FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
POULTRY DEVELOPMENT REVIEW

Poultry health and disease control in developing countries

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INTRODUCTION

In the last half century, significant increases in the productivity of modern poultry stocks have been achieved for both the meat and the egg production sectors of the global poultry industry. Synergies have resulted from advances made in all the major activities of poultry management and housing, nutrition and ration formulation, applying poultry genetics knowledge in commercial breeding programmes and better diagnosis and control of avian diseases. Of all these core elements, poultry health and disease can be the least predictable.

Although poultry diseases from nutritional and metabolic causes can be of concern, the emphasis in this information note is on controlling diseases that are caused by infectious agents, which can exert damaging – and sometimes immediate – negative effects on the profitability of commercial operations. The development of an intensive poultry industry in many of the countries discussed here depends on the growth in number and size of small and medium-sized commercial poultry operations. The emphasis in this review is therefore primarily on optimizing poultry health for this scale of operations. Because of the importance of small-scale village-based production units in many developing countries, however, the poultry health implications for and from such flocks are also included.

POULTRY DISEASES: PATHOGENS AND THEIR COSTS TO PRODUCTION SYSTEMS

- *Pathogens are* disease-causing microorganisms, and include various bacteria, viruses and protozoa.
- *A specific pathogen* is a microbe that is able to cause a specific disease following inoculation of a susceptible host chicken with a purified culture. For example, avian health research has shown that ILT virus is the sole cause of the poultry respiratory disease syndrome recognized in the field as infectious laryngotracheitis (ILT), while the bacterium *Pasteurella multocida* is the specific cause of another respiratory disease known as subacute fowl cholera.
- "Although the relative importance of poultry diseases may differ between countries and geographical areas, there are few important diseases that are unique to particular parts of the world" (Biggs, 1982).
- At the global level, however, differences in distribution among regions are now apparent, because genetic variants have emerged within some of the major specific pathogens of chickens. This has become important for attempts to prevent the spread of virulent strains through international movements of poultry products. Table 1 shows the regional distribution of different biotypes of some important pathogens in 2008. ***Inter-regional variation in the distribution of pathogen strains of higher virulence will become more significant in trade, as the poultry industries of developing countries enter export markets.***

Avian pathogens in the future

Emerging pathogens are those for which recognition continues to occur over time (see Information Note on Emerging Pathogens of Poultry Diseases). These pathogens arise through various genetic

TABLE 1

Regional distribution of higher-virulence strains of major poultry pathogens in 2008

Pathogen	Africa	Asia	SE Asia	Australasia	Europe	Near East	Americas	
							North	South
Avian leucosis virus (ALV)-J (see Information note 1)	+	+	+	-	-	+	-	+
Avian influenza (HPAI) (high pathogenicity)	+	+	+	-	-/+	+	-	+
Infectious bursal disease virus (IBDV)								
vv strains	+	+	+	-	+	+	-	+
variant strains	+	+	+	-	-	+	+	+
Newcastle disease virus (NDV) high virulence	+	+	+	-	+	+	-	+
Ornithobacterium rhinotracheale (ORT)	+?	+	+	-	+	+	+	+
Salmonella enteriditis PT4	+?	+	+	-	+	+	-?	+
Turkey rhinotracheitis (TRT) virus	+	+	+	-	+	+	+	+

Source: Bagust, 2008, Avian Health Online™.

mechanisms, including mutation, recombination or co-evolution with vaccines (e.g., Marek's disease virus) or the medications used (e.g., coccidiostats). ***There is a very high probability that several new poultry pathogens will emerge during the next ten to 20 years.*** The most likely candidates are pathogenic variants of avian ribonucleic acid (RNA) viruses, specifically those causing infectious bronchitis, Newcastle disease, infectious bursal disease and avian influenza, as well as a hypervirulent form of Marek's disease caused by an avian DNA (herpes) virus, which is arguably the most challenging disease to control in intensive poultry industries worldwide.

Developed poultry industries are characterized by on-site biosecurity programmes, which are designed to prevent or minimize incursions by known infectious diseases. These programmes are supported by close veterinary and laboratory surveillance for poultry health. A newly emergent disease can therefore most likely be recognized quickly in any developed poultry industry. ***However, in countries where poultry production sites still lack adequate biosecurity programmes and access to competent veterinary services with laboratory backup, the economic consequences and time needed to identify, control and resolve the problem are much greater.*** The danger is that one or more emerging pathogens become established within a country's poultry populations and then continue to pose a threat as an endemic infection.

