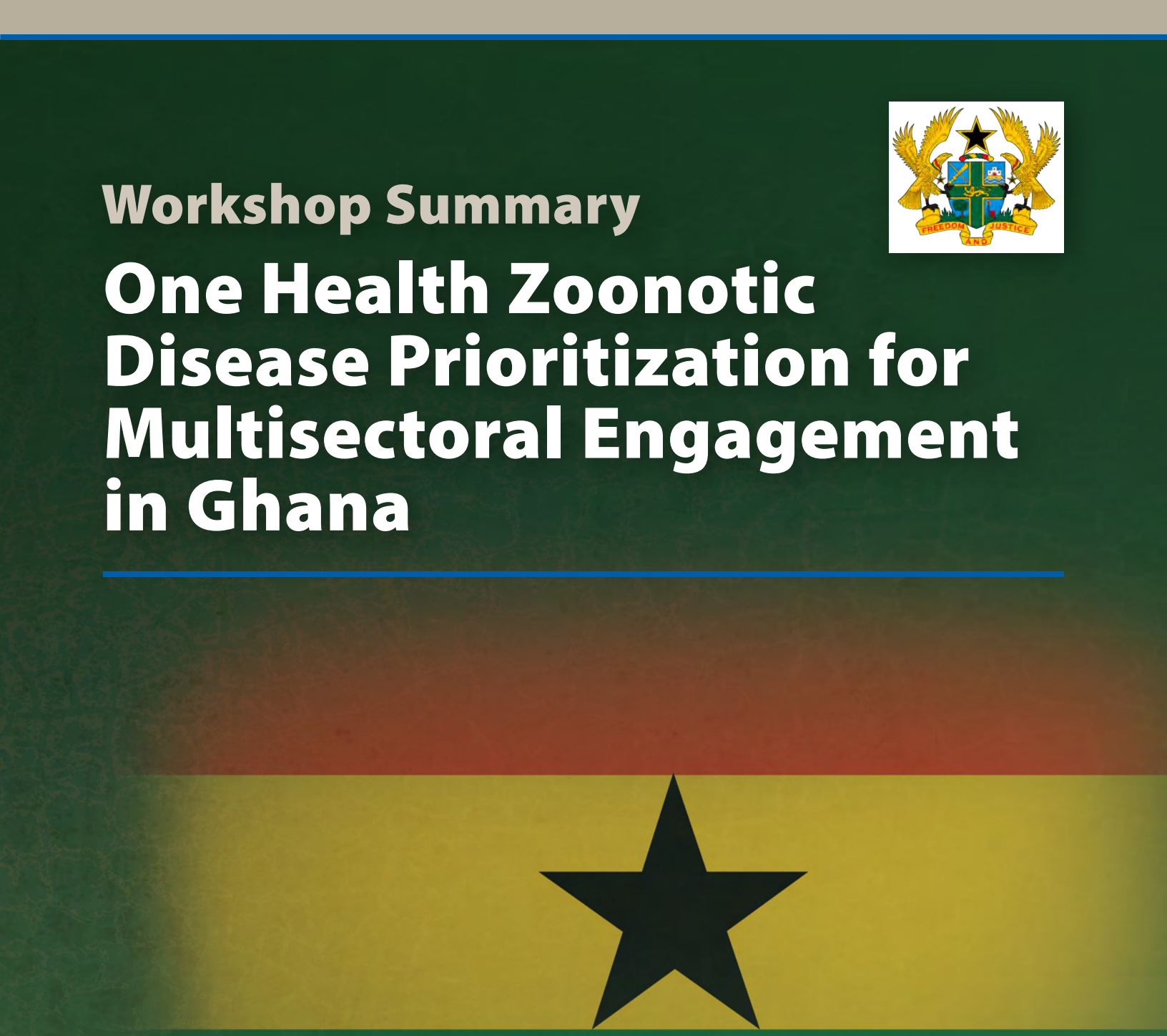
Workshop Summary

One Health Zoonotic Disease Prioritization for Multisectoral Engagement in Ghana



Accra, Ghana

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Photo 1. Kakum National Park Cape Coast, Ghana.

DISCLAIMER

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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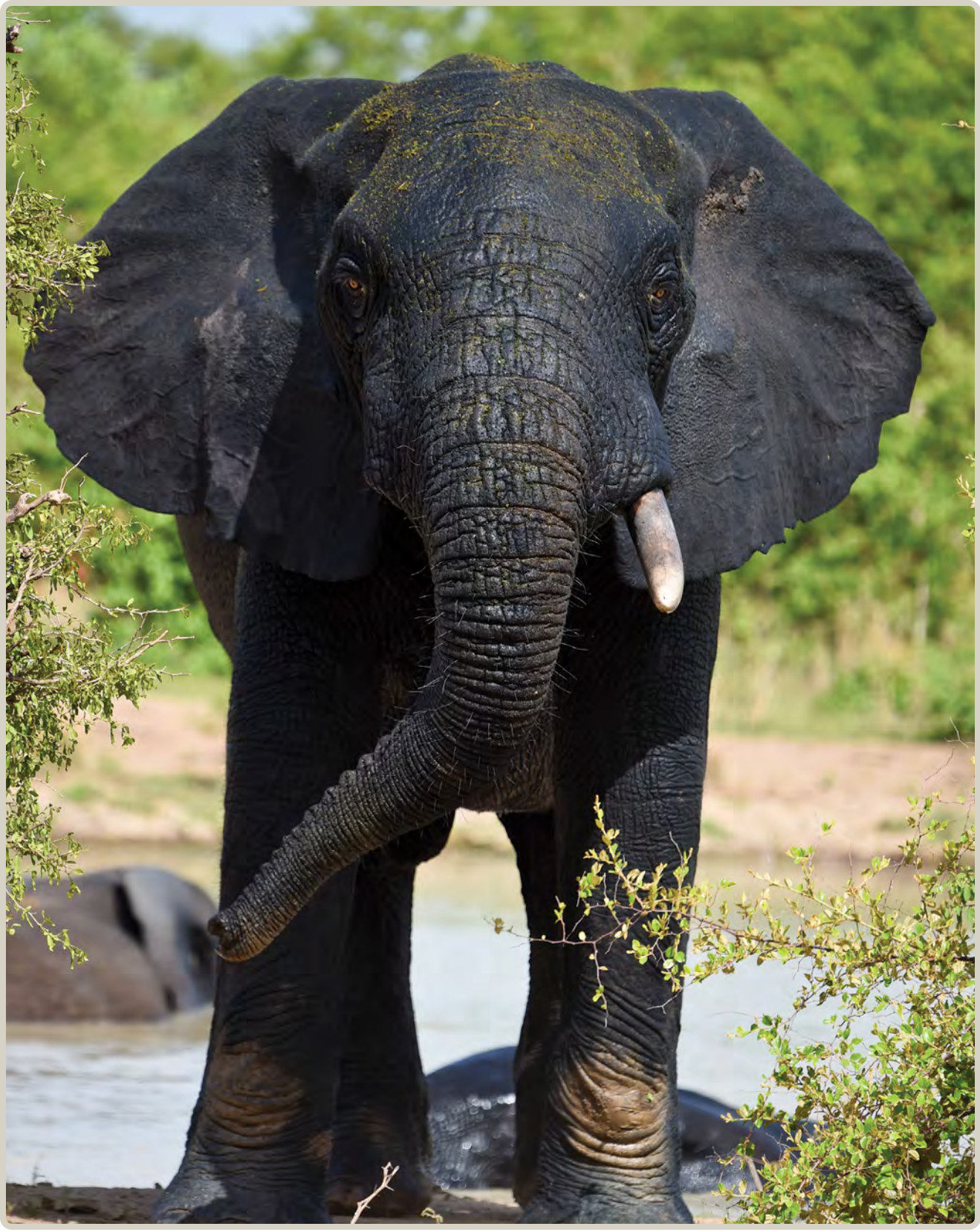


