# The One Health landscape in sub-Saharan African countries

OHRECA
One Health Centre in Africa

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# Acknowledgements

This report is an output from a desk review and survey conducted across Africa to map the existing One Health Initiatives by sub-Saharan African countries and regions. We acknowledge the supervisory roles of Kristina Roesel and Bernard Bett of the International Livestock Research Institute (ILRI). We thank Irene Lukassowitz for her inputs. We also thank Ariel Rivas for reviewing the document and for facilitating the short video at the end of the document. The funding for the study was provided by the Federal Ministry for Economic Cooperation and Development (BMZ), Germany, through the ILRI-led One Health Research, Education and Outreach Centre in Africa (OHRECA).

# Executive summary

To inform the establishment of the One Health Research, Education and Outreach Centre in Africa (OHRECA), the International Livestock Research Institute (ILRI) commissioned a review of One Health activities and initiatives across sub-Saharan Africa with a view to contribute to the emerging issues in One Health in Africa. With funding and co-organization from the Federal Ministry for Economic Cooperation and Development (BMZ), Germany, ILRI was positioned to utilize the opportunity to co-host the OHRECA in the continent. The centre's activities focus on four major themes including neglected tropical zoonotic diseases, emerging infectious diseases (EIDs), food safety and antimicrobial resistance. The centre will contribute significantly to enhancing human, animal and ecosystem health by developing capacity in One Health, supporting One Health network initiatives, and developing pathways from evidence to policy and practice. However, in view of the recent COVID-19, these themes have been extended to incorporate actionable research on COVID-19 included in the theme on EIDs.

To facilitate the assignment above, ILRI commissioned a review of all One Health initiatives in Africa to date with the aim of mapping the existing One Health initiatives in sub-Saharan African countries spatio-temporally while creating a link to a database on One Health in Africa and stimulating critical One Health thinking in Africa. In this work, we comprehensively evaluated the One Health initiatives available in sub-Saharan Africa, as per the UN definition of sub-Saharan Africa (UN 2003). This geographical area includes 46 of Africa's 54 countries.

A detailed desk review of available literature, expert opinions surveys, limited interviews and wider consultations with selected One Health stakeholders in Africa and those outside Africa who have impacted One Health in Africa were conducted. Specifically, all available information on One Health related to Africa was searched for in global peer-reviewed databases using relevant search terms related to or closely aligned with One Health. In addition, the strengths, weaknesses, opportunities, threats, gaps, enablers and hindrances to One Health initiatives were extracted from various reports. Furthermore, a pretested questionnaire tool was circulated among selected stakeholders (n = 57) to collect data and key inputs on One Health activities and initiatives, influences, interests, impacts and views on motivating and moving One Health forward in the future. To improve participation and encourage wider circulation, the

questionnaire survey was made available online (https://www.surveymonkey.com/r/M66QTTF). The link to the questionnaire is available continuously for regular inputs to periodically improve the outcomes of One Health initiatives in Africa.

Whereas the details of the transitioning of the One Health approach is detailed in the document, it should be known that One Health as an approach is gradually transiting from multidisciplinary to interdisciplinary and transdisciplinary concepts because of its multiple facets with many disciplines, locally, nationally, regionally and globally. One Health uses collaborative effort to attain optimal health, welfare and well-being for people, animals and the environment. The traditional view of One Health as a proxy for zoonoses management has changed significantly and the field has extensively broadened out to include many previously excluded or hardly considered fields including but not limited to nutrition and food safety, social sciences, geography, policy and planning, economics, welfare and well-being, antimicrobial resistance (AMR), vector-borne diseases, toxicosis and pesticides issues.

In view of its rapidly evolving nature, both globally and in sub-Saharan Africa, certain misconceptions and gaps have become normalized in One Health. For instance, One Health is sometimes perceived as a single discipline, course, lecture or transferred technical skill but as a routine integrative approach, the delivery of its concepts in terms of training is often lopsided and may be heavily weighted toward the disciplines that prime its concept in a country; the issue of multidisciplinary versus interdisciplinary approach are sometimes mixed up. To date, the majority of the identified One Health networks in sub-Saharan Africa are academic and the reductionist view and imbalance in stakeholders' representation often translate into narrow perspectives in addressing One Health issues or prevent further buy-in from stakeholders who are outside the main networks. Clearly defined theory of change and proven monitoring and evaluation frameworks for One Health are hardly visible in most initiatives hence key outputs and outcomes are difficult to account for with the resultant waste of resources.

The clearly identified areas of One Health efforts in sub-Saharan Africa include coordination, organization, collaboration, communication, capacity development, information sharing tool development and joint research. Specific but little evidence of joint surveillance and monitoring, joint border patrols, disease controls, emergency interventions, disaster interventions and recoveries, policy development, advocacy and community engagements were observed. One Health initiatives were spatially and temporally spread across eastern, western, southern and central Africa with a greater concentration in eastern and southern Africa.

A comprehensive database of these initiatives is available at the OHRECA website: https://www.ilri.org/research/facilities/one-health-centre. Few specific examples were documented in the report including those from Uganda, Kenya, Nigeria, Tanzania and those with regional perspectives. Important stakeholders were identified and grouped based on perceived impacts, interests and influence (policy power). Identified stakeholders were also mapped on One Health quadrants based on their perceived contributions to One Health initiatives. This mapping revealed the key stakeholders who cannot be ignored in One Heath initiatives, the latent stakeholders, the marginal stakeholders and the One Health defenders. The ministries responsible for public and animal health, professional regulatory bodies, veterinary officers in the field, livestock holding grounds, livestock markets, medical officers in clinics and hospitals; politicians and policymakers, ministries responsible for agriculture, wildlife authorities, and veterinary and medical research institutions are key stakeholders. Latent stakeholders include but are not limited to the higher

authorities and policymaking institutions (e.g. offices of the president and vice presidents), the climate office, and hatcheries and breeder farms. The marginal stakeholders include the law enforcers, private financial institutions, government boards, the local governments and the public. Finally, the One Health defenders include the offices of the prime minister, national research funding bodies, media, associations for animal and animal products producers and such other bodies. Furthermore, opinions and ideas on the likely utilization of seed funding to stimulate national One Health activities were listed by various stakeholders and these are a useful pool of information to draw from in kick-starting or supporting national and subnational One Health initiatives.

Though One Health has made a lot of inroads in sub-Saharan Africa, some enablers and hindrances have been identified in this work. Some of the major strengths in One Health in the region are availability of manpower, existence of relevant committee to implement One Health, presence of national One Health platforms, existence of basic infrastructure and willingness to mobilize resources among others. The identified weaknesses include but are not limited to poor information sharing culture among stakeholders, poor coordination mechanisms, minimal involvement of other sectors apart from public and animal health, bureaucracies, lack of clear guidelines for One Health implementation, sectoral, ministerial and disciplinary preservations and territory protections, and lack of institutionalization of One Health concepts in organizations and among stakeholders. The specific gaps identified, and mitigation measures are discussed in the document.