The costs of diseases within a country's poultry industry

Using figures from the United States, Biggs (1982) reported that the total economic costs of disease (including vaccines and condemnations) were about 20 percent of the gross value of production (GVP) and about three times the cost of losses from mortality. An analogous 2007 analysis conducted by the University of Georgia, United States, calculated that the GVP of the United States poultry industry in 2005 was US$28.2 billion, and disease losses were 8.2 percent of this. Both studies showed that for each US$1 000 loss due to mortalities, another US$2 000 is lost elsewhere owing to depressed productivity resulting from disease.

There is little information on the economic consequences of poultry diseases in developing counties. Hence one of the future challenges for these industries will be to organize the health infrastructure needed to conduct such analysis. Another will be to move from using frank mortality rates as an economic indicator of losses, to accounting for and then countering the high losses of productivity that result from health-related sub-optimal production.

Infrastructural capacity to diagnose the main causes of disease losses accurately will therefore prove necessary for countries seeking to develop a sustainable poultry industry.

POULTRY PATHOGENS AND THEIR MAJOR MEANS OF TRANSMISSION AMONG POULTRY PRODUCTION SITES

Table 2 lists 25 of the major infectious poultry diseases worldwide. Based on World Organisation for Animal Health listings (OIE, 2000), these are recognized globally as the diseases of most concern, because of their economic effects on commercial poultry production and their potential for negative effects on trade.

The diseases that are of the highest risk of accidental introduction into farms are denoted by ». These pathogens possess inherent properties of high transmissibility, and have enhanced resistance to inactivation (loss of infectivity) due to environmental temperature and sunlight. Such pathogens therefore tend to occur more frequently on poultry sites. Table 2 summarizes the major route(s) of transmission for each of the major pathogens. Knowing the means of spread of any pathogen is fundamental to the development of a plan of action to prevent spread of the pathogen and outbreak of the disease within a production site.

The poultry diseases listed in Table 2 are those likely to be caused by a single specific pathogen. Competent avian veterinarians and the technical personnel who undertake poultry health servicing for farmers in a modern poultry industry must be able to identify or at least suspect these diseases in their classical or relatively uncomplicated forms.

Further disease effects

Respiratory disease complex: Under field conditions, pathogens often interact with not only the host (bird) and its environment, but also one another. For example, day-old chicks arriving infected from the hatchery (vertical transmission) and remaining chronically infected for life are susceptible to other respiratory diseases such as infectious bronchitis or Newcastle disease. Fine dust particles in the poultry house air can then combine with superinfection by *Escherichia coli* bacteria contribute to additional respiratory insults, which will produce the (multiple) lesions that are seen at autopsy for *complex respiratory disease*. Field disease interactions often also involve common immunosuppressive agents, such as infectious bursal disease, Marek's disease or chicken infectious anaemia viruses. These increase the complexity of the disease pictures clinically and the lesions observable at autopsy.

Immunosuppression significantly decreases the ability of young poultry to respond effectively to standard vaccinations, and also predisposes them to infection by other specific pathogens. However, sub-clinical immunosuppression is often not readily apparent to the farmer, and therefore a common "silent" cause of significant economic losses. Pathogens causing such infectious disease conditions are termed "erosive" for site productivity (Shane, 2004). In contrast, major pathogens with high death rates and rapid spread such as NDV, IBDV or HPAI, although generically termed "catastrophic" diseases, cause lower economic losses in the longer term than the lower-level but more pervasive and widespread erosive pathogens do. Immunosuppression results from a range of known infectious and non-infectious causes, as shown in Table 3.

To diagnose the cause(s), competent autopsies combined with systematic on-site investigations of flock production, vaccination history and management practices need to be undertaken. However, results from laboratory examinations will often be needed to confirm a diagnosis. The Information Note on "Poultry Disease Diagnosis: Field Skills and Laboratory Procedures" gives further details.

