production landscape.

Much effort has been invested at many different levels – from the free-range operators to the commercial sector – in an attempt to improve the management of poultry production. It became evident that, in some locations, the proactive provision of information and training about biosecurity and better practices was a good entry point for communication with the commercial sector and provided a way to improve its connections with government services in the context of public-private partnerships (PPPs).

The meaning and use of the term biosecurity sometimes causes confusion. Animal biosecurity has been defined as the product of all the actions taken to prevent the

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introduction of disease agents into a specific area and to safeguard the health of living organisms from hazards. Two basic goals of biosecurity are exclusion and containment. Methods used include: isolation, traffic control, C&D, and disposal of mortality and waste. As such, it is a comprehensive approach encompassing different means of prevention and control. In the industrial poultry world, biosecurity is a state indicating more or less absolute barriers to the ingress of infectious agents into a production facility. In many instances where the term is used, barriers are not possible; rather, it refers to measures that are designed to impede in some way the flow or buildup of virus in the environment. In general, the measures used relate to hygiene, although physical intervention may also form part of the biosecurity approach.

SITUATION IN 2005

In 2005, basic management practices in much of the commercial sector were not in alignment with the concept of biosecurity, especially in the case of small commercial operators. Most production units were open to the environment and few of these units had even simple barriers put in place to restrict the flow of pathogens into facilities. In retrospect, many have described the HPAI episodes and spread as a "disaster waiting to happen". Management was generally focused on vaccination against the important industrial diseases, such as ND, for which effective vaccine regimes exist. In the case of broilers, the production cycle was short enough to reduce the impact of other diseases. When H5N1 gained a foothold in the market chains, it quickly spread to poultry supply units.

After the initial onslaught of the virus, many small operators were put out of business and were waiting to see if they could re-enter the market. For many household producers, HPAI was a more severe manifestation of what had been experienced previously with ND. Therefore, traditional coping mechanisms were used – i.e. to either slaughter and eat sick chickens quickly before they died or, if the disease was nearby and posed a significant threat, to sell birds to the market. In many instances, this salvage by sale was also a common practice in the commercial sector. While the prevalent official position is that people do not eat recently dead birds, in protein-scarce communities the opportunity for such a chicken meal is often exploited. Another important issue was that there was a wide range of production standards both across the sectors and also within sectors. Producers with significant investments were severely caught out, and after the disease arrived they dealt with it by adopting methods they used before for dealing with other infectious agents i.e. vaccination and marketing tactics. Many farms raised broilers in multiple age groups without the barrier of "all-in, all-out" production and C&D between batches. It was common practice for broiler buyers to enter a number of different premises on a given day to select birds for market; moreover, egg trays were not routinely disinfected before entering egg layer facilities.

The standards of hygiene in many markets were unsatisfactory, with substandard practices being followed in the disposal of dead birds, offal, feathers and manure in markets. Opportunities for cross-infection between species abounded, and as the "all-in, all-out" practice was not applied on any given day, birds might remain in the market for a number of days before sale, thereby enabling virus circulation to be sustained in a market environment.

SITUATION IN 2011

It is difficult to assess improvements in biosecurity across the poultry sector, owing to the diversity of the production environments involved. Much work has gone into developing biosecurity guidelines for the commercial sector and, in some countries, there have been suggestions about linking compensation to the proper application of the guidelines in this sector.

Within ECTAD-RAP, national biosecurity guidelines have been drawn up for the commercial sector in Bangladesh, Nepal and Lao PDR. Guidelines were developed in the spirit of PPPs in a consultative process, with the participation of the public sector (central and provincial veterinary officer), private sector (poultry companies, poultry associations, veterinary associations, feed suppliers and pharmaceutical suppliers), academia and NGOs. The guidelines are used as the starting point for introducing biosecurity and also as a spur for implementing biosecurity programmes. In addition, the guidelines are linked to activities such as the development of biosecurity SOPs, the development and delivery of biosecurity training and communication materials, and the development of auditing and certification programmes. A guideline implementation structure (oversight committee and working groups) was also developed in line with the national administrative requirements.

Training programmes were delivered to cover the following areas: the principles of guideline development; policy application of guideline development; operational application of guideline development; roles and responsibilities – who should do what; elements of biosecurity; farm isolation with respect to location; farm characteristics; traffic on and off the farm; pest management and management of other animals; good farm hygiene, including house cleaning, disinfection, personal hygiene and apparel; flock health care and monitoring; good farm management practice; and the importance of compliance with government regulations and international standards.

On the ground, the programme has progressed furthest in Bangladesh. Constructive dialogues were established between the public and private sectors through neutral facilitation by FAO. In Bangladesh, senior veterinary officers were trained in the biosecurity auditing of commercial poultry farms, and they subsequently trained field-level veterinarians to carry out this process. Biosecurity training was then provided throughout the country for poultry industry suppliers as well as for farm managers. Continued dialogue between the public and private sectors has evolved into collaborative efforts aimed at accessing international markets through compartmentalization. However, the fact that a portion of commercial farms remains unregistered, and therefore do not comply with standards, indicated that an incentive might encourage registration and compliance. In India, a session on biosecurity practices for veterinarians in the field was incorporated into a surveillance training workshop on disease surveillance.

In Viet Nam, a set of biosecurity guidelines was prepared for chicken and duck producers in the smallholder sector. In addition, a biosecurity training programme targeting small poultry (chicken and ducks) producers was developed and delivered in seven HPAI-infected countries in the Asian region (Bangladesh, Indonesia, Lao PDR, Myanmar, Nepal, and Viet Nam). This programme emphasizes that biosecurity is the most effective tool for the prevention and control of HPAI and other important poultry diseases. The training programme included modules on an introduction to biosecurity, C&D, calculation of rates and application of disinfectants, and safe disposal of dead poultry and manure by composting. The training programmes involved training of trainers (TOT) as well as direct training of targeted poultry producers (chickens and ducks), allied services providers, private veterinarians and government officers (veterinarians and animal production officers).

In addition to the work done with the producers, a substantial amount of work was carried out in several countries to improve standards in LBMs. In Lao PDR, a pilot project was initiated in a main provincial market to increase poultry traders' awareness of the need to improve hygiene in the markets and to help construct a prototype stall model for live poultry marketing. A set of biosecurity guidelines was prepared to help officials understand the principles behind the measures to be applied, and two training courses were conducted for market operatives. Ninety percent of the attendees on these training courses were women. An impact evaluation was conducted after the project had been in operation for five months.

Even though the infrastructure and caging were in place, and the bird market had been located away from other food areas, with different species being caged separately, and although there was good knowledge about hygiene practices, the actual daily cleanup was not diligently practised, and live birds not sold at the end of the market day were returned to the stallholder's house, where they remained until the next day. Intensive follow-up is needed to improve the situation.

LBM projects were also carried out in China and Bangladesh. One LBM project in China was based on seven critical control points which were ranked by the market stakeholders, and included the principle of PPP. One outcome of the activity was an increase in cooperation between market operators and the local authorities. The provincial administration agreed to the PPP principle while expanding improvements in LBM management to the remaining main markets in the province. In Bangladesh, 24 markets were upgraded and hygiene practices were introduced to improve the overall biosecurity of the markets.

In Indonesia, while progress has been made in improving the relationship between the public and private sectors, there is scope for further improvement, particularly in the area of biosecurity on small-scale Sector 3 farms. Through the establishment of the National Poultry Health Council, an official partnership was established between the commercial poultry industry and the Directorate General of Livestock and Animal Health Services. In biosecurity, the gaps in operational biosecurity practices on farms and at marketing points along the post-production market chain have been more clearly identified and are being directly addressed by the disease control programme. Biosecurity training materials have been developed; training has been provided at every point of the production chain, and research is currently under way to identify the most cost-effective biosecurity practices for layer farmers. Along the post-production market chain, there have been several achievements: C&D SOPs have been prepared; 210 private sector stakeholders and public sector livestock service staff have been trained in effective C&D practices; 17 public sector and private sector C&D trainers have been put in place; 47 poultry collector yards have been equipped with C&D equipment; and five poultry truck C&D stations have been constructed in the greater Jakarta area. The capacity to implement market C&D days was also established at 22 LBMs, and infrastructure rehabilitation was provided to five LBMs in the Jakarta area. Through the Commercial Poultry Health Programme, 40 local government veterinary service officers have been trained in poultry farming, and over 2 000 farmers have been directly engaged and supported by these local government veterinary officers to date. In South and West Sulawesi, the Village Biosecurity, Education and Communication (VBEC) pilot project was implemented in six village communities, in order to improve awareness of how HPAI spreads and to develop locally suitable methods of control and prevention of poultry disease. A series of videos as well as a manual were also produced and distributed; these demonstrated both the village-based process and findings from the VBEC project.

In addition to providing formal animal health services training programmes for technical staff, a substantial amount of community-based training has been carried out by non-technical persons through communications initiatives conducted by NGOs. In certain cases, there has been interest in, and some uptake within markets of, for example, some of the simple technical measures that it has proved possible for such communications to deliver. A slight disadvantage of these programmes is that in the absence of technical expertise the capability to observe and record, or respond to what is actually being practised – and to provide sound, impromptu advice – is lacking. There have also been concerns that some of the mass messaging about biosecurity was not appropriately tailored to the audience to whom it was being delivered. For example, the message to confine scavenging poultry is simply not practical in some situations, and when the audience is actively discarding what is seen as one of the key messages, the overall message loses credibility. Notwithstanding this, mass communications programmes were an effective mechanism for disseminating messages about risk behaviours and practices to large numbers of stakeholders in different areas of the poultry sector.

OUTPUTS

- National biosecurity guidelines were drawn up for the commercial sector in Bangladesh, Nepal and Lao PDR. Guidelines were developed in the spirit of PPP, in consultation with the public sector (central and provincial veterinary officer), the private sector (poultry companies, poultry associations, veterinary associations, feed and pharmaceutical suppliers), academia and NGOs.
- Training programmes were delivered to cover principles of guideline development; policy and the operational application of guideline development; roles and responsibilities; elements of biosecurity and other topics.
- Biosecurity training was provided throughout Lao PDR for poultry industry suppliers as well as for farm managers.
- A session on biosecurity practices for veterinarians in the field was incorporated into a surveillance training workshop on disease surveillance held in India.
- Biosecurity guidelines were developed for chicken and duck producers in Viet Nam. A biosecurity training programme was conducted for small poultry producers (chickens and ducks) in seven HPAI-infected countries in the Asian region (Bangladesh, Indonesia, Lao PDR, Myanmar, Nepal, and Viet Nam).
- A prototype stall for live poultry marketing was constructed in a provincial market in Lao PDR. Biosecurity guidelines were drawn up to help officials to understand the measures to be applied, and two training courses were conducted for market operatives.