There is a need for all government ministries, departments and parastatals to view One Health as an approach that transcends territorial protection and open it up to other disciplines that can jointly deliver cost-effective solutions. National road maps for One Health implementation and institutionalization will need to be developed to avoid a return to 'business-as-usual' scenarios. National efforts should transcend the rolling out of interventions in piecemeal and small-scale plans. One Health projects that are delivered as proof of concept for should have a verified scaling up method for nationalizing them to track, monitor and evaluate initiatives effectively. The national One Health platforms should develop clear ways to institutionalize annual programs for budgeting because continuous dependence on external funding is unsustainable. Countries must also put in place the necessary policy and legal instruments, including those with regional and continental implications to facilitate the push towards incremental implementation of One Health in sub-Saharan Africa. The identified gaps should be prioritized taking into cognizance contemporary issues like urbanization, endemic poverty and other emerging issues. The development of local One Health capacities for subnational delivery of One Health approaches will be key for implementation at local levels. Realizing that sub-Saharan Africa has burden of infectious and zoonotic diseases, particularly at the human-animal-environment interfaces and coupled with growing food insecurity, threatened livelihoods and endemic poverty, Africans will need to take advantage of technologies and strategies in surveillance, prevention and management for diseases that align with the One Health approach.

In the current scenario of rapidly spreading infectious diseases and pandemics that have ravaged the world and Africa in particular, for example, the ongoing COVID-19 and past highly pathogenic avian influenza H5N1 among others, One Health allows for facilitations through online collaborative meetings utilizing available online communication technologies such as Skype, Microsoft Teams, Zoom, Google Hangouts and other platforms, in the context of limited resources such as is prevalent in sub-Saharan Africa. Such online communication technologies can be used to set up platforms and networks of individuals from different background that will enable information sharing from diverse perspectives on specific topics/

issues and deliver interventions and solution in cost-effective ways. An example of this is the One Health community of practice, which was set up by the One Health for Humans, Environment, Animals and Livelihoods (HEAL) project and is co-funded by OHRECA: https://www.oh4heal.org/community-of-practice/. Such multiple sources of information should enable the reconsideration and re-evaluation of each field/discipline's positions and ideologies in order to accommodate other views. This is in addition to the fact that One Health is an anticipatory and not responsive in approach that can significantly benefit effective budgeting and outbreak control costs by providing prompt diagnosis and rapid containment of diseases from animal sources before the risk of spillover to humans occurs.

# Definitions

| Term and acronym | Definitions |
|---|---|
| One medicine | The concept whereby human and animal healthcare advances hand-in-hand with veterinarians, physicians and researchers collaborating to ensure that all humans and animals benefit from sustainable and equal medical progress but not at the expense of an animal's life.[a] |
| Zoonosis | Any disease or infection that is naturally transmissible from vertebrate animals to humans[b] (anthropozoonosis: human-animal, zooanthroponosis: animal-human). It may be direct or indirect transmission. |
| Human-animal-environment interface | Complex and dynamic interactions involving human and non-human species as well as the environment. They can include the actual geographical location or virtual space where such interactions occur.[c] |
| Antimicrobial resistance (AMR) | The ability of microorganisms such as bacteria, fungi or protozoans to grow despite exposure to antimicrobial substances designed to inhibit their growth.[d] |
| Global health (GH) | A study, research, and practice that places a priority on improving health and achieving health equity for all people worldwide. They are health issues that transcend national boundaries and governments and call for actions on the global forces that determine the health of people.[e] |
| Surveillance | The process of systematically collecting, consolidating, analysing, and evaluating pertinent data, as well as disseminating results to relevant actors.[f] |
| One Health** | This is described as either a narrow approach primarily combining public health and veterinary medicine or as a wide approach as in the wide-spread 'umbrella' depiction including both scientific fields, core concepts and interdisciplinary research areas.[g] |
| EcoHealth | Synonymous with biodiversity, it is an approach that emphasizes the need to protect all living creatures, implying that parasites, unicellular organisms, and possibly viruses have a value and should be protected.[g] |
| Planetary health | The goal or process of achieving the highest attainable standard of health, well-being, and equity worldwide through judicious attention to the human—political, economic, and social—systems that shape the future of humanity and the earth's natural systems. It aims at defining the safe environmental limits within which humanity can flourish.[h] |
| International health | Also called geographic medicine, international medicine, or global health, it is a field of health care, usually with a public health emphasis, dealing with health across regional or national boundaries.[i] |
| Environment health | The science and practice of preventing human injury and illness while promoting well-being through the identification and evaluation of environmental sources and hazardous agents. It focuses on limiting exposures to hazardous physical, chemical and biological agents in air, water, soil, food and other environmental media or settings that may adversely affect human health.[j] |

| Term and acronym | Definitions |
|---|---|
| Conservation medicine | Also known as ecological health or conservation health. It works together with other disciplines in the field of disease and conservation to create healthier ecosystems, recognize and treat diseases that cross the human-animal (wildlife and domestic) barrier, prevent outbreaks of these diseases and better understand how our natural environment is interdependent.k |
| Public health | The medical branch that aims at protecting the safety and improving the health of communities through education, policymaking and research for disease and injury prevention. It promotes the health of people and the communities where they live, learn, work and play.l |
| Tropical medicine | An interdisciplinary branch of medicine that deals with health issues that occur uniquely, are more widespread, or are more difficult to control in tropical and subtropical regions.m |
| Reductionism | Analyzing and describing a complex and/or dynamic (changing) phenomenon in terms of one (or a few) simple and/or static indicators, while interactions are ignored. It leads to erroneous inferences and omissions. One example is binary thinking, whereby the answer to a problem is limited (reduced) to just two alternatives when, in fact, more than two alternatives exist: for example, the phrase 'it is either black or white' ignores red, green, blue and many other colours.n |
| Interdisciplinarity | The process by which many fields of knowledge are integrated and new knowledge is created to solve a specific problem –which may have a suboptimal or self-defeating solution if a single discipline is considered. It differs from multidisciplinarity, in which several fields may participate but no integration and no new knowledge is created. While interdisciplinarity investigates the problem before the solution is created, multidisciplinarity (as well as reductionism) chooses the solution before the nature of the problem is identified.n |
| Brainstorming | An educational strategy used to both demonstrate knowledge gaps in any one field, later addressed by the dialogue generated by a group of people trained in several fields. It aims at constructing, deconstructing and reconstructing knowledge by, first, revealing the limitations of uni-disciplinary reductionism and, second, fostering novel (and problem-specific) solutions that include but exceed any one field. |

[a] Humanimal Trust. 2020. One Medicine. (Available from http://www.humanimaltrust.org.uk/what-is-one-medicine/) (Accessed 27 April 2020)

[b] World Health Organization. 2020. Zoonosis. (Available from https://www.who.int/topics/zoonoses/en/) (Accessed 27 April 2020)

[c] Authors' definition.

[d] Nature. 2020. Antimicrobial resistance. (Available from https://www.nature.com/subjects/antimicrobial-resistance) (Accessed 27 April 2020)

[e] Koplan, J.P., Bond, T,C., Merson, M.H., Reddy, K.S., Rodriguez, M.H., Sewankambo, N.K. et al. 2009. Towards a common definition of global health. ***Lancet*** 373:1993–1995; and Kickbush I. 2006. The need for a European strategy on global health. ***Scandinivian Journal of Public Health*** 34:561–565.