In the context of poultry health and disease control, ***the government of a country that aims to develop a sustainable modern poultry industry MUST THEREFORE also put in place competent field and veterinary laboratory capacity for the diagnosis of poultry diseases.*** There is a strong need

TABLE 2

Infectious poultry diseases, pathogens and their routes of transmission among production sites

Poultry disease	Agent	Main signs and lesions produced in diseases in the field	Major route of spread		
			Faeco-oral (and contact)	Aerosols (and contact)	Eggs
Avian mycoplasmosis	Bacterium	Respiratory disease, air-sacculitis (*M. gallisepticum*) lameness, joint lesions, *M. synoviae*		+	+
Fowl cholera »	Bacterium	Acute form – septicaemia Chronic infections are associated with respiratory and head lesions	+ (wild birds and vermin)	+	
Highly pathogenic avian influenza	Virus #	Respiratory disease and high levels of deaths: HPAI H5N1 human deaths		+	
Infectious bronchitis »	Virus	Respiratory and kidney disease, egg production drops		+	
Infectious larnygotracheitis	Virus	Respiratory disease (varying severities) and conjunctivitis		+	
Newcastle disease	Virus #	Respiratory and nervous system disease: conjunctivitis (humans)		+	
Turkey rhinotracheitis	Virus	Swollen head, egg production drops, pneumonitis		+	
Infectious bursal disease »	Virus	Illness and losses especially 3–5 weeks old, with immunosuppression related diseases e.g. poor growth, necrosis of wingtips, inclusion body hepatitis	+		
Avian leukosis and reticuloendotheliosis	Virus	Tumours stunted chickens, tumours			+ +
Mareks disease »	Virus	Paralysis of legs and/or wings, tumours viscera, skin, nerves, eyes		+ contaminated dander and feathers	
Fowl typhoid Pullorum disease	Bacterium Bacterium	Watery diarrhoea, bronze livers Sick chicks, ovary disease in adults	+ +		+ +
Poultry enteritis complex » (turkeys)	Virus (mixed)	Spiking mortalities, diarrhoea, weight loss and depression 1–4 weeks old	+		
Avian adeno Gp1 »	Virus	Inclusion body hepatitis broilers	+		+
Avian adeno Gp3	Virus	Egg drop syndrome in layers	Contact with ducks		+
Avian reovirus	Virus	Lameness, tendosynovitis	+		+
Avian chlamydiosis	Bacterium #	Infections of the spleen, liver and airsacs. Humans – precautions at autopsy!	+ Contaminated dust/aerosol		+
Campylobacter infection »	Bacterium #	Infections but not disease in chickens, Poultry meat serious source for humans	+		+
Paratyphoid Salmonella »	Bacterium #	Enteric infections in chickens and humans	+		+
END OF LISTING OF DISEASES OF TRADE CONCERN (OIE 2000)					
Avian encephalomyelitis »	Virus	Epidemic tremours in chicks, egg production drops in layers		++	
Chick infectious anaemia »	Virus	Anaemia and ill-thrift, then diseases of complex aetiology (causes) which are predisposed to by CIAV immunosuppression		++	
Infectious coryza	Bacterium	Nasal and ocular discharge, facial swelling, drops in egg production	+ (and spread via drinking)		
Fowlpox	Virus	Cutaneous lesions (dry) and wet forms	Transmission by mosquitoes		
Coccidiosis »	Eimeria	Dysentery, soft mucoid faeces. Blood in specific intestinal areas (7 chicken spp.)		+	

» Specific pathogens that are of highest risk of accidental introduction into farms.
Zoonotic poultry pathogen.

TABLE 3

Common causes of immunosuppression in poultry production

Infectious	Non-infectious
Infectious bursal disease	Stress
Marek's disease virus	Poor nutrition
Coccidiosis *E. coli* bacteria	Mycotoxins, e.g. aflatoxins Ammonia
Newcastle disease virus	Dust
Chicken infectious anaemia virus	Improper use of antibiotics
Fowl cholera *Pasteurella multocida*	Vitamin deficiency, e.g. A, C, E

Source: Horrox, 2000.

for close collaboration between the public and private sectors in achieving this important goal.

SITE BIOSECURITY: THE PRIMARY KEY TO POULTRY DISEASES CONTROL AND PREVENTION IN COMMERCIAL PRACTICE

Avian pathogens, which comprise disease-causing bacteria, viruses and protozoan parasites, do not recognize national boundaries, only production sites and their disease control circumstances.

The most important measure for sustainable and profitable production on a poultry site is therefore to have forward defences in place – i.e., a biosecurity programme whose components (see

Information Note on "Site Biosecurity and Supporting Strategies for Disease Control and Prevention") work together to *reduce the risk of introduction of poultry pathogens* into a production site. For further and pathogen-specific protection measures, the farmer will also need to have correctly applied vaccination programmes for the dangerous (catastrophic) poultry pathogens that are known to be active in that region, such as Newcastle disease virus and virulent infectious bursal disease virus strains. Through this, disease outbreaks can largely be prevented, even if such pathogens gain entry to the site. A second tier of vaccinations – such as against some major immunosuppressive and respiratory disease agents (profit-erosive) – is also highly desirable. For poultry disease control, the most common problem on sites in many developing countries is their overreliance on vaccinations, rather than investing to achieve effective site biosecurity. The primary approach to poultry health on a production site should be to attempt to EXCLUDE diseases, rather than allowing relatively ready entry of a pathogen to flocks and then attempting to reduce its effects by immunoprotection, i.e., vaccination.