- LBM projects were carried out in China and Bangladesh. In China, an LBM project based on seven critical control points, and including the principles of PPP, was implemented. In Bangladesh, 24 markets were upgraded, and hygiene practices were introduced to improve the overall biosecurity of the markets.
- A National Poultry Health Council was established in Indonesia, as a partnership between the commercial poultry industry and the Directorate General of Livestock and Animal Health Services.
- Biosecurity training materials were developed in Indonesia, and training in effective C&D practices was provided for 210 private sector stakeholders and public sector livestock service staff. A total of 17 public sector and private sector C&D trainers were put in place, 47 poultry collector yards were equipped with C&D equipment, and five poultry truck C&D stations were built in the greater Jakarta area.
- Capacity to implement market C&D days was established at 22 LBMs, and infrastructure rehabilitation was provided to five LBMs in the Jakarta area.
- A total of 40 local government veterinary service officers were trained in poultry farming in Indonesia, and over 2 000 farmers were directly engaged and supported by these local government veterinary officers. In South and West Sulawesi, the Village Biosecurity, Education and Communication (VBEC) pilot project was implemented in six village communities to improve awareness of HPAI and also to improve the control and prevention of poultry disease.

OUTCOMES

- Knowledge and awareness of biosecurity concepts has increased among poultry producers, markets, allied services and government officers.
- Implementation of biosecurity measures on small poultry farms has improved.
- The risk of HPAI outbreaks has reduced; better health outcomes and performance have been achieved, profits for farmers and other stakeholders have increased.
- The risk of human infection has reduced.
- Cooperation between market operators and local authorities has increased. Commitments have been secured from provincial administrators to expand improvements to LBM management to the remaining main markets in the province.

LESSONS LEARNED

- There was a lot of resistance to partnership between the public and the private sectors. This occurred in various locations and for different reasons. In many instances, once the common ground had been identified and the advantages of combining forces were recognized, cooperation and early collaboration began to emerge. However, there is still a long way to go as, in some environments, public officials are not well respected.
- While individuals may understand some of the underlying principles of hygiene and biosecurity, it is still not an easy task to persuade people to change perceptions, behaviours and practices that have been ingrained and require effort on their part to make the requisite changes.

- It was encouraging to see that some individuals who introduced better hygiene practices in markets began to enjoy better business, as customers recognized the benefits of the changes for them.
- Many individuals involved in the poultry sector, including veterinary staff, do not appreciate the need for proper cleaning before disinfection. Moreover, in many cases, manual equipment purchased for disinfection is not likely to deliver disinfectants at the rates required to effect a proper result. In many instances the activity is cosmetic rather than functional.
- It is critical to evaluate the study of risks from marketing links between sectors.
- In general, considering the complexity of, and variation within, the commercial poultry industry throughout the region, solutions developed locally through direct engagement with stakeholders have been more effective than solutions imported from other regions.
- Building commercial poultry health competency within local government veterinary services is necessary in order to maintain improved communication and trust between local government and commercial poultry farmers.
- Training and capacity building exercises in C&D practices were most effectively delivered when skilled trainers with experience in both adult learning and practical experience in C&D were used, rather than relying on trainers provided by an equipment vendor or other unverified sources.

SUSTAINABILITY

In some environments, the principles of biosecurity have been adopted when individuals and groups perceive a benefit from improving standards. However, all of these aspects require ongoing effort and investment, and implementation delays persist, especially at the grassroots level. In urban areas, as health authorities impose stricter hygiene standards for food, it will become necessary for markets and traders either to adapt or to leave the industry. Until the volume of poultry produced in the smallholder sector is reduced from its current level (more than 70 percent of poultry are raised in systems where it is difficult to implement even simple biosecurity measures), and this is particularly applicable to free-range ducks, the overall population will remain relatively exposed to the risk of disease incursion.

A variety of PPP mechanisms is needed in order to improve buy-in and commitment from both government and stakeholders in the commercial poultry industry. This approach has resulted in farmers adopting best practices recommended by government and FAO; it has also resulted in private sector market chain operators assuming responsibility of covering ongoing costs of C&D in their facilities. Finally, by focusing on building the technical and training capacity of both government and private sector stakeholders in biosecurity practices, a sustainable resource for ongoing training and mentorship has been developed.

THE FUTURE

Maintaining biosecurity training programmes in HPAI-infected countries is essential in order to create greater awareness; to develop better understanding of these issues among producers and other partners, and in order to ensure broader implementation of biosecurity programmes as a tool for the prevention and control of HPAI and other important poultry diseases, in particular zoonotic diseases such as HPAI and salmonellosis.

While the future sustainability of the training programme rests largely in the hands of the private sector, the support of government veterinary services will be required, particularly in relation to smaller producers.

FAO should continue to support the poultry industry and the veterinary services in the development and delivery of training programmes for stakeholder groups with specific needs in the poultry sector.

FAO and its counterpart government veterinary services should continue to focus on the identification of the most cost-effective approaches for reducing the risk of disease spread at market chain critical control points, and on farms. With a stronger evidence base, specific high-impact practices can be targeted for future capacity building and advocacy programmes. In particular, FAO is keen to identify farm biosecurity practices that will reduce risk from HPAI while also improving farm profitability.

Socio-economics

Since H5N1 HPAI emerged in Southeast Asia in late 2003, the application of socio-economic analysis to disease control programmes has been significantly strengthened, from the perspectives of both FAO and national animal health authorities. The initial control approaches to HPAI focused on implementing technical activities without taking into account socio-economic aspects, specifically compliance incentives. Since then, there has been a steady evolution in the focus of socio-economic enquiry. The early concentration on the structure and function of compensation measures has been replaced by a focus on the costs and benefits of technical activities and the integration of value chains with risk assessment and disease control strategy (FAO, 2011; FAO, 2012). Inputs have also been made in the area of gender, and understanding attitudes to disease and its control. Socio-economics now occupies a mainstream role in FAO's approach to HPAI control.

While government systems and structures vary considerably, there was only one technical approach to the control of HPAI, and it often proved difficult to adapt this quickly to the needs of a given country. Socio-economic analysis has been a very valuable mechanism for adapting technical guidelines to different cultural and political landscapes.

SITUATION IN 2005

In the HPAI emergency response mode, there was some expectation that poultry producers would feel a responsibility or a need to cooperate with governments in controlling HPAI.

FAO AI TEAM, CAMBODIA

However the global concern about H5N1 was not mirrored at local level and, with the exception of Thailand, the links between the poultry sector and the region's governments, as represented by the official animal health services, were weak. Many producers in the region did not belong to or even have a producer organization to represent their interests to government. This led to government services not having a reliable conduit to the poultry sector and, in some cases, not being interested enough to deal with the producers and suppliers involved on key issues arising from the H5N1 control programme. The commercial sector did not receive technical inputs from the official animal health services and consequently considered them to be lacking in the expertise required to solve the private sector's problems. Government services were usually treated with suspicion, as they were mainly involved in regulatory activities.

Good relationships between producers and official animal health services are thought to be axiomatic for the success of any disease control programme, and official services need to have a sound understanding of the structure and operations of the industry sector, in addition to the professional competence to provide quality services. As these conditions did not exist in 2005, FAO did not have a dependable channel for engaging with the complex poultry sector. At that time, the international community was adhering to a disease control model based on OIE guidelines, with a focus on international trade. This model was of limited use in most countries, as there was little understanding of incentives that would bring about poultry producers' compliance with disease control measures, especially where there were no industry-based compensation packages for producers after stamping-out operations.

Poultry producers adjusted to the effects of HPAI in different ways. Some sharpened their management and biosecurity practices while others simply went out of production. Where vaccines were available, commercial producers used them to varying extents, with the commercial layer sector dominating (Hinrichs *et al.,* 2010). When disease was suspected, some producers responded by selling birds to salvage some investment, a practice common in the early stages of the outbreak and still prevalent in some places (Otte *et al.,*2008). Throughout the region, the most common business model was the low-investment, family-run operation that represented a way to turn a labour asset into a financial gain. As long as the capital requirements were low, and no outlay on wages was required, small commercial producers could continue to tolerate low margins and sustain an essentially subsistence livelihood. Many operators chose not to invest in technical knowledge and, therefore, engaging them in a disease control programme proved to be an enormous challenge. To them, HPAI simply represented another constraint to be dealt with in time-honoured ways that did not include scientific disease prevention and control. In some countries where production practices were diverse, a weakness in one area of the poultry sector could easily threaten the commercial aspect. For example, Indonesia's commercial sector was not transparent about its difficulties in controlling endemic HPAI with vaccination.

At this time, although there was limited knowledge of the poultry sector across the region, there was much anecdotal evidence and conjecture about the possible role of cross-border trade activities in spreading HPAI. While FAO had some knowledge of the role of poultry in the context of smallholder livelihoods, there was inadequate understanding of the impact of diseases and the strategies adopted by producers to deal with them. Initially, the poultry production systems were differentiated by biosecurity levels (Sectors 1 to 4), but there was limited knowledge about the different species used, the seasonality of production, market cycles, and other parameters such as input supplies and costs.

Where the vaccine had been introduced as a control measure, there was no information available in 2005 about the costs and benefits of the programmes, or even whether the vaccination strategies were cost-effective. While mass vaccination programmes were in place in Viet Nam and Indonesia, there were major constraints to the implementation of this measure in smallholder poultry units, and the incentives for compliance were not fully appreciated.

While it was recognized that women were heavily involved in smallholder poultry production, especially with chickens, most programmes were not designed to reach this audience. Women, who were well represented in markets and in the marketing of poultry and poultry products, had not been taken into account and their needs had not been integrated into disease control strategies. This resulted in a gap in outreach activities.

SITUATION IN 2011

By the end of 2011, socio-economic analyses of a range of issues related to disease control were well advanced in the region, and the usefulness of the outputs was, by then, well appreciated by animal health services. Poultry production systems, and the main actors in value chains, had been identified and characterized in order to gain a better understanding of their disease control compliance incentives, and also in order to target interventions efficiently (FAO, 2011). In many countries, poultry sector reviews have been made available to disease control planners and sector development policy-makers (FAO, 2004; FAO, 2008b). HPAI control costs for vaccination, surveillance and culling have been assessed and these may be used to budget for the financial resources required for technically efficient disease control measures (McLeod *et al.,* 2007; Hinrichs *et al.,* 2006). Vaccination costs and willingness-to-pay assessments in Viet Nam have shown that there is limited scope for public sector savings through more targeted or voluntary HPAI vaccination while maintaining an acceptable HPAI risk level. FAO and governments now have a clearer picture of the complexity of the poultry production sector and its concerns. In China, value chain and network analyses identified LBMs as a high risk for the onward spread of HPAI to other markets (Martin *et al.,* 2011). This enabled the prioritization of the limited funds available to increase biosecurity conditions in markets for these critical points in the chain.