[f] Heymann D.L. 2008. ***Control of communicable diseases manual***. 19th edition. Washington, DC: American Public Health Association.

[g] Lerner, H. and Berg, C. 2017. A comparison of three holistic approaches to health: One Health, EcoHealth, and Planetary Health. ***Frontiers in Veterinary Science***. doi: 10.3389/fvets.2017.00163.

[h] Horton, R. and Lo, S. 2015. Planetary health: a new science for exceptional action. ***The Lancet*** 386:1921–1922. http://dx.doi.org/10.1016/S0140-6736(15)61038-8.

[i] Wikipedia. 2020. ***International Health***. (Available from https://en.wikipedia.org/wiki/International_health) (Accessed 29 April 2020)

[j] National Environmental Health Association. 2020. ***Definitions of environmental health***. (Available from https://www.neha.org/about-neha/definitions-environmental-health) (Accessed 29 April 2020)

[k] World Extreme Medicine Academy. 2020. ***Conservation medicine***. (Available from https://worldextrememedicine.com/blog/2018/06/what-is-conservation-medicine/) (Accessed 29 April 2020)

[l] American Public Health Association & University of Pittsburgh Graduate School of Public Health. 2020. Public Health. (Available from https://www.apha.org/what-is-public-health and https://www.publichealth.pitt.edu/careers/what-is-public-health) (Accessed 29 April 2020)

[m] Wikipedia. 2020. ***Tropical Medicine***. (Available from https://en.wikipedia.org/wiki/Tropical_medicine) (Accessed 29 April 2020)

[n] Hittner, J.B. et al. 2019. The third cognitive revolution: The consequences and possibilities for biomedical research. ***EMBO Reports*** 20:e47647. Doi:10.15252/embr.201847647.

# Background

One Health is the collaborative effort of multiple disciplines working locally, nationally and globally, to attain optimal health for people, animals and the environment (AVMA 2018; CDC 2020). It is based on the fact that humans coexist in a complex, interdependent relationship with the companion, production, and wild animals (for food, livelihoods, and well-being) as well as with the environment (for living, exploitation and work). Hence, the world has an established interface between humans, animals, and the environment, which is an opportunity to share multiple resources but also a source of diseases that influence public health as well as social and economic well-being of the human species (WHO 2020a).

To achieve the goals of One Health and, therefore, to address potential or existing global and transnational health risks, policies should be systematic, coordinated, collaborative, multidisciplinary and cross-sectoral (Kimani et al. 2019; Yasobant et al. 2019). Such health risks include those originating from prioritized zoonotic diseases (Salyer et al. 2017), neglected zoonotic diseases (Elelu et al. 2019), emerging diseases and re-emerging diseases (Muzemil et al. 2018), mineral poisoning (WHO 2015; CDC 2016a), food safety, antimicrobial resistance (AMR), vector-borne infectious diseases, toxicosis and pesticides (Kimani et al. 2019). Although the One Health concept has stemmed largely from zoonoses and the environment—including infectious diseases—the spheres of One Health have broadened to include other phenomena like climate change, food and water safety and security, disaster preparedness and relief, comparative biology, biodiversity, conservation medicine, human-animal bonding, non-communicable disease, plant and soil health, and the welfare of animals, humans and the planet. It has also incorporated communication, policy, planning, economics and many other social science fields. It is worth noticing that the One Health approach has gained a lot of traction in the past two decades. It now includes a global view on complex health systems.

Ranging from the inter-sectoral, multi-country, multi-institutional research and surveillance platforms to combined practice and combined healthcare services to social sciences, One Health has made significant inroads into the health systems in Africa (Schelling et al. 2005; Karimuribo et al. 2012; Sweeney et al. 2018). The rapid adoption of One Health concepts has resulted, globally, in more than 100 One Health networks, with 24 initiatives located in Africa (Khan et al. 2018). Currently, the major foci of One Health platforms are

coordination, organization, collaboration, communication, capacity development, information sharing tool development and joint research (Khan et al. 2018). However, a great deal of issues in health systems remain unresolved to date. Furthermore, the One Health continues to broaden out to include more fields and discipline.

The detailed history of One Health has been described elsewhere (Bresalier et al. 2015; Killewo 2019; Table 1). Briefly, Hippocrates (c. 460 BCE – c. 370 BCE) recognized the role of environmental factors and its impact on human health, promoting the concept that public health depended on a clean environment[1] (free of hazards to human health) (Table 1). Between the mid-1800s and early 1900s, Rudolf Virchow and William Osler recognized the link between animal and human medicine, and coined the name 'zoonosis' to describe the associated disease that can be passed from animals to humans (and vice versa), and thereafter actively advocated for veterinary medical education (CDC 2016b). These events were followed by the works of James H. Steele, a veterinarian who was trained in public health and founder of the Veterinary Public Health Division at the Centers for Disease Control and Prevention (CDC), in Atlanta, in 1947. His works contributed significantly to the understanding of the epidemiology of zoonotic diseases (CDC 2016b). Calvin Schwabe (1927–2006), another veterinarian trained in public health, coined the term 'one medicine' in a veterinary medical textbook in 1964. This important contribution stressed the similarities between animal and human medicine and emphasized the importance of collaboration between veterinarians and physicians to jointly solve global health problems (CDC 2016b). The twelve Manhattan Principles were created in 2004 at a One World, One Health symposium organized by the Wildlife Conservation Society held at Rockefeller University, in New York (Gibbs 2014). These principles birthed the links between humans, animals, and the environment; how these links are integral to understanding disease dynamics, and the importance of interdisciplinary approaches to prevention, education, investment, and policy development[2].

The challenges and uncertainties associated with the global H5N1 influenza outbreaks of the early 2000s in poultry, other animals and infections in humans led the American Veterinary Medical Association to establish a One Health Initiative Task Force, in 2006 (Gibbs 2014; AVMA 2018), while the American Medical Association passed a One Health resolution to promote partnering between veterinary and human medical organizations in 2007, and a One Health approach was recommended for responses to global disease outbreaks, in 2007 (Gibbs 2014). The December 2007 International Ministerial Conference on Avian and Pandemic Influenza, held in New Delhi, decided to further develop the One Health concept and strengthen linkages between the human and animal health systems especially for the pandemic preparedness and human security. Following that conference, in 2008, the Food and Agriculture Organization of the United Nations (FAO), the World Organisation for Animal Health (OIE), and the World Health Organization (WHO) together with the United Nations Children's Fund (UNICEF), the United Nations System Influenza Coordination (UNSIC), and the World Bank developed a framework titled 'Contributing to one world, one health-a strategic framework for reducing risks of infectious diseases at the animal-human-ecosystems interface', with key recommendations for One Health approach to global health (FAO/OIE/WHO/UNSIC/UNICEF/WB 2008; Gibbs 2014). The formal presentation and adoption of this framework was done at another International Ministerial Conference on Avian and Pandemic Influenza in Sharm El Sheik, Egypt, in October 2008. It was concluded that the One Health approach should adopt a strategy for combatting avian influenza and other infectious diseases, particularly where human-animal-ecosystem interfaces exist

1 The Internet Classics Archive. Hippocrates. 'On Airs, Waters, and Places.' 400 BCE. Translated by Francis Adams. (Available from http://classics.mit.edu/Hippocrates/airwatpl.html) (Accessed 1 June 2020)

2 29 September 2004 Symposium. (Available from www.oneworldonehealth.org) (Accessed 4 April 2020)

(Killewo 2019). With the expansion of the above jointly developed framework, the organizations involved also developed implementable policies on One Health in 2010 at the Stone Mountain Meeting, which was held in May 2010, in Georgia[3] (Gibbs 2014). At this meeting, six workgroups were also formed to focus on: 1) cataloguing and developing One Health training curricula, 2) establishing a global network, 3) developing a country-level need assessment, 4) building capacity at country-level, 5) developing a business case to promote donor support and 6) gathering evidence for proof of concept through literature reviews and prospective studies.

