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Technical guidelines on rapid risk assessment for animal health threats

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Acronyms and abbreviations

ASF	African swine fever
ASFV	African swine fever virus
EKE	expert knowledge elicitation
FAO	Food and Agriculture Organization of the United Nations
OIE	World Organisation for Animal Health
ProMED	Program for Monitoring Emerging Diseases
RRA	rapid risk assessment
RVF	Rift Valley fever
WHO	World Health Organization

Summary

When an imminent threat or emergency arises from an animal health event, it is important to conduct a rapid risk assessment (RRA) that informs animal health decision-makers of the most efficient control measures that they can take to control the disease concerned. These technical guidelines on rapid risk assessment provide a simple and practical tool that assists decision-makers in veterinary departments in conducting qualitative RRAs on the emergence, incursion and/or spread of animal health events caused by infectious diseases. Depending on the information, capacities and human resources available, a small, multidisciplinary team can carry out an RRA in two weeks. The simple and flexible methodology for conducting an RRA when facing a disease event proposed in these guidelines covers the full risk assessment process, from the moment when a disease event is suspected or identified through the routine disease intelligence activities, to the assessment of risks and the preparation of a risk assessment report that communicates the results.

The RRA methodology detailed in this document consists of eight steps that are illustrated with examples. In step 1, the disease event is assessed through a triage process based on specific criteria that indicate whether the event should trigger an RRA. Step 2 involves the establishment of a multidisciplinary RRA team. In step 3, the hazard profile of the threat is updated, or a new profile is prepared. Step 4 consists of formulation of the risk questions to be answered by the RRA, and in step 5, the data required to address these questions are collected. If insufficient data are available, an expert opinion is sought in step 6, and once all the necessary information is available, the RRA team will perform the qualitative RRA as step 7. In step 8, the RRA team prepares a short and concise report on the RRA to communicate the risk levels and potential mitigation measures to the risk managers. The outcome of the RRA will provide evidence on the level of risk, which will guide decision-makers and risk managers in responding through the implementation of timely prevention, control and eradication measures that contribute to sustainable livelihoods, animal health, public health and enhanced food security.

Introduction

High-impact animal diseases including zoonoses pose a threat to animal production, food chains and human and animal well-being through their detrimental effects on food security, food safety, animal health and welfare, human health, livelihoods, national economies and global markets, with poor and vulnerable communities facing the greatest threats. The occurrence of high-impact animal diseases disrupts production, livelihoods and access to trade in international and regional markets for livestock and livestock commodities, posing a constant threat to the livelihoods of livestock farmers.

Risk assessment is crucial in providing early warning of animal disease outbreaks and enabling national authorities to inform farmers and other populations at risk of measures for the prevention and control of threats, and to prepare and develop mitigation strategies that minimize the risk of the introduction and spread of animal health threats. An accurate rapid risk assessment (RRA) is crucial for decision-makers involved in the identification and selection of appropriate management (prevention or control) activities.

In many developing countries, the capacities of veterinary service personnel to conduct risk assessments in a timely and systematic manner are limited or lacking. Historically, the risks associated with animal health threats have been assessed according to immediate needs, on an ad hoc and informal basis without a systematic and standard approach. The RRA approach described in these guidelines can also help to establish baselines and support preparedness for the threats arising from animal health events by providing the data and information required to conduct RRAs rapidly.

In an emergency situation, when a rapid and effective response is needed, the limited time available is insufficient to allow a quantitative risk assessment and collection of all the necessary data. The time required for a risk assessment varies according to the issues to be explored, the methodologies chosen, the difficulties associated with data collection and the human resources available during an emergency response. Emergency situations caused by an animal health event call for a rapid assessment of the risk arising from the event in order to inform fast decision-making. A rapid risk assessment results in a qualitative assessment of the risk and can be produced quickly. The results of an RRA inform national veterinary services and the international community of the emergence or spread of a transboundary animal disease or zoonosis and the issues that require attention at the animal–human–ecosystem interface.

Several international and national institutions and agencies routinely perform RRAs, but few technical guidelines and protocols on how to conduct RRAs are currently available at the national level. In addition, RRA procedures are often tailored to the scope and structure of the organization concerned. Through its animal health programmes, the Food and Agriculture Organization of the United Nations (FAO) has vast experience of performing risk assessment in collaboration with the World Organisation for Animal Health (OIE) and the World Health Organization (WHO). FAO programmes support members in addressing

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Woman farmer feeding a local breed pig affected by porcine teschovirus *disease.*

priority diseases and severe outbreaks of, for example, African swine fever, foot-and-mouth disease, Rift Valley fever, Ebola virus disease and highly pathogenic avian influenza. These risk assessment guidelines build on FAO's experience of conducting risk assessments to alert member nations and provide them with early warning information.

The increased need for RRAs calls for the development of methods, standard procedures and a consistent, structured, harmonized and timely approach that allows RRAs to be conducted rapidly with the available data.

In collaboration with its partners, FAO has developed a harmonized approach and methodology that support early warning, risk-based surveillance and decision-making for effective and timely response to animal disease outbreaks and selection of the most appropriate disease control and mitigation strategies.

Development of this flexible approach to RRA was made possible through support from a group of experts convened to advise and guide FAO on preparing the guidelines at a technical expert meeting held at FAO Headquarters in July 2018. Experts from WHO, European Union organizations (the European Centre for Disease Prevention and Control and the European Food Safety Authority), universities (North Carolina State University in the United States of America and Wageningen University in the Netherlands), national institutions (the Canadian Food Inspection Agency, the Department for the Environment, Food and Rural Affairs in the United Kingdom of Great Britain and Northern Ireland, the *Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise* in Italy and the Eastern Africa Regional Epidemiology Network) and FAO. See Annex 1 for a full list of participants.

Purpose and objectives of the guidelines

The purpose of these guidelines is to provide a simple methodological step-by-step approach to the development and conduct of an RRA by animal health authorities at the national and regional levels.

The overall objective is to provide a tool for qualitative RRA of the emergence, introduction or spread of priority transboundary animal and zoonotic disease events. Other more complex quantitative approaches that support disease management are available elsewhere, but these are not feasible or practical for an initial RRA conducted in an emergency situation or under an imminent threat.

The guidelines are for use in RRAs of the emergence, incursion or spread of disease in domestic animals and wildlife, including at the interface between animal and human populations. While the steps in the methodology can be followed to assess the medium- and long-term risks that already exist in a country or zone, other guidelines and resources for such a purpose are available elsewhere, such as the Progressive Control Pathway for Foot-and-Mouth Disease. If these guidelines are followed for purposes other than assessment of the emergence, incursion or spread of disease, such as for the eradication of a disease or the monitoring of endemic diseases, the timeframe for conducting the tailored risk assessment will need to be modified.

The outcome of the RRA will provide evidence for decision-making regarding the design of timely prevention, control and eradication measures that contribute to sustainable livelihoods, public health and enhanced food security.

TARGET AUDIENCE

The primary aim of these guidelines is to support development of the capacity of animal health personnel in veterinary services and other professionals in the wildlife, environmental and public health sectors so that they can conduct RRAs during the outbreak and/or the spread of animal health threats.

The intended users of these guidelines are assessors of risks associated with animal health; providers of animal health services in the private and non-governmental sectors; and educational institutions, to provide support for training activities, curriculum development and the design of programmes for the transfer of knowledge on RRA within and among countries.

THE RISK ANALYSIS PROCESS

Risk analysis is an iterative process that comprises four distinct interrelated components: hazard identification, risk assessment, risk management and risk communication.

The risk assessment component of risk analysis is the main focus of these RRA guidelines (Figure 1). Risk assessment is the systematic process of assessing or evaluating the

FIGURE 1
Four main components of the risk analysis process

Source: FAO, 2012.

magnitude of the risk of an unwanted outcome resulting from a hazard. In risk analysis, risk is defined as being composed of two contributing components: i) the likelihood (probability) of the hazard causing the unwanted outcome; and ii) a measure of the impact (consequences) of the unwanted outcome (FAO, 2011).

Risk assessments can be quantitative or qualitative. In *quantitative risk assessments,* likelihood, impact and uncertainty are expressed as numeric values. Such assessments usually involve the development of mathematical models, which can be deterministic when both the inputs and the outputs are expressed as single numbers or point values, or probabilistic when variables are described as probability distributions (OIE, 2004). In *qualitative risk assessments,* likelihood, impact and uncertainty are expressed using descriptive categories and scales. The likelihood of the unwanted outcome and the magnitude of the consequences are expressed in qualitative terms such as high, moderate, low or negligible (OIE, 2010). Qualitative risk assessments usually require less time to complete than quantitative ones, and are therefore particularly useful in emergency situations. A qualitative risk assessment methodology is presented in these guidelines. A *semi-quantitative risk assessment* approach can also be followed by assigning numbers (scores) to qualitative estimates in the form of probability ranges, weights or scores, and combining them by addition, multiplication or other mathematical operations to define the final risk estimate (OIE, 2010).