Regional perspective

The insights from socio-economic activities and analyses have helped to make some of the approaches to disease more compatible with national and regional circumstances. The tools used have been impact assessments, compensation frameworks, value chain studies, mapping trade flows, understanding incentives, cost-benefit studies and assessments of control costs (FAO 2011; FAO 2012). For example, it has been shown that rather than treating the borders themselves as risk points, the issue that needs to be addressed is the nature of the value chain that crosses the border. The porous nature of many borders makes interventions in cross-border trade somewhat difficult, and a risk-based approach based on the value chain has emerged as the most effective way to manage the disease risks. Investments in quarantine-type tactics at borders, which are still favoured by some administrations, are not particularly cost-effective. In addition, campaigns aimed at raising awareness and effecting behavioural change to reduce cross-border trade risk were ineffective in the face of the high economic driver of the price differential of the traded poultry products. In contrast, engaging directly with actors in the chain to make them aware of their role, and to provide them with tactics to manage risk, has proven valuable. Overall, there is increased knowledge about the sophisticated, complex and heterogeneous food systems in which disease occurs, and surveillance strategies have been adjusted to take account of the trade flow of poultry products. The biosecurity-based classification of poultry production systems has evolved into a system that takes into account the purpose for which poultry is produced and the value chain to which the product is linked. While there are still gaps in the application of compensation programmes, models for improving compensation have been developed for Nepal and Viet Nam.

The considerable negative economic and social impacts of culling and movement control were determined, and these were used to advocate for a more tailored use of these measures, or a disease control measure based on epidemiological assessments rather than a fixed 3 km ring (Otte *et al.,* 2008). The estimated, vast negative market impact from demand shocks was also used to advocate for enhanced risk communication. Examination of willingness to pay, vaccination costs and coverage of HPAI vaccination scenarios delivered the evidence that cost-effective vaccination and substantial costs savings for the public veterinary service were mutually exclusive outcomes in Viet Nam.

An important anthropological study in Cambodia described the attitudes of rural people to HPAI and HPAI control directives, noting that until behaviour change communication took note of and respected cultural beliefs about disease there would continue to be a gap between awareness and practice (Hickler, 2007). This study has greatly informed both communications thinking and disease control thinking. Important studies on gender issues related to poultry production and disease control were also carried out in Cambodia and Myanmar.

Country perspectives

Cambodia: In 2005, little was known about poultry production systems and their value chains. Socio-economic studies, which have been a major thrust of the activities undertaken, have supported the drafting of veterinary legislation and have also addressed the following areas:

- socio-economic impact on, and assessments of, smallholder livelihoods;
- surveys of consumer preferences for poultry products, especially live birds;
- assessments of poultry value chains within the country and also at border areas;
- characterization of native chicken and duck production systems and the supply of ducklings;
- biosecurity assessments of poultry markets and impacts on the livelihoods of the traders involved.

These studies have led to a greater understanding of the poultry sector and of the tactics required for the efficient utilization of resources for disease risk reduction.

In 2007, FAO began to help the Royal Government of Cambodia draft animal health and production legislation. After a lengthy consultative process with stakeholders, the final draft was prepared in November 2011, and is now with an interministerial committee, which is expected to approve it and present it to Parliament by early 2013.

China: Limited work has been carried out in China on the social and economic aspects of H5N1. The studies conducted have primarily mapped trade flows and the established social networks. In the current epidemiological context in China, where the clinical expression of the disease is becoming an exception, the Chinese national veterinary authorities face new challenges with the silent circulation and likely persistence of HPAI H5N1 in traditional LBMs or in specific ecosystems where free-ranging duck farming systems are dominant. Addressing these challenges, and designing targeted, risk-based, surveillance and control interventions, requires a better knowledge of HPAI H5N1 risk factors as well as innovative ideas for better integrating poultry production and marketing systems into risk assessments. Among the techniques being used, value chain analyses and social network analyses are playing an increasing role in describing infectious disease transmission patterns and in guiding control policies developed by health authorities. Value chain analyses have provided an analytical framework to allow characterization of distinct parts of the poultry industry as well as interconnections between various actors in the industry. This work delivers insights into the circulation and dissemination of H5N1 virus in China, and assists in the design of market surveillance activities and prioritization of market biosecurity upgrading investments.

Indonesia: In 2005, there was little information available about the structure and complexity of the poultry market chain, or about the value of products at each point along the chain. In particular, the ongoing economic impact of H5N1 on commercial poultry production was not acknowledged by the industry itself; instead, industry representatives at the time claimed that the disease was well controlled via a combination of vaccination and biosecurity.

The most successful practice in Indonesia has been direct engagement, using participatory techniques with private sector stakeholders to gain a better understanding of the structure of the poultry market chain and a greater awareness of how farmers manage their farms from an economic perspective.

Progress has been made on several fronts. The poultry market chains for layer chickens, broiler chickens, native chickens, and ducks have been described for Bali, North Sumatra and the greater Jakarta area (FAO, 2007; FAO, 2008; FAO, 2008), and are now well understood. In addition, value chain studies of commercial poultry production systems have elucidated the points between input supply and output to consumer where the value of the product changes. A better understanding of the ongoing impacts of H5N1 on backyard poultry producers and small-scale, market chain stakeholders has been achieved through improved surveillance, targeted research and improved engagement between local government and poultry production communities. Finally, the HPAI control programme has provided clarification on how specific management and vaccination changes impact on layer farm productivity and profitability, enabling layer farms to make better, evidence-based decisions that reduce the risk of HPAI while also improving farm productivity.

An important individual outcome was that the Jakarta market restructuring process was revised to include private stakeholder engagement and the option for private sector-proposed relocation sites for poultry slaughter. A specific, critical control point for the spread of HPAI to humans in Jakarta was identified via the native chicken market chain from Central Java and East Java. The risk of continued interprovincial movement of H5N1 virus was also better understood in the context of production and value disparities between provinces, for example, between East Java and Bali.

Myanmar: In 2004, FAO conducted a review of the livestock sector in Myanmar. However, this did not contain the level of detail on the poultry production systems that was necessary in order to understand the risk factors for the spread of HPAI. Today, however, the country's animal health services have a good understanding of the principles of supply chains and their linkages to epidemiology and disease risk.

Information is now available on the socio-economic impact of HPAI and its effect on farmers and households. A large body of socio-economic assessments was carried out, based on individual family case studies on the impact of livestock diseases including HPAI on livelihoods, and this is now an accepted approach that could lead to important policy adjustments. Gender studies undertaken have already resulted in changes to the departmental training policy.

There has also been an emphasis on supply chain studies linked to managing and understanding risks. While early work in this area focused on risk issues related to cross-border trade, later risk assessments included high consumer centres as well as supply chains associated with areas of wild bird migration. A national database of commercial farms has now been created, with all farms georeferenced to provide information to assist disease control activities. A major national study was also carried out to describe the input and output chains for the poultry sector. Training programmes have been conducted to ensure that the supply chain methodology is fully integrated into disease surveillance approaches.

Nepal: A number of studies on the livelihoods of rural families in Nepal carried out prior to 2005 addressed issues related to poultry production and marketing. Studies conducted by various bodies including government, NGOs and academics addressed topics such as marketing channels and value chain approaches. However, none of these studies had a focus on disease control.

A national study on poultry production has led to a better understanding of present day poultry production in Nepal, and has confirmed the role of poultry in providing rural households with a readily realizable asset and valuable nutritional support. Another study has produced detailed information on market flows, volumes and the factors influencing them. This has informed the formulation and reformulation of control and surveillance guidelines for the designation of high-risk districts and active surveillance sites. WB funds have been used for providing compensation based on an updated compensation mechanism. The very existence of a compensation mechanism has had a positive effect on overcoming reluctance to report poultry disease events to the authorities, and is a critical element in passive surveillance efficiency. However, despite readjustment, the amounts paid are still below the market values for adult birds.

Lessons learned from the border trade and from the effectiveness of regulatory approaches were particularly useful. Movement across Nepal's open land borders is not controllable, and internal animal health checkpoints, properly manned and free from coercion, were identified as more reliable HPAI control measures.

Viet Nam: A government structure that has significant devolution of authority posed special challenges in Viet Nam. As part of a large effort to link disease control activities to the interests and focus of local authorities, value chains were mapped in pilot provinces, which included hatcheries for ducks and chickens. Two publications were produced: an atlas of commercial enterprises in pilot areas and a guide for efforts to understand poultry production. The visual perspective provided by the atlas was useful in discussions with local planning authorities, and it informed poultry sector restructuring policies and development plans.

The cost-effectiveness of surveillance for HPAI, both active and passive, was compared across several projects at different time intervals for the years 2007 to 2010. Important indicators for the effectiveness of surveillance were the number of suspicious cases investigated, the number of confirmed cases, the time that elapsed between reporting and investigation, and the number of viruses isolated from positive cases. The study concluded that as a result of better management of the disease, including the adoption of better control measures, the number of outbreaks in a given geographical region had reduced from year to year. The decrease in the number of outbreaks had been matched by an increase in the cost of surveillance over the years. The study also concluded that the quality of surveillance had improved over time, as a result of better trained manpower, improved methodologies, increased awareness about the disease and deeper understanding of the disease at the field level.

Viet Nam's GETS project, conducted between 2009 and 2011, evaluated the cost-effectiveness of a targeted vaccination strategy in five project provinces. The vaccination strategy, which focused on ducks – a high-risk source of HPAI infection – has shown positive results. The application of the strategy saved the government 21 percent of the cost of vaccination in the five project provinces. However, the increased implementation of monitoring activities led to a fivefold increase in the cost of surveillance, when compared with the pre-GETS period. The total public cost of HPAI control decreased by 4.7 percent, compared with a reduction in public vaccine costs of 18 percent in the GETS period.

Cross-border market chain studies have been very useful in illustrating that border controls are not effective in the face of a significant economic driver of trade, and that a more strategic approach to managing the inevitable inflow of product is more effective in mitigating risk. FAO has facilitated bilateral discussions with China to examine the cross-border trade in spent hens and the potential risks that this poses to the poultry sector in north Viet Nam. Establishing a 'dirty corridor', or slaughter before entry, was identified as one option for reducing the high HPAI disease incursion risk from the informal importation of spent hens.

An integrated assessment of the animal health, socio-economic and environmental impact of government-led, poultry sector restructuring was carried out. Considerable profitability and disease spread risks were identified. The original policy of having high-density, mixed-species animal production areas was subsequently modified and not implemented nationwide. Studies on the duck production systems have yielded a deeper understanding of production dynamics and of the roles of the various stakeholder groups involved, including the effect of gender on roles.

OUTPUTS

- Poultry value chain mapping workshops were conducted at the borders of Lao PDR, Cambodia, China and Myanmar, and visits were made to borders in Thailand and Viet Nam.
- A cross-border HPAI risk assessment tool with 12 epidemiological and socio-economic risk indicators was developed and applied in risk assessments at six border regions.
- An extensive report on a poultry production and market chain study was prepared in Cambodia.
- Two flagship guideline documents were produced: *Taking a value chain approach to animal diseases risk management. Technical foundations and a practical framework for field application* (FAO, 2011) and *Designing and implementing livestock value chain studies. A practical aid for Highly Pathogenic and Emerging Disease* (HPED) control (FAO, 2012).
- Capacity building to conduct value chain studies and incorporate the methodology into surveillance systems was undertaken.
- A socio-economics training module was developed and applied at a regional FETPV programme.
- A report on anthropological aspects of HPAI control in Cambodia: Bridging the gap between HPAI awareness and practice in Cambodia (Hickler, 2007) was published.