In 2009, the CDC (Atlanta, Georgia, US) established a One Health Office to serve as a point of contact for external animal health organizations, which would aim at procuring external funding. The office has since expanded its role to support public health, facilitate data exchange, implement zoonotic disease prioritization and enhance cross-disciplinary research across sectors. It is now known as the National Center for Emerging and Zoonotic Infectious Diseases. Also, in 2009, the United States Agency for International Development (USAID) launched the Emerging Pandemic Threats (EPT) program to ensure a coordinated comprehensive international effort to prevent, detect and respond to emergence of animal-origin diseases that could threaten human health. The EPT has since expanded its program to include capacity development and laboratory strengthening. One Health and various other issues are now actively supporting the Global Health Security Agenda. Furthermore, the Public Health Agency of Canada hosted, in 2009, a One World, One Health Expert Consultation meeting in Winnipeg, Canada, to discuss the 'One world, one health' strategy and the objectives listed in the Strategic Framework released at Sharm el-Sheik, a year earlier.

It should be noted that another International Ministerial Conference on Avian and Pandemic Influenza was held in Hanoi, Vietnam, in April 2010; a meeting which was used to adopt the Hanoi Declaration, which called for a focused attention at the animal-human-ecosystem interface and recommended a broad implementation of One Health (Killewo 2019). Following the Hanoi meeting, the World Bank and the United Nations jointly released the 'Fifth global progress report on animal and pandemic influenza.' In 2011, the European Union (EU) published a report titled, 'Outcome and impact assessment of the global response to the avian influenza crises: 2005–2010.' This report confirmed that the EU was taking new initiatives using the One Health approach. It also emphasized the need to translate One Health concepts into practical policies and strategies that promote inter-agency and cross-sectoral collaborations (EU 2011).

The first International One Health Congress was held in Melbourne, Australia, in February 2011 and this was followed by the first One Health Conference in Africa in Johannesburg, South Africa, in July 2011 (Mackenzie and Jeggo 2011; Gibbs 2014; Killewo 2019). Similarly, in November 2011, there was a High-Level Tripartite Technical meeting held in Mexico City to consider the Tripartite Concept Note and address health risks that occur in the different geographic regions using selected diseases and issue (rabies, influenza and antimicrobial resistance) as points of departure in building political will and engaging health ministers on issues of One Health. The International Congress on Pathogens at the Human-Animal Interface (ICOPHAI) was set up to address important challenges and needs for capacity development in the field of One Health. The inaugural ICOPHAI congress was held at the United Nations Conference Center (UNCC) in Addis Ababa, Ethiopia, in 2011, followed by the second in Porto de Galinhas, Brazil (2013), the third in Chiang-Mai, Thailand (2015) and the fourth in Doha, Qatar (2017) and the fifth conference was held in Quebec, Canada. In February 2012, the Global Risk Forum (GRF) One Health Summit (OHS) 2012 – Towards the

3 Wikipedia. 2020. One Health. (Available from https://en.wikipedia.org/wiki/One_Health) (Accessed 4 April 2020)

'Davos One Health Action Plan' was held in Davos, Switzerland, with the title, 'One health – one planet – one future, risks and opportunities'.

To date, three of such meetings have been held to influence policies globally (GRF 2020). Specifically, the GRF is part of the Swiss non-governmental organizations (NGOs) that aim to more effectively mitigate risks and enhance prevention of risks in their humanitarian and development oriented endeavours, advisory services and policymaking through the capturing of diversity of knowledge and experiences. The body also directly impact the health-related aspects of the Sustainable Development Goals (SDGs). Furthermore, the GRF OHS aims to promote policies and foster an integrative approach in managing health risks at the interface of human-animal and environment health with a strong link to food safety and security and to agriculture. The organization strives for intensified collaboration among professionals, experts and practitioners from the different sectors and disciplines tangent to a comprehensive health perspective, particularly the pharmaceutical and food industry, which will provide significant added value in identifying cost-effective measures (Byskov et al. 2019; GRF 2020).

From 2011 to date, zoobiquity conferences have been held globally, first in response to the book published on the connection between human and animal health (Natterson-Horowitz and Bowers 2012) and, later, in reference to many interdisciplinary issues on humans and animals. In 2013, the second International One Health Conference was held, in conjunction with Prince Mahidol Award Conference, to commemorate the Rockefeller Foundation Centennial. This conference was held in collaboration with WHO, FAO, and OIE with the theme: 'A world united against infectious disease: cross–sectoral solutions,' and it focused on interdisciplinary collaborations and communications in all aspects of policy and actions for human and animal health, as well as environment health[4]. Furthermore, from 2013 until 2019, the One Health Central and Eastern Africa (OHCEA) organized three International Conference on One Health in Addis Ababa, Ethiopia, (first) and Kampala in Uganda (second and third).

In 2016, The One Health Commission initiated the idea of a One Health Day together with the One Health Platform and the One Health Initiative Team. The International One Health Day is now celebrated every 3 November (OHC 2020). On this day, events targeted at utilization of the One Health approach are carried out globally and pre-event details can be submitted to the One Health Commission's website for global recognition (OHC 2020). The sixth World One Health Congress with the theme 'Bridging one health science and global health security policy' was originally scheduled for June 2020 in Scotland, UK, but has now been shifted to 30 October – 3 November 2020 due to the global pandemic of COVID-19[5] (Osterhaus et al. 2020) The congress will focus on the 'One health science, antimicrobial agents and resistance and science policy interface (Table 1).

4 The second International One Health Conference was held in conjunction with Prince Mahidol Award Conference. (Available from: http://www.pmaconference.mahidol.ac.th/). (Accessed 4 April 2020).

