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ANIMAL HEALTH **RISK ANALYSIS**

ASSESSMENT No. **4**

CHINESE-ORIGIN H7N9 AVIAN INFLUENZA SPREAD IN POULTRY AND HUMAN EXPOSURE

Qualitative risk assessment update

The current risk assessment concerns Chinese-origin H7N9 avian influenza, both low and highly pathogenic strains and covers the period January to May 2018. The document only presents new information available since the last risk assessment published in ***July 2017****.*

SUMMARY

- The likelihood of the Chinese-origin H7N9 virus spreading[1] from affected areas to other areas of China during the period January to May 2018 through:
  - Formal or informal live bird trade can be considered as moderate for juvenile and adult chickens and low for day-old chicks and other poultry (ducks, geese, quail), both with medium uncertainty.
  - Formal or informal trade in poultry products can be considered as low for frozen chicken carcasses or meat and feathers and negligible for eggs, both with low uncertainty.
  - Fomites can be considered as moderate with medium uncertainty, depending on the awareness of farm visitors and travellers, cleaning and disinfection standards as well as biosecurity measures in place.
  - Movements of wild birds (migratory or nomadic[2]) can be considered as negligible with medium uncertainty.
- The likelihood of the Chinese-origin H7N9 virus spreading from known affected areas of China to unaffected countries of South[3] and South-east[4] Asia from January to May 2018 through:
  - Live bird trade can be considered as:
    - Moderate with medium uncertainty for the Lao People's Democratic Republic through informal or formal trade, depending on measures in place.
    - Moderate with medium uncertainty through informal trade in Viet Nam and Myanmar, but negligible via formal trade, given there are trade bans in place.
    - Low with medium uncertainty for other countries of South-east Asia (e.g. Thailand and Cambodia) through informal or formal trade, depending on measures in place.
    - Negligible for countries of South Asia (e.g. Nepal and India).
  - Trade in poultry products can be considered as low with medium uncertainty, regardless of virus survival in those products.
  - Fomites can be considered as:
    Moderate with medium uncertainty for Viet Nam, the Lao People's Democratic Republic and Myanmar due to informal trade with China.
    Negligible with medium uncertainty for other countries of South and South-east Asia (e.g. India, Cambodia and Indonesia).
  - Movements of migratory or nomadic wild birds from January to May 2018 can be considered as negligible with low uncertainty.
- The likelihood of the Chinese-origin H7N9 virus spreading from known affected areas of China to unaffected countries

[1] The likelihood of spread, risk questions 1, 2 and 3, is assessed on the basis of the likelihood of introduction or reintroduction of the pathogen into an area or country and the likelihood of that pathogen encountering poultry in the production system of an area or country (exposure).

[2] Nomadic birds are species with no fixed territory that move according to weather and food availability.

[3] Mainland South Asia comprises Afghanistan, Bangladesh, Bhutan, India, Nepal and Pakistan. Maritime South Asia comprises Maldives and Sri Lanka..

[4] Mainland South-east Asia comprises Cambodia, the Lao People's Democratic Republic, Myanmar, Thailand, Viet Nam and West Malaysia. Maritime South-east Asia comprises Brunei, Christmas Island, Cocos (Keeling Islands), East Malaysia, East Timor, Indonesia, the Philippines and Singapore.

beyond South and South-east Asia from January to May 2018 through:
- Global trade in poultry and related products, and travellers is still considered to be negligible with low uncertainty, although the virus may occasionally be found in smuggled poultry meat.
- Migratory wild bird movements is still considered negligible with medium uncertainty for Japan, Mongolia, the Republic of Korea and the Russian Federation and negligible with low uncertainty for other countries.

■ The likelihood of a human being exposed[5] to the Chinese-origin influenza A(H7N9) virus through contact with live birds or live bird market (LBM) visits within affected areas of China from January to May 2018 is currently considered as:
- Moderate with medium uncertainty during the high-risk influenza season where there is usually a higher activity of the H7N9 virus, lower temperatures that favour virus survival in the environment and the local festivals, in particular the Lunar New Year;[6]
- However, the likelihood is expected to decrease and become low to moderate, with moderate for occupational exposure and medium uncertainty towards the end of the "influenza season" in the northern hemisphere (the end of April 2018) when temperatures rise.

The likelihood of human exposure depends, among other factors, on the extent of infection in farms and whether infected birds are sent to market. Although opportunities for human exposure remain, the number of human cases is expected to be much lower for January to May 2018 than in corresponding periods of previous years due to a decreased proportion of infectious birds and lower environmental contamination levels in LBMs.

FAO commends the Ministry of Agriculture of China (MoA) and the poultry industry for implementing the vaccination programme as an important measure to safeguard human health and promote safer poultry trade. By achieving very high coverage nationwide with a well-matched vaccine, it is expected that shedding of virus and contamination levels in markets will decrease. Findings so far, including the small number of positive findings in markets and human cases during this wave, suggest this has occurred. FAO also acknowledges the efforts of the millions of poultry producers who are complying with this initiative and contributing to the programme. The H7N9 virus will not be eliminated – at least in the short term, as we have also seen for H5 HPAI viruses. Vaccination will reduce the prevalence of infection in poultry and human disease. But it is important to recognize the scientific evidence that the virus is still present in affected areas of China. Some trade in infected poultry will continue, exposing humans to it, especially during the high-risk season around the Lunar New Year.

Therefore we need to continue reminding all those involved in poultry-keeping, marketing, butchering etc., to maintain their efforts to improve biosecurity practices and personal protection measures.

FAO also recommends that veterinary and customs services in neighbouring countries remain aware of the potential introduction of infected poultry or contaminated poultry products.