OUTCOMES

- Animal health authorities have a greater understanding of the need to go beyond technical issues when undertaking disease control programmes.
- Value chain insights have now been incorporated into the mainstream of animal health surveillance and risk management strategies (FAO, 2011; FAO, 2012).
- Easier identification of stakeholders and greater engagement of stakeholders in determining strategies for disease control along value chains facilitates the implementation of disease risk reduction measures.
- Identification of different value chains in the region has increased understanding of the conduits of risk and their relative importance in disease spread (Hickler, 2007). This, in turn, has increased understanding of the institutional arrangements required to develop better control programmes, especially where cross-border issues are important.
- Value chain studies have provided assessments of trading volume, seasonality and socio-economic drivers of trade, and have identified the public health risks and disease spread risks associated with trading practices. High-risk points in value chains have been identified, providing the potential to increase the efficiency of surveillance and control measures. In addition, value chain studies have uncovered types of trade that require novel control interventions.

BEST PRACTICES

- The value chain approach is fundamental to achieving an understanding of the patterns of, and the critical points in, the poultry production and marketing chain, and to facilitating risk management. Participatory interaction with stakeholders in value chains leads to solutions relevant to their interests; it also increases their engagement in the disease control programme and their ownership of the outcomes (FAO, 2011; FAO, 2012; Martin *et al.,* 2011).

- Attention is increasingly being paid to incentives for stakeholders in the poultry sector while, at the same time, designing disease control measures that depend on their compliance (Hinrichs *et al.,* 2010).
- Case studies, and better understanding at the household level, are very useful for informing government about the impacts of disease and control programmes on the livelihoods of the less privileged (Otte *et al.,* 2008).
- Providing visual and two-dimensional imaging of production systems, market chains and trade flows, as well as using geographic information systems and maps, has helped communication with decision-makers.
- Livelihood frameworks are useful for analysing the contributions that poultry production makes at stakeholder level, and are also useful for designing and assessing the likely impact of policy changes on stakeholders, and their propensity to accept them.
- The inclusion of anthropological analysis can provide vital information on the issue of incentives and adds a useful dimension to the multidisciplinary approach needed for addressing complex issues such as HPAI control (Hickler, 2007).

LESSONS LEARNED

- Socio-economics must be integrated into any disease control project in order for it to be effective, and stakeholders' reasons for non-compliance should be taken into account. The required economic data must be collected in real time and in an integrated way as part of any disease control intervention. Interventions should be linked to, or integrated with, the needs of the disease control authorities, in order to ensure that the outputs are useful to decision-makers and policy-makers.
- Disease control interventions should be assessed for likely animal and public health benefits against potential negative socio-economic impacts, and a response that is proportionate to the assessed risks should be adopted. Overreaching, or what may be perceived as overreaction, creates barriers with stakeholders that it can take a long time to break down. For example, global-level concerns about H5N1 pandemic potential were not shared by producers whose livelihoods depended on the output from small flocks.
- Unenforceable legislation that goes against the grain of age-old, albeit economically sound trading practices is counterproductive, as communities and stakeholders will continue with the status quo and will resist health inspection and other assurances of disease-free status. An assessment of regulatory capacity should be included in the development of policies that require regulatory enforcement.
- Where culling is used for control, compensation for slaughter must reflect the market value of the relevant class of poultry. However, financial resources for compensation schemes are difficult to obtain and, without control practices and the cooperation of stakeholders, compensation alone may not improve control. Incentives for compliance do not always meet the expectations of stakeholders.

- Neither government disease controllers nor the international community recognized the ongoing difficulties of the commercial poultry sectors in preventing and controlling H5N1. While this partly reflected their lack of expertise in working with the commercial sector, it also resulted from a lack of transparency within the industry, which distrusted government and had concerns about market shocks. Over time, greater effort was made to create bridges to engage with the commercial sector.
- Movement across open land borders is not controllable and, in most cases, internal animal health checkpoints, properly manned and free from coercion, are likely to be a more reliable way to reduce the spread of HPAI. The internal poultry trade is very efficient at spreading HPAI.
- For trade in general, and for cross-border trade in particular, awareness campaigns generally produced no evidence of behavioural change either in communities or in traders, who were unconvinced of the risks and were guided principally by economic factors inherent in commercial activity. Moreover, while evidence and strategies for different policy approaches might have seemed compelling to international stakeholders, local authorities could sometimes be slow to respond because of the complexities of the policy environment and constraints to change.
- Assessment of the governance of poultry production systems, and supports to strengthen the efficiency and operation of poultry production chains, can have significant animal health and socio-economic benefits.
- Key drivers for change are financial incentives coupled with financial risk minimization. Interventions that carry such financial benefits should communicate them effectively and credibly to those who are expected to comply with the changes proposed.

SUSTAINABILITY

Outputs from socio-economic interventions are welcomed and appreciated by the animal health services and other stakeholders. While the knowledge base accumulated will not be lost, it will be difficult for animal health services to find resources to conduct further investigations, especially as circumstances change. The expertise to carry out such work does not have a natural home in an animal health service and should, therefore, be housed in another part of the ministry – for example, in a department of animal production – or sourced from outside the government. For this reason, it is necessary to ensure that a certain capacity is maintained in animal health services to analyse and collect the required data, and to ensure more effective and efficient animal disease control. This will also allow for clearer engagement between veterinary services and policy-makers and, as a consequence, more transparent access to funding resources. Within FAO, the value of this approach is now well recognized and it will be an important component of any future animal health programmes.

THE FUTURE

The control of HPAI and other high-impact emerging and re-emerging infectious diseases can only be effective if incentives to stakeholders, and the context within which they operate, are taken into account. Hence it will require detailed value chain impact and assessments of control costs for other livestock subsectors as part of any disease control intervention, project or programme. This applies especially to any projects or programmes that are launched using a One Health approach. The programme should assess the potential impact of market chain-based interventions to reduce the risk of other emerging infectious pathogens concentrating along urban market chains and subsequently spreading to dense urban populations. Guidelines that will assist governments in conducting HPAI impact assessments need to be drawn up.

The poultry industry in Asian countries contributes considerably to their gross domestic product and is, therefore, a valuable national resource that must be protected. The allegiance of poultry associations to government policies on HPAI control and prevention must be maintained. Backyard, village-level producers need more support and guidance on the spectrum of poultry production issues, including husbandry and health, so that poultry production may reach its potential to provide income and nutritional benefits to these community members. The HPAI programme needs to be better aligned with the issues facing poultry farmers – not only from a perspective of productivity and profitability but also in terms of livelihood resilience. Poultry or general livestock sector development policies, aimed at achieving sustainable production with healthy animals, must become integral to animal health promotion programmes.

Wildlife

At an early stage in the HPAI emergency it was suggested that wild birds may have played a significant role in the dissemination of H5N1 to new environments, especially in the rather spectacular spread of the virus to Europe and Africa in late 2005. As early as 2003, the H5N1 virus was isolated from captive wild birds in the Hong Kong Special Administrative Region – an area which provides opportunities for contact between poultry and migratory water birds, particularly in rice cropping wetlands where both migratory waterfowl (the natural reservoir of low pathogenic AI viruses) and openly-grazed domestic ducks forage together. FAO was perceived by both the public and the animal health sectors as a key player in the process of developing a scientific base and technical capacity to address the role of wild animals in the epidemiology of AI. Today, one of the issues that still requires attention is how to manage the potential risks posed by wild birds and also how to avoid any unnecessary impact on wild bird populations resulting from overzealous disease management strategies.

SITUATION IN 2005

In 2005, the FAO–EMPRES Animal Health Wildlife Health and Ecology Unit had not yet come into existence, and most wildlife-related activities were conducted through FAO Forestry Department wildlife officers – with little emphasis on disease ecology issues related to the interface between livestock, wildlife and humans, or eco-health matters. Also around

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this time, relatively little work related to the wildlife disease domain was taking place within the animal health service. Moreover, FAO did not have dedicated in-house wildlife expertise to support this work.

At the country level, general matters related to wildlife fell under the jurisdiction of the equivalent of the relevant ministry of forestry's environment department i.e. whichever department was responsible for natural resource management, including wildlife. Animal health services generally did not have established links to facilitate wildlife surveillance or investigations into outbreaks of disease involving wildlife species, and staff in the responsible department generally did not have the requisite wildlife health expertise. At the global level, several large INGOs had strong interests in wildlife-related issues and, in particular, the potential impact of H5N1 on wild bird populations. In addition, a number of international conventions on wetlands and migratory species had been adopted; these conventions' secretariats and field representatives were potential stakeholders in the investigations and measures proposed.

SITUATION IN 2011

In response to the H5N1 HPAI emergency, FAO's Animal Production and Health Division (AGA) hired a wildlife veterinarian to help determine the role of wild birds in the emergence and spread of HPAI. The EMPRES Animal Health Wildlife Health and Ecology Unit, established in March 2006, played a key role in the FAO-OIE International Conference on the Role of Wild Birds and Avian Influenza, which was held the same year. Initially, the Unit's Coordinator worked at FAO headquarters as a seconded officer from the Wildlife Conservation Society (WCS). In July 2007, FAO independently appointed a Wildlife Health and Ecology Unit Coordinator. This initiative was prompted by two factors: the priority to understand the role of wild birds in the spread of H5N1 HPAI and the recommendations of the 2006 International Conference on the Role of Wild Birds and Avian Influenza. Between 2006 and 2011 the number of Unit staff employed in AGA at the FAO headquarters in Rome fluctuated between one and three, and an additional Unit staff member was appointed in ECTAD-RAP. Both the FAO headquarters Wildlife Health and Ecology (W&E) Unit positions and the FAO Regional Office for Asia and the Pacific Assistant Wild Bird Coordinator position (2007-2009) were funded by a number of donor countries, including the UK, Sweden, Canada and Australia.

The W&E Unit directly contributed to many USAID-funded activities specifically in the areas of capacity development, surveillance and outbreak response, biosecurity and disease ecology studies, while respecting USAID's decision to particularly focus HPAI-related funding on understanding the impact of livestock (rather than wildlife) on the spread of the disease. FAO also liaised closely with USAID's Global Animal Information System (GAINS) programme to ensure that wildlife surveillance conducted by both organizations was complementary.