The terminology used in these guidelines is explained in Annex 2.

Rapid risk assessment method

The time required to conduct a risk assessment can range from days to weeks, months to one year depending on the methodologies chosen and the challenges faced in gathering data and information. In emergency situations, it is important that risks are assessed quickly in order to inform the identification and selection of appropriate management measures (prevention or control), because there is often insufficient time available for a full risk assessment exercise. Ideally, an RRA will take less than two weeks to complete.

RRA will support and inform the decision-making process, including:

- the risks that have been identified and their relevance to the scope of the assessment;
- the methods used;
- the applicability and limitations of the assessment.

The following steps in the RRA process are depicted in Figure 2.

Step 1: Triage. A mechanism that uses an algorithm based on specific criteria to indicate whether or not a health event requires an RRA. The criteria considered during triage include potential impacts on animal production and human health, and the risk of emergence of a new pathogen that affects an animal species or of a pathogen jumping to a different animal species. This step can take one day.

Step 2: Establishment of an RRA team. Constitution of a multidisciplinary team to conduct the RRA. The team should be established the day after the triage algorithm has triggered an RRA.

Step 3: Hazard profile. A concise description of the health event, its context, the current state of knowledge of the problem, and potential risk management options. Preparation or updating of the hazard profile of the hazards involved in the health event can take up to two days.

Step 4: Formulation of risk questions and sub-questions. Definition of the specific questions to be answered during the RRA. This step can take between one and three days.

Step 5: Data collection and literature review. Collection and review of relevant information from various sources. This step can take up to two days.

Step 6: Expert opinion (if required). The process of obtaining opinions and judgements from a group of experts.

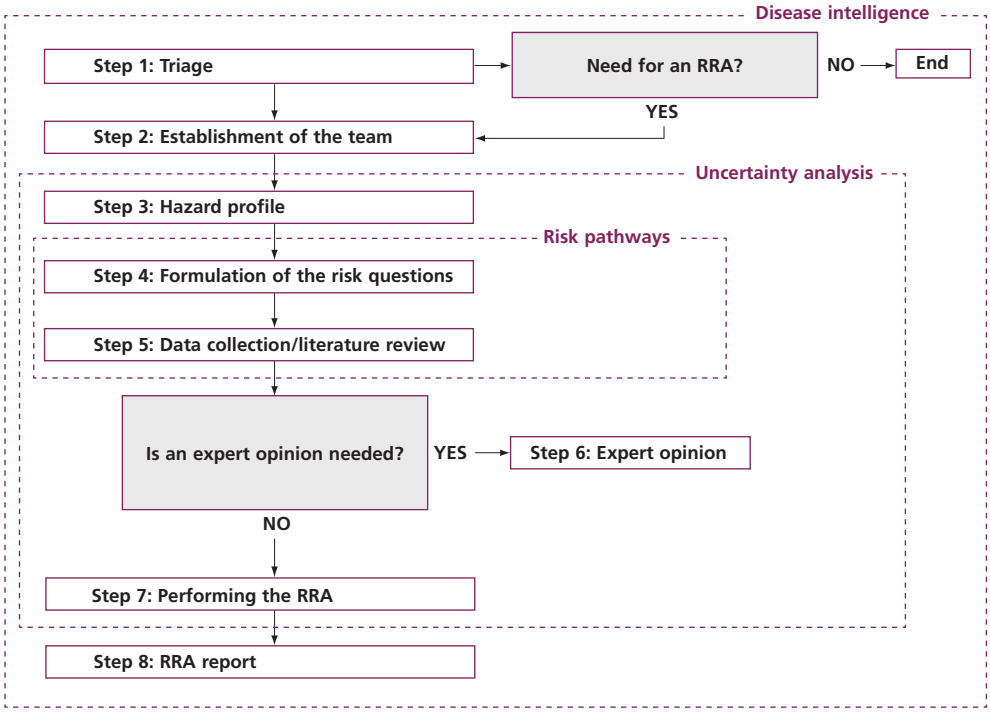
Step 7: Performing the RRA. The process of assessing the risks in accordance with the risk questions. This step can take up to three days.

Step 8: Reporting on the RRA and its results. Preparation, presentation and dissemination of a report on the results of the RRA. This step can take up to two days.

In addition, the following cross-cutting activities must be performed before and/or during the RRA process.

Disease intelligence. The systematic collection, analysis and communication of data and information for detecting, verifying, assessing and investigating events and levels of risks

FIGURE 2
Process for conducting a rapid risk assessment for animal health threat events



Source: Authors.

in order to provide early warning or inform the design and implementation of a response. Disease intelligence activities are conducted at all the steps in the RRA process.

Identification of risk pathways. Presentation of a graphical representation of the logical pathways by which a hazard might be introduced into a new area or might spread.

Uncertainty assessment. The process of identifying and characterizing areas of uncertainty related to input data and variables collected during the risk assessment process, and those that affect the structure of the risk assessment.

RRA is an iterative process. For example, when new data or information become available, the outputs of the steps in the RRA can be reviewed and revised. Periodic reviews of the RRA are also needed when the epidemiological situation changes or new mitigation measures that affect the level of risk are applied.

The following subsections detail the step-by-step approach and the cross-cutting activities.

TABLE 1
Triage criteria for evaluation of the need for a rapid risk assessment

Criteria	Score (Yes = 1; No = 0)
1. Credibility of data sources	
Has the health event been reported by multiple independent and reliable unofficial sources (e.g., the media, ProMED,* field sources, twitter)?	Yes ☐ No ☐ Unknown ☐
Has the health event been reported or confirmed by an official source?	Yes ☐ No ☐ Unknown ☐
Subtotal score	
2. Severity of the disease and its consequences	
Has the international spread of the disease (via live animals or their products, vectors or fomites) been proved?	Yes ☐ No ☐ Unknown ☐
Has the disease been shown to have a significant impact on the health of domestic animals in multiple countries?	Yes ☐ No ☐ Unknown ☐
Is it a zoonotic disease associated with severe consequences for public health?	Yes ☐ No ☐ Unknown ☐
Has the disease been shown to have a significant impact on animal production and/or trade with possible detrimental economic consequences for the affected country or countries?	Yes ☐ No ☐ Unknown ☐
Has the disease been shown to have a significant impact on the health of wildlife or on the environment, including biodiversity, in one or more countries?	Yes ☐ No ☐ Unknown ☐
Has the causative agent of the disease developed resistance to treatments, thereby posing a significant danger to public and/or animal health?	Yes ☐ No ☐ Unknown ☐
Subtotal score	
3. Relevance of the health event	
Is the observed health event possibly linked to the evolution or change of an existing disease agent?	Yes ☐ No ☐ Unknown ☐
Is the observed health event related to the spread of a known disease to a new geographic area, species or population?	Yes ☐ No ☐ Unknown ☐
Is the observed health event related to a known disease that is occurring with increased incidence or morbidity in the host population(s)?	Yes ☐ No ☐ Unknown ☐
Is the observed health event caused by an unknown or previously unrecognized disease agent?	Yes ☐ No ☐ Unknown ☐
Is the observed health event affecting vulnerable groups of the population, such as infants or elderly people, who are likely to be disproportionately affected?	Yes ☐ No ☐ Unknown ☐
Is the observed health event attracting a high actual or potential level of media interest or public concern?	Yes ☐ No ☐ Unknown ☐
Subtotal score	
Total score	

* ProMED = Program for Monitoring Emerging Diseases.

STEP 1: TRIAGE

A standardized approach should be used to determine the need for an RRA. Such standardization can be achieved through the use of a triage algorithm based on specific criteria, as shown in Table 1. A score is assigned to each yes/no answer, with Yes scoring 1 and No 0. In cases of doubt about the answer or when information is lacking, an additional score for "unknown" can be assigned. A threshold value for triggering a risk assessment has to be set, and the sum of all the scores obtained will be compared with that threshold. Triage can be conducted by the team responsible for the risk assessment and/or for disease intelligence activities.

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Livestock market, Gbessia, Conakry (Guinea).

Based on the information available, the triage process focuses on:

1. the credibility of the data sources used, with possible verification in the field before treating the signal as a health event;
2. the severity of the disease and its consequences;
3. the relevance of the health event to animal and human health, farmers' livelihoods, the economy and food security.