[5] This risk question addresses the likelihood of a person being exposed to the virus. It is important to bear in mind that exposure does not necessarily result in human infection or disease.

[6] In China, Lunar New Year's Day refers to the Chinese New Year and in Viet Nam to the Têt Festival. Both took place on 16 February 2018, within the assessment period.

BACKGROUND

China has reported several avian influenza virus strains, mostly belonging to the H5, H7 or H9 subtypes and often causing outbreaks either in poultry and/or humans. Since its first detection in March 2013, almost every administrative region of China has reported H7N9 low pathogenic avian influenza (LPAI) virus, with around 3 000 positive virological samples collected from poultry or LBM environments and more than 1 600 human case reports. The fifth wave from October 2016 to September 2017 was the most severe thus far in terms of geographical spread of the virus and the number of human cases and high-mortality poultry outbreaks caused by the highly pathogenic (HP) strain that evolved during this wave. In an attempt to limit the spread of both low and highly pathogenic H7N9 strains, in July 2017 the Chinese government piloted bivalent poultry vaccination against H5 and H7 subtypes in Guangdong and Guangxi provinces. This bivalent inactivated vaccine, produced using reverse genetics, offers protective immunity in poultry against recent H7N9 and Clade 2.3.4.4 H5Nx viruses. The pilot campaign was therefore followed by the launch of a national vaccination programme in early September 2017, targeting all poultry on mainland China.

Even though at this stage it is difficult to assess the effectiveness of the vaccination programme at field-level, detections of H7N9 in poultry seem to be decreasing compared to previous waves and, as a result of reduced virus circulation, it appears there are fewer reports of human cases. However, festivals at the beginning of 2018 (in particular the Lunar New Year in mid-February) increased demand and movements of live poultry and poultry-related products, potentially increasing the risk of the virus spreading; since H7N9 is still circulating in some areas of China. FAO therefore reassessed the risk of the potential spread of H7N9, both low pathogenic and highly pathogenic strains, within China and on to other countries in South-east Asia and beyond from January to May 2018, as well as human exposure in affected areas of China.

Risk questions 1 to 3 below were modified slightly compared to the previous assessment published in July 2017 so as to fit with the recent geographical expansion of H7N9 during the fifth wave, affecting almost all of mainland China. This current assessment considers several pathways for virus incursion, such as movement of live poultry, poultry products via formal and informal trade and movement of migratory and nomadic wild birds.

FIGURE 1. *H7N9 low and highly pathogenic viruses confirmed in human cases or samples from birds or live bird market environments since the beginning of wave 6 (1 October 2017)*

ASSESSMENT

Main risk questions

The risk questions guiding this assessment are:

1. What is the likelihood of the Chinese-origin H7N9 virus spreading from affected areas to other areas of China from January to May 2018 through formal or informal trade in poultry or their products, fomites or wild birds?
2. What is the likelihood of the Chinese-origin H7N9 virus spreading from known affected areas of China to unaffected countries of South and South-east Asia from January to May 2018 through formal or informal trade in poultry or poultry products, fomites or wild birds?
3. What is the likelihood of the Chinese-origin H7N9 virus spreading from known affected areas of China to unaffected countries beyond South and South-east Asia during the period January to May 2018 through global trade in poultry and related products and the movement of travellers or wild birds?
4. What is the likelihood of a human being exposed to the Chinese-origin influenza A(H7N9) virus through contact with live birds or during LBM visits in affected areas of China from January to May 2018?

Methodology for qualitative risk assessment and uncertainties

The risk assessment defined the likelihood of spread exposure from highest to lowest levels as follows: high (highly likely to occur); moderate (potentially occurring); low (unlikely to occur); and negligible (extremely unlikely to occur). The likelihood of spread in Questions 1, 2 and 3 refers to the likelihood of introduction or reintroduction of the pathogen into a particular area or country and the likelihood of exposure of poultry to that pathogen in their production system. Question 4 addresses the likelihood of a human, in contact with live poultry or visiting LBMs, being exposed to the H7N9 virus, bearing in mind that exposure does not necessarily result in human infection or disease. The evidence used to answer each question of the risk assessment is in the Considerations section. Given the limited availability of surveillance data and studies on H7N9 HPAI and LPAI at the time of the assessment, some considerations are based on assumption. The assessment has added levels of uncertainty, low, medium and high, to reflect this.

- High uncertainty (H): lack of data, limited data, or lack of conclusive data; weak correlation or crude speculation;
- Medium uncertainty (M): small sample, fair correlation/ good fit; reliable method;
- Low uncertainty (L): large sample set; known fact, event known to occur, or exact measure.

CONSIDERATIONS

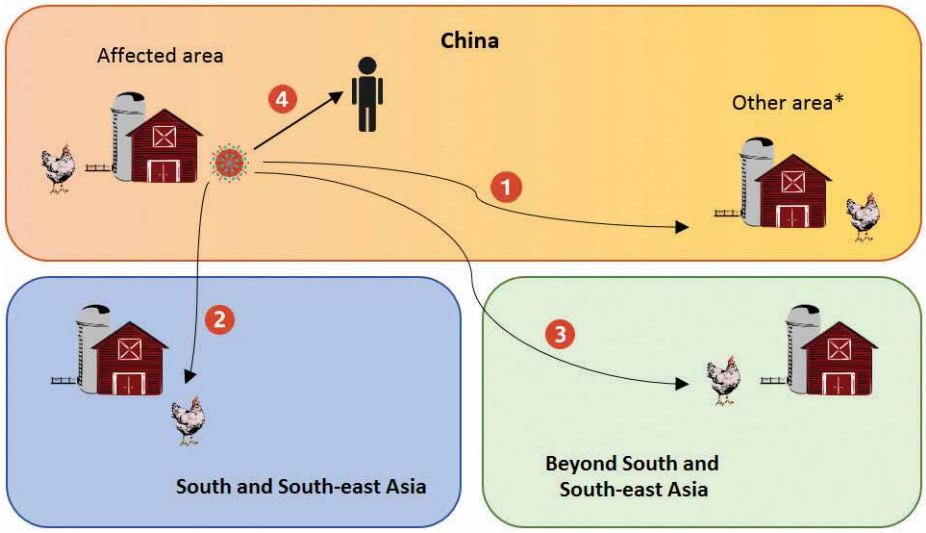
1. What is the likelihood of the Chinese-origin H7N9 virus spreading from affected areas to other areas of China from January to May 2018 through:

1.1. Live poultry trade:

This section considers:

- Evidence presented in the July 2017 assessment.

FIGURE 2. *Main risk questions addressed by the qualitative risk assessment*



Note: Other areas include those that have not reported any human case or animal/environmental findings since the beginning of wave 6 (1 October 2017).

TABLE 1 *Post-vaccination monitoring results for November and December 2017 (MoA, 2017b; MoA, 2017c)*

2017	Total number of samples collected from birds	Average PVM immunization rate (target 70%)	Range of post-vaccination immunization rate
November	167 059*	88.01%	15.24% (Yunnan Province) to 96.02% (Shandong Province)
December	216 186*	86.34%	55.17% (Xinjiang Autonomous Region) to 94.77% (Shandong Province)

* Sampling varied from 70 to 16 763 in November 2017 and from 580 to 30 671 in December 2017 depending on the province/administrative region/municipality. In certain areas, results are pending or no samples were collected (e.g. Tibet Autonomous Region).

- The Ministry of Agriculture of China (MoA) has implemented a nationwide vaccination programme[7] against H5 and H7 subtypes targeting all poultry on mainland China including chickens, ducks, geese, quail, pigeons and rare birds in captivity. The vaccination programme is mandatory in every province. However, for poultry raised in an avian influenza (AI) free zone or for export purposes, permission not to vaccinate can be requested from provincial veterinary authorities (FAO China [FAOCN], 2017- personal communication; MoA, 2017a).
- Broiler chickens are vaccinated once at 10-14 days and receive a booster if their growth period exceeds 70 days. For example, yellow-feathered broilers, which are the dominant broiler breed in southern China (Guangdong Province, Hong Kong SAR), have a production cycle of approximately 120 days and are usually vaccinated twice at 20-30 day intervals (FAOCN, 2017; FAORAP, 2017 - personal communication).
- Compulsory poultry vaccines against H5 and H7 are free of charge and village vets or veterinarians working for private companies mainly administer the vaccine (FAOCN, 2017; Regional Office for Asia and the Pacific [FAORAP], 2017 - personal communication).
- Movement of live poultry within China requires flock certification, issued when either: 1) H7N9 virology results are negative (samples from one farm can be pooled); or 2) if the flock immunization rate is >70 percent with poultry H7 hemagglutination inhibition antibody titre ≥24 (MoA, 2017a). In the 21 days before birds leave the pen, a minimum of 30 swab or serum samples per flock must be collected, tested with test results issued by an authorized laboratory. If the results meet the above requirements, the County or higher level Animal Health Supervision Organisation issues an Animal Quarantine Qualified Certificate to the poultry producer (FAOCN, 2017 - personal communication; MoA, 2014).
- Provincial veterinary authorities are performing post-vaccination monitoring (PVM) mainly on antibody level. Table 1 shows the latest results obtained for the months of November and December 2017.

[7] The vaccine is a bivalent recombinant (H5N1 Re-8 + H7N9 H7-Re1) inactivated vaccine.

CONTRIBUTING EXPERTS

All questions were assessed with publications, reports and data made available by experts:

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- The vaccination programme against H5 formerly in place in China did not completely prevent market contamination (MoA, 2017d)) but did reduce contamination levels. Market data have shown that the H7 virus is still present in some markets (FAO, 2017). Thus H7N9 prevalence in LBM may be reduced but is unlikely to be eliminated.
- With the vaccination programme ongoing, farmers may have a false sense of security, possibly resulting in decreased enforcement of biosecurity measures. The H7N9 infection in poultry may be under-estimated due to the absence or the presence of only mild clinical signs in vaccinated poultry that can easily be overlooked (Peyre *et al.*, 2009; Vergne *et al.*, 2012). Generally, biosecurity measures are often imperfect in small farms, with or without vaccination.
- Under experimental conditions vaccinated chickens challenged with LP or HP H7N9 strains did not shed virus (CADC, 2017). However, since vaccination under field conditions may not necessarily provide optimal immunity, some level of H7N9 virus shedding is likely to occur.
- In the coming months, until the next round of the national vaccination programme occurs around April 2018, juvenile birds in small flocks hatched since the last mass campaign may not receive vaccination. In addition, H7-specific antibody titres in the remaining vaccinated birds in these flocks will decline. As a result, there may be reduced immunity in flocks covered by the government vaccination programme.
- During the fifth wave (October 2016 to September 2017), the number of cases in animals and humans and the number of contaminated LBMs as well as the severity of poultry outbreaks from the emergence of a highly pathogenic strain, have been higher than previous waves.
- During the fifth wave, all nine officially reported outbreaks of H7N9 infection in poultry were caused by the highly pathogenic strain in the provinces of Hunan, Hebei, Henan, Tianjin, Shaanxi, Inner Mongolia, Heilongjiang and Anhui, indicating this strain is already widespread in China. Eight of these outbreaks were identified in layer chicken farms and one in a broiler farm; the latter was confirmed on 24 August 2017 in Anhui Province and constitutes the most recent official report (FAO, 2017).
- Since September 2017, 167 009 virological samples were collected from poultry and environment in 28 provinces/municipalities/autonomous regions through national animal H7N9 surveillance and 15 samples tested positive for H7N9 (Table 2). Twenty-three positive environmental samples have also been recorded in markets in Anhui Province through CDC active surveillance in 2017, but are likely to refer to wave 5. (FAO, 2017).
- In November 2017, sick and dead chickens reported in relation to the confirmed H7N9 human case in Yunnan Province suggested the presence of a highly pathogenic strain (FAO, 2017). However gene sequences for the virus are not available to date (February 2018).
- The China Animal Disease Control Center reported no human influenza A(H7N9) cases in official surveillance for December 2017. In previous years, between five and 106 human cases occurred in December, see Table 3 (NHFPC, 2018). This could be a result of less virus currently circulating in LBMs than in corresponding periods of previous years, especially December 2016. This will only be confirmed as more results become available in subsequent months.