5 Sixth World One Health Congress. (Available from: https://worldonehealthcongress.org/). (Accessed 23 April 2020).

Table 1. Chronological transition and major One Health initiatives*

| No. | Contributor(s)/ organization(s)/event(s) and timeline(s) | Contributions to One Health advancement |
|---|---|---|
| 1 | Hippocrates (460–370 BCE) | Recognized the role of environmental factors and impact on human health.[a] |
| 2 | Rudolf Virchow and William Osler (1821–1902) | Recognized the link between animal and human medicine, and coined the name 'zoonosis'.[b] |
| 3 | James Steele (1947) | Veterinarian who was trained in public health who founded the Veterinary Public Health Division at the Centers for Disease Control and Prevention (CDC), in Atlanta, in 1947. His works contributed significantly to the understanding of the epidemiology of zoonotic diseases.[b] |
| 4 | Calvin Schwabe (1927–2006) | A veterinarian trained in public health, coined the term 'one medicine' in a veterinary medical textbook in 1964.[b] |
| 5 | Wildlife Conservation Society (2004) | The twelve Manhattan Principles were created in Rockefeller University, New York. They showed the links between humans, animals and the environment. Also showed how these integrate understanding disease dynamics, and the importance of interdisciplinary approaches to prevention, education, investment and policy development.[c] |
| 6 | American Veterinary Medical Association (2006) | Established One Health initiative task force.[d] |
| 7 | American Medical Association (2007) | Passed a One Health resolution to promote partnering between veterinary and human medical organizations. Recommended One Health approach for responses to global disease outbreaks.[e] |
| 8 | International Ministerial Conference on Avian and Pandemic Influenza (2007) | Developed the One Health concept and strengthened linkages between the human and animal health systems especially for the pandemic preparedness and human security, New Delhi, India.[e] |
| 9 | International Ministerial Conference on Avian and Pandemic Influenza in Egypt (2008) | Development of a framework titled 'Contributing to one world, One Health-a strategic framework for reducing risks of infectious diseases at the animal-human-ecosystems interface,' with key recommendations for One Health approach to global health.e, [f] |
| 10 | International Ministerial Conference on Avian and Pandemic Influenza (2008) | Adoption of the developed framework on 'Contributing to one world, One Health-a strategic framework for reducing risks of infectious diseases at the animal-human-ecosystems interface 'at Sharm El Sheik, Egypt.[g] |
| 11 | FAO/OIE/WHO/UNSIC/ UNICEF/WB (2008) | Development of the implementable policies on One Health finalized in 2010 at the Stone Mountain, Georgia.[e] |
| 12 | Centers for Disease Prevention and CDC (2009) | Establishment of a One Health Office to serve as a point of contact for external animal health organizations which would aim at procuring external funding. The office has since expanded its role to support public health, facilitate data exchange, implement zoonotic disease prioritization and enhance cross-disciplinary research across sectors. |
| 13 | USAID (2009) | Launching of the Emerging Pandemic Threats (EPT) program to ensure a coordinated comprehensive international effort to prevent, detect and respond to emergence of animal-origin diseases that could threaten human health. |
| 14 | Public Health Agency of Canada (2009) | Held One World, One Health Expert Consultation meeting, Winnipeg. |
| 15 | International Ministerial Conference on Avian and Pandemic Influenza (2010) | Expansion of the above jointly-developed framework the organizations involved also developed implementable policies on One Health and the development of six workshops. |
| 16 | International Ministerial Conference on Avian and Pandemic Influenza (2010) | Adoption of the Hanoi Declaration (focused attention at the animal-human-ecosystem interface), Hanoi, Vietnam. |
| 17 | WB and UN (2010) | Joint release of the 'Fifth global progress report on animal and pandemic Influenza.' |
| 18 | EU (2011) | Published a report on 'outcome and impact assessment of the global response to the avian influenza crises: 2005–2010.' [h] |
| 19 | 1st international One Health Congress (2011) | Meeting was held in Melbourne, Australia.e, [i] |

| No. | Contributor(s)/ organization(s)/event(s) and timeline(s) | Contributions to One Health advancement |
|---|---|---|
| 20 | The International Congress on Pathogens at the Human-Animal Interface (ICOPHAI) (2011, 2013, 2015, 2017, 2019) | To address important challenges and needs for capacity building in the field of One Health, an inaugural ICOPHAI congress was held at the United Nations Conference Center (UNCC) in Addis Ababa, Ethiopia, in 2011; followed by the second in Porto de Galinhas, Brazil (2013), third in Chiang-Mai, Thailand (2015) and fourth in Doha, Qatar (2017) and the fifth conference in Quebec, Canada. |
| 21 | 1st One Health Conference in Africa (2011) | Meeting was held in Johannesburg, South Africa e, [i]. |
| 22 | High-level Tripartite Technical meeting (2011) | Considered the Tripartite Concept Note and addressed health risks that occurred in the different geographic regions using three selected diseases and issue (rabies, influenza and antimicrobial resistance) as points of departure to build political will and engage Health Ministers on issues of One Health. |
| 23 | Global Risk Forum - One Health Summit (2012) | A policy and economic forum to advocate for 'One Health–One Planet–One Future.'[j] |
| 24 | Zoobiquity publication and conferences (2012) | Published a book on the connection between human and animal health and, later, in reference to many interdisciplinary issues on humans and animals, followed by conferences held globally.[k] |
| 25 | 2nd International One Health Conference in collaboration with WHO/FAO/OIE (2013) | Meeting was held in Bangkok, Thailand.[g] |
| 26 | International Conference on One Health (Africa) | Funded by USAID, OHCEA organized three meetings in Addis Ababa, Ethiopia, (first) and Kampala in Uganda (second and third) from 2013–2019. |
| 27 | International One Health Day | Set up in 2016 and held every 3 November. [l] |
| 28 | 3rd international One Health Congress (2015) | Meeting was held in Amsterdam, The Netherlands. |
| 29 | 4th international One Health Congress (2016) | Meeting was held in Melbourne, Australia |
| 30 | 5th international One Health Congress (2018) | Meeting was held in Saskatoon, Canada |
|  | 6th World One Health Congress (2020) | Meeting will be held in Edinburgh, UK.[m] |

*Note that the list is not exclusive as many One Health-related events are happening that may not have been formally captured.

[a] Bresalier et al. 2015

[b] CDC 2016b

[c] 29 September 2004 Symposium. (Available from www.oneworldonehealth.org) (Accessed 4 April 2020)

[d] AVMA 2018

[e] Gibbs 2014

[f] FAO/OIE/WHO/UNSIC/UNICEF/WB 2008

[g] Killewo 2019

[h] European Union 2011

[i] Mackenzie and Jeggo 2011

[j] GRF 2020

[k] Natterson-Horowitz and Bowers 2012

[l] OHC 2020. (Available from https://www.onehealthcommission.org/en/events/one_health_day/).

[m] Osterhaus et al. 2020. (Available from https://icophai.org/about-icophai) (Accessed 4 April 2020)

The One Health concept is likely to be profoundly influenced by the COVID-19 pandemic. A critical although concise analysis of the ongoing pandemic of SARS CoV2 disease (also known as coronavirus disease 2 or COVID-19) suggests that numerous One Health-related concepts and policies are likely to be both promoted and expanded. First, the ecological perspective on the virus has established a conundrum among the human-bat-pangolin and live bird market in Wuhan, Hubei Province, China (Bonilla-Aldana et al. 2020; Zhang et al. 2020a; Zhang et al. 2020b; El Zowalaty and Järhult 2020; Rothan and Byrareddy 2020). Secondly, the approach to manage the COVID-19 pandemic has been, primarily, a sector-centric (primarily health) and disaggregated by geographies, a situation where a country's infection is seen as the

country's problem alone. Originally seen as a health problem limited to the People's Republic of China, little attention was paid to it by policymakers globally. However, as of 23 August 2020, at least 216 countries and territories have been affected with at least 23,057,288 cases in humans, 800,906 human deaths, infection in cats, dogs and zoo animals, enormous psychosocial stress, severe disruption of the industries, economies and education sectors globally worth several trillion in USD, enormous changes in policies and control measures globally, lots of chemical utilization in the environment and a global stall in the airline industries among other effects (WHO 2020; WEF 2020). It is clear that the response to the COVID-19 pandemic should be inter- or transdisciplinary, as well as multi-sectorial (including, but not limited to health professionals, scientists, economists, psychologists, planners, policymakers, communicators, anthropologists, behavioural scientists, security personnel, transporters, logistic suppliers, industry chiefs, and social organizations). That is, the response required to address this unprecedented challenge may benefit from, and further expand, One Health approaches.