Photo 2. African elephant on the waterhole banks in Mole National Park in Ghana.

PARTICIPATING ORGANIZATIONS

Ministry of Environment, Science, Technology, and Innovation (Environmental Protection Agency) Ministry of Food and Agriculture (Veterinary Services Directorate)

Ministry of Health (Ghana Health Service)

Ministry of the Interior, National Disaster Management Organization

Ministry of Lands and Natural Resources, Forestry Commission, Wildlife Division

Ministry of Local Government and Rural Development

Ghana Library Association

Noguchi Memorial Institute for Medical Research

Ghana Private Veterinarian Association/Private Veterinary Hospitals

Kwame Nkrumah University of Science and Technology (Kumasi Center for Collaborative Research in Tropical Medicine)

University of Ghana, School of Medicine and Dentistry

University of Ghana, School of Public Health

University of Ghana, School of Veterinary Medicine

Veterinary Council of Ghana

Food and Agriculture Organization of the United Nations, Ghana (FAO)

Food and Agriculture Organization of the United Nations, ECTAD, Regional Office

Centers for Disease Control and Prevention (CDC)

United States Agency for International Development, Ghana (USAID)

United States Agency for International Development, PREDICT-2

SUMMARY

The purpose of this 2-day One Health Zoonotic Disease Prioritization (OHZDP) Workshop was to identify zoonotic diseases of greatest national concern for Ghana using equal input from representatives of human health, livestock, environment, wildlife, research, development partners, and higher education sectors. During the workshop, representatives identified a list of zoonotic diseases relevant for Ghana, defined criteria for prioritization, and determined questions and weights relevant to each criterion. Six zoonotic diseases were identified as a priority by participants using the One Health Zoonotic Disease Prioritization tool, a semi-quantitative selection tool, developed by the U.S. Centers for Disease Control and Prevention (CDC) (Appendix A).[1, 2]

The prioritized zoonotic diseases for Ghana are anthrax, rabies, zoonotic avian influenza, zoonotic tuberculosis, viral hemorrhagic fevers (including Ebola, Lassa fever, yellow fever, dengue fever, etc.), and trypanosomiasis (Table 1). The final results of the OHZDP process and normalized weights for all zoonotic diseases discussed at the OHZDP Workshop in Ghana are shown in Appendix B. This report summarizes the One Health process used to prioritize the top zoonotic diseases for Ghana that should be jointly addressed using a multisectoral, One Health approach including human, animal, and environmental health ministries and other sectors relevant to the prioritized zoonotic diseases.

Photo 3. Fishing boats in Cape Coast in Ghana

Table 1. Description of priority zoonotic diseases selected in Ghana by voting members using a multisectoral process in the One Health Zoonotic Disease Prioritization Workshop conducted in March 2018.

Zoonotic Disease	Causative Agent	Human Disease Burden	Animal Disease Burden	Diagnostics, Treatment, and Prevention
Anthrax	*Bacillus anthracis*	Outbreaks are reported annually among humans. Anthrax has been associated with infected livestock through direct contact or contaminated animal products.[3]	Anthrax is endemic in Ghana and annual outbreaks usually occur in the north among livestock.[4]	An effective animal vaccine and treatment for humans (antibiotics) exist.[5]
Rabies	Rabies virus	In 2015, there were 34 human deaths due to rabies in Ghana and 55 deaths in 2016. The most recent reported death was in January 2017.[6]	In Ghana, rabies virus actively circulates in dogs, particularly domestic dogs during the dry season (dog breeding season).[7–9]	An effective animal vaccine exists, and human vaccines are available but expensive. Post-exposure prophylaxis is available but there is no specific treatment for the disease.[10]
Zoonotic avian influenza	Influenza A virus	No human cases of zoonotic avian influenza have yet been reported in Ghana.	In 2018, an H9N2 outbreak occurred among poultry, with a 100% mortality rate.[11] H5N2 and H5N1 have also been previously reported in Ghana.[12,13]	Vaccines for avian influenza virus are available for both animals and humans.[14] Treatment for humans includes supportive care and antiviral agents.[15]
Zoonotic tuberculosis	*Mycobacterium* spp.	The incidence rate of all tuberculosis in Ghana is 211 per 100,000 people; however, it is unknown what proportion of this burden is zoonotic.[16]	Zoonotic tuberculosis primarily affects cattle or buffalo and is prevalent throughout Ghana.[17,18]	A vaccine and treatment are available for humans, but not animals.[19,20]
Viral hemorrhagic fevers (Ebola, Lassa, yellow fever, dengue fever, etc.)	Ebola virus, Lassa virus, Yellow fever virus, Dengue virus	No cases of Ebola or dengue fever have been reported in Ghana. One case of Lassa fever was reported in 2018.[21] Yellow fever is endemic in Ghana.	Viral hemorrhagic fevers (VHFs) are not known to infect animals in Ghana.	Currently, there are no animal vaccines for VHFs; however, human vaccines are available for yellow fever and dengue fever. Human Ebola vaccines are undergoing clinical trials. Treatment for humans is supportive care; ribavirin may be helpful in treatment of Lassa fever.[22,23]
Trypanosomiasis	*Trypanosoma* spp.	Trypanosomiasis is rarely reported in humans, with only sporadic cases.[24]	Trypanosomiasis is endemic in Ghana and has a high mortality rate among livestock.[25]	No vaccine exists for humans nor animals. Treatments exist for humans and animals; however availability, side effects, and the treatment regimen may limit their use.[26,27]