TABLE 2 *National animal H7N9 influenza surveillance results from September to December 2017 (FAO, 2017)*

Reporting period	Total number of virological samples collected (both animal and environmental)	Number of virological sample positives for H7N9	Administrative area (sample origin and location)
September 2017	23 156	2	**Fujian Province** (1 duck sample from a LBM) and **Liaoning Province** (1 chicken sample from a limited liability company)
October 2017	19 936	0	–
November 2017	41 506	2	**Yunnan Province** (2 chicken samples from a limited liability company)
December 2017	83 211	11	**Fujian Province** (1 duck sample and 1 environmental sample from two LBMs; 1 quail sample from a farm) **Hunan Province** (2 chicken samples from two LBMs) **Tibet Autonomous Region** (6 chicken samples from a LBM)

TABLE 3 *Number of influenza A(H7N9) human cases reported in December of previous years (NHFPC, 2018)*

Reporting period	Number of human influenza A(H7N9) cases reported
December 2013	5
December 2014	19
December 2015	10
December 2016	106
December 2017	0

- The China Animal Disease Control Center of the MoA requests each province to collect at least 30 samples from 170 sites per month. Some western areas such as the Tibet Autonomous Region, Qinghai, Gansu and Ningxia - with relatively low poultry density - are allowed to reduce their sample sizes accordingly. The Harbin Avian Influenza National Reference Laboratory and the Yangzhou Avian Regional Reference Laboratory (CAHEC) collect more samples from high-risk areas like South and South-east China (FAOCN, 2017; FAORAP, 2017 - personal communication).
- While there is generally appropriate testing capacity in most provinces, some remote areas may have lower capacity, e.g. the Tibet and Xinjiang Autonomous Regions (FAOCN, 2017 - personal communication).
- Informal trade in unvaccinated poultry may be occurring within and between provinces. Likewise, young chicks or ducks soon to be slaughtered may also not be vaccinated (FAOCN, 2017 - personal communication).
- Prior to or during festivals there is no specific legislation in force regarding movements of live poultry or poultry products (FAORAP, 2017). Market closures in some major cities before and during the Lunar New Year (16 February 2018) and Qingming (5-7 April 2018) festivals could potentially result in traders seeking alternative destinations for poultry, leading to increased informal trade.
- Increased poultry trading in southern China around the Lunar New Year have historically been associated with higher H5N1 HPAI virus infection risk in humans and poultry (Soares *et al.*, 2012).
- Broiler meat prices dropped with the emergence of H7N9 HPAI but there have been no major price changes for live poultry and poultry products since September 2017. However, prices are expected to increase slightly before and during festival months (mainly January and February 2018) if H7N9 activity remains low (FAOCN, 2017 - personal communication; GAIN, 2017). In this case there may be increased demand for live poultry and poultry products.
- Areas that cannot meet local consumption demands import live poultry and poultry products. Jiangsu and Anhui Provinces are the main chicken suppliers for Shanghai Municipality and Zhejiang Province (Zhou X. *et al.*, 2015). Highly populated and rich areas such as Guangdong and the eastern provinces/municipalities attract the majority of either formal or informal trade (NBSC of China, 2017).
- In cold areas of China with difficult access during winter, movements may be reduced and concentrated towards big cities that have accessible road and rail networks. Even though live poultry trade may be reduced, low temperatures are favourable for virus survival (Gautret *et al.*, 2014) resulting possibly in the prolonged survival and accumulation of viruses in poultry premises.
- In many of the northern provinces the sale of birds through LBMs is less developed, especially given that the main chicken type produced for meat is the white-feathered broiler (IATP, 2014), which is more likely to be sold directly to a central integrated slaughter facility without using the LBM system.

Therefore the likelihood of the Chinese-origin H7N9 virus spreading from affected areas to other areas of China from January to May 2018 through formal or informal live bird trade can be considered as moderate for juvenile and adult chickens, low for day-old chicks and other poultry (such as ducks, geese and quail), both with medium uncertainty.

1.2. Poultry products:

This section considers:

- Evidence presented under 1.1 and in the July 2017 assessment.
- There is no large scale trade in eggs for breeding in China. In addition, vaccination against H7 was implemented in

Chickens, quail and a duck being sold at a live bird market, Viet Nam.

September 2017 for breeders and layers, thus it is unlikely that infected eggs will be found in the market chain (FAORAP, 2017 - personal communication; MoA, 2017a).