# Misconceptions, gaps and issues in One Health

Due to the rapid evolution and transformation in the numerous fields already utilizing the One Health approach during the last 20 years (Manlove et al. 2016; Khan et al. 2018), One Health has been misconceived partially or wholly. While One Health is conceived by a school of thought that applies to a single discipline, it is a concept implemented through an interdisciplinary approach. In addition, the current method of delivery of One Health makes it extremely challenging for students and the future workforce to recognize the opportunities to integrate One Health into their own line of practice/discipline. In a recent study, Manlove and colleagues (2016) concluded that One Health training programs must blend in-depth training of students in their own domain with sufficient cross-disciplinary perspectives for effective participation in interdisciplinary work.

The One Health concept should not be delivered as a single course, lecture, topic or technical skill, but should be seen and delivered as an approach that needs to be constantly integrated in everyday health system thinking and practice. Furthermore, One Health is not species- or discipline-specific but an approach that should be embedded, and developed in components and contextually to fit into each and every topic taught, while its applications should be modified to fit into changing scenarios, as the need arises (Little 2012; Rüegg et al. 2018).

The majority of the identified One Health networks globally are largely academic (78%) or government bodies (22%) and approximately a third of them have very narrow perspectives (human-animal health issues only) (Khan et al. 2018; Essack 2018). This reductionist view and imbalance in stakeholders' representation will translate into narrow perspectives in addressing One Health issues and the lack of buy-in from other stakeholders who are kept outside the main networks. For instance, a carefully considered and well-developed One Health policy will fail to thrive and get implemented nationally if politicians, policy planners, economists and social scientists are not involved in its design.

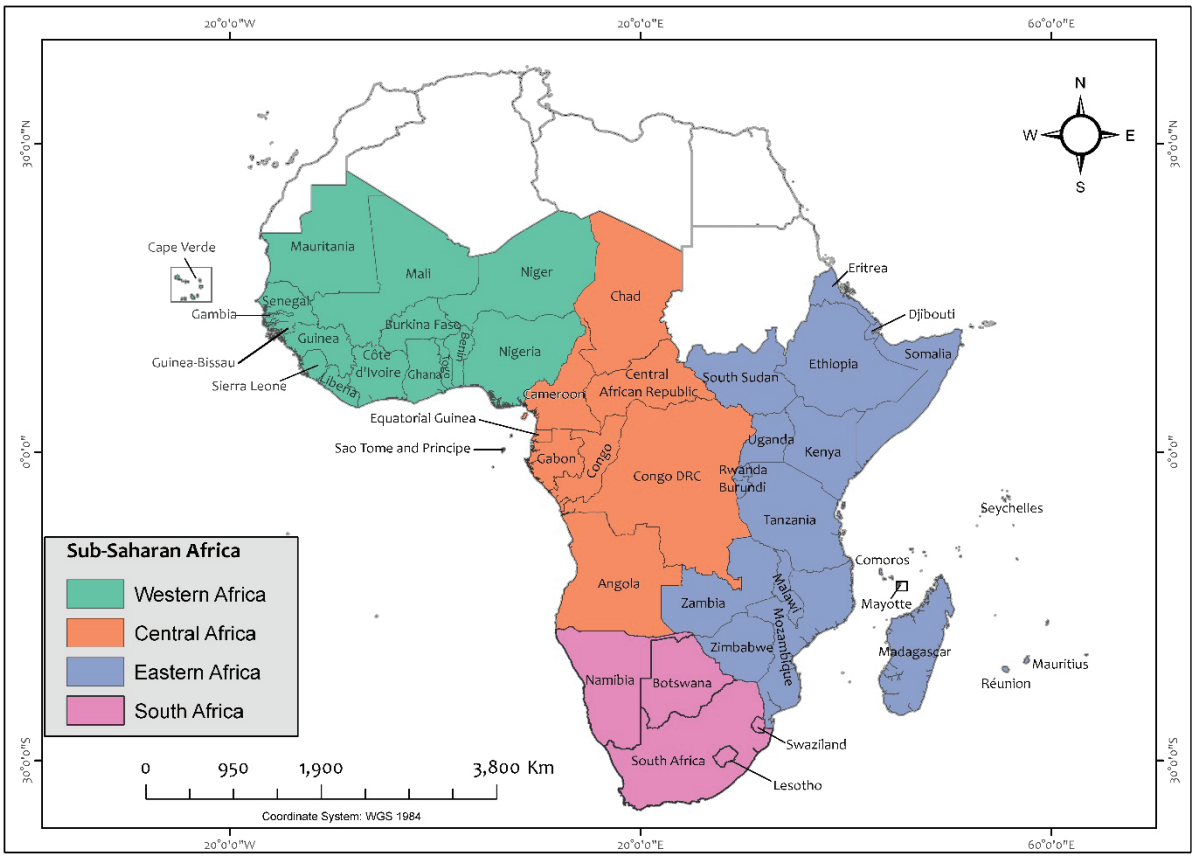
In the developing world, particularly the low- and middle-income countries (LMICs), One Health networks collaborate less and do not usually involve a clearly defined theory of change. To date, the monitoring and evaluation frameworks for One Health issues are hardly in place globally (Khan et al. 2018). This gross lack of a clear framework for monitoring and evaluation (M&E) will likely result in lack of direction and the conduct of many One Health activities without key outputs and outcomes in mind. The theory of change is essentially a comprehensive description and illustration of how and why a desired change is expected to happen in a particular context. It focused on mapping out or 'filling in' what has been described as the 'missing middle or missing link' between what a program or change initiative does (its activities or interventions) and how these lead to desired goals being achieved. Its absence may also lead to waste of resources because activities are more likely to be duplicated, and half-delivered results are likely to prevail. It is important to see health issues beyond the prism of human-animal health alone and, instead, include all sectors and stakeholders in the planning and implementation of interventions that utilizes the One Health approach.

Despite the efforts in the areas of coordination, organization, collaboration, communication, capacity development, information sharing tool development and joint research to date, the One Health concept, however, has lots of mileage to gain. They include, for instance, in the areas of surveillance and monitoring, joint border patrols, disease controls, emergency interventions, disaster interventions and recoveries, policy development, advocacy, community engagement and M&E.

# Definition of sub-Saharan Africa

The term sub-Saharan Africa geographically refers to an area of the African continent, south of the Sahara comprised of 46 out of the 54 members states of the African Union (see Appendix 1). However, this list is sometimes challenged because the following countries: Somalia, Djibouti, Comoros and Mauritania are geographically in sub-Saharan Africa and are also members of the Arab League (UN 2020). The designation sub-Saharan Africa (SSA) is commonly used to indicate all of Africa except northern Africa, with the Sudan included in SSA.