BACKGROUND

Zoonotic diseases are diseases shared between animals and people. Most known human infectious diseases and about three-quarters of newly emerging infections originate from animals. Ghana is particularly vulnerable to the effect of zoonotic diseases because approximately 46% of the population is engaged in agriculture.[28] Of these individuals, 74% are involved in livestock farming and crop farming, with 5% engaged in livestock production alone.[29] Ghana is noted to have 1.8 million cattle, 7.1 million goats, 4.9 million sheep, 760,000 pigs, and 80.3 million poultry.[30] Other livestock in Ghana include donkeys, horses (approximately 14,800), rabbits, and grasscutters.[29] There are approximately 570,000 dogs and 126,000 cats.[30] Zoonotic diseases from wildlife represent a significant, growing threat to global health. Harvesting (hunting), consumption, and trade of bush meat are important causes of both biodiversity loss and potential zoonotic disease emergence. Ghana is considered a biologically rich country with 16 Wildlife-Protected Areas (PAs), 5 coastal Ramsar Sites, and the Accra and Kumasi Zoos. There are also community-owned wildlife sanctuaries. Ghana's estimated wildlife richness includes 220 species of mammals, 725 species of birds (including 176 regular seasonal migrants), 74 species of bats, 37 species of rodents, and many others.[31]

Ghana borders Côte d'Ivoire to the west, Burkina Faso to the north, Togo to the east, and the Atlantic Ocean to the south along the Gulf of Guinea.[29, 32] The country can be divided into three main geographic regions: the northern savannah zone (approximately two-thirds of the country), the southern forest zone (approximately one-third of the country), and the coastal region.[32] Ghana's climate is tropical.[28] The northern zone is dominated by two seasons: a wet season (April to October) and a dry season (November to March). In the southern forests, there is a bimodal rainfall system with two distinct wet seasons, one from April to July, and another from September to November.[28, 32] The annual mean temperature ranges from 26 to 29 degrees Celsius;

humidity varies from 12% to 100%, depending on season and region. Most commercial agricultural production comes from the forest zone, where cacao (cultivated extensively in the country), timber, minerals, and crops are grown and harvested. However, the northern savannah zone is well-suited to livestock breeding, as is the coastal region for fish and seafood.[28, 32]

Zoonotic diseases that occur in large numbers can impact Ghanaian society in three main ways:

- Threaten the health of animals resulting in illness, loss of productivity, and death.
- Threaten the livelihood of a large segment of the population dependent on livestock as a major source of income.
- Threaten the health of people, with the ability to cause a large burden of illness and death, which is also associated with significant social and economic losses.

To begin addressing zoonotic disease challenges in Ghana, a One Health Zoonotic Disease Prioritization (OHZDP) Workshop was held during March 28–29, 2018, at the Swiss Spirit Alisa Hotel in Accra. The purpose of this 2-day workshop was to use a multisectoral, One Health approach to identify zoonotic diseases of greatest national concern for Ghana. The specific goal of the prioritization process was to use a multisectoral, One Health approach to prioritize endemic and emerging zoonotic diseases of major public health concern that should be jointly addressed by human, animal, and environmental health ministries and other relevant sectors. The effort was supported by the Government of Ghana, the Food and Agriculture Organization, CDC, and the United States Agency for International Development (USAID), as well as part of the Global Health Security Agenda (GHSA).

To build in-country capacity to conduct future OHZDP workshops, five local partners representing human, animal, and environmental health sectors were trained by CDC and FAO facilitators. The following trained partners then served as the facilitators during the workshop: Kwame Nkrumah University of Science and Technology (Kumasi Center for Collaborative Research in Tropical Medicine) (n=1); the Ministry of Food and Agriculture (Veterinary Services Directorate) (n=1); the Ministry of Health (Ghana Health Service) (n=1); the Ministry of Lands and Natural Resources (n=1); and the Ministry of the Environment, Science, Technology, and Innovations (Environmental Protections Agency) (n=1). Nine (100%) of the voting members attended the 2-day facilitator training; this allowed the voters to have a detailed understanding of the OHZDP tool and contributed to an efficient workshop.

Photo 4. The Umbrella Rock in the Yilo Krobo District outside of Accra, Ghana.

WORKSHOP METHODS

The OHZDP process involved a semi-quantitative tool developed by CDC. The methods have been described in detail in Appendix A [1, 2]. The first step of the process was to identify a country-specific list of potential zoonotic diseases of concern. A disease was selected if it was known to spread between animals and people and thought to occur in Ghana or the surrounding region. A list of 31 zoonotic diseases, shown in Table 2 of Appendix C, was considered during the workshop. Next, the workshop participants jointly identified five criteria for quantitative ranking of these 31 zoonotic diseases. Once the five criteria were chosen, each member of the selection committee individually indicated their preferences for the relative importance of each criterion to help generate a final group of weights for each criterion. The criteria and weights assigned to each criterion are listed in Appendix D.

One categorical question for each criterion was selected through group discussion. All questions had either binomial (yes/no) or ordinal multinomial (1–5%, 5–10%, 10–20%, etc.) answers. The ordinal nature is necessary for the scoring process and is determined by the participants and available data. Data were identified through an extensive literature search, as well as information from WHO, OIE, ProMED, and other relevant websites. Data on incidence, prevalence, morbidity, disability-adjusted life years (DALYs), and mortality were collected for the selected zoonotic diseases. If disease information for a particular zoonotic disease was not available for Ghana, data for other West African countries were used. If regional data were not available, global disease data on prevalence, incidence, morbidity, mortality, and DALYs were used. Over 570 articles were collected with disease-specific information on prevalence, morbidity, mortality, and DALYs for the African continent. These were compiled with over 350 articles researched for zoonotic disease workshops in other African countries. These articles were provided to the workshop participants for reference.