The results of the triage determine the subsequent steps of the risk assessment process, which can be as follows:

a. No need for further action: the threshold value has not been reached.
b. Need to gather more detailed or additional information: too many of the answers related to the triage criteria are "unknown".
c. Need for an RRA: the threshold score has been reached and the urgency of the case is considered to require an RRA.

Examples of use of the triage algorithm are provided in Annex 3.

The threshold value beyond which the triage score triggers an RRA varies depending on the capacity of the veterinary services to perform an RRA. For instance, if the veterinary services have the mandate and several staff members have the capacity and are available to perform an RRA, a lower threshold value will be set than when the veterinary services have few officers with the capacity and availability to conduct a RRA.

STEP 2: ESTABLISHMENT OF THE RAPID RISK ASSESSMENT TEAM

When the score obtained from the triage algorithm reaches the threshold value that triggers an RRA, a team needs to be established to conduct the RRA. Depending on the organizational structure and division of functions in the animal health authority dealing with the disease event, the team can be established by the epidemiology unit of the animal health department responsible for gathering and managing disease intelligence, or the emergency operations centre. This step should take no more than one day.

The RRA assessment team should be multidisciplinary and, depending on circumstances and the capacities available, can include experts in risk assessment or analysis, disease epidemiology or ecology, animal health, value chains, entomology (if the disease is vector-borne or transmitted by vectors), animal health economics, public health, wildlife, and ecology and the environment. Each member of the team can assume more than one role; for instance, an expert in risk assessment may also be an expert in public health. The team should appoint a leader to lead the RRA process, coordinate with experts and consolidate feedback.

The team will also need a spokesperson tasked with managing communications with internal stakeholders and reporting to external institutions or other bodies when needed.

STEP 3: HAZARD PROFILE

Once the team has been established, its first step is to compile and/or update a hazard profile of the threat that is causing the health event. A hazard profile is a description of a health event and its context, the current state of knowledge of the problem and potential risk management options. It includes a comprehensive description of the pathogen (for example, virus, bacteria, parasite, protozoa, fungus, biological toxin, prion), information on the health event, and a description of each hazard (including the transmission and distribution of the pathogen), control measures and the impact of the disease. Compilation of a hazard profile must not be confused with a systematic literature review. The hazard profile applies to the specific context in which the risk assessment will be conducted; draws on data that are related only to the health event concerned; and provides basic information for conducting the RRA. It is therefore useful to prepare general hazard profiles of known pathogens that can be adapted and updated when a health event occurs, thereby speeding up step 3 in the RRA process by facilitating the formulation of risk questions.

The RRA team will gather the information required from available data sources or from expert opinion when limited data are available, such as when the disease involves a new emergent pathogen. It is recommended that the RRA team take a maximum of two days to finalize the hazard profile.

A detailed list of the aspects to be taken into consideration in formulating a hazard profile is provided in Annex 4.

STEP 4: FORMULATION OF RISK QUESTIONS AND SUB-QUESTIONS

The RRA team should formulate the risk questions during the development of the RRA objectives. Depending on the structure and functions of the national animal health department, risk managers in the department may provide the objectives of the RRA, in which case the RRA team will need to prepare risk questions that address those objectives.

The number of risk questions will depend on the objectives of the risk assessment. Each risk question includes a statement on what is to be evaluated and is clearly linked to the objectives of the assessment. Risk questions must therefore be unambiguous and detailed enough to cover all relevant risk factors and each question should be split into a number of detailed and specific sub-questions. It is recommended that risk questions start with "what is the probability of…" or "what are the consequences (or impact) of…" or similar wording. The sub-questions must be very precise and should cover the four main dimensions of risk: i) what – the hazard and event concerned and the effects of the hazard; ii) where – the

TABLE 2
Examples of ambiguous and correctly worded risk questions

Health event	Examples of ambiguous risk questions (RQs) and sub-questions (RSQs)	Examples of correctly worded RQs and RSQs
Emergence of Rift Valley fever (RVF) in countries where it is endemic, in areas that are close to the borders with RVF-free countries	RQ: What is the risk of RVF spreading internationally? RSQ: What is the risk of RVF spreading from infected country X to neighbouring countries?	RQ: What is the probability of RVF being introduced into country Z from infected country X during the next six months? RSQ: What is the probability of RVF being introduced from infected country X into country Z (via active movement or windborne dissemination) of infected vectors during the next six months? RSQ: What is the probability of RVF being introduced into country Z through the movement of viraemic sheep from infected country X during the next six months?
Emergence and spread of highly pathogenic avian influenza (HPAI) (H5N1) in certain countries	RQ: What is the risk of HPAI spreading from currently infected countries into Europe? RSQ: What is the probability of HPAI being introduced and spreading in Europe? RQ: What is the risk of having a certain number of human cases of HPAI in currently infected countries? RSQ: What number of human cases of HPAI are expected in infected countries?	RQ: What is the probability of H5N1 HPAI being introduced into Europe from currently infected countries during the next three months? RSQ: What is the probability of H5N1 HPAI being introduced into various European countries via infected migratory birds from currently infected countries during the next three months? RQ: What are the public health consequences of H5N1 HPAI infection in currently infected countries? RSQ: What are the expected numbers of human cases and deaths due to H5N1 HPAI in people exposed to the infection through close contact with birds on infected farms in infected countries during the current year?

population and location affected; iii) when – the timeframe of emergence; and iv) how – the possible pathways that the hazard may follow.

As mentioned earlier in this section, risk managers can guide the development of specific risk questions by clearly stating the objectives of the RRA. For example, when one of the objectives of the assessment is to evaluate the possibility of the incursion or spread of a certain infection or pathogen from an infected region into a particular non-infected region, all the relevant characteristics of the infection or pathogen, and the extent of the geographic area under evaluation, must be considered, and the species, subspecies, subtypes and strains of the pathogen must be clearly defined, if necessary. The hosts and/or vector species, spatial area and timeframe covered by the assessment must be defined, including potential pathways of transmission. In general, the more detailed the risk question, the easier it is to identify the data and information required. Examples of ambiguous and correctly worded risk questions and sub-questions are shown in Table 2.

Once the risk questions and sub-questions have been correctly formulated, the available data, evidence and possible sources of information for each question and sub-question must be listed. It is also useful to identify and list the possible approaches to data analysis and the related methods to be used during the risk assessment. In addition, it is during step 4 that the RRA team must decide whether to follow a qualitative or quantitative risk assessment approach (these technical guidelines focus on qualitative risk assessment) and

how to address and communicate uncertainties and gaps in existing data and knowledge. The results of this preliminary evaluation will assist in the identification of the data, timeframe, human resources, skills and expertise required for the risk assessment. For example, the RRA team may decide that an expert with a different skillset from those that are already available is required. It is useful to include the limitations of the selected risk assessment approach in the list of uncertainties.

A template for reporting all of the information required for step 4 in a systematic and standardized way, with an example, is presented in Annex 5.

The risk questions and sub-questions formulated must be closely related to the outcomes of the analysis of risk pathways, which is a cross-cutting component of RRA with interconnections to the formulation of risk questions (see Figure 2).

STEP 5: DATA COLLECTION AND LITERATURE REVIEW

During step 5, after identifying the risk questions and data needs, the RRA team rapidly collects the data and evidence needed for the assessment. Data collection and analysis for supporting risk assessment are costly and resource-intensive and uncertainties related to the data often represent one of the main constraints to the timely production of robust RRAs. The data requirements must be clearly defined in detail in order to guide data research and retrieval activities effectively. The literature review and retrieval of data from national and international databases should cover only the information that is essential for performing the RRA in accordance with the nodes of the identified risk pathways (see the section on Risk pathways on page 15) and the formulated questions and sub-questions.

To facilitate the search for data, eligibility criteria should be defined that take into consideration the animal population(s) of interest, the variable of concern, possible geographical and time restrictions and any other specific conditions related to the variable of interest. These criteria will be used to calculate an uncertainty estimate for each step in the risk pathway.

Eligibility criteria include the design and conditions under which the data have been obtained, the time periods when the data were collected or of the most recent experimental reports, whether the data are consistent throughout several studies and, when available, any measure of uncertainty affecting the values.

When data for some crucial input variables are not available, estimates of likely values can be requested from experts through expert opinion exercises and proxy data can be used when primary data are unavailable.

STEP 6: EXPERT OPINION

If there are gaps in the required information and data, expert opinion is essential for providing the necessary inputs and validating the inputs and data for use in risk assessments. Opinions can be obtained via an online questionnaire, from an expert panel or through focus group discussions and interviews using qualitative techniques. When sufficient time is available, expert knowledge elicitation can be carried out using the systematic methodologies described in Annex 6.