Figure 1. Map of Africa indicating areas covered by sub-Saharan Africa




The map was developed based on the UN definition of sub-Saharan Africa and information available from https://unstats.un.org/unsd/mi/africa.htm. (Accessed 20 April 2020).

# Developments in One Health initiatives in sub-Saharan Africa and the funding mechanisms

One health as a concept is very suitable and adaptable to sub-Saharan Africa as it can facilitate cross-sectoral cross-disciplinary engagement and produce outcome at a cheaper cost (Rwego et al. 2016; Fasina et al. 2020). However, the funding for most (>90%) of the One Health initiatives across sub-Saharan Africa has originated largely from outside the continent with some partial co-funding from national governments in SSA. There is hardly any subnational funding identified to support One Health initiatives. Furthermore, although there were at least 24 One Health networks in SSA, many of the networks and institutions have their headquarters in Europe or North America with the exception of ILRI and the Southern African Centre for Infectious Disease Surveillance (SACIDS) (Khan et al. 2018; Onyango et al. 2019). In the current review, a total of One Health initiatives identified in sub-Saharan Africa include 101 in east Africa, 85 in southern Africa, 65 in central Africa and 64 in west Africa (Figure 2; Appendix 2); but some One Health initiatives cut across more than one region. With rapid development of many more One Health initiatives, some relatively new and upcoming institutions are taking roots in and are based in Africa, although without a sustained funding system (Appendix 2). The full list of all identified One Health initiatives is in Appendix 2.

# Specific examples of One Health initiatives in sub-Saharan Africa

While One Health initiatives are spread across sub-Saharan Africa (Appendix 2), specific examples of One Health implementation are highlighted below:

1. The Coordinating Office for the Control of Trypanosomiasis in Uganda (COCTU): perhaps one of the few One Health initiatives with documentary evidence in Africa. The COCTU, an inter-ministerial platform in Uganda, has been implementing joint human African trypanosomiasis (HAT), animal trypanosomiasis and Glossina species (tsetse fly) control in Uganda for almost three decades (Okello et al. 2014). Despite the milestones and achievements of COCTU, and a high-level political endorsement and backing, it continues to face financial challenges for its sustainability, and it is housed within the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) as per the Ugandan law. This latter reason has pushed some One Health stakeholders in Uganda to perceive COCTU as a MAAIF parastatal or an establishment of the ministry (Okello et al. 2014). In addition, because it is perceived that HAT has been contained, COCTU is now considered almost obsolete and is struggling to work in other fields (e.g. vector-borne disease like Rift Valley fever [RVF]), to maintain itself.

2. The Kenya Medical Research Institute (KEMRI) and the Kenya Ministry of Health collaborated with the US CDC to establish the Global Disease Detection Division (GDDD) later referred to as the Division of Global Health Protection (DGHP) at CDC Kenya which facilitates diagnostic and epidemiologic capacity development for selected diseases in East Africa (Munyua et al. 2019). In addition, KEMRI is currently working with ILRI to test for COVID-19 in human samples, a good example of a shared human-animal sample platform for laboratory analysis.

3. Kenya utilized a One Health approach and established a multisectoral committee to develop preparedness planning and efforts at mitigating the potential introduction and spread of HPAI H5N1 in the country. This body responded to an outbreak of RVF in the eastern Africa region during 2006–2007 (Munyua et al. 2019). The absence of such platform in previous outbreaks of RVF in 1996/97, despite its endemic nature in East Africa, had led to significant delays in diagnostic and response capacity which contributed to an RVF outbreak in 27,500 people and 170 deaths in Garissa, northeastern Kenya (Munyua et al. 2019). The coordinated efforts between the Ministry of Health (MoH) and Ministry of Agriculture, Livestock, and Fisheries (MALF) in joint coordination and communication, built human capacity especially through the Field Epidemiology and Laboratory Training program (FELTP) and other sustained collaboration with US-supported programs led to the development of a fully functional BSL-3 laboratory at KEMRI and the formation of a national One Health coordinating office, the Zoonotic Disease Unit (ZDU), in 2012 (Mbabu et al. 2014; Munyua et al. 2019). As the name suggested, the ZDU was set up to focus primarily on zoonotic pathogens and earlier neglected other areas of One Health like food safety, AMR, vector-borne infectious diseases, toxicosis and pesticides (Kimani et al. 2019). Kimani and colleagues (2019) have recently proposed a broadening of the One Health focus for the ZDU.

4. On 12 December 2005, in anticipation of a potential HPAI H5N1 outbreak in Nigeria, the Nigerian Federal Government inaugurated a technical committee of experts for the prevention and control of HPAI. By 8 February 2006, and with the first reported case of HPAI H5N1 in poultry in Africa, the national government rapidly set up a National Inter-Ministerial Steering Committee on Avian Influenza (NISCAI) with the Minister of Agriculture and Rural Development and the Minister of Health as co-chair. In addition, the National Technical Committee on Avian Influenza (NTCAI) was also set up in parallel and co-chaired by both the Minister of State for Agriculture and Rural Development and the Minister of State for Health. This technical committee coordinated and implemented an emergency

action plan and strategy proposed for the prevention and control of the outbreak (World Bank 2006). Although the NISCAI and NTCAI brought together multidisciplinary staff from the multiple ministries, policymakers, communicators and industry players at the national level; whether this was replicated at subnational level is doubtful. It will appear that the bodies faded away with the elimination of the HPAI H5N1 in Nigeria and did not get institutionalized (Okello et al. 2014). The Nigeria Field Epidemiology and Laboratory Training Program (NFELTP), which started in October 2008, is facilitating joint human-animal-environment and laboratory-field joint investigations and interventions (Nguku et al. 2014).

5. The rabies intervention project in Tanzania has benefitted from multiple partnership, academic programs and research interventions. The wildlife ecosystems of the Serengeti, Selous and other areas have benefitted from funding from the Bill & Melinda Gates Foundation (BMGF) for a rabies elimination program in Tanzania covering 23 high-risk districts (Okello et al. 2014). A research group from the University of Glasgow had delivered several rabies interventions both in Tanzania's mainland and Zanzibar using a One Health approach (Cleaveland et al. 2002; Sambo et al. 2013; Lushasi et al. 2016; Mpolya et al. 2017; Sambo et al. 2017; Sambo et al. 2018; Changalucha et al. 2019). At the same time, the Global Alliance for Rabies Control has been partnering with World Animal Protection since 2009 to deliver both diagnostic and control interventions on rabies using a One Health approach in Zanzibar (Coetzer et al. 2019). Using an innovative One Health approach involving practitioners and students of One Health, FAO had partnered with the government of Tanzania to deliver rabies control in Moshi, Kilimanjaro Region (Mtui-Malamsha et al. 2019; Fasina et al. 2020). Such rabies interventions as delivered in Tanzania had occurred elsewhere in Africa (Zinsstag et al. 2009; Coetzer et al. 2019; Welburn et al. 2017; Darkaoui et al. 2017). The challenges with project-based deliveries remain the sustainability, national ownership and resource limitations of such initiatives (Okello et al. 2014). A national rabies control strategy has been developed recently in Tanzania and its implementation is expected to start soon.