A decision tree was designed using Microsoft Excel™ and used for determining the final disease ranking. Each weighted criterion was applied across all diseases, and scores were assigned based on the response to each question. Country-specific, regional, and global data compiled previously for all zoonotic diseases under consideration were used to determine appropriate responses for each question. The scores for all five questions were summed and then normalized such that the highest final score was 1. See Table 2 in Appendix C for a complete listing of normalized scores for all zoonotic diseases that were considered in the workshop.

The list of zoonotic diseases and their normalized scores was presented to the group for discussion. A panel of nine representatives from different sectors voted on a final list of 6 zoonotic diseases (Table 2).

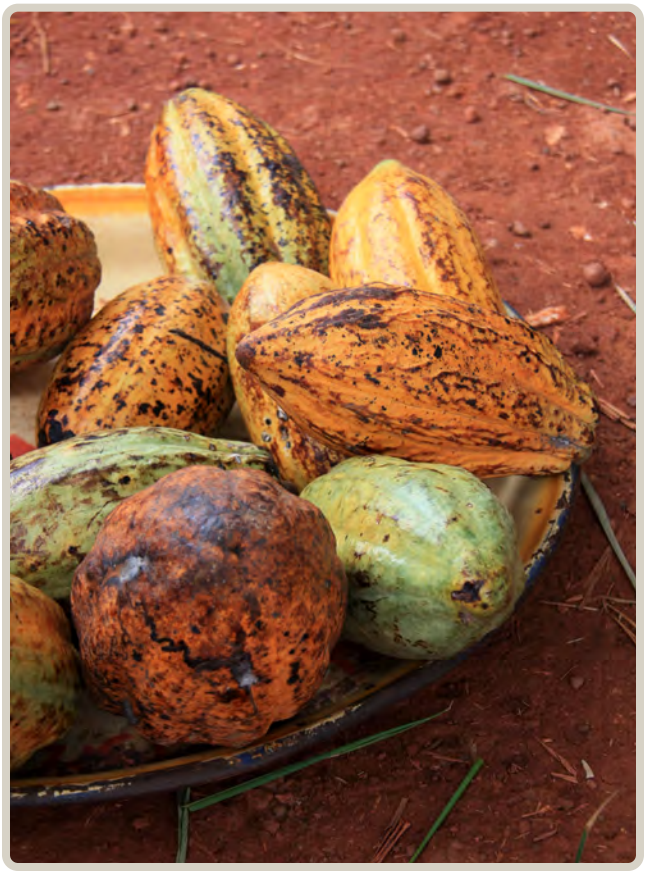


Photo 5. Cocoa fruits for sale on a market stall next to the street at the Kakum National Park near Cape Coast, Ghana.

CRITERIA SELECTED FOR RANKING ZOONOTIC DISEASES

The criteria for ranking zoonotic diseases selected by the voting members in Ghana are listed in order of importance below (Appendix D).

1. **Pandemic/Epidemic Potential**

   The first ranked criterion was pandemic/epidemic potential. Diseases that caused an outbreak in Ghana OR West Africa in the last 5 years in humans AND animals received the highest score of 2. Diseases that caused an outbreak in Ghana OR West Africa in the last 5 years in animals OR humans received a score of 1. Diseases that have not had an outbreak in neither animals nor humans in Ghana or West Africa in the last 5 years received a score of 0.

2. **Severity in Humans**

   The second ranked criterion was severity in humans. Diseases with a case-fatality rate in humans of >10% received the highest score of 2. Diseases with a case-fatality rate in humans of 5–10% received a score of 1. Diseases with a case-fatality rate of <5% received a score of 0.

3. **Economic/Environmental/Social Impact**

   The third ranked criterion was economic, environmental, and social impact. If there was a risk of both international AND in-country travel restrictions, the disease received the highest score of 3. If there was a risk of only international restriction, the disease received a score of 2. If there was a risk of only in-country restriction, the disease received a score of 1. If there was no risk of trade or travel restriction, the disease received a score of 0.

4. **Ability to Prevent and Control**

   The fourth ranked criterion was the ability to prevent and control the disease. If adequate interventions (vaccine OR treatment) were available to prevent and control the disease for both animals AND humans, the disease received the highest score of 2. If adequate interventions were available for animals OR humans, the disease received a score of 1. If no adequate interventions were available, the disease received a score of 0.

5. **Existing Collaboration**

   Finally, the fifth ranked criterion was existing collaboration between the Ministry of Health, Ministry of Food and Agriculture, and the Ministry of the Environment, Science, Technology, and Innovations. If there was a functional collaboration mechanism between all three ministries, the disease was given a full weight of 2. If the disease only had current functional coordination between two of the three ministries, it received a score of 1. If the disease did not have any current functional collaboration, it received a score of 0.

Photo 6. African fabrics with amazing colors and patterns being sold in a market in Accra, Ghana.

PLANS AND RECOMMENDATIONS

GENERAL RECOMMENDATIONS

After finalizing the list of priority zoonotic diseases, the workshop participants discussed recommendations and further actions that could be taken to address the prioritized zoonotic diseases. This was done in a two-stage process. To begin, participants were asked to make general recommendations for how to approach the priority diseases without considering the constraints of their respective institution. A summary of the most prominent recommendations organized by theme follows:

- **One Health Coordination Mechanisms (leadership, technical level)**
  - There is currently a National Technical Coordinating Committee run by the National Disaster Management Organization (NADMO), part of the Ministry of the Interior. This committee was formed in response to the avian influenza outbreaks in 2007. It meets ad hoc when disease outbreaks occur in the country. There are various subcommittees also on this committee, such as for communication, and participants are on the technical level. However, there is no committee specifically dedicated to One Health.
  - A primary objective is to establish a One Health committee, incorporating all ministries representing humans, animals, and the environment.
    - The NADMO platform is desired to be used for organization since it is at the national level, they are experts at coordination of activities, and they are outside of the animal, human, and environmental ministries and can remain unbiased.
    - Establish a "Zoonotic Diseases Unit" that involves all sectors (the environment will need to be brought in).
    - The consensus was to establish the "Zoonotic Diseases Unit" from a platform that already exists.
    - A meeting was be held in April 2019 to suggest this proposal to NADMO.
- **Surveillance**
  - Surveillance is already performed in the human and animal sectors for all the prioritized diseases.
  - The Ministry of Health provides weekly and monthly (in the case of trypanosomiasis) electronic bulletins that are shared only with the Ministry of Food and Agriculture.
    - These bulletins will be more widely shared among ministries, including sending them to the environmental sector.
  - The Ministry of Food and Agriculture does not currently share their surveillance data.
    - These data need to be more widely shared and efforts will be made to create a sharable modality (currently it is not in a sharable format) for surveillance data, and then share it with the human health and environmental sectors.
  - Public health leaders had a recent meeting on how to implement better surveillance data sharing mechanisms and expressed a need for more timely reporting of data. However, a platform is needed for sharing this information, such as a LISTSERV or database.
    - CDC expertise with surveillance sharing was requested to assist with this.
- **Laboratory Capacity**
  - Noguchi Memorial Institute for Medical Research laboratory has the capacity to test for all the prioritized diseases for both humans and animals, with the exception of rabies.