TABLE 3
Example of probability levels for use in entry and exposure assessments

Probability level	Category	Likelihood	Definition
1	Negligible	Extremely unlikely	May only occur in exceptional circumstances
2	Low	Unlikely	May occur, but not in the majority of cases
3	Moderate	Likely	May occur in the majority of cases
4	High	Very likely	Can be expected to occur frequently

STEP 7: PERFORMING THE RAPID RISK ASSESSMENT

Once the risk question(s) are prepared and information for assessing the risks is available, the RRA team performs the RRA. This step can take up to three days. The types of output produced may vary considerably depending on the specific purposes of the RRA. For example, when the main objectives of the assessment are to estimate the probability of a pathogen introduction into pathogen-free countries or zones (entry assessment), or the probability of infection of specific animal or human populations (exposure assessment), the analysis can provide only levels of probability, while assessments that consider the effects of the infection or spread (consequence assessment), both components of the risks – the probability and the consequence – must be taken into account, assessed and jointly evaluated.

Probability estimation – entry and exposure assessment

For each sub-question, the level of probability of the unwanted outcome occurring has to be estimated from a set of probability categories. In entry and exposure assessments, the probability levels reported in Table 3 can be used. Table 3 should be considered only as a general reference to be adapted to each case taking into consideration the implicit and explicit assumptions behind each decision.

Most RRAs can be performed using a qualitative approach, which is easier for decision-makers to understand, particularly because outputs are expressed in terms of risk levels.

Consequence assessment

When the magnitude of the consequences of the occurrence of a certain health event are to be considered, it should be assessed separately from the probability estimation. A health event may have a high probability of occurring, but only minor consequences (such as an endemic disease under a control programme) and vice-versa.

As in probability estimation and uncertainty assessment, consequence levels for use in the assessment must be predefined as in Table 4.

Risk estimation

A simple way to combine probability and consequence levels is to use a simple risk matrix with pre-fixed risk levels (Table 5).

Risk matrices can be very useful for combining results into a single risk estimate, but this methodology must be used carefully. Estimation of the final level of risk should include

TABLE 4
Example of consequence levels for use in animal health-related risk assessments (including for high-impact zoonotic diseases)

Level	Category	Description
1	Negligible	Few herds infected and animals suffering from mild disease. Very small decrease in production and productivity of the herd.
2	Low	Few herds and animals infected suffering from severe disease resulting in both significant production losses and high morbidity. Loss of few animals due to the event and decrease in productivity.
3	Moderate	Several herds and livestock value chains affected and animals suffering severe disease resulting in significant production losses and high mortality. Farmers incurring loss of livestock income and herds becoming unsustainable (herds cannot reproduce themselves). Significant direct economic losses.
4	High	Most herds infected and animals suffering severe disease resulting in significant production losses, high mortality and case fatality. High socio-economic impact with additional losses due to trade restrictions, loss of consumer confidence and impact on tourism and biodiversity.

TABLE 5
Example of a risk matrix combining probability and consequence level

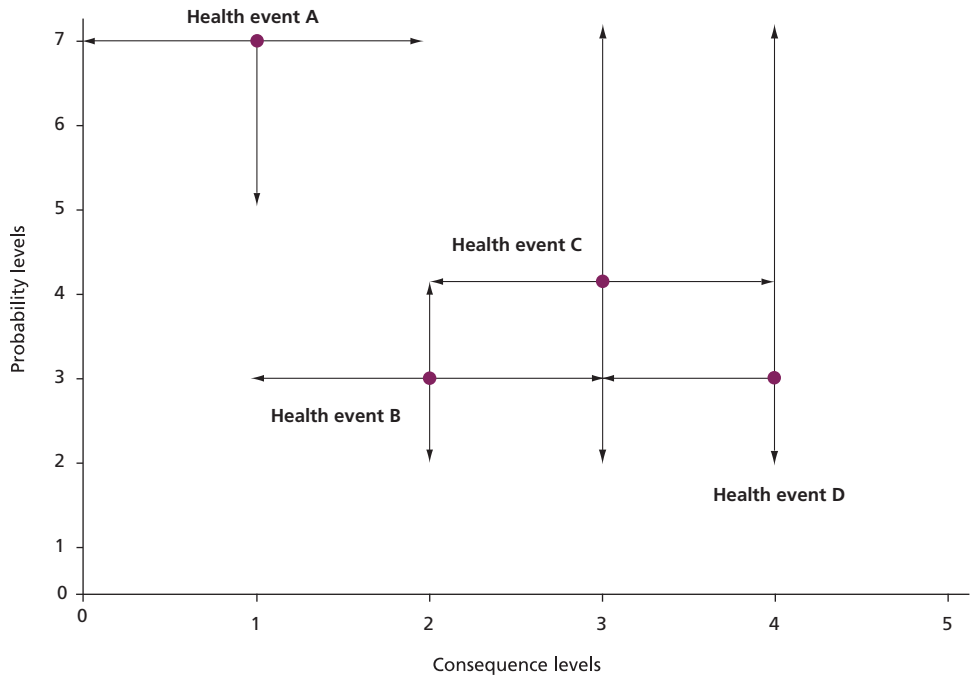
			Consequence			
			1	2	3	4
			Negligible	*Low*	*Moderate*	*High*
Probability	4	*High*	Medium	High	High	Very high
	3	*Moderate*	Low	Medium	High	High
	2	*Low*	Low	Low	Medium	High
	1	*Negligible*	Negligible	Low	Low	Medium

consideration of the type of health event concerned. For events of particular social or public concern, even in the case of minor or moderate consequences and low probability of occurrence, the final risk can be unacceptable for risk managers and require urgent control or prevention actions.

In addition, the selection on how to derive the final risk values from the probability and consequence levels implies judgement regarding the shape of the distribution in the final risk estimate. For example, in Table 5 the risk levels are symmetric, giving the same weight and importance to the various levels. In other words, the choice of a certain type of risk matrix may imply some judgements regarding the acceptable level of risk, which is ultimately the task of risk managers.

The use of risk matrices presents advantages and disadvantages. Advantages include providing a simple visual way to represent risk as a combination of probability and consequences, enabling many stakeholders to participate in the customization of category definitions, and not requiring special expertise in quantitative risk assessment methods or data analysis. However, there are also limitations such as poor resolution resulting from the

FIGURE 3
Example of a probability–consequence diagram for comparing risk estimates related to health events A, B, C and D



Source: Authors.

ability of risk matrices to compare only a small proportion of hazards, and likelihood of error resulting from the assignment of high qualitative ratings to risks that are quantitatively small, suboptimal resource allocation and a cumbersome procedure for the categorization of uncertain consequences (Cox, 2008).

It is essential that the description of risk combines both the probability and the consequences of the risk concerned. Visually displaying both components can be very useful for comparison of risk estimates related to various health events. Figure 3 illustrates a probability–consequence diagram for health events A, B, C and D. In order to allow comparisons among various health events, the probability and consequence levels must be defined in the same way for all the health events being assessed.

STEP 8: RAPID RISK ASSESSMENT REPORT

Once the risks have been assessed, an RRA report has to be prepared. This step can take a few days. As a general recommendation, a draft of the RRA report should be tailored to the audience to which it is directed. When the main target audience is risk managers, the report must be simple, short and succinct, avoiding technical terminology and focusing on the possible implications of the results of the assessment.

In general, an RRA report can include:

Body of the report:

- date and version of the report;
- disease, country and region;
- objective of the RRA;
- version of the assessment;
- risk questions;
- summary description of the event, with its index number if it is linked to a management information system and situation analysis, and description of the hazard profile;
- clear summary with a concise description of the main conclusions from each risk question;
- overall risk assessment statement and uncertainty level;
- summary of the data or evidence supporting the assessment;
- recommendations including science-based actions to be taken to mitigate the risk, based on the socio-economic and epidemiological context.

Annexes:

- the risk questions and sub-questions that have been addressed;
- background to the event;
- scenario tree depicting risk pathways;
- in-depth description of RRA outcomes, with a clear interpretation of possible implications for the selection of appropriate control and prevention measures;
- method(s) used for the assessment;
- list of all possible sources of uncertainty related to the input data and information and the methodology used for the assessment;
- the sources and references of the data used;
- names and designations of risk assessment team members.

An example of a template for an RRA report is provided in Annex 7.