6. The Zoonoses and Emerging Livestock Systems (ZELS) project, under ILRI and the Institute of Global Health, University of Liverpool, involved several field-orientated projects with primary research focus on neglected zoonoses. The ZELS brings together a team of epidemiologists, biologists, veterinarians and medical practitioners interested in the biology and control of re-emerging diseases, particularly zoonoses, and the project's research explores the factors involved in emergence, risk, transmission, persistence, spread, and disease burden of pathogens in both human and animal populations. The understanding of the influence of the physical environment on pathogen transmission, understanding of pathogen epidemiology, and the development of informed and evidence-based policy on optimal and cost-effective methods of disease control were among the goals of the ZELS project. ZELS has contributed several research papers particularly from East African perspectives.

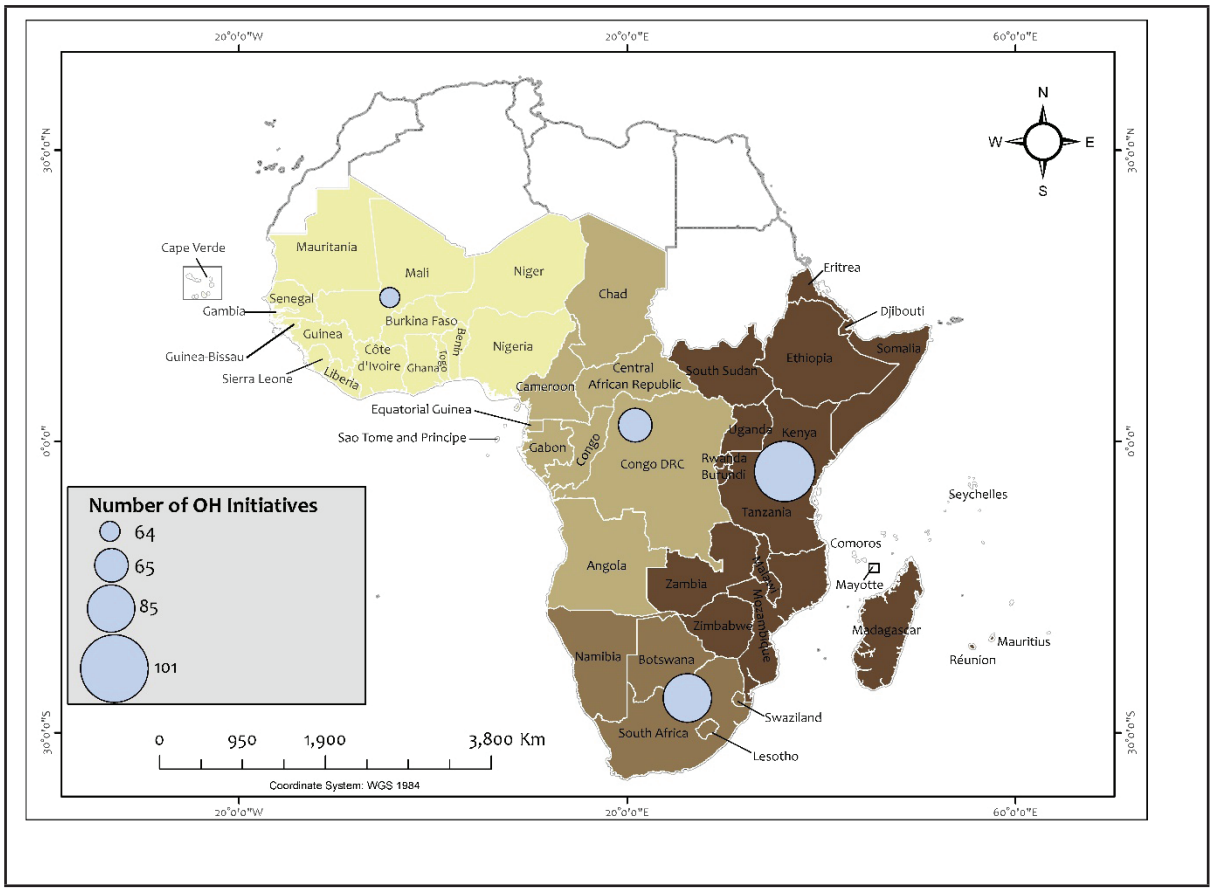
7. Currently, FAO through the Global Health Security Agenda's Zoonotic Diseases and Animal Health in Africa (GHSA-ZDAH), which is funded by the USAID has been supporting many One Health interventions through policy documents, control strategies, protocols, evaluations, national veterinary laboratories strengthening, epidemio-surveillance capacity development and workforce development. These activities are expected to continue into the foreseeable future.

# Results

## Survey

A total of 145 One Health initiatives were identified across sub-Saharan Africa in this study and these were broadly classified into coordination, organization, implementation, capacity development, research, tools/applications and multipurpose initiatives. East Africa has significantly more One Health initiatives (n = 101) compared to the other subregions of the continent in terms of total numbers of these initiatives. Southern Africa, central Africa and west Africa have 85, 65 and 64 identified initiatives, respectively (Figure 2). These initiatives were national, regional, continental or global in sphere and many of the initiatives cut across more than one subregion. Coordination and duplication of platforms appeared to be a major challenge among the different initiatives.

Figure 2. Map of sub-Saharan Africa showing number of One Health initiatives identified per region




Based on a remotely conducted survey among key informants (n = 57) including experts from the following fields: global One Health leaders, veterinarians, physicians, animal scientists, public health professionals/ epidemiologists, butchers, infectious disease experts, aquaculture experts and animal health technicians; a total of 55 organizations or professional groupings have been identified as relevant to the One Health agenda in Africa. These were grouped into stakeholders with high, moderate or low impact on One Health initiatives using the median scores (Table 2). In addition, the mean scores were used to classify and map all identified stakeholders into One Health quadrants (key stakeholders, latent stakeholders, marginal stakeholders and defenders of One Health initiatives) (Table 2; Figure 3). In addition, in the pairwise correlation analysis of interest, influence and power-policy, only the interest and influence scores have good correlation (correlation score = 0.71, $p < 0.0001$) but policy-power was poorly correlated with interest (correlation score = 0.17, $p = 0.27$) and influence (correlation score = 0.18, $p = 0.25$; appendix 3).

Specifically, the ministries responsible for public and animal health; professional regulatory bodies; veterinary officers in the field, holding grounds for livestock, and livestock markets; medical officers in clinics and hospitals; politicians and policymakers, ministries responsible for agriculture, wildlife authorities, veterinary and medical research institutions are all among the key stakeholders (Figure 3). Latent stakeholders include but are not limited to the higher authorities (offices of the president and vice president), the climate office, and the hatcheries and breeder farms. The marginal stakeholders include the law enforcers, private financial institutions, government boards, the local governments and the public. Finally, the One Health defenders include the office of the prime ministers, national research funding bodies, the media, the associations for animal and animal products producers and such other bodies

(Figure 3). It is important to know that the weakest link for One Health implementation in Africa and the future foci and plans, should resources be made available for implementation, will need a more qualitative evaluation. This opportunity should be used to avoid pitfalls that have delimited the success of previous One Health efforts (Table 3).

Table 2. List of identified organizations and groupings, likely impact, mean interest, mean influence and policy power scores of One Health initiatives and policies