  - Noguchi does not have the specific reagents for rabies. This is a major gap. Funding is needed to obtain these reagents and train personnel on testing.
- Other veterinary labs have the ability to test for rabies (in animals only) via immunofluorescence for rabies antigen, but this is not available at Noguchi.
- For rabies, fixed slides should be brought to Accra (Noguchi) for confirmation. For accurate reporting, funds and transport must be procured to ensure all specimens are sent to Noguchi for confirmation.
- Kumasi Center for Collaborative Research is able to test for all diseases except for trypanosomiasis. They also have rabies reagent available for research.
- Local capacity must be strengthened to test for the priority diseases, in lieu of needing specimens to be sent to reference laboratories. This would involve procurement of funds and training of staff at the local level.

Photo 7. Houses in a village in the North of Ghana.

- **Outbreak Response**
  - Rapid response teams (RRT) exist in both the animal and human sectors for both anthrax and zoonotic avian influenza.
  - Rabies RRTs exist only for the animal sector. For humans, case management is the only "plan" available (there is no outbreak response plan).
  - The Ghana FELTP program (which includes veterinarians) helps respond at both the national and local levels.
    - The veterinary sector has not, to date, invited Field Epidemiology and Laboratory Training Programme (FELTP) to participate in outbreak response efforts.
  - The consensus was that the initial focus of efforts regarding outbreak response should be the strengthening of RRTs for rabies in all sectors. The RRTs also need to communicate among the sectors.
  - Ghana needs international partners to achieve a successful emergency response. Local and national capacity to respond should be improved, with a primary focus on rabies for all sectors.
- **Preparedness Planning**
  - Strengthen overall multisectoral, One Health coordination, communication, collaboration, and information sharing among all sectors
  - Share data among the sectors more broadly (both within the agency and between agencies)
  - Outline current research needs for the prioritized zoonoses across all relevant sectors for each disease
  - Improve multisectoral communication strategies regarding the prioritized diseases
  - Preparedness plans are done at the level of NADMO.
  - Committees (one for each the human, animal, and environmental sectors) meet regularly and include technical people from each sector (including the environment).

- The veterinary preparedness protocols are generic and are not necessarily tailored to a specific disease.
  - Provision of funds are lacking, so emphasis has not previously been placed on writing detailed disease-specific preparedness plans.
- For those diseases in which there is a current preparedness plan, they have not been shared among ministries.
- Since there is a joint zoonotic avian influenza plan in place developed by the Ministry of Health and the Ministry of Food and Agriculture, this plan will be shared with the environmental sector, to make contributions, and create a completely integrated One Health zoonotic avian influenza preparedness plan.

• Workforce

- Each district in Ghana has the following: an environmental health officer (Ministry of Sanitation and Water Resources/Ministry of Local Government and Rural Development), a public health epidemiologist, and a veterinarian.
  - Emphasis was placed on also having an Environmental Protection Agency liaison in each district, under local jurisdiction. This is important since the environmental health officer and the EPA have very different roles regarding public health. These two people should work together, and with the human and animal sectors, to best work toward preparedness and response for the prioritized diseases.
- The FELTP program has veterinarians, but there needs to be further integration of veterinarians in the program. This may be expanded by using the FELTP program for both animal and human outbreak responses. Possible integration of environmental health trainees should also be explored.
- There is a recurrent post-response sustainability issue related to maintaining the measures implemented by FELTP trainees after they leave the local area.
  - Training local workforce should be a main focus.

• Other Areas: Partnerships and Funding

- Once a One Health platform is established in Ghana, an effort must be made to solicit partnerships with other international agencies for funding to begin the above suggestions.
- The One Health platform would ideally be the sole source of funds when coordinating zoonotic disease efforts (i.e., a "One Health bank account"). This will eliminate the disagreement over which ministry funds which effort, whether it be preparedness, response, etc.
- Sensitization must continue regarding the One Health process and premise.

Photo 8. A Large Giant Ghana Snail—*Achatina achatina*

SPECIFIC NEXT STEPS

Finally, each government ministry involved in the decision process and the collaborating agencies who observed the process were given an opportunity to make suggestions for specific next steps that ministries could take to improve the multisectoral development of laboratory capacity, surveillance, joint outbreak response activities, and prevention and control strategies. A summary of the next steps suggested by each sector follows:

- **Ministry of Health (Ghana Health Service)**
  - Propose a One Health platform (Zoonotic Diseases Unit) at the next NADMO meeting to all sectors.
  - Share the weekly and monthly surveillance electronic bulletin(s) with the environmental sector.
  - Coordinate a shared platform with the other ministries to share surveillance data.
  - A rabies rapid response plan must be drafted and shared among ministries for input.
  - Share the MOH/MOFA zoonotic avian influenza joint preparedness plan with the environmental sector.
- **Ministry of Food and Agriculture (Veterinary Services Directorate)**
  - Propose a One Health platform (Zoonotic Diseases Unit) at the next NADMO meeting to all sectors. Once established, assist with the operationalization of the platform.
  - Create a sharable format of surveillance data for the prioritized diseases. Once this is in a sharable format, it must be shared with the other sector ministries.
  - Begin to invite the Ghana FELTP to outbreak responses.
  - Rabies RRTs must be strengthened via funding and training of personnel.
  - Focus on writing disease-specific, detailed preparedness plans and sharing these with the other ministries.
  - Share the MOH/MOFA zoonotic avian influenza joint preparedness plan with the environmental sector.
- **Ministry of the Environment, Science, Technology, and Innovation (Environmental Protection Agency)**
  - Once established, assist with the operationalization of the One Health platform.
  - Review the MOH/MOFA zoonotic avian influenza joint preparedness plan and suggest places for the incorporation of the environmental sector.
  - Consider the placement of an EPA liaison in each district, under local jurisdiction.
  - Consider the usefulness of having environmental health practitioners in the FELTP program.
- **Ministry of Lands and Natural Resources**
  - Create a sharable format of surveillance data for the prioritized diseases. Once this is in a sharable format, it must be shared with the other sector ministries.
  - Begin to invite the Ghana FELTP to outbreak responses.
  - Rabies RRTs must be strengthened via funding and training of personnel.
  - Focus on writing disease-specific, detailed preparedness plans and sharing these with other ministries.
- **Research and Academic Partners**
  - Noguchi Laboratory:
    - Secure funding to both train personnel and test for rabies (obtain reagents) in humans and animals.
  - Kumasi Center for Collaborative Research:
    - Obtain diagnostics for trypanosomiasis.
- **International Partners**
  - U.S. Centers for Disease Control and Prevention:
    - Assist with development of a surveillance data sharing platform.