CROSS-CUTTING COMPONENTS OF THE RAPID RISK ASSESSMENT PROCESS

Disease intelligence

Disease intelligence activities consist of continuous monitoring, screening, situation analysis and assessment of emerging and re-emerging threats in order to detect changes in frequency, geographical distribution, transmission patterns, host ranges, virulence and other relevant epidemiological aspects of health events. They require a team or group of people dedicated to the continuous gathering, verification, analysis, assessment and sharing of data and information. Disease intelligence information is gathered from various data sources. Data sources include official and unofficial sources that can be monitored through various approaches and methodologies, including traditional event-based surveillance in the field and the use of innovative web-based tools.

Risk pathways

A crucial step in conducting any risk assessment is the identification and analysis of risk pathways through which a hazard may be introduced and/or spread in a population. This step is interconnected to the formulation of risk questions and the collection of data.

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A veterinarian visiting a herd of horses in Mongolia.

A risk pathway includes all the logical sequences by which a certain animal or human population can be exposed to an infection, or a certain hazard can be transmitted within animal or human populations. It depicts the main mechanisms through which a hazard can, for example, be introduced into or spread throughout a new area. The use of scenario trees is an effective way of depicting risk pathways and:

- identifying data requirements;
- describing a logical chain of events in space and time;
- assisting in the identification of potential risk management measures;
- assisting in estimation of the likelihood of occurrence and subsequent consequences.

By convention, in a scenario tree, boxes or nodes are used to describe the sequence of events, while the probability of each event occurring is defined by an arrow linking the respective boxes or nodes (OIE, 2010).

The probability of transiting from one node to the next is the main objective of step 5 of these guidelines, on data collection. When data are not available, an expert can be asked to estimate these probability values, as described in step 6 in these guidelines, on expert opinion. The correct identification of risk pathways is one of the most crucial components of a risk assessment and must be carefully conducted and revised.

The risk assessors must consider the probability of each event occurring when the event in the previous step of the chain has occurred. For qualitative or semi-quantitative assessments, various approaches may be followed to combine probability ranges or categories.

An example of a scenario tree is shown in Annex 8.

Uncertainty assessment

Assessment of the sources of uncertainty regarding the input data and methods used and their possible effects on the outcomes of the risk assessment is a crucial step in providing a reliable estimation of the level of risks and the associated uncertainty. Uncertainty assessment should not be addressed only at the end of the RRA, but should be considered as soon as the risk questions are formulated and be monitored throughout the RRA process.

TABLE 6
Examples of levels of uncertainty

Level	Description
Low	Information and data that are relevant to the RRA, consistent and not conflicting are available. No subjective judgement is introduced. Published data can be used.
Moderate	Some information and data are lacking, incomplete, inconsistent or conflicting. Subjective judgement with supporting evidence is introduced. Published data can sometimes be used.
High	Most information and data are lacking, incomplete, inconsistent or conflicting. Subjective judgement may be introduced without supporting evidence. Unpublished data are frequently used.

In risk assessments, uncertainty should be clearly documented, with all the sources of uncertainty (including the assumptions made and the methods used for the RRA) described and assigned a qualitative level of uncertainty. Table 6 shows an example of low, moderate and high levels of uncertainty.

For instance, the risk of H7N9 avian influenza spreading from affected areas of China to other areas of China between January and May 2018 through formal or informal trade of eggs could be considered negligible with low uncertainty because the available data were known facts: there was no large-scale trade in eggs for breeding in China during that period, and breeder and layer poultry were vaccinated against H7 in September 2017 (FAO, 2019).

Assumptions must always be listed, clearly reported, and considered as potential sources of uncertainty and treated as such. Assumptions establish the conditions that limit the range of applicability of the assessment results. Generally, assumptions are made and used for the sake of simplicity or they derive from the statistical methods used. For example, in risk assessment models, one assumption is that the animals in a specific population (or sub-population such as those sharing living premises, a region, a pasture, etc.) are considered perfectly representative of that population and are randomly mixed within it. This implies, for example, that all the animals in the same (sub-)population have the same probability of being infected by a certain pathogen or of coming into contact with an infected animal within the (sub-)population. Although this proposition is not biologically sound, it is assumed in order to simplify the calculations and allow probabilistic sampling principles to be applied in the assessment.

When an expert opinion is used and experts are uncertain about the probability level that matches the question, they could express their uncertainty regarding the estimates by providing a range of qualitative probability levels rather than a single level.

The causes of uncertainty, effects of uncertainty on the overall system, and associated assumptions at all phases of the RRA process should be explicitly stated in the report. A rationale for the range of uncertainty indicated should also be provided, listing all the sources of uncertainty sources identified. If time permits, feedback on results can be sought with a view to reaching agreement among experts in order to narrow down the overall uncertainty range.

Risk communication

During the RRA process, the communication of risk always needs to be considered. Interactive and transparent communication of risk should ideally start from the beginning of the RRA process and continue throughout and after implementation (OIE, 2019b; FAO, 2011).

A risk communication process should take into consideration the target audience, stakeholders, perceptions of risk and communication channels.

An important factor to take into account in risk communication is the perception of risk – how key stakeholders perceive the risk. The message and language used in messages and reports on the RRA should be adapted to the risk perception (FAO and WHO, 2016). Risk perception can be influenced by many different factors, as illustrated in Table 7.

RISK COMMUNICATION IN EMERGENCY SITUATIONS

The underlying principles of successful risk communication such as trust, transparency, early announcement, listening and planning (WHO, 2008) should be applied in an emergency situation. Communication is important in building, maintaining or restoring trust between the public and risk managers. Early announcement of health risks is important in preventing the spread of rumours and misinformation. Transparency is required to maintain the public´s trust throughout an outbreak. Listening is crucial to understanding the public´s risk perceptions, views and concerns and facilitates effective communication. Planning is required to ensure effective communication.

TABLE 7
Examples of factors influencing the risk perception

Factor	Increase in perceived risk	Decrease in perceived risk
Naturalness	Unnatural/human-made hazard (e.g., laboratory created pathogen, bioterrorism)	Natural hazard (e.g., known pathogen)
Controllability	Uncontrollable risk (e.g., no measures for prevention in place)	Controllable risk (e.g., emergency measures and prevention in place)
Scientific knowledge	Risks unknown to science (e.g., new pathogen)	Risks known to science (e.g., known pathogen)
Familiarity	New risk (e.g., newly emerging pathogen or exotic disease)	Familiar risk (e.g., re-emerging pathogen)
Control over exposure	Involuntary exposure to hazard (e.g., migratory birds)	Control over exposure to hazard (e.g., illegally imported live animals)
Immediacy of consequences	Immediate consequences (e.g., high mortality)	Delayed consequences (e.g., loss of productivity)
Distribution	Uniform distribution of risk (e.g., multiple outbreaks in the country)	Unequal distribution of risk (e.g., outbreak in one village)

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Smallholder poultry farm feeding his chickens in Sukabumi, Indonesia.

An important distinction to be taken into account is whether the RRA communication is about an emerging risk or an imminent crisis. When an emerging risk occurs, messages are often direct, frequent and urgent. An emerging risk requires a rapid and effective response, and there may not be enough time for full consultations with all target audiences and key stakeholders for informing the development of messages. There may be incomplete information about the extent and impact of the risk or who is affected; this will need to be addressed in the communication. Coordination of communications among principal stakeholders is also important in order to avoid contradictory messages and public confusion.

RISK COMMUNICATION ON ENDURING RISKS

Enduring risks which last for prolonged periods often require sustained communications. In addition, more detailed information about the risks may be available. For example, communication might focus on stakeholders' roles in good biosecurity practices following an outbreak. In these cases, messages are often developed, refined and distributed over time (for example, when warning farmers not to give food waste to animals, or to respect biosecurity), or at specific periods of high risk, such as during the summer for vector-borne diseases.