POULTRY HEALTH: NETWORK BUILDING IN A DEVELOPING COUNTRY.

Why should a network approach be taken to poultry health?

Because the real challenge for a developing country is to build sustainable poultry disease control systems that can focus and integrate their available professional poultry health resources. Although personal and political networks are often strong, professional health networking and the sense that industry personnel are working with the government sector to achieve common agreed aims can be much less evident. Fragmentation and duplication of resources and services, along with disagreements as to which (and how) areas of weakness must be strengthened, can mean that little real improvement of overall poultry health is achieved.

A distinguishing feature of the poultry health services in developed countries is the regular exchange of information among industry veterinarians (although their companies will be commercial competitors), government health services (laboratory and field) and often the universities in a region. Such communication and cooperation occur regularly, for example, quarterly within a soundly developed industry, because it is recognized that the mutual benefits of communicating about poultry health matters far outweigh the collective losses from silence.

How can the government agencies of a developing country position themselves to accelerate the development of a poultry industry?

Experiences gained in developed poultry industries worldwide have demonstrated that investing State resources in a ***central poultry health facility/unit with designated functions*** can provide an integrated special-purpose vehicle for delivering avian health-in-production services, as illustrated in Figure 1.

Government agencies and all industry stakeholders stand to benefit. ***Interaction between government and industry representatives is therefore essential for successful*** design and planning, and also later, when periodically reviewing the unit's performance in health and disease control. Industry might well contribute to financing this, for example, by providing funding for major pieces of laboratory equipment or other infrastructure that it expects will provide high benefit to itself. However, the guiding principle must be to achieve focused and integrated health functions for the unit to produce the health outputs needed to support sustainable poultry production in the developing country concerned. Avian veterinarians should also have pivotal roles in the poultry industry, through protecting both poultry and human health (see Information Note on "Veterinary Roles in Health and Knowledge Transfer across a Poultry Industry").

The primary thrust for senior government personnel, in partnership with industry, should be the planning of human resources to strengthen laboratory and extension skills for integrated activities that can deliver appropriate health services across the four sectors of the country's poultry industry. Proof of success will be visible evidence of the private sector choosing to use government services.

Investment in the construction of large purpose-built buildings or a stand-alone new facility should not be seen as the primary aim of this exercise. However, some low-cost special-purpose additions to an existing laboratory may significantly enhance the functional capacity of that unit. Examples could include the strengthening of microbiological health surveillance, or a simple building for secure maintenance of a small specified pathogen-free (SPF) poultry flock. Production of SPF eggs and chickens can then enhance local investigations, including with experimental reproduction of field diseases.

The overriding goal for the central poultry services unit is to be accessible and cost-effective for the veterinary and technical personnel who service commercial poultry production operations, particularly small and medium-sized farming enterprises. The modus operandum should be fee-for-service.