- In November, Japan's animal border control detected the H7N9 virus in duck meat from China for the second time in 2017 (FAO, 2017). Even if vaccination is likely to reduce the prevalence of H7N9 infection in Chinese poultry, the virus may be found along the market chain. It remains unclear whether the duck meat originated from an infected duck or whether it was contaminated during slaughter.
- Transport of poultry products (eggs and feathers), chilled or frozen poultry meat and carcasses requires certification when crossing provincial borders within China (FAOCN, 2017 - personal communication).
- The Chinese government promotes centralized poultry slaughter and a cold chain to distribute poultry carcasses and meat which may help reduce live poultry movements during festivities in certain areas of China such as major cities. However, the centralized poultry slaughter policy is not mandatory in every province and may not affect the general pattern of poultry movements throughout China, or may simply shift movements from one place to another.

Therefore the likelihood of the Chinese-origin H7N9 virus spreading from affected areas to other areas of China from January to May 2018 through formal or informal trade in poultry products can be considered as low for frozen chicken carcasses or meat and feathers and negligible for eggs, both with low uncertainty.

1.3. Fomites:

This section considers:

- Evidence presented under 1.1, 1.2 and in the July 2017 assessment.
- Informal trade in live poultry and related products takes place in China during which biosecurity measures are likely to be insufficient to mitigate the risk of H7N9 virus spread or of any other avian influenza virus.
- Some urban authorities in China will maintain closures for LBMs until April 2018, after the festivals. These closures are permanent in the case of Beijing Municipality and frequent in the case of Chongqing, Shanghai and Tianjin municipalities and Guangdong Province (FAO, 2017; FAOCN, 2017; FAORAP, 2017). However, the nature and extent of biosecurity measures implemented during closures as well as the length of closure may vary greatly from one area to another and they may be restricted to certain markets.

Therefore the likelihood of the Chinese-origin H7N9 virus spreading through fomites from affected areas to other parts of China from January to May 2018 can be considered as moderate with medium uncertainty, depending on the awareness of farm visitors and travellers, cleaning and disinfection levels as well as biosecurity measures.

1.4. Wild birds:

This section considers:

- Evidence presented under 1.1, 1.2, 1.3 and the July 2017 assessment.

- Ducks inoculated intra-nasally with H7N9 HPAI viruses in infection experiments carried out in early 2017 presented low infection rates and little, if any, virus shedding, suggesting poor adaptation of the virus to ducks and, as a consequence, unlikely transmission and spread to and among wild *Anatidae* (NIAH, 2017; OFFLU, 2017).
- More recent strains of LP virus have not been assessed for their capacity to infect *Anatidae*.

Therefore the likelihood of the Chinese-origin H7N9 virus spreading from affected areas to other areas of China during January to May 2018 through movements of migratory or nomadic wild birds can be considered as negligible with medium uncertainty.

Countries of South and South-east Asia

2. What is the likelihood of the Chinese-origin H7N9 virus spreading from a known affected area of China to unaffected countries in South and South-east Asia from January to May 2018 through formal or informal trade in poultry or their products, fomites or wild birds?

2.1. Live poultry trade:

This section considers:

- Evidence presented under 1. and in the July 2017 assessment.
- Among the countries bordering South-east China, only the Lao People's Democratic Republic is still officially importing live poultry, mainly day-old chicks (DOCs) and day-old ducks (DODs) and poultry products from China[8] (FAO Lao PDR [FAOLA], 2017 - personal communication).
- H7 vaccination is currently illegal in Viet Nam, the Lao People's Democratic Republic, Myanmar or Cambodia (FAO Cambodia [FAOKH], 2017; FAOLA, 2017; FAO Myanmar [FAOMM], 2017; FAO Viet Nam [FAOVN], 2017 - personal communication).
- The H7N9 human case and the two H7N9 positive chicken samples reported in Yunnan Province in November 2017 show that countries such as Viet Nam, the Lao People's Democratic Republic and Myanmar which share borders with Yunnan, continue to be at risk of cross-border H7N9 introduction, especially through informal trade. Likewise, Guangxi Province, where the virus was reported up to the end of July 2017 (FAO, 2017), borders Viet Nam and there are informal poultry movements between these two areas (Desvaux *et al.*, 2016).
- With festivals occurring from February to April in Asia, there will likely be an increased demand for live poultry and poultry products, leading to more informal cross-border movements between China and other countries of South and South-east Asia, as in the case of Viet Nam (Delabouglise *et al.*, 2017). There has been a similar increase in demand in previous years yet there are no reports of H7N9 virus incursions from these countries.
- Most of the regulatory officials in Asian countries are aware of avian influenza hazards and there are strict regulatory frameworks in place at borders, including import bans on live poultry and/or strict movement regulations involving testing and certification. In July and November 2017 H7N9-infected duck meat was confiscated at an airport in Japan (FAO, 2017). However, informal trade between China and neighbouring countries continues and is difficult to control.
- Even though importation of live poultry and poultry products from China is formally restricted in Viet Nam, large numbers of "spent hens" are imported and the number of young chicks and young ducks up to 21 days old crossing the border informally is estimated at millions per year (FAOVN, 2017 - personal communication). To a lesser extent such informal trade also occurs in Myanmar, and the Lao People's Democratic Republic (FAOMM, 2017; FAOLA, 2017 - personal communication).
- In the past the formal or informal trade in live poultry from China has introduced H5 viruses to the Lao People's Democratic Republic, Viet Nam and Myanmar.
- Chinese construction projects in other countries of the region may result in imports of Chinese poultry or poultry products to these sites to supply workers.