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Annexes

Annex 1

Participants in the technical expert meeting on the development of a rapid risk assessment method,

(FAO Headquarters, July 2018)

Name of participant	Institution
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Annex 2
Terminology

Term	Definition	References
Bias	Systematic deviation of results or inference that distorts the view of what is occurring.	WHO, 2012
Communication channels	The effectiveness of different communication channels is influenced by the goal of the risk communication, the content or nature of the message (e.g., the urgency) and its accessibility for and use by target audiences. For example, during an emergency, the media and social networks are usually the most rapid means of disseminating information.	FAO and WHO, 2016
Confidence	The degree to which the assessment team is sure of an estimate. It reflects what in some disciplines is referred to as the certainty or uncertainty about an estimate.	WHO, 2012
Consequence	The downstream effects resulting from an action or condition, which may be negative or positive. A negative health consequence causes or contributes to ill health. Consequences may include social, technical and scientific, economic, environmental, ethical or policy and political effects.	WHO, 2012
Diagnostic sensitivity	The proportion of reference animals known to be infected that test positive in the assay; infected animals that test negative are considered to have false negative results.	OIE, 2019a
Diagnostic specificity	The proportion of reference animals known to be uninfected that test negative in the assay; uninfected reference animals that test positive are considered to have false positive results.	OIE, 2019a
Entry assessment (formerly known as release assessment)	A description of the biological pathway(s) along which pathogenic agents are introduced into a particular environment, combined with an estimation of the probability, qualitative or quantitative, of that introduction occurring.	Adapted from OIE, 2010
Exposure assessment	A description of the biological pathway(s) along which animals and humans in the importing country are exposed to hazards (in this case, pathogenic agents) released from a given risk source, combined with an estimation of the probability, qualitative or quantitative, of that exposure occurring.	OIE, 2010
Hazard profile	A concise description of a health problem and its context, the current state of knowledge of the problem and potential risk management options, including health policy that may influence additional possible actions.	Adapted from CAC, 2007
Hazard	A biological, chemical or physical agent in, or a condition of, an animal or animal product with the potential to cause an adverse health effect.	OIE, 2019b
Hazard identification	A step in the risk analysis process. It involves identifying the pathogenic agents that could produce adverse consequences. It is a step in categorization that helps to identify whether biological agents are hazards or not.	OIE, 2019b
Health event	Any event that may have negative health consequences on humans and/or animals.	Adapted from WHO, 2012
Impact	The magnitude of the biological and economic consequences of a health event occur, should it occur.	

(Cont.)

Term	Definition	References
Qualitative risk assessment	A reasoned logical discussion of the relevant commodity, epidemiology and economic factors associated with a hazard where the outputs on the likelihood of the outcome or the magnitude of the consequences are expressed in qualitative terms such as high, medium, low or negligible.	OIE, 2010
Quantitative risk assessment	A risk assessment in which the outputs are expressed numerically. It usually involves the development of a mathematical model that links the steps in the risk pathway.	OIE, 2010
Rapid risk assessment (RRA)	The timely assessment of the risk in qualitative terms to animal and human health arising from a health event. An RRA is typically delivered in a few days (24–48 hours) or weeks (1–2 weeks).	
Risk	The likelihood of the occurrence of an adverse event and the likely magnitude of the biological and economic consequences and the effects on animal or human health of that event.	OIE, 2019b
Risk assessment	Evaluation of the likelihood and the biological and economic consequences of the entry, establishment and spread of a hazard. It is a systematic process for gathering, assessing and documenting information to inform the assignment of a level of risk. It involves evaluating the risk (or risks, as there may be more than one) resulting from a hazard and describing the risk(s) in terms of the likelihood (probability) and the impact (consequences) of an unwanted outcome. An unwanted outcome is a harmful or damaging event that may (or may not) be caused by the hazard (e.g., flooding, an epidemic). The risk assessed is a combination of the likelihood of the unwanted outcome happening and its impact if it should happen.	OIE, 2019b WHO, 2012 FAO, 2011
Risk communication	The interactive transmission and exchange of information and opinions concerning risk, risk-related factors and risk perceptions throughout the risk analysis process among risk assessors, risk managers, risk communicators, the general public and other interested parties.	OIE, 2019b
Risk management	The process of identifying, selecting and implementing measures that can be applied to reduce the level of risk.	OIE, 2019b
Risk perception	The judgements that stakeholders and the general public make about the characteristics, likelihood and severity of a specific risk. Addressing people's risk perception is part of the risk communication process.	FAO and WHO, 2016
Semi-quantitative risk assessment	A risk assessment in which the outputs are expressed in semi-qualitative terms (as scores), associated with numerical ranges of probability and severity of impact. It involves assigning numbers to qualitative estimates by using probability ranges, weights or scores and combining them by addition, multiplication or other mathematical operations.	OIE, 2010
Stakeholders	An individual or group of people who may be affected by a particular issue, or may influence the issue. Stakeholders in an RRA may include representatives of government, industry, farmer and consumer associations, non-governmental organizations, universities and research institutes. Ideally, stakeholders should be involved from the beginning of the risk assessment and their contributions and opinions should be taken into account in the formulation of risk questions.	FAO and WHO, 2016
Target audience	A group or subgroup of stakeholders towards whom messages, risk communications or potential recommendations are aimed. The target audience of an RRA may include risk managers, farmers, other risk assessors and the general public	FAO and WHO, 2016
Threat	A potentially damaging event or incident. In these guidelines, threat is also defined as an outbreak or incident occurring in one or several countries and having an impact on public health at the international level.	ECDC, 2011

(Cont.)

Term	Definition	References
Triage	The process of determining whether an event or alert detected by a surveillance system poses a potential risk to public and/or animal health and prioritizing it for action.	Adapted from WHO, 2012
Uncertainty	All the limitation of the available knowledge that affect the range and probability of possible answers to an assessment question.	EFSA Scientific Committee *et al.*, 2018
Variability	The heterogeneity of values over time, space or different population groups.	EFSA Scientific Committee *et al.*, 2018

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Annex 3

Examples of triage criteria and their use

Example 1: First occurrence/introduction of African swine fever (ASF) in China

Criteria	Scoring (Yes = 1; No = 0)
1. Credibility of data sources	
Has the event been reported or confirmed by an official source (e.g., animal health authorities, FAO offices, OIE, WHO)?	1
Has the event been reported by multiple independent unofficial sources (e.g., media, ProMED,* reports from field sources, twitter)?	1
Subtotal score =	2
2. Severity of the disease and its consequences	
Has the international spread of the disease (via live animals or their products, vectors or fomites) been proven?	1
Has the disease been shown to have a significant impact on the health of domestic animals at multi-country level?	1
Is it a zoonotic disease associated with severe consequences for public health?	0
Has the disease been shown to have a significant impact on animal production and/or trade, with possible detrimental economic consequences for the affected country or countries?	1
Has the disease been shown to have a significant impact on the health of wildlife, or on the environment, including biodiversity, in one or more countries?	1
Has the causative agent developed resistance to treatments that poses a significant danger to public and/or animal health?	0
Subtotal score =	4
3. Relevance of the health event	
Is the observed health event possibly linked to the evolution or change of an existing disease agent?	0
Is the observed health event related to a known disease spreading to a new geographic area, species or population?	1
Is the observed health event related to a known disease occurring with an increased incidence or morbidity in host population(s)?	0
Is the observed health event caused by an unknown or previously unrecognized disease agent?	0
Is the disease affecting vulnerable groups of the population, such as infants or elderly people, who are likely to be disproportionately affected?	0
Is the observed health event characterized by a high actual or potential level of media interest or public concern?	1
Subtotal score =	2
Total score =	8/14

* ProMED = Program for Monitoring Emerging Diseases.

Example 2: Reoccurrence of Rift Valley fever in Kenya in 2018

Criteria	Scoring (Yes = 1; No = 0)
1. Credibility of data sources	
Has the event been reported or confirmed by an official source (e.g., animal health authorities, FAO offices, OIE, WHO)?	1
Has the event been reported by multiple independent unofficial sources (e.g., media, ProMED,* reports from field sources, twitter)?	0
Subtotal score =	1
2. Severity of the disease and its consequences	
Has the international spread of the disease (via live animals or their products, vectors or fomites) been proven?	1
Has the disease been shown to have a significant impact on the health of domestic animals at multi-country level?	0
Is it a zoonotic disease associated with severe consequences for public health?	1
Has the disease been shown to have a significant impact on animal production and/or trade, with possible detrimental economic consequences for the affected country or countries?	1
Has the disease been shown to have a significant impact on the health of wildlife, or on the environment, including biodiversity, in one or more countries?	0
Has the causative agent developed resistance to treatments that poses a significant danger to public and/or animal health?	0
Subtotal score =	3
3. Relevance of the health event	
Is the observed health event possibly linked to the evolution or change of an existing disease agent?	0
Is the observed health event related to a known disease spreading to a new geographic area, species or population?	0
Is the observed health event related to a known disease occurring with an increased incidence or morbidity in host population(s)?	1
Is the observed health event caused by an unknown or previously unrecognized disease agent?	0
Is the disease affecting vulnerable groups of the population, such as infants or elderly people, who are likely to be disproportionately affected?	0
Is the observed health event characterized by a high actual or potential level of media interest or public concern?	0
Subtotal score =	1
Total score =	5/14

* ProMED = Program for Monitoring Emerging Diseases.

Annex 4
Example of the contents of a hazard profile

The following aspects should be compiled in a hazard profile.

CLASSIFICATION OF THE CAUSATIVE AGENT

- virus, bacteria, parasite, protozoa, fungus, biological toxin, prion;
- taxonomic name;
- number of strains;
- different levels of pathogenicity of strains and related importance for immunogenicity/vaccination.