The principal focus of the W&E Unit was to coordinate activities at the interface of wildlife and livestock systems. In addition, unit staff engaged in some interaction with public health scientists who were concerned about the movement of zoonotic agents, either through domestic animals to humans or directly to humans. The unit became a global leader in collaborative research projects aimed at elucidating the potential role of migratory birds in long-distance movements of H5N1 viruses. It was heavily involved in developing capacity to respond to outbreaks and to conduct surveillance at the wild bird-domestic bird interface. The unit also provided training within FETPV programmes; it produced two training manuals related to influenza and wild birds; conducted international workshops and meetings; carried out field investigations; delivered direct training in the safe handling of wild animals; and provided wildlife health expertise to international working groups and networks, including working with the United Nations Environment Programme – Convention on Migratory Species (UNEP-CMS) to co-convene the Scientific Task Force on Avian Influenza and Wild Birds and, later, the Scientific Task Force on Wildlife and Ecosystem Health.

The W&E Unit has developed a Wildlife Investigation in Livestock Disease and Public Health (WILD) module in collaboration with AU-InterAfrican Bureau for Animal Resources and the Royal Veterinary College for capacity development and the FETPV programme. This course has been delivered four times for African countries, twice for Southeast Asian countries, and once in China. Participants learn about the interface between livestock, wildlife, humans and the environment; they also learn about their role as field epidemiologists in dealing with disease ecology, TADs and EIDs. Specific attention is paid to evidence-based decision-making and cooperation among agriculture, natural resources and public health agencies, and important diseases in their region. The role of wildlife as disease reservoirs or in transmission is addressed through wildlife and domestic animal surveillance programmes, and by identifying the role and importance of wildlife biologists in outbreak investigations. This two-week training module incorporates class lectures, field exercises and group work to encourage multidisciplinary collaboration.

In South and Southeast Asia, HPAI H5N1 surveillance and outbreak response strategies incorporating the participation of the wildlife sector have been developed for Bangladesh, Cambodia, China, Hong Kong, India, Lao PDR, Mongolia, Myanmar, Thailand and Viet Nam. These were supplemented by programmes involving training in wildlife capture in addition to programmes on handling and sampling field techniques, which were carried out in Bangladesh, China, Hong Kong, India, Myanmar, Mongolia, Thailand, the Philippines and Viet Nam. Surveillance has involved farmed wild bird species in China; free-ranging wild birds in Cambodia, China, Hong Kong, Mongolia and Thailand; and openly-grazed domestic ducks in Bangladesh, China and Indonesia. The W&E Unit has participated in CMC-AH missions related to H5N1 HPAI to India, Nepal, South Korea, Turkey and Thailand.

Training manuals produced to support the W&E Unit field activities include:

- *Wild Bird Highly Pathogenic Avian Influenza Surveillance: sample collection from healthy, sick and dead birds*. 2006.
- *Wild Birds and Avian Influenza: An introduction to applied field research and disease sampling techniques*. 2007
- *Investigating the Role of bats in Emerging Zoonoses; Balancing ecology, conservation and public health interest*. 2011.

These manuals have been supplemented by a number of other publications including *Avian Influenza and Wild Birds: What is their true role in the spread of the virus* (brochure from the Scientific Task Force on Avian Influenza and Wild Birds); *Focus on: Wildlife Health and Ecology* (brochure on the working areas of the Scientific Task Force on Wildlife and Ecosystem Health); *Wildlife and Ecosystem Health News* (bimonthly newsletter of the

Scientific Task Force on Wildlife and Ecosystem Health); the Philippines Bat Conservation brochure; *Wildlife and H5N1 HPAI: Current Knowledge* (HPAI and Wild Bird Fact Sheet); a chapter on wildlife health and diseases as part of FAO Forestry Paper 167 *Wildlife in a Changing Climate*; One health – one destiny: appreciating the connectivity of health among ecosystems, wildlife, livestock and people (a One Health chapter in *Unasylva*, an international journal on forestry and forest industries); and a One Health article entitled Integrating Aquatic Biosecurity into the Way Forward – A Natural Progression, which was published in the *FAO Aquaculture Newsletter*.

In RAP, the W&E Unit has led or collaborated in migration and disease ecology projects in Bangladesh, China, Hong Kong, India and Mongolia, providing information that has been cited in more than 20 peer-reviewed publications. Globally, the W&E Unit plays a technical leadership role in international networks such as the Scientific Task Force on Wildlife and Ecosystem Health (which it co-chairs), participating in international conferences on wildlife issues, and supporting FAO participation in OIE working group on wildlife diseases. In addition, the unit is a member of the East Asia Australasia Flyway Partnership, and it also acts as Co-Chair of the Wild Bird and AI Working Group within the partnership. The unit has helped to organize large AI and wild bird workshops with partners such as USDA, WCS, Mahidol University and the Federation of Asian Veterinary Associations (FAVA). It has also co-led three annual, community-based risk modelling workshops in Asia with multiple partners. These workshops have provided a mechanism for advancing science related to global AI risk modelling. (Information on these workshops is available at http://www.eomf.ou.edu/workshop/). Other important global initiatives which the W&E Unit has contributed to include OFFLU, EMPRES-i Disease Event Modules, GLEWS, Movebank, the Earth Observation and Modelling Programme at Oklahoma State University (OSU), the United States Geological Survey (USGS), the Wildlife Health Event Reporter and, most recently, USAID's Emerging Pandemic Threats (EPT) programme.

In addition to HPAI-related activities, the W&E Unit has collaborated on issues relating to bushmeat or wild meat, disease transmission, food security and conservation, as well as activities related to livestock-wildlife disease transmission among cattle and African buffalo in transborder conservation areas. Other areas of collaboration have included landscape ecology, conservation, disease and ecosystem services projects. One particular example of this work at the interface included work on FMD prevention and control among pastoralist cattle herds and Mongolian gazelles. Most recently, the W&E unit has been working on public health issues at the interface between bats, pigs and people in South and Southeast Asia, including projects on Ebola Reston and Henipavirus.

The W&E Unit has provided inputs to the development of the FAO-AGA One Health Strategy (Sustainable Animal Health and Contained Animal-related Human Health Risks in Support of the Emerging One Health Agenda). It has also provided inputs to the joint FAO-OIE-WHO-UNICEF-World Bank Strategic Framework *Contributing to One World One Health* and to the FAO inter-departmental One Health Workshop; it has encouraged internal collaboration through Interdepartmental Working Groups on One Health and Biodiversity, and it has been involved in the GLEWS collaboration between FAO-OIE-WHO for moving into the One Health domain by supporting broader activities on wildlife health, food safety and fisheries.

OUTPUTS

The W&E Unit's principal outputs have been in capacity development, studies of migration and disease ecology, and training materials. Specific outputs are as follows:

- Over 500 professionals were trained in surveillance and outbreak response.
- About 10 000 surveillance samples were collected and analysed for H5N1, and reports from five outbreak responses describing the role of wild birds in HPAI events were published.
- 556 satellite transmitters were deployed on 23 species of waterfowl in 12 countries. The information collected on AI disease ecology and the role of wild birds was subsequently published in peer-reviewed international journals.
- Two manuals on wild bird field techniques and sampling were published.

OUTCOMES

- There has been increased participation by wildlife health professionals in investigations into the role of wild birds in HPAI ecology, as well as increased participation in poultry mortality event investigations at national and regional levels.
- Wild bird surveillance has been included in national influenza surveillance strategies.
- There is now a clear understanding that wildlife species are not reservoirs of H5N1 HPAI. Additional information collected during outbreaks of the disease in wildlife along the central Asian flyway and East-Asian-Australasian flyways has shown that wild bird populations continue to suffer from mortalities due to varying clades of H5N1 HPAI.
- There is greater standardization of approaches to field investigations and interventions, owing to translated training materials which provide accessible resources for field workers.
- There is increased awareness that FAO's expanded in-house agriculture expertise goes beyond food security and livestock health, and that it also encompasses ecology, conservation, environmental and human health. The engagement with international networks has provided valuable technical leadership and has helped guide global efforts in synchrony with principles established by FAO and OIE.
- The wildlife component is routinely incorporated into standard HPAI programming and activities by FAO ECTAD teams and RAP. There is increased awareness among the veterinary, biology and public health communities about the actual role of wild birds in the spread of H5N1 HPAI.

Global visibility for FAO's leadership has increased. FAO has successfully demonstrated how the integration of wildlife expertise and collaboration between human health, animal health and wildlife health and natural resource management sectors is crucial to addressing the global HPAI crisis – a true One Health approach which now goes beyond AI, and includes activities with international partners, multilateral environmental agreements and other UN partners. Among international organizations and country partners, there is now greater acknowledgement of FAO's activities and capacity in terms of dealing with issues at the wildlife-livestock interface.

SUCCESSFUL PRACTICES

Ministries of agriculture, forestry/environment and public health have participated in training programmes. This has led to developing trust among partners and to encouraging cross-pollination of ideas between different areas of expertise.

Ministries of agriculture, forestry/environment and public health have cooperated in joint planning for surveillance and outbreak response. For large projects – such as those on disease and migration – areas related to ecology, planning, coordination and implementation must involve ministries of agriculture and forestry/environment at the very least.

SUSTAINABILITY

Reduced funding has resulted in loss of staff and decreased ability to build capacity, conduct surveillance, and carry out disease/migration ecology projects. Because of its engagement in several large collaborative partnerships, FAO can continue to provide expert opinion and feedback to help address important issues. In countries where local expertise has been developed, FAO can work with these trained personnel, utilizing a One Health approach to support human-animal-ecosystem health initiatives.

THE FUTURE

The W&E Unit can continue to contribute significantly and lead One Health initiatives, as well as address global animal health concerns. Much work remains to be done on the bats-pigs-people surveillance approach in South and Southeast Asia, especially in the Philippines, Thailand and Viet Nam, and specifically in relation to the follow-up on the Ebola Reston results from the FAO TCP in the Philippines.

The FETPV WILD courses need to be expanded to include a number of other countries, and a Wildlife, Ecology and Environment (WEE) training course and manual needs to be developed for natural resource managers and biologists from ministries of forests/environment, as well as other partner ministries. To this end, the W&E Unit is uniquely positioned to contribute to the finalization of the National One Health strategic framework for Bangladesh – and for other interested countries in the region. The role of wildlife in livestock diseases such as FMD will also require further investigation as regional efforts to control FMD gain momentum. The ultimate One Health challenge is to work towards achieving biodiversity preservation and sustainable natural resource consumption, while simultaneously maintaining resilient ecosystem services and improving food security globally.

Communication and advocacy

Communication was originally promoted as the best remedy for a wide range of disease control problems. FAO has never had direct involvement in mass communication for behavioural or social change; this function was mandated by the United Nations (UN) to the United Nations Children's Fund (UNICEF). While UNICEF's experience and approach were strong in matters of human health, an area in which it had institutional technical support and experience, this was not so in the case of communications concerning animal health and poultry production-related issues, where it had no in-house experience or support. In addition, UNICEF's working model was to seek initial technical input and then to independently develop simple messages to be applied regionally. This approach sometimes created difficulties when the variable local contexts of animal health and poultry production were not fully taken into account. Developing communication for farmers with production and profit issues was not the same as straightforward symptom-and-action-based human health messages. There were periods when FAO's energy and efforts were being expended in realigning mass communications campaigns with the reality of farming systems, and with poultry production in particular. There was often a cultural void between the agencies that had singular communications roles and FAO, which had a broader perspective on the disease control programme and was in closer alignment with government priorities.