- Assist with building capacity (coordination and collaboration) for the prioritized zoonotic diseases.
- A Stepwise Approach towards Rabies Elimination (SARE) workshop is already scheduled for the end of May 2018.
- Continue One Health sensitization.
- Provide technical support and assistance, as requested, on any of the prioritized zoonotic diseases.

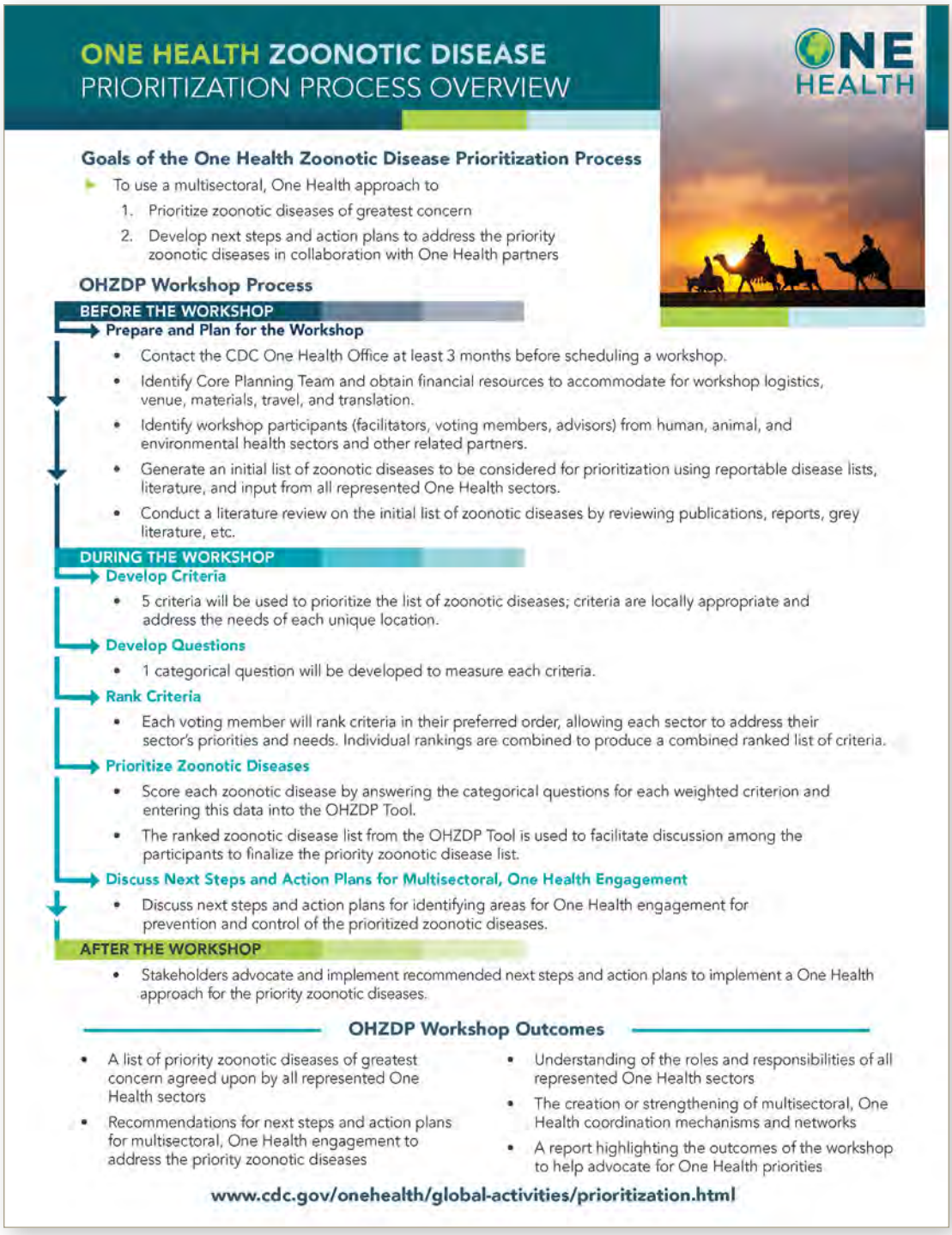
➤ Others:

- Continue to train and promote rapid response teams.
- Provide funding for One Health-related programs in Ghana. NGOs have a very large presence in-country, so this would be a reasonable place to begin.
- Assist with building capacity (coordination and collaboration) for the prioritized zoonotic diseases.
- Provide technical support and assistance, as requested, on any of the prioritized zoonotic diseases.
- Continue to support the strengthening of multisectoral, One Health coordination capacity.

Photo 9. Bamboo houses built upon a lagoon at the village of Nzuelnzu in Ghana.