PERSISTENCE

- chemical and physical tolerance (pH, temperature, disinfectants, resistance to ultraviolet light);
- presence in meat, germinal products, dairy products, skins and hides, mechanic and biological vectors.

PATHOGENESIS

- dynamics of infection and replication in vertebrate hosts: organs with pathogen replication, organs where the pathogen can persist and timing, length of viraemia, shedding routes and timing;
- characteristics of immune response in vertebrate hosts: timing and length of antibody response (for each antibody class) to natural infection and vaccination, length of maternal immunity, importance for serological diagnosis;
- dynamic of infection and replication in invertebrate hosts (for vector-borne diseases): vector competence, extrinsic incubation period, presence of transovarial/transstadial transmission.

EPIDEMIOLOGY

- definitive hosts;
- intermediate hosts;
- reservoirs;
- zoonotic potential;
- vectors implicated (biological, mechanical);
- transmission: direct or indirect, transovarial, transplacental, sexual transmission, direct contact, aerosol, etc.;

- sources of disease agent and their relevance for agent transmission/spread: carcasses, fresh or frozen meat, skins and hides, germinal products, environment or water;
- geographical distribution: enzootic, epizootic, sporadic or seasonal;
- transmission parameters such as basic reproduction number (R0), infectious period.

DIAGNOSIS

- clinical signs and pathognomonic signs;
- differential diagnosis;
- laboratory tests available and their performance (sensitivity and specificity), OIE gold standard tests and those recommended for international animal trade.

PREVENTION AND CONTROL

- prevention measures for international trade (OIE);
- availability of vaccination or antimicrobial treatment;
- control strategies applied: culling of all contact animals, culling of only affected animals, recommended size of control zones, (emergency) vaccination, movement restrictions, screening, other control strategies;
- feasibility of vector control measures.

IMPACT

- number of outbreaks and number of species/animals affected in main epidemics (reported by year, country or other relevant epidemiological features) according to available official and unofficial data;
- morbidity per species;
- case fatality rate per species;
- production losses;
- tourism losses;
- losses due to reduction of consumer confidence;
- animal welfare;
- trade restrictions, by commodity;
- environmental impact, impact on biodiversity;
- public health impacts;
- economic impact considering the costs of prevention, control, eradication, trade restrictions, production losses, mortality, human disease.

Annex 5

Example of the formulation of rapid risk assessment objectives and risk questions and sub-questions

OCCURRENCE OF RIFT VALLEY FEVER (RVF) HUMAN CASES IN THE NIGER IN 2016

The RRA had the following objectives:

a. to assess the risk of RVF spreading into neighbouring countries;

b. to assess the potential consequences for public and animal health in the Niger.

The following table provides examples of possible questions and related sub-questions.

Question	Sub-question	Data required	Data sources	Data analysis
What is the probability of RVF spreading in the following six months into Mali, Burkina Faso, Benin or Nigeria considering that the RVF first occurred in the Niger?	What is the risk of RVF spreading by contiguity, through infected vectors (via either active vector movement or windborne dissemination)?	• Duration of infection in vectors and in vertebrate hosts • Data related to vector capacity (animal/vector density, biting rate, vector survival, vector competence) • Biological characteristics of vectors (temperature range/humidity conditions for breeding/ hatching, etc.) • Biotic and abiotic conditions in countries where the disease could potentially spread	• Literature review • Expert opinion	• Vector Capacity Calculation • Modelling • Expert knowledge elicitation
	What is the risk of RVF being spread by animal movements?	• Data on international trade in live ruminants in the region • Data on animal movement for pastoralism, transhumance, etc.	• Literature review • International databases • Expert opinion	• Modelling • Expert knowledge elicitation

(Cont.)

Question	Sub-question	Data required	Data sources	Data analysis
What are the potential consequences for public and animal health in the Niger in the six months following the report of the outbreak?	What is the expected impact on public health in the Niger?	• Incidence of human cases in previous similar circumstances • Length of epidemic • Data on the proportion of severely affected people	• Data from official notifications • Results from ad hoc surveys • Literature review • Expert opinion	• Modelling • Expert knowledge elicitation
	What is the expected impact on animal health and production in the Niger?	• Prevalence and incidence in the different animal species, categories of animal (young, adult) and seasons • Basic reproduction number • Demographic data on vertebrate hosts • Efficacy of vaccination • Vaccination rate	• Data from official notifications • Results from ad hoc surveys • Literature review • Expert opinion	• Modelling • Expert knowledge elicitation
	Is there any trade impact for the Niger?	• Are there any existing trade certificates that require RVF freedom at the regional or country-wide level? What is the value of the export market?	• Data from trade sources (e.g., United Nations Statistics Division, Comtrade) • Import/export teams for certificate requirements	• Economic analysis of trade impacts • Cost–benefit analysis of disease control measures

Annex 6
Expert knowledge elicitation

Expert knowledge elicitation (EKE) is a standardized method of obtaining knowledge from experts who can be asked for specific information (data, facts, etc.) or judgements (probabilities, estimates, etc.), the latter being more challenging as experts are frequently asked to use their expertise to estimate uncertain quantities. The estimations made by the experts are personal and subjective and express the expert's own beliefs. Elicitation methods aim to reduce this subjectivity through consensus or mathematical aggregation of experts' estimates.

Three EKE methodologies are presented in the following paragraphs. The time required to implement these methodologies ranges from ten days to several months.

The Sheffield protocol. This method allows experts to interact with each other during face-to-face meetings or elicitation workshops during which they discuss and exchange opinions about the questions concerned under the supervision of the elicitor. EKE through this method can be completed in two to three days following at least two weeks of preparation. Discussion among the experts is required in order to seek consensus on the estimates (behavioural aggregation). This method does not need mathematical manipulation and aggregation of estimates. Results can be quite robust as they derive from an in-depth discussion among experts. Possible shortcomings include issues related to the management of groups where minority opinions, although valid, may be overwhelmed by the most popular judgements or dominant personalities.

Cooke's method. This method requires between ten days and two weeks for completion and is highly dependent on the availability of the experts, especially when a web survey is used rather than individual interviews. Much attention needs to be devoted to the formulation of questions in the questionnaire to avoid misunderstandings in the interpretation of respondent experts, and mathematical procedures for the aggregation of answers must be carefully chosen and applied to avoid unwanted distortions. This method does not allow the experts to discuss their judgements and interaction is limited to the initial training and briefing session. Instead of behavioural aggregation, a form of mathematical aggregation is applied. Weighted aggregation of experts' estimations is carried out. For this purpose, seed questions are used to "calibrate" the experts, identify those who are most capable of giving judgements with high precision, and define the weight to be applied to the opinion of each expert.

The Delphi method. This method shares features with both of the others and is the most time-consuming of the three. Repeated rounds of elicitation are managed by an elicitor over a period of up to several weeks. Judgements from each round are returned to the experts in the subsequent round anonymously. EKE through this method can be carried out through a web-survey approach alone. When all rounds are completed, final estimates are obtained via simple, equal-weighted, mathematical aggregation.

Selection of the method for performing an EKE should take into consideration:

- the deadlines and time available for performing a formal EKE;
- the availability of human and financial resources for physical meetings and/or elicitation workshops;
- the languages spoken by the experts and difficulties in finding a common language;
- the disciplines of the experts and possible difficulties in reaching a common understanding regarding the risk questions and related terminology;
- the possible existence of differences in opinion due to institutional relations or scientific positions.

Further details on how to aggregate the judgements provided by experts during an EKE are provided in the following paragraphs.

PROBABILITY EXPRESSED USING CATEGORICAL LEVELS

If experts are requested to express their probability judgements using categorical levels, the following method can be used to aggregate their estimates:

1. If it is possible to gather experts (even by telephone) for a collegial discussion, agreement should be reached through discussion of discrepancies among the judgements (starting with the most extreme values) and the rationale for them.
2. If it is not possible to gather experts or agreement is not reached, the uncertainty in the judgement has to be reflected in terms of a range of levels with the minimum and maximum levels estimated by the experts delineating the lower and upper bounds of the range. For instance in a case where three experts provide levels of 2, 2 and 3, the aggregated judgement would be "between 2 and 3" (i.e., ranging from "unlikely" to "likely"). The range reflects the heterogeneity of judgements among experts.
3. As an alternative, an empirical distribution could be set based on the relative frequency with which the experts select each level as an estimate. In the example above, a frequency of 66.66 percent (two out of three experts) would be assigned for level 2 and 33.33 percent (one out of three experts) for level 3, reflecting the uncertainty in the judgements or estimates among the experts.