While direct donor investment in communications activities has declined over the past six years, FAO's understanding of the role and nuances of communication, and its role in

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HPAI prevention and control and, later, One Health programmes, has grown. In addition, FAO has garnered deep experience in the proper and systematic use of advocacy to meet regional policy and structural goals, such as the Field Epidemiology Training Programme for Veterinarians (FETPV) and One Health. In the future, it will be important that the previous model of communications and advocacy, in which FAO was mined for technical information and subsequently not engaged in the implementation process, is not repeated.

ECTAD set up its communication unit at the FAO headquarters in Rome in June 2007 in response to demands for strategic policy guidance, technical assistance, advocacy, capacity development in animal health communication from member countries, as well the need to mobilize new resources through advocacy and communication. At this time, the goals of communication and advocacy were predominantly institutional and were not directly related to disease control. Also at this time, there were communications officers in seven of the national ECTAD teams; these communications officers were fully engaged in a range of communication and advocacy approaches tailored to suit the national environments in which they worked.

The first version of an institutional communication strategy document, which required more intense interaction at the field level to drive and mentor, would not emerge until 2009, a year after a communications unit was established at ECTAD-RAP. FAO's accumulated insights and analyses into the role of communication in social and behavioural change, informed by technical and ground-level realities in animal and human health sectors, led to the creation in 2011 of a regional communication strategy framework, *One Health: Seeing around corners*. This document also marked FAO's maturity from a variable player in disease control communication to one with significant offerings and influence.

SITUATION IN 2005

UNICEF was the designated recipient of major international financial support for communications activities, and the coordination between FAO and UNICEF was neither smooth nor fully effective. Early on in the regional effort, communications staff were placed in countries in order to get some traction with the key communications programmes required to support the official animal health services in undertaking HPAI control actions, including vaccination, if used. There was virtually no expertise within animal health departments to undertake these critical activities, and the communications area was rapidly filled with INGOs supported directly by donors, who often had no interaction or dialogue with the official animal health service or international technical agencies. While ECTAD-RAP's work across the region has inevitably entailed continuous advocacy at institutional and governmental levels, FAO initially had little presence in the area of strategic communication for social or behavioural change in response to HPAI.

SITUATION IN 2011

ECTAD-RAP has made significant and influential contributions to strengthening the understanding and practice of advocacy and communication across countries in the region, and it is recognized today among agency partners, donors and NGOs as an important and influential partner both in communication and advocacy. As the HPAI programme progressively focuses on EIDs, with emphasis on multisectoral collaboration between human and animal health, FAO's role, expertise and contributions to communication and advocacy have become uniquely relevant, and it is important that this position is underpinned.

Regional perspective

While ECTAD-RAP's communications activities centred mainly on supporting ECTAD country teams in their communication activities on animal health, its involvement also encompassed field missions, helping with the production of country-specific communication and advocacy materials, and supporting the ECTAD country teams through participation in field missions. In addition, ECTAD-RAP engaged with regional initiatives, such as those directed by UNICEF or involving the United Nations System Influenza Coordination (UNSIC).

FAO's communications efforts provided accurate, consistent and timely information to policy-makers, regional and international partners, media, livestock producers and traders, as well as consumers, in order to help them inform the public about the disease situation, raise awareness, promote prevention and control measures and mitigate market shocks when disease outbreaks occurred. Through its understanding of community and individual beliefs and practices, FAO promoted a more effective and focused community-based approach to communication and public awareness.

In collaboration with partners, FAO has conducted knowledge, attitudes and practices (KAP) studies and anthropological research (in Cambodia, Indonesia, Lao PDR, Timor-Leste and Viet Nam) to gain a better understanding of the dynamics of community and individual beliefs and behaviour, and to incorporate this knowledge into communication plans. Studies have also resulted in the development of audiovisual materials, behaviour guidance and advocacy and information documents to ensure better understanding of strategic issues, and to promote FAO's role in the prevention and control of HPAI. Technical assistance as well as capacity development for communication planning have been provided, with emphasis on strengthening capacities and competencies of ministries of agriculture and livestock departments. Since the establishment of the Regional ECTAD Communication Unit, communication strategies have been developed or revised in Cambodia, Indonesia, Lao PDR and Timor-Leste.

Training programmes to develop capacity have been conducted in Bangladesh, Cambodia, Indonesia, Lao PDR, Timor-Leste and Viet Nam. These have included the training of community animal health workers (CAHWs) as grassroots-level communicators; continuing education for animal health officers for community mobilization and awareness raising; community fora that enable community members to increase their knowledge and capacity for decision-making on HPAI prevention; market fora to provide knowledge and influence the behaviour of stakeholders in poultry production and market chains; community biosecurity initiatives to encourage communities to identify and develop biosecurity measures. Training materials such as flip charts, printed materials and animated training DVDs have been developed. Initial analysis of these programmes shows an increase in awareness among audiences and an increase in trust towards animal health workers as the primary sources of information on animal health, husbandry and disease.

ECTAD-RAP has made significant contributions to both communication and advocacy in the Southeast Asia region. The most influential of these is *One Health: Seeing around corners*, the first ever regional strategic communication framework that is driven by One

Health considerations and proposes specific new directions and shifts in communication for social and behavioural change. The document is the result of a collaborative effort which has involved UNICEF, UNSIC and the WHO South-East Asia Regional Office (WHO SEARO), among others.

As a result of specific international support, a Media Fellowship Project entitled The Human Face of Avian Influenza was launched by ECTAD-RAP in Viet Nam and Indonesia in order to bring journalists working in various media outlets into contact with FAO and to improve the technical quality of the media products routinely produced.

Country-level perspective

Countries in the region had no capacity to undertake communications activities or to interact with NGOs and INGOs who were implementing communications programmes. The situation varied from country to country and FAO, because of its close links to the government system, focused on strengthening the capacity of government services to deliver communications programmes, while at the same time delivering communications in areas where there was a perceived gap. Where donors preferred to work through INGOs, FAO established working relationships with these parallel systems, setting up working groups to coordinate and harmonize the programme in cases where a number of other parties were involved. Community awareness activities conducted through these processes have reached tens of thousands of farmers, providing information about risk reduction, HPAI prevention and control measures. Where necessary, FAO has helped by producing in-country materials, including videos, printed materials, and television and radio broadcasts. Some examples of the modalities are outlined below.

Collaboration and coordination

In Cambodia and Lao PDR, where in-country communications operatives were actively involved in field programmes, FAO collaborated and coordinated with WHO, UNICEF, and the NGO that had been designated by USAID to carry out the communication programme – the erstwhile Academy for Educational Development (AED). In both countries, FAO participated in building capacity within the government system to deliver communications and to train key community persons at the next level. FAO also engaged with trusted figures in the community, such as village chiefs and local veterinary workers – CAHWs in Cambodia, veterinary village workers (VVWs) in Lao PDR – and the Lao Women's Union.

In both countries, FAO was an active participant in national-level working groups who coordinated the communications effort; such groups included the National Coordinating Committee on IEC for AHI in Cambodia. As Lao PDR and Cambodia have virtually no commercial poultry sector, and as the disease occurred only sporadically, the challenge was to reach as many communities as possible in higher-risk areas and thus stimulate dialogue about HPAI among villagers. In Cambodia, this involved engaging in specific activities with community fora, and a great deal of effort was expended on building the communications capacity of provincial and district officials, village chiefs and CAHWs. The last two groups in particular were regarded as being uniquely influential with the public. FAO's anthropological study in Cambodia, *Bridging the gap between HPAI awareness and practice in Cambodia*, revealed that high levels of awareness about HPAI did not lead to much change in community attitudes and behaviours towards managing the disease. In Lao PDR there was more participatory training involving provincial officials interacting with village chiefs, VVWs and representatives of the Lao Women's Union.

Participatory approaches

While methods driven by community participation were deployed in Indonesia, there was a particular emphasis on training the official veterinary services in these approaches. In addition, as government capacity to develop technical communication support materials was low, FAO helped to produce these. Participatory approaches have been shown to be effective for developing information, education and communication (IEC) materials, as well as for delivering messages to a range of target audiences. Moreover, the use of these processes has ensured the development of appropriate materials by stakeholder group and by gender. FAO trained a network of 2 500 local animal health workers in basic participatory communications and supplied them with standardized training materials.

Technical support

Initially, FAO supported Viet Nam's animal health service with mass communications related to the vaccination campaign and disease control, including methods such as early reporting and safer practices for poultry production. However, when resources available to FAO for general communication were withdrawn, FAO became a key member of the working group for behaviour change communication. Communications were implemented by UNICEF and carried out by NGOs engaged by UNICEF or USAID; FAO provided technical advice to UNICEF, as the agency had no in-house experience or technical expertise in issues related to farmers, poultry production or animal diseases. FAO's technical input was key to the technical direction and ultimate efficacy of the programme at the smallholder level.

A locally intense communications programme, which formed part of the GETS project, was designed to deal specifically with technical issues at the project level. There were also considerable advocacy inputs from FAO to ensure policy-level support for the project at the level of local administrations. Both inputs were key to the success of the GETS project.

Training materials

In 2006, a significant effort was made to standardize training curricula and to ensure that training materials produced nationally were being properly validated. Across the region, many different training materials were developed quickly for the large training programmes required to increase the technical understanding of both animal health system personnel and key community persons. However, FAO did not have people who were experienced in extension methods, and the training principles being used had not been standardized. An important issue for consideration in the future is the role of government extension services which, although they are very well developed in many countries, have traditionally been used only in the area of agronomy. Animal health services have not always been enthusiastic about using extension services to assist with training, and this may, therefore, have resulted in some inefficiency.

Advocacy

FAO had significant involvement in various international and regional fora to advocate for the need to control HPAI at source. In the early days, there was a bias towards the human health side of the issue, where the focus was chiefly on pandemic preparedness. It was clearly necessary to advocate for an increased focus on the problems confronting poultry producers at all levels. FAO was active in UNSIC, and it provided technical inputs to the Asia Pacific Economic Cooperation (APEC) forum. FAO had a strong technical interaction with ASEAN in promoting better disease control practices through the ASEAN strategy, and it has been a key player in raising critical issues at the level of IMCAPI. FAO has been able to convene ministers of agriculture at the Asia regional level and at the ASEAN level (meeting of ministers of agriculture and forestry) to advocate for HPAI policy proposals.

FAO has worked closely with international partners such as OIE, WHO, UNICEF, UNSIC and WB to develop global and regional plans. A good example of this partnership has been the consensus on the approach to dealing with EIDs, described in the interagency document *Contributing to One World One Health: A Strategic Framework for Reducing Risks of Infectious Diseases at the Human-Animal-Ecosystems Interface* (FAO *et al.,* 2008). Guided by this approach, the global conversation has begun to move away from emergency response against individual diseases towards including more measured and integrated action for the long-term prevention of EIDs.