APPENDIX A: Overview of the One Health Zoonotic Disease Prioritization Process

U.S. Centers for Disease Control and Prevention: Overview of the One Health Zoonotic Disease Prioritization Workshop https://www.cdc.gov/onehealth/global-activities/prioritization.html



APPENDIX B: One Health Zoonotic Disease Prioritization Workshop Participants for Ghana

WORKSHOP PARTICIPANTS—Voting Members

Name	Organization	Title/Position
Meyir Yiryele Ziekah	Ministry of Lands and Natural Resources, Wildlife Division	Epidemiologist (wildlife)
Boi Kikimoto	Ministry of Food and Agriculture	Head of Public Health
Kingsley Aryee	Ministry of Food and Agriculture	Deputy Director
Kwame K. Achempem	Ministry of Health	Disease Surveillance Officer
David Opare	Ministry of Health	Head of National Public Health Reference Laboratory
Emmanuel Dzotsi	Ministry of Health	Senior Public Health Specialist
Constance Daq Roberts	Ministry of the Environment, Science, Technology, and Innovation	Program Officer
Isaac Deborah Yeboah	Ministry of the Environment, Science, Technology, and Innovation	Program Officer
Godfred S. Azaglo	Ministry of the Environment, Science, Technology, and Innovation	Program Officer

WORKSHOP PARTICIPANTS—Advisors/Observers

Name	Organization	Title/Position
Ernest Kenu	University of Ghana	Program Director, Ghana Field Epidemiology and Laboratory Training Program
David Turkson	Ministry of Lands and Natural Resources—Wildlife	Principal Forester
Sarah Adinku	Ghana Library Association	E-librarian
Samuel Bel Nono	USAID/PREDICT-2	Country Coordinator
Finsoley M. Aryee	Ministry of the Environment, Science, Technology, and Innovation	Deputy Director
Amakye Amin	La Veterinary Hospital	Private veterinarian
Kofi Afakye	FAO	AMR National Coordinator
Emmanuel Odotei	USAID, Ghana	WASH Advisor
Lawson Tevi	Ministry of the Interior, National Disaster Management Organization	Head of Department
Emmanuel Kodua	Noguchi Memorial Institute for Medical Research	Researcher
Paa Kobina Turkson	University of Ghana, School of Veterinary Medicine	Professor/Dean
William B. Amanfu	Veterinary Council of Ghana	Consultant

Name	Organization	Title/Position
Prosper Apawudza	Ministry of Local Government and Rural Development	Assistant Director
Margaret Lartey	University of Ghana, School of Medicine and Dentistry	Professor/Dean
Perdita Lopes	Ministry of Food and Agriculture	Epidemiologist
Sally-Ann Ohene	World Health Organization	Advisor
K. Kenneth Gbeddy	Veterinary Services Directorate, Ministry of Food and Agriculture	Director
Sege Gbappa	FAO	Officer
Phyllis Addo	University of Ghana	Professor
Damien Punguyire	WHO	Epidemiologist
Theresah Bannerman	Ministry of Local Government and Rural Development	ADPO
William Ampofo	Noguchi Memorial Institute for Medical Research	Professor
Asma Saidoubi	FAO-ECTAD	Regional Epidemiologist

WORKSHOP PARTICIPANTS—Facilitators

Name	Organization	Title/Position
Anthony Akunzule	Food and Agriculture Organization, Ghana	National Project Coordinator
Garba Ahmed Maina	Food and Agriculture Organization, ECTAD Regional Office	Epidemiology Advisor
Kristina Angelo	CDC, Atlanta	Medical Epidemiologist
Richard Odame Phillips	Kwame Nkrumah University of Science and Technology, Kumasi Center for Collaborative Research	Professor/Scientific Director
Yaw Fenteng Danso	Ministry of Food and Agriculture	Epidemiologist, Head of Epidemiology Unit
Franklin Asiedu-Bekoe	Ministry of Health, Ghana Health Service	Head of Disease Surveillance
Hope Smith Lomotey	Ministry of the Environment, Science, Technology, and Innovation, Environmental Protection Agency	Principal Programme Officer
Richard Suu-Ire	Ministry of Lands and Natural Resources—Wildlife	Wildlife Veterinarian

WORKSHOP PARTICIPANTS—Other key staff

Name	Organization	Title/Position
Linda Boadu	FAO-ECTAD	Administrative Secretary
Barbara Addo	FAO-ECTAD	Assistant Regional Operations Manager
Maiga Ibrahim	FAO-ECTAD	Regional Operations Manager

WORKSHOP ORGANIZERS

Name	Organization	Title/Position
Anthony Akunzule	FAO, Ghana	National Project Coordinator
Adama Sow	FAO, Ghana	Regional Laboratory Expert
Asma Saidoubi Oulebsir	FAO, Ghana	Regional Epidemiologist
Dr Garba Ahmed Maina	FAO, ECTAD	Epidemiology Advisor
René Bessin	FAO, Côte d'Ivoire	Country Team Leader
Dr Chastity Walker	CDC Ghana	Country Director, CDC Ghana
Grace Goryoka	CDC Atlanta	Health Scientist, CDC One Health Office
Dr Kristina Angelo	CDC Atlanta	Medical Epidemiologist, CDC OHZDP Facilitator
Dr Casey Barton Behravesh	CDC Atlanta	Director, CDC One Health Office
Emmanuel Odotei	USAID Ghana	WASH Advisor
Rebecca Fertziger	USAID Ghana	Deputy Office Director, Office of Health, Population and Nutrition
Dr Sarah Paige	USAID Washington	Senior Infectious Disease Advisor/EPT2 POC Uganda
Maiga Ibrahim	FAO, ECTAD	Regional Operations Manager
Barbara Addo	FAO, ECTAD	Assistant Regional Operations Manager
Linda Boadu	FAO, ECTAD	Administrative Secretary

Photo 10. A farm in Bolgatanga, northern Ghana.

APPENDIX C: Final Results of One Health Zoonotic Disease Prioritization Workshop in Ghana

Table 2. Zoonotic diseases considered for prioritization in Ghana: Final results of prioritization and normalized weights for 31 zoonotic diseases. The top prioritized zoonotic diseases selected by the voting members representing all ministries active in zoonotic disease work are shown in bold.