Therefore the likelihood of the Chinese-origin H7N9 virus spreading from known affected areas of China to unaffected countries in South and Southeast Asia from January to May 2018 through live bird trade can be considered as:

- ► Moderate with medium uncertainty for the Lao People's Democratic Republic through informal or formal trade, depending on measures in place.
- ► Moderate with medium uncertainty through informal trade in Viet Nam and Myanmar, but negligible through formal trade, provided appropriate measures are enforced.
- ► Low with medium uncertainty for other countries of South-east Asia (e.g. Thailand and Cambodia) through informal or formal trade, depending on the measures in place.
- ► Negligible for countries of South Asia (e.g. Nepal and India).

2.2. Poultry products:

This section considers:

- Evidence presented under 1., 2.1 and in the July 2017 assessment.
- Eggs are informally traded – to an unknown extent – between China and neighbouring countries. Informal imports of eggs in South and South-east Asian countries

[8] A day-old chick or a day-old duck is newly hatched and we consider the terms refer to an unfed chick or duck that is less than 72 hours old.

With festivals occurring from February to April in Asia, there will likely be an increased demand for live poultry.

usually increase during festivals because of higher consumer demand (FAOMM, 2017; FAOLA, 2017; FAOVN; 2017 - personal communication).

Therefore the likelihood of the Chinese-origin H7N9 virus spreading from known affected areas of China to unaffected countries in South and South-east Asia from January to May 2018 through trade in poultry products can be considered as low with medium uncertainty, regardless of virus survival in those products.

2.3. Fomites:

This section considers:

- Evidence presented under 1., 2.1, 2.2 and in the July 2017 assessment.
- Little or no biosecurity practices are likely to be applied during informal transport of live poultry or poultry products across the Chinese border (FAOMM, 2017; FAOVN, 2017 - personal communication). There are few biosecurity measures such as truck disinfection at the border checkpoints of the Lao People's Democratic Republic which still allows poultry trade with China (FAOLA, 2017 - personal communication).
- Therefore the likelihood of the Chinese-origin H7N9 virus spreading from known affected areas of China to unaffected countries in South and South-east Asia from January to May 2018 through fomites can be considered as moderate with medium uncertainty for Viet Nam, the Lao People's Democratic Republic and Myanmar for informal trade with China and negligible with medium uncertainty for other countries of South and South-east Asia (e.g. India, Cambodia and Indonesia).

2.4. Wild birds:

This section considers:

- Evidence presented under 1.4 and in the July 2017 assessment.

Therefore the likelihood of the Chinese-origin H7N9 virus spreading from known affected areas of China to unaffected countries in South and South-east Asia from January to May 2018 through movements of migratory or nomadic wild bird can be considered as negligible with low uncertainty.

Countries beyond South and South-east Asia

3. What is the likelihood of the Chinese-origin H7N9 virus spreading from known affected areas of China to unaffected countries beyond South and South-east Asia from January to May 2018 through global trade in poultry and related products, travellers or wild birds?

3.1. Global trade in poultry and related products and travellers

This section considers:

- Evidence presented under 1., 2. and in the July 2017 assessment.
- Most Chinese chicken exports are to Hong Kong SAR and Japan (GAIN, 2017). In Hong Kong SAR, local farms provide live chickens and currently there are only imports of eggs, chilled or frozen poultry meat and carcasses. Japan only authorizes processed poultry meat imports from designated Chinese facilities (MAFF of Japan, 2017).
- Outside South and South-east Asia generally there are strict regulatory frameworks concerning formal trade for specific poultry imports such as processed poultry meat

and for crossing national borders, such as certification and quarantine of imports (EUR-Lex, 2001; FSIS, 2017). But infected or contaminated poultry exports are possible, with some cases reported in the past.

- Chinese construction projects in other countries may result in Chinese poultry or poultry product imports to these sites to supply workers (Brioudes and Gummow, 2016).

Therefore the likelihood of the Chinese-origin H7N9 virus spreading from known affected areas of China to unaffected countries beyond South and South-east Asia from January to May 2018 through global trade in poultry and related products and the movement of travellers is still considered to be negligible with low uncertainty, although the virus may occasionally be found in smuggled poultry meat.

3.2. Wild birds

This section considers:

- Evidence presented under 1.4 and in the July 2017 assessment.
- In the period covered by the risk assessment, January to May 2018, spring migration patterns are of interest. However, any spread will only occur if the virus is able to survive in one or more species during long-distance migration.

Therefore the likelihood of the Chinese-origin H7N9 virus spreading from known affected areas of China to unaffected countries beyond South and South-east Asia from January to May 2018 through migratory wild bird movements is still considered negligible with medium uncertainty for the Russian Federation, Mongolia, Japan and the Republic of Korea and negligible with low uncertainty for other countries.

4. What is the likelihood of a human being exposed to the Chinese-origin influenza A(H7N9) virus through contact with infected live birds, during LBM visits within affected areas of China from January to May 2018?

This section considers:

- Evidence presented under 1.1., 1.2., 1.3. and in the July 2017 assessment.
  Since September 2017 there are reports of only five influenza A(H7N9) human cases, with three of them probably occurring before the vaccination campaign started in poultry (FAO, 2017). In December 2017 there were no reports of human cases, as opposed to December 2016 when there were more than 100 human cases (NHFPC, 2018).
- On 12 January 2018 there was one influenza A(H7N9) case in a 72 year-old man in Xinjiang Province. He died shortly after the onset of symptoms, indicating the virus is still circulating in mainland China, even in remote regions (FAO, 2017).
- Both HP and LP viruses have infected humans but the majority of cases reported appear to derive from the LP strain. To date, the HP strain has been confirmed in 32 H7N9 human cases (FAO, 2017). The HP strain is generally easier to identify as infected birds present clinical signs which may result in reduced human exposure and thus infection.
- Field investigation and review of medical records regarding human cases reported in Guangdong Province between 2013 and 2017 indicate that direct exposure to live poultry (i.e. raising backyard poultry, buying live poultry in LBMs and sale or slaughter of live poultry) and indirect exposure by visiting LBMs at least once, were the main exposure histories reported for influenza A(H7N9) cases (Yang *et al.*, 2017).
- Even though Chinese consumer confidence in the safety of domestic poultry may have declined following the high number of H7N9 human cases reported during wave 5 from October 2016 to September 2017 (GAIN, 2017), increased demand and consumption of poultry meat and products are expected during the festivals in China.
- LBM visits are still the main risk factor for human exposure due to the high density of live birds for sale and slaughtering practices. The cause of the sudden increase in the number of human cases during the fifth wave may be greater market contamination, as shown by routine environmental surveillance (Zhou L. *et al.*, 2017), but also the increased geographical spread reaching semi-urban and rural areas and exposing a larger susceptible population.
- Planned temporary market closures in central urban areas may result in shifting of poultry movements to LBMs in suburban/rural areas where biosecurity measures may be weaker. Human infection may shift to these areas, as shown in the case of Zhejiang Province (Cheng *et al.*, 2017).

Therefore the likelihood of a human being exposed to the Chinese-origin influenza A(H7N9) virus through contact with live birds or LBM visits within affected areas in China from January to May 2018 is considered moderate with medium uncertainty during the high-risk influenza season where greater H7N9 virus activity is usually recorded, lower temperatures that favour virus survival in the environment and the local festivals, in particular Lunar New Year. However, the likelihood of infection is expected to decrease and become low to moderate, with moderate for occupational exposure and medium uncertainty towards the end of the influenza season in the northern hemisphere, the end of April 2018, when temperatures rise.

For more details on human exposure risk, please refer to WHO Risk Assessment on influenza at the human-animal interface.

Active surveillance in LBMs is continued in China and neighbouring countries.

Conclusions and consequence assessment

The risk of H7N9 spread, both low and highly pathogenic strains, from affected areas to other areas of China or neighbouring countries through trade in poultry or poultry products and fomites is assessed as moderate for January to May 2018.

Since September 2017, the nationwide compulsory vaccination programme appears to have reduced the prevalence of H7N9 virus in poultry in mainland China and may thus explain the relatively few case reports from both animal and public health authorities, an encouraging development. However, the virus can continue to circulate in partially immunized flocks, where infected poultry may shed reduced amounts of virus without displaying clinical signs, even in the case of H7N9 HPAI infection. A silent H7N9 virus circulation in vaccinated flocks will continue to present opportunities for human exposure, e.g. in LBMs but also encourage ongoing spread of the virus to native poultry populations such as commercial and backyard poultry.

Poultry farmers and traders may also develop a false sense of security after vaccination, leading to the possibility of decreased enforcement of biosecurity measures. Although opportunities for human exposure persist, the number of human cases is expected to be much lower for January to May 2018 than in corresponding periods of previous years due to fewer infectious birds and declining environmental contamination levels in LBMs. Regarding formal trade within China, vaccination certificates and quarantine are mandatory for any flock crossing provincial borders within China, tending to limit the spread of the H7N9 virus.

However, this does not take account of the informal trade, which may include the movement of unvaccinated birds. Festivals held in February and April 2018 are likely to increase poultry trade in China and into neighbouring countries to the south. There may well be animal and human cases, either in urban areas of China where LBMs remain open and have weak biosecurity measures, or in suburban/rural areas due to urban LBM closures and the consequent shift in the live poultry trade. In addition, neighbouring countries that have an informal poultry trade with China are also at moderate risk during the festival period. Should H7N9 be introduced into these countries, the virus can spread in and amongst unvaccinated flocks where vaccination is prohibited and lead to human exposure.

Regarding the role of wild birds, evidence remains unchanged since the last assessment and the spread of H7N9 within China, throughout Asia and to other continents via wild birds is still considered negligible.

The economic impact of H7N9 introduction, spread and control is still considered to be high and the reader is referred to the previous assessment, published in July 2017. China needs to consider the additional high costs associated with a nationwide vaccination campaign, continuation of active surveillance in LBMs and farms as well as post-vaccination monitoring. This

investment is crucial to early detect foci of virus circulation and to prevent spread by appropriate measures, such as culling, cleaning, disinfection, fallowing and temporary closure of premises. If a human is exposed to infected live poultry or poultry products, or to contaminated environments or materials, the exposure to either the low or highly pathogenic strain does not necessarily lead to human infection or disease. The latter also depends on the virus strain, the amount of virus present and infectious dose required, susceptibility of the individual, etc.

However, where human infection does occur, it can result in severe respiratory disease and death. If H7N9 is introduced into a country with a poor health care system the cost of medical treatment will affect national budgets considerably. The general public may avoid consumption of poultry products, as happened at the beginning of the H5N1 HPAI epidemic in 2003-06, severely impacting on national economies, the poultry industry and related livelihoods. It is expected that the vaccination campaign in China will reduce virus circulation and shedding in poultry and, even if total elimination of the virus from poultry populations is not realistic, reduce contamination levels and thus the risk of infection for humans.

In the previous assessment covering May to September 2017 the likelihood of H7N9 virus spread through live bird trade and fomites was assessed at low to moderate risk, with poultry products assessed at low risk. The observed decline in H7N9 animal detections, especially from July onwards, supports these assessments. As expected, during this period H7N9 HPAI outbreaks continued to occur in poultry farms, mainly layer farms, largely in previously unaffected provinces. Nevertheless, Chinese-origin H7N9 virus was not detected in any country other than China. Likelihood levels for human exposure were assessed at low to moderate risk, with increased risk for occupational exposure. This assessment was supported by a decline in the number of human cases reported during this period compared to the beginning of previous years (i.e. January-March 2016).