Annual strategy review meetings provided FAO with influential fora where the organization could advocate for technical changes to national strategies. Within the HPAI control programme in Indonesia, FAO has invested considerable effort in the development and presentation of strategic plans to government and donors, as well as in strengthening links between the government veterinary services and the commercial poultry sector. FAO has successfully engaged with the laboratory system in the OIE/FAO global programme OFFLU to have viruses submitted to reference laboratories for analysis.

ECTAD-RAP coordinated an assessment of existing national legislation relevant to disease control and prevention. This included examining the regulatory frameworks of ten South and Southeast Asian countries, and evaluating the adequacy of practical measures necessary for the prevention, detection, containment and eradication of epidemic diseases of livestock, particularly HPAI. Among the important recommendations presented at the Regional Workshop on Strategic and Legislative Aspects of Controlling Highly Pathogenic Avian Influenza and Emerging Infectious Diseases, held in Bangkok in September 2008, was a recommendation that FAO should coordinate the development of a regional agreement on information sharing about regional and country-level animal health legislation reviews.

As part of the planning processes to support advocacy, the following strategies were developed and used to guide the HPAI programme in the region:

- *A Strategic Framework for HPAI Prevention and Control in Southeast Asia* (May 2006);
- *The Global Strategy for Prevention and Control of H5N1 Highly Pathogenic Avian Influenza* (October 2008);
- *The FAO Regional Strategy for Highly Pathogenic Avian Influenza and other Emerging Infectious Diseases of Animals in Asia and the Pacific, 2009–2014* (July 2009);
- *FAO Regional Strategic Framework for Communication on Highly Pathogenic Avian Influenza and other Emerging Infectious Diseases in Asia and the Pacific, 2009–2015* (September 2009).

OUTPUTS

- FAO provided major inputs to *Contributing to One World One Health: A Strategic Framework for Reducing Risks of Infectious Diseases at the Human-Animal-Ecosystems Interface*, an inter-agency document that has guided the move towards greater intersectoral collaboration between FAO, WHO and OIE.
- Two video films, *Farmers in dialogue* and *Messages from the farm*, were produced. These documented successful practices related to communication, biosecurity and outbreak response.
- A regional communication strategy framework, *One Health: Seeing around corners* was developed and published.
- ECTAD-RAP helped countries in the region to develop first drafts of advocacy action plans to promote One Health in their national settings.
- ECTAD-RAP developed and field-tested a 13-session biosecurity training module which used dialogue-based approaches to increase understanding of the science underlying biosecurity among non-technical, low-literacy audiences.
- Training materials for animal health workers aimed at strengthening their understanding of HPAI, and also aimed at strengthening their capacity for communication with poultry producers at grassroots level, were developed and published.
- TOT materials (flip charts, disease recognition booklets, and information brochures for farmers) for veterinary officers were developed and published.
- FAO instituted media fellowship programmes in Viet Nam and Indonesia; these programmes resulted in the training of nine media practitioners in responsible reporting on HPAI matters and the development of communications resources in both Viet Nam and Indonesia.
- FAO contributed technical oversight to the United Nations Joint Programme (UNJP) on behaviour change communication in Viet Nam.
- Newsletters and bulletins aimed at providing regular information to stakeholders were produced at national level.
- In Indonesia, videos on biosecurity for small-scale broiler and layer farms, backyard chicken production and hobby birds were produced. An animation film on how viruses spread was also produced; the film was aimed at communicating this information to particular target groups.
- In 2008, a film entitled *Viet Nam Experience* was produced in Viet Nam. This was also reproduced for IMCAPI and was well received by the Government of Viet Nam.
- FAO developed a website exclusively about HPAI in Viet Nam.

OUTCOMES

- Effective and robust training of large networks in animal health systems was carried out across the region.
- FAO is now in a strong position to advocate and influence the direction of One Health projects relating to the animal health sector.
- Stronger connections with partners such as WHO and ASEAN have been developed.
- There is now better understanding of the challenges and requirements of communications aimed at raising awareness and behaviour change.

- There is greater understanding of the need for country-level strategies to promote One Health across the region. This has been accomplished through leveraging the growing tripartite collaboration between the human health, animal health and wildlife sectors.

SUCCESSFUL PRACTICES

- The documenting of successful country-level practices in video and in print has been useful for advocacy at national level, and this may also be adapted for use at regional level.
- The use of dialogue-driven participatory processes and tools created understanding and ownership of technical knowledge about infection, transmission, biosecurity and disease prevention among non-technical audiences such as farmers.
- Regular review of plans and strategies, in partnership with stakeholders, has helped to create greater ownership of policy changes and to increase commitment and uptake by national partners.
- Joint training of animal and human health staff helped to build synergy, and also ensured that messages were synchronized and reinforced.
- The engagement of a poultry disease specialist with experience in training and communications at the grassroots level, and also with experience in the evaluation of materials, was instrumental in developing a large body of communications materials, especially in Indonesia.
- In Indonesia, talkback radio was effective, as it addressed local concerns in the local language; questions and comments were analysed in order to gain a better understanding of community concerns.

LESSONS LEARNED

- At times, several players were involved in the communications programmes, each independently developing messages from a narrow technical base without consulting with each other to ensure that messages were strategically harmonized. Messages were sometimes lifted from other sources and recycled without adequate field-testing. This led to a glut of occasionally inappropriate messages conveying unachievable or unrealistic objectives, thus creating confusion for both stakeholders and government partners. In Viet Nam, for example, a review carried out in 2008 found that a large number of different messages were being promulgated by different players. It was necessary to reduce the number of these messages and to align and simplify their content in order to prevent the various problems that were arising.
- There is a clear need for FAO to provide leadership in developing guidelines, tools and processes for interpreting and communicating technical information to non-technical audiences such as the government, and also to some farmers. Without such leadership, the poor understanding of technical issues among the ‘non-technical’ agencies involved in communication becomes the weakest link in the communications effort.
- Communications professionals should weigh a campaign’s potential to promote safe poultry and animal production practices and appropriate consumer behaviour against its potential to create local market and trade disruption by causing panic or fear.

- The complexities of poultry production and marketing chains are only now being addressed in national communication strategies; furthermore, the factors that may motivate communities and producers to adopt safe production practices are still not fully understood as a result of limited analysis of socio-economic/cultural realities. In shaping communications strategies, it is essential that communications professionals incorporate and integrate the knowledge from predictive modelling, socio-economic research, supply chain/market chain analysis, cross-border studies, KAP studies and participatory research, in order to target high-risk audiences strategically with appropriate messages and feasible recommendations.
- The lack of communications capacity within ministries of agriculture and departments of livestock services to respond effectively to HPAI and other EIDs at the beginning of the crisis created significant imbalance in the effort to control the disease and engage communities. Communications capacity needs to be enhanced at these levels.
- Enhanced capacity of national authorities in the surveillance and prevention of disease, together with response to outbreaks of disease, necessitated regular review and revision of national communication strategies and of the communication component of national emergency preparedness plans. This was achieved through a collaborative and coordinated approach involving national and subnational multisectoral authorities, UN agencies, international organizations, donors and other stakeholders; it also included the establishment of formal structures such as national communication committees/working groups.
- The dissemination of coherent messages across different sectors helps to reinforce these messages within communities. It is, therefore, important to establish a cross-sectoral approach at the outset of a campaign, as it is more difficult to do this at a later stage when the different sectors have become set in their way of thinking and in their operational modalities.
- FAO can probably be most effective by maintaining a low profile in communications and by leading ‘from behind’ through processes of collaboration and cooperation – although this proved to be a major problem early on, when working with UNICEF. FAO’s image is that of a technical lead agency, and communications is not seen as either its mandate or its area of strength, especially by USAID. However, the same agency recognizes and funds FAO’s activities in advocacy, thereby acknowledging that FAO is uniquely positioned to lead in this area. FAO’s technical dominance, coupled with its intense activity at the human-animal-ecosystem interface, renders it singularly suited to making valuable inputs in the area of communications.

SUSTAINABILITY

Mass communications that require community engagement need a level of financial support that is unlikely to continue. However, strategic communications and advocacy will continue to be significant components of One Health approaches to problems, and it is important that FAO leverages lessons learned, and develops guidelines and approaches for maximizing the efficacy of communications within a multisectoral and multidisciplinary programme.

ECTAD-RAP's current approach to both communication and advocacy is tending towards regional-level strategies and guidance followed up by national-level initiatives.

At present, considerable animal health communications capacity rests in the hands of individuals and is not institutionalized because, like socio-economics, communications expertise does not have a natural home within animal health services. Reducing the external support resources for animal health services and communications will threaten the progress made to date. Therefore, in order to sustain the communications capacity built within the animal health services, it is necessary to empower these services with communications professionals and to pursue the course of action that they see as technically appropriate to the problem at hand. While this may be done partly through One Health initiatives, it may also be necessary to have a communications network that includes animal health professionals across the region.

THE FUTURE

ECTAD-RAP will continue to work closely with the animal health services of national governments in order to ensure close alignment between the technical directions of disease control programmes and the advocacy needed to bring about policy and regulatory changes to facilitate disease control efforts.

While it is unlikely that FAO will undertake mass communication programmes directly, it will, however, need to take a strong and equal role in helping to develop guidelines, strategic frameworks for communication and advocacy, tools, processes, and overall guidance, both for HPAI and for One Health projects. In order to ensure that communications plays a supporting role as opposed to an independent role in the field, FAO's technical leaders will need to be well versed in communications theory and practice. Building and strengthening this capacity will be a key role for a communications practitioner in RAP.

There is potential for FAO to engage with existing extension services to deliver communications about biosecurity, improved production management practices and general animal health, especially poultry health. It would be advisable, however, to introduce some form of quality control of the extension process, as resident animal health expertise does not, generally, exist within national agricultural extension services.

Lessons learned

POLICY

Legislation that cannot be enforced is usually counterproductive

Unenforceable legislation which goes against the grain of age-old but economically sound trading practices is counterproductive: experience shows that communities and stakeholders will invariably continue with the status quo and will also resist health inspection as well as other assurances of disease-free status. Assessment of regulatory capacity should form part of the development of any policies that require explicit enforcement mechanisms.

One particular example of unenforceable legislation is the Nepalese law banning the direct import of poultry, eggs and other poultry products across the highly porous 800-km border between Nepal and India. The Nepalese law runs counter to economic good sense, as these products are significantly cheaper on the Indian side. Implementation of the law has resulted in effectively turning cross-border trade in the area into a clandestine activity; it has also succeeded in reducing opportunities for authorities to inspect poultry and poultry products imported into Nepal.

COORDINATION

Understanding developmental issues is critical – even in an emergency response

By maintaining a development perspective while working in emergency modality, FAO has helped to transform the scope and perspective of disease control. Specifically, FAO has

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succeeded in widening the focus to include livelihoods and socio-economic factors as well as nutrition and other development aspects. This, in turn, has helped to foster a spirit of professional partnership and collaboration between FAO, donors and governments, based on an acknowledgment of comparative advantages.