Rank#	Disease	Raw Score	Normalized Final Score
1	**Anthrax**	**0.973467878**	**1**
1	**Rabies**	**0.973467878**	**1**
1	**Trypanosomiasis**	**0.973467878**	**1**
4	**Zoonotic avian influenza**	**0.801906939**	**0.823763122**
5	**Zoonotic tuberculosis**	**0.744100136**	**0.76438078**
6	**Ebola**	**0.734369017**	**0.754384436**
6	**Lassa fever**	**0.734369017**	**0.754384436**
8	**Yellow fever**	**0.707836895**	**0.727129175**
9	**Dengue fever**	**0.659477431**	**0.677451661**
10	Leptospirosis	0.640027544	0.657471662
11	Cysticercosis	0.613544997	0.630267326
12	Plague	0.603813877	0.620270982
13	Brucellosis	0.601448774	0.617841417
14	Listeriosis	0.581986535	0.59784873
15	Salmonellosis	0.574916652	0.590586156
16	Rift Valley fever	0.555738194	0.570884984
17	Leishmaniasis	0.555454413	0.570593468
18	Crimean-Congo hemorrhagic fever	0.536275955	0.550892296
19	Colibacillosis	0.504729845	0.518486389
20	Marburg	0.468738033	0.481513611
21	Hydatid disease	0.458735485	0.47123844
21	Toxoplasmosis	0.458735485	0.47123844
23	Campylobacteriosis	0.403355712	0.414349278
24	Zoonotic swine influenza	0.306686358	0.315045175
25	Dracunculiasis/Guinea worm disease (GWD)	0.306636784	0.31499425
25	Schistosomiasis	0.306636784	0.31499425
27	Hepatitis E	0.239098862	0.245615564
28	Q Fever	0.231794772	0.2381124
28	Shigellosis	0.231794772	0.2381124
30	Typhus	0.135075844	0.138757372
30	Trichinosis	0.135075844	0.138757372

APPENDIX D: The Numerical Weights for the Selected Criteria for Ranking Zoonotic Diseases in Ghana

1. Pandemic/Epidemic Potential (criterion weight=0.34)

Question: Has the disease caused an outbreak in Ghana OR West Africa in the last 5 years?

Answer:

- ☐ No (0)
- ☐ Animals OR humans (1)
- ☐ Animals AND humans (2)

2. Severity in Humans (criterion weight=0.32)

Question: What is the case-fatality rate?

Answer:

- ☐ <5% (0)
- ☐ 5–10% (1)
- ☐ >10% (2)

3. Economic/Environmental/Social Impact (criterion weight=0.15)

Question: Is there a risk of international or in-country trade OR travel restriction?

Answer:

- ☐ None (0)
- ☐ Only local restriction (1)
- ☐ Only international restriction (2)
- ☐ Both local and international restriction (3)

4. Ability to Prevent and Control (criterion weight=0.14)

Question: Are there adequate interventions (vaccine OR treatment) available (not only in Ghana) to prevent and control the zoonotic disease?

Answer:

- ☐ Available for animals AND humans (2)
- ☐ Available for animals OR humans (1)
- ☐ None (0)

5. Existing Collaboration (criterion weight=0.05)

Question: Is there functional collaboration between:

Answer:

- ☐ All ministries (2)
- ☐ Two ministries (1)
- ☐ No ministries (0)

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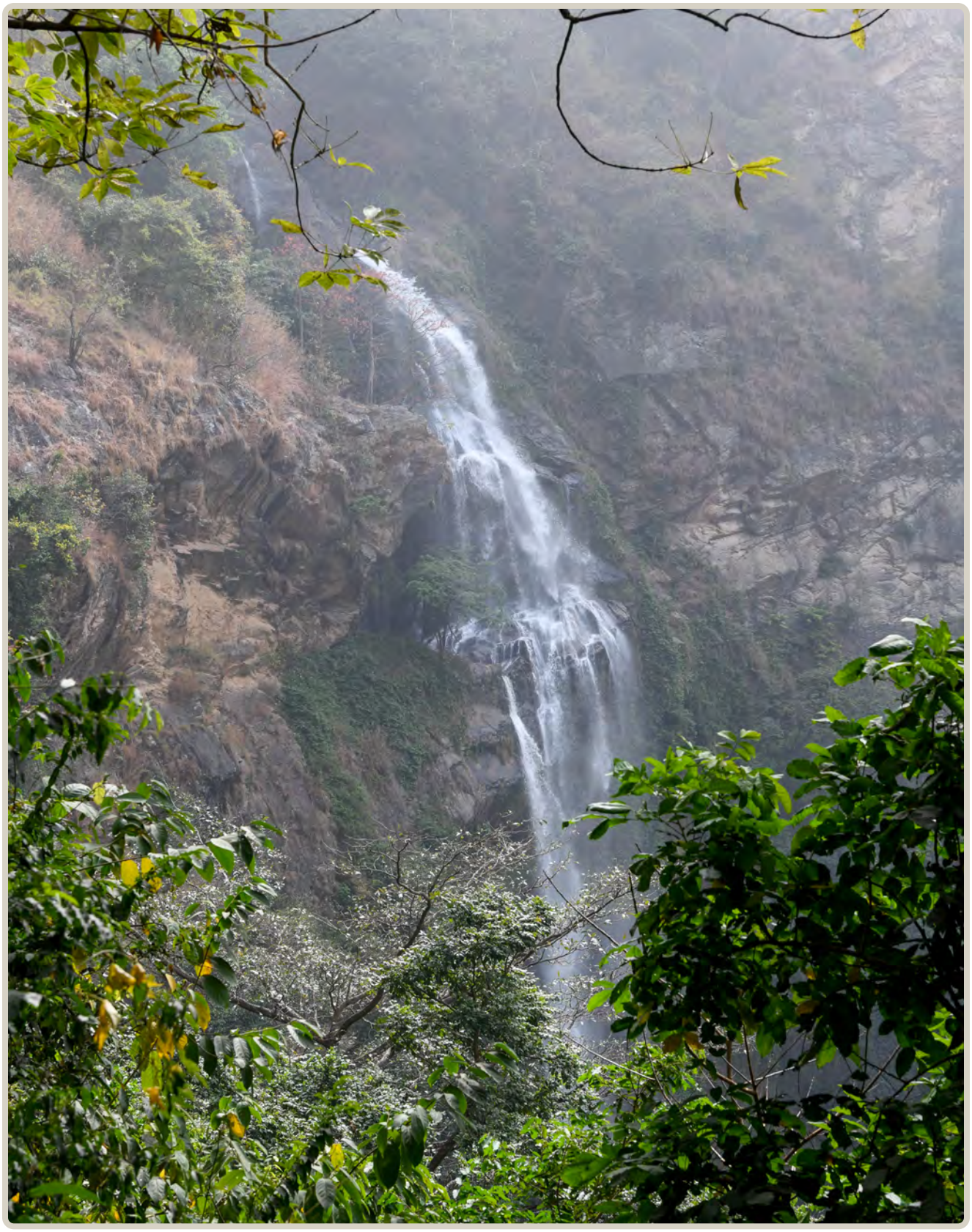

Photo 11. Wli Waterfalls in the middle of the mountains in Ghana.

http://www.cdc.gov/onehealth