FAO commends the Ministry of Agriculture of China (MoA) and the poultry industry for implementing the vaccination programme as an important measure to safeguard human health and promote safer poultry trade. By achieving very high coverage nationwide with a well-matched vaccine, it is expected that shedding of virus and contamination levels in markets will decrease. Findings so far, including the small number of positive findings in markets and human cases during this wave suggest this has occurred. FAO also acknowledges the efforts of the millions of poultry producers who are complying with this initiative and contributing to the programme. The H7N9 virus will not be eliminated – at least in the short term, as we have also seen for H5 HPAI viruses. Vaccination will reduce the prevalence of infection in poultry and human disease. But it is important to recognize the scientific evidence that the virus is still present in affected areas of China. Some trade in infected poultry will continue, exposing humans to it, especially during the high-risk season around the Lunar New Year.

Therefore we need to continue reminding all those involved in poultry-keeping, marketing, butchering etc., to maintain their efforts to improve biosecurity practices and personal protection measures.

FAO also recommends that veterinary and customs services in neighbouring countries remain aware of the potential introduction of infected poultry or contaminated poultry products.

Knowledge gaps

A nationwide poultry vaccination programme took place in September 2017 but the Chinese authorities have made limited information available regarding current virus circulation, post-vaccination monitoring results and control actions where an infected vaccinated flock is detected. This information would be key to locating areas where the virus persists and where to target control measures. At the end of wave five, H7N9 had spread widely in mainland China reaching several new provinces, particularly in northern China (i.e. Inner Mongolia, Heilongjiang), but the mechanisms of northward spread and the extent of infection in farms are unknown. Knowledge of infection levels in LBMs over time, especially those in southern provinces where informal trade with neighbouring countries takes place, is of utmost importance as these provinces can act as a source of H7N9 virus for Viet Nam, the Lao People's Democratic Republic, or Myanmar, as was seen with other AI viruses such as H5N1. Epidemiological investigations of each newly reported H7N9 finding in either animals or humans are critical to understand the mechanisms of continued virus spread and human exposure despite the vaccination programme in place.

The important data gaps are:

- Information on H7N9 LP and HP strain circulation in China, including:
  - Current infection status in the provinces, especially those bordering Viet Nam, the Lao People's Democratic Republic and Myanmar or where H7N9 is known to be endemic, i.e. Guangdong Guangxi and Yunnan Provinces;
  - Information on the extent of infection on farms in China prior to and post-vaccination;
  - Detailed H7N9 surveillance results from poultry, such as species, breed, age and production type;
  - LBM surveillance results to assess past (pre-vaccination) and current levels of contamination in such markets, being the most common source of human infection and probably critical in spreading infection back to farms;
  - Mechanisms of H7N9 spread to northern China during the fifth wave;

Poultry products sold at a local market.

- ► Any change in pathobiology and increased transmission of H7N9 HPAI viruses collected in late 2017, especially those isolated from ducks or pigeons and the H7N9 HPAI viruses recovered from duck carcasses informally imported into Japan.
- Information regarding the level of infection or susceptibility of poultry likely to be exported from China to other countries, through formal or informal trade;
- Information on epidemiological characteristics of recent human cases.

Mitigation measures

For a list of mitigation measures, please see the previous assessment (July 2017). [9]

[9] Please note there is a change in the fifth bullet on page 5 of this assessment under the heading "Mitigation measures reducing the likelihood of the influenza A(H7N9) virus spreading from an infected farm/unit to an uninfected farm/unit within affected areas of China and from a known affected area to a moderate- to high-risk area". Since the emergence of the highly pathogenic strain, this should read:
"Even though influenza A(H7N9) may not cause illness in poultry, H5N1 and other highly pathogenic avian influenza viruses do and it remains important that all signs of illness or sudden and unexplained deaths in poultry, farmed birds, wild birds or other animals are reported to the authorities to handle and investigate appropriately. Other than influenza A(H7N9), other H7 viruses have been shown to be able to mutate into HPAI with associated high mortality in terrestrial poultry."

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NOTES


FAO/Ken Inui

RISK ANALYSIS IN ANIMAL HEALTH

Risk analysis is a procedure, which we all do intuitively in our everyday life as we also do in our professional work to assess the risk of any hazard or threat. In animal health, risk analysis has been most widely used as a decision tool about the most appropriate health interventions to support disease control strategies, guide disease surveillance and support of disease control or eradication strategies.

It should be remembered that risk is not equal to zero and never stays static. Risks changes as drivers or factors of disease emergence, spread or persistence change such as intensification of livestock production, climate change, civil unrest and changes in international trading patterns. Risk analysis should therefore not be seen as a "one off" activity and it should be seen as a good practice of animal health systems to conduct their regular activities. Therefore, risk analysis process should be repeated and updated regularly.

Risk analysis comprises the following components:

H **Hazard identification:** the main threats are identified and described.

A **Risk Assessment:** risks of an event occurring and developing in particular ways are first identified and described. The likelihood of those risks occurring is then estimated. The potential consequences or impact of the risks if they occur are also evaluated and are used to complete the assessment of the risk.

M **Risk Management:** involves identifying and implementing measures to reduce identified risks and their consequences. Risk never can be completely eliminated but can be effectively mitigated. The aim is to adopt procedures that will reduce the level of risk to what is deemed to be an acceptable level.

C **Risk Communication:** an integrated processes that involves and informs all stakeholders within the risk analysis process and allows for interactive exchange of information and opinions concerning risk. It assists in the development of a transparent and credible decision-making processes and can instil confidence in risk management decisions.

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