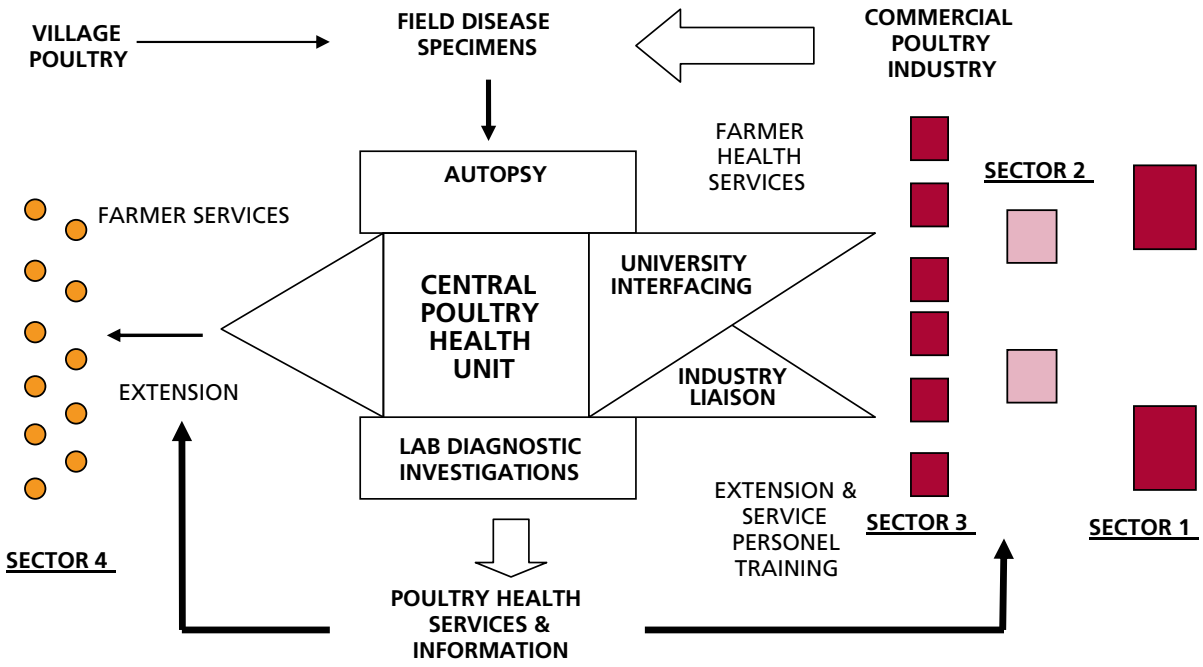
There will however be a clear responsibility for the services provider to direct and develop its staff resources adequately, to ensure that the services offered are relevant to the needs of the developing industry. The interfacing of industry and government poultry health production activities can then help to drive both (Bagust, 1999; Information Note on "Veterinary Roles in Health and Knowledge Transfer across a Poultry Industry"). For developing countries, there is another interesting development prospect: if government laboratory-based services are of sufficient quality, the large-scale intensive industrial operators (Sector 1 in Figure 1) may choose to pay for using those services. This scenario is not a fantasy – in Viet Nam some industrial poultry companies have been submitting samples to a government regional diagnostic laboratory on a fee-for-service basis, thereby gaining access to the expertise of government staff in enzyme-linked immunosorbent assay (ELISA) serological testing.

When quality services are achieved, additional benefits will begin to flow at the national level.

First, the central poultry unit will provide a natural focus for poultry health planning by industry and government, through its functioning in laboratory services, disease intelligence and field extension-outreach. Second, it can also act as a viable interface for health intelligence between commercial industry sectors (Sectors 1, 2 and part of 3 in Figure 1) that have the commercial imperative and economic means to minimize the risk of disease introduction, and the village (family) poultry sector (Sector 4 in Figure 1), which is often viewed as an important reservoir of path-

FIGURE 1

Delivery of the health services needed for support of poultry industry growth in a developing country



ogens of risk to commercial sectors. Although village-based poultry are clearly quite separate from commercial enterprises, it will be vital to include this sector in health services and surveillance. Family-based village poultry production is currently undertaken by a majority of families in rural regions in many developing countries, and contributes very significantly to poverty alleviation and food security.

REFERENCES

Bagust, T.J. 1998. Profitable (village) family poultry production – an achievable development vision or a mirage? *Proceedings of the Fourth Asia Pacific Poultry Health Conference*, Melbourne, Australia, November 1998, pp. 43–48. Australian Veterinary Poultry Association.

Bagust, T.J. 1999. Poultry health research and education in China for sustainable and profitable production Y2000+. *Proceedings of the First International Conference on Veterinary Poultry:* Beijing, 28–30 July 1999, pp. 61–69. Chinese Animal Husbandry and Veterinary Science Association.

Biggs, P.M. 1982. The world of poultry disease. *Avian Pathology*, 11: 281–300.

Horrox, N. 2000.Countering immunosuppression. *International Poultry Production*, 8(8): 8–12.

OIE. 2000. Diseases of poultry: world trade and public health implications (monograph). *Revue Scientifique et Technique*, 19: 343–665. Paris, OIE.

Payne, L.N. 2001. Avian leukosis virus – new mutations: A threat for the upcoming century. *World's Poultry Science Journal*, 57: 265–274.

Shane, S. 2004. Global poultry diseases update – avian influenza overshadowing erosive diseases. *World Poultry*, 21: 22–23.

RECOMMENDED TEXT

For a sound overview of poultry diseases in the field, their causes and diagnosis:

Pattison, M., McMullin, P.F., Bradbury, J.M. & Alexander, D.J., eds. 2008. *Poultry diseases*, sixth edition. Philadelphia, Pennsylvania, USA, Saunders Elsevier. 611 pp. ISBN: 978-0-7020-2862-5.