SURVEILLANCE

Targeted surveillance needs more work; passive surveillance is unreliable

While targeted surveillance can be useful for detecting the virus in healthy birds, systems for tracing the source of outbreaks are not yet reliable. More effort is required to understand how to monitor virus levels in the population in a way that either helps assess the impact of control measures or provides early warning of a possible upsurge in the level of virus activity.

Passive surveillance can be unreliable, especially when commercial operators conceal outbreaks because the compensation offered is not adequate to fully cover their economic losses. Proxy indicators of disease outbreaks, such as market prices, also need to be monitored so as to detect hidden problems.

EPIDEMIOLOGY

It is important to regularly isolate and characterize viruses

The importance of regularly isolating and characterizing viruses from field outbreaks has been well recognized in Indonesia. The early problem with poor vaccine efficacy in Indonesia was recently rectified by incorporating the virus strain compatible with viruses circulating in the field.

Monitoring and characterizing field virus isolates for changes in behaviour may help signal vaccine failure, or the spread of disease, including new outbreaks. For example, the genetic subgroup of H5N1 clade 2.3.2.1 was able to break through the vaccine used in Viet Nam. The increased susceptibility of wild birds to this genetic subgroup is associated with the spread of the virus to Bangladesh, Bhutan, China, India, Japan, the Republic of Korea, Lao PDR, Myanmar and Nepal.

LABORATORY CAPACITY

The secret recipe for developing capacity is backstopping

Establishing technical working relationships with national laboratory staff and offering backstopping support has been an important feature of the FAO strategy for strengthening laboratory performance and developing viable and active laboratory networks. This has involved visiting laboratories, helping with on-site solutions to problems, liaising with regional organizations, developing standardized approaches for diagnosis, and conducting workshops.

OFFLU has had sustained technical engagement in the region, and this has helped to spread technical advances and strengthen linkages between national laboratories and the global network. The close linkages have also led to improvements in the number of virus samples submitted to international reference laboratories, which in turn has led to a deeper understanding of virus strains in circulation.

Laboratory experts must be made available when needed to help national staff set up equipment, establish diagnostic tests and prepare SOPs. On-site training was greatly facilitated by experts 'in residence' who helped to speedily introduce new technology into laboratory systems. In several countries, a national-level network that linked laboratory scientists to field epidemiologists helped improve the outcomes of diagnostic efforts.

BIOSECURITY

Local solutions work better than imported ones

Given the level of complexity and variation within the commercial poultry industry throughout the region, solutions developed locally through direct engagement with stakeholders have been found to be more effective than those 'imported' from other regions.

In addition, it has been shown that the most effective training and capacity building exercises in C&D practices are those delivered by trainers with practical experience in adult learning methodologies as well as C&D. This has proved more effective than relying on trainers provided by an equipment vendor or other sources.

SOCIO-ECONOMICS

Socio-economics must be integrated into any disease control project in order for it to be effective

Disease control fails, and leads to non-compliance, if it does not take socio-economic factors into account. Stakeholders' reasons for non-compliance should be understood, and economic data should be collected in real time in an integrated way as part of any disease control measures. Interventions should be linked to, or integrated with, the needs of disease control authorities in order to make outputs useful to decision-makers and those who formulate policies.

The response should be proportionate to the risk

Disease control interventions should be assessed for likely animal and public health benefits as well as for potential negative socio-economic impacts. The response adopted should be proportionate to the outcome of the risk-benefit assessment. Overreaching or overreaction may result in distancing stakeholders and building barriers that can take a long time to break down. For example, global concerns about H5N1's pandemic potential were seen as exaggerated by producers whose livelihoods depended on the output from small flocks; this, in turn, led to distrust of communication on this issue.

Compensation should reflect the economic value of poultry

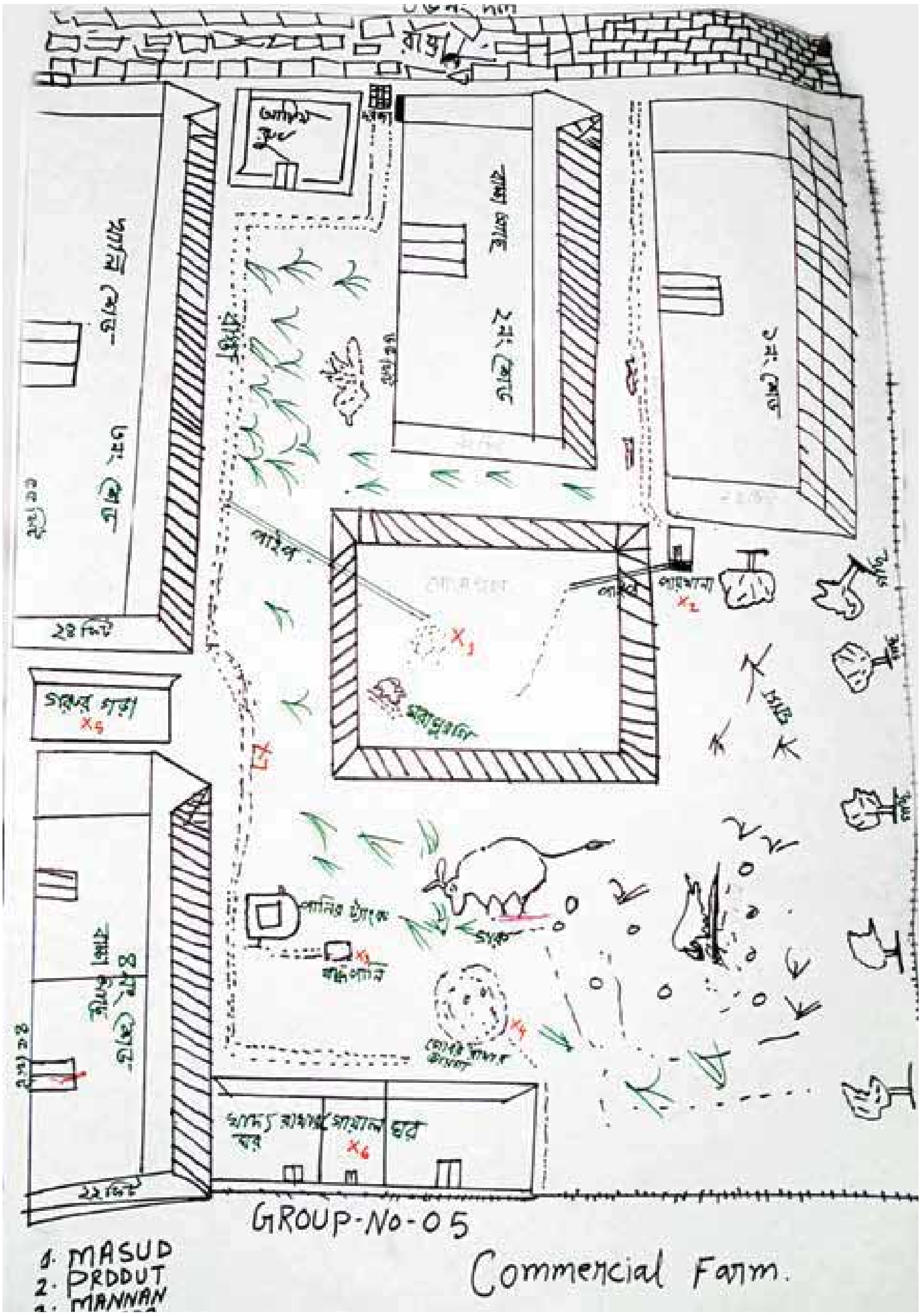
Where culling is used for disease control purposes, compensation for slaughter must reflect the market value of the relevant class of poultry. However, financial resources for compensation schemes are difficult to obtain, and without control practices and the cooperation of stakeholders, compensation alone may not improve control. Incentives for compliance do not always deliver the expected outcomes.

Financial incentives, coupled with financial risk minimization, are key drivers for change. Interventions that deliver such benefits should communicate them effectively and credibly to those who are expected to comply with proposed changes.

COMMUNICATION

Awareness alone does not change behaviours or practices

In general, awareness campaigns have not succeeded in producing behavioural change in communities or traders, who have tended to remain unconvinced about disease-associated risks and have been primarily influenced by economic factors.



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For example, in Nepal, a country where HPAI communication largely failed to bring about behavioural change, messages lost their credibility through overemphasizing the threat of human deaths. In addition, the initial emphasis on the negative aspects of HPAI, rather than on the benefits of adopting hygiene-based measures such as cooking at high temperatures, served to alienate commercial producers, who perceived their livelihoods as being threatened by the messages being communicated to target audiences.

The motivations of communities and producers to adopt safe production practices are still not well understood, due to limited analysis of socio-economic and cultural realities. Communication specialists should compile their knowledge of target audiences through diverse tools including predictive modelling, socio-economic research, supply chain and market chain analyses, cross-border studies, KAP studies and participatory research. Communication campaigns that are based on such a rich understanding are less likely to alienate audiences who are at risk of exposure to highly pathogenic and emerging diseases.

Participatory approaches work better

Participatory approaches, such as those used in the FETPV and PDSR programme in Indonesia, have demonstrated that outcomes improve when relationships are established with communities.

Field veterinarians have participated in surveillance and outbreak control activities but they need to be trained in basic epidemiology and the proper collection, storage and submission of samples. In the case of the PDSR programme, there was an increase in passive surveillance and self-reporting in locations where communities were involved in a participatory process.

Establish cross-sectoral collaboration at an early stage

Coherent messages across sectors reinforce these messages within the community. It is important to establish a cross-sectoral approach at the beginning of a project, as it is more difficult to do this once the affected sectors have become set in their thinking and in their operational modalities.

Building government capacity is key

The lack of communication capacity within ministries of agriculture and government livestock services departments to respond effectively to HPAI at the beginning of a crisis creates significant imbalance in efforts to control the disease and engage communities. Communication capacity needs to be enhanced at these levels.

From a disease control and prevention perspective, different government departments should be equally competent in communication, with open access to intersectoral communication maintained at all times.

In addition, building commercial poultry health competency within local government veterinary services is essential in order to ensure improved communication and trust between local government officials and commercial poultry farmers.

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Over the last 3-4 years FAO's role and priority has evolved from a predominantly emergency response to long term capacity building to improve surveillance, early detection and response in HPAI-infected and at-risk countries. FAO has also broadened its HPAI programme to include other EIDs and adopted a One Health approach to promote greater multisectoral and multidisciplinary participation. This transition provides an opportunity to reflect on the work done so far in HPAI control in the Asia region, and identify achievements, success stories, challenges, lessons learned and impact. This document represents the outcome of this exercise and provides in one place the knowledge, insights and recommendations of experts with first-hand knowledge and over eight years of experience in dealing with H5N1 HPAI in Asia.

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