PROBABILITY EXPRESSED USING RANGES

When individual judgements are expressed as ranges of levels, two options are available:

1. Use face-to-face, telephone or virtual discussions to seek agreement among the experts regarding the range.
2. If this cannot be achieved, determine the aggregated range by computing the minimum of the lower bounds and the maximum of the upper bounds of all the ranges indicated by the experts. For instance, if three experts provide the following estimated probability levels:
   - from 1 to 2 ("extremely unlikely" to "unlikely");
   - from 1 to 3 ("extremely unlikely" to "likely");
   - from 2 to 3 ("unlikely" to "likely");

   the aggregated probability estimate would be: from 1 ("extremely unlikely") to 3 ("likely") or from < 1 percent to 66 percent. In this case, the range will reflect the uncertainty in each

judgement and the variability in judgement among the experts, with all the values in the range considered equally probable.

3. As a third option, an empirical distribution could be set by calculating the relative frequency of each of the levels included in the ranges provided by the experts. In the example above, in which a total of seven overall probability levels are expressed by the three experts (two by the first expert, three by the second and two by the third), a step function with frequency of 0.29 = 2 out of 7; 0.43 = 3 out of 7; 0.29 = 2 out of 7 for levels 1, 2 and 3 respectively, would reflect the uncertainty in the judgements/estimates, with differential probability reflecting the differences in the confidence assigned to the various levels.

Annex 7

Report template for a rapid risk assessment of a health threat event

Confidentiality notice: This document is confidential and contains information and intellectual property of (name of institution). Neither this document nor any of the information contained herein may be disclosed or distributed.

Date of start of the RRA: dd/mm/yyyy

Index number of disease event (if in the information management system):

Disease, country and region:

Objective of the assessment:

Version of the assessment:

Last update made by:

Summary of the event and hazard profile

-
-
-
-
-

Risk questions

Overall risk assessment statement and uncertainty

Summary data or evidence supporting the assessment

Recommendations/actions

-
-
-
-
-

Risk assessment (please note that the risk assessment questions need to be adapted to the specific objective of the risk assessment)

Likelihood (1 = extremely unlikely; 2 = unlikely; 3 = moderately likely; 4 = highly likely)	Consequence (1 = negligible; 2 = minor; 3 = moderate; 4 = severe)	Risk (negligible, low, medium, high)	Uncertainty (low, moderate, high)
Risk question 1: What is the risk of disease A spreading among animal species B from region X to region Y in country Z between May and July of year XXXX?			
Rationale			
Related sub-question: What is the risk of disease A spreading among animal species B from region X to region Y in country Z by competent vectors between May and July of year XXXX?			

Rationale			
Related sub-question: What is the risk of disease A spreading among animal species B from the movement of animals from region X in country Z to region Z in country B between May and July of year XXXX?			
Rationale			
Risk question 2: What is the risk of humans being infected with disease A by vectors in region X in country Z to region Z in country B between May and July of year XXXX?			
Rationale			
Risk question 3: What are the potential consequences for public and animal health in country Z in the six months following the report of the outbreak?			
Rationale			

Annex 1: Event background to and background information on the specific health threat

Annex 2: Scenario tree of risk pathways (an illustration of the risk questions and the timeline)

Annex 3: Risk matrix used

Experts consulted

Risk assessment team members

Name	Role/designation

References and data sources

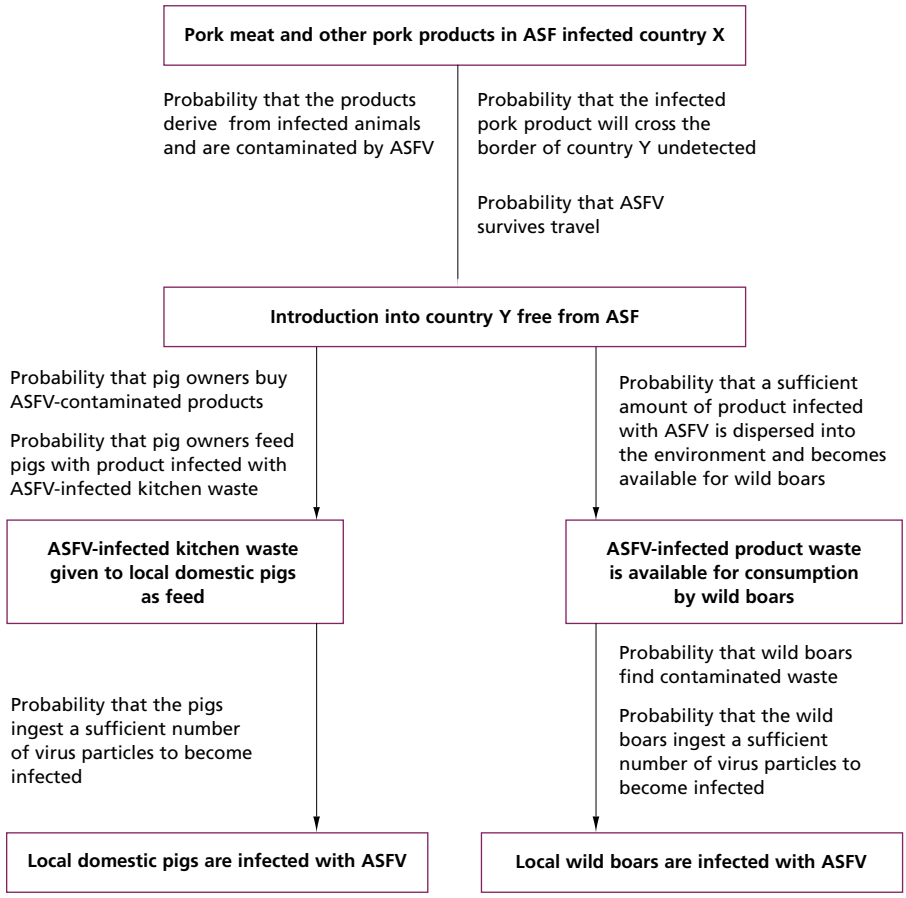
Disclaimer

Document information: Based on a comprehensive review of official information from various sectors and technical documents, in this risk assessment document, we assess the risk of XXX [insert here the main risk question]. We separately consider the likelihood and the consequence(s) of an epidemic, and the impact of the epidemic based on XX questions.
Aim of the RRA
Statement This summary of the risk assessment is based on information available to date [dd/mm/yyyyy] and will be reviewed as new findings emerge from field investigations, laboratory testing and epidemiological studies.
Contacts

Annex 8
Example of a scenario tree

The following is an example of a scenario tree depicting risk pathways of the introduction of African swine fever virus (ASFV) into country Y, which is not infected by African swine fever (ASF), through contaminated pork meat and other pork products from ASF infected country X and the subsequent infection of local domestic pigs or wild boar in country Y.

FIGURE 4
Scenario tree for the introduction of ASFV into country Y through contaminated pork meat and other pork products and subsequent infection of local domestic pigs or wild boar



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FAO ANIMAL PRODUCTION AND HEALTH GUIDELINES

1. Collection of entomological baseline data for tsetse area-wide integrated pest management programmes, 2009 (En)
2. Preparation of national strategies and action plans for animal genetic resources, 2009 (En, Fr, Es, Ru, Zh)
3. Breeding strategies for sustainable management of animal genetic resources, 2010 (En, Fr, Es, Ru, Ar, Zh)
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5. Guidelines for the preparation of livestock sector reviews, 2011 (En)
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15. The feed analysis laboratory: establishment and quality control – Setting up a feed analysis laboratory, and implementing a quality assurance system compliant with ISO/IEC 17025:2005, 2013 (En)
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17. Biosecurity guide for live poultry markets, 2015 (En, Fr[e], Zh[e], Vi)
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Ar – Arabic
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Pt – Portuguese
Ru – Russian
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Zh – Chinese

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[e] E-publication

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The occurrence and spread of an animal health threat can be prevented when a timely assessment of the risk is carried out to inform prevention, response and control measures. These technical guidelines on rapid risk assessment (RRA) are designed as a simple and practical tool to be used by veterinary services to build risk assessment capacities and assist decision-makers in conducting qualitative RRA on the emergence, occurrence and/or spread of animal health threats. Using available evidence, data and information, a multidisciplinary team can conduct an RRA in a short time (within two weeks).

The publication provides a simple and flexible methodology for conducting a RRA when facing a disease event. Eight steps in the RRA process are described and detailed examples are provided. The final outcomes of the RRA provide robust evidence and guidance for decision-makers in designing timely prevention, control and eradication measures that contribute to sustainable livelihoods, animal health, public health and enhanced food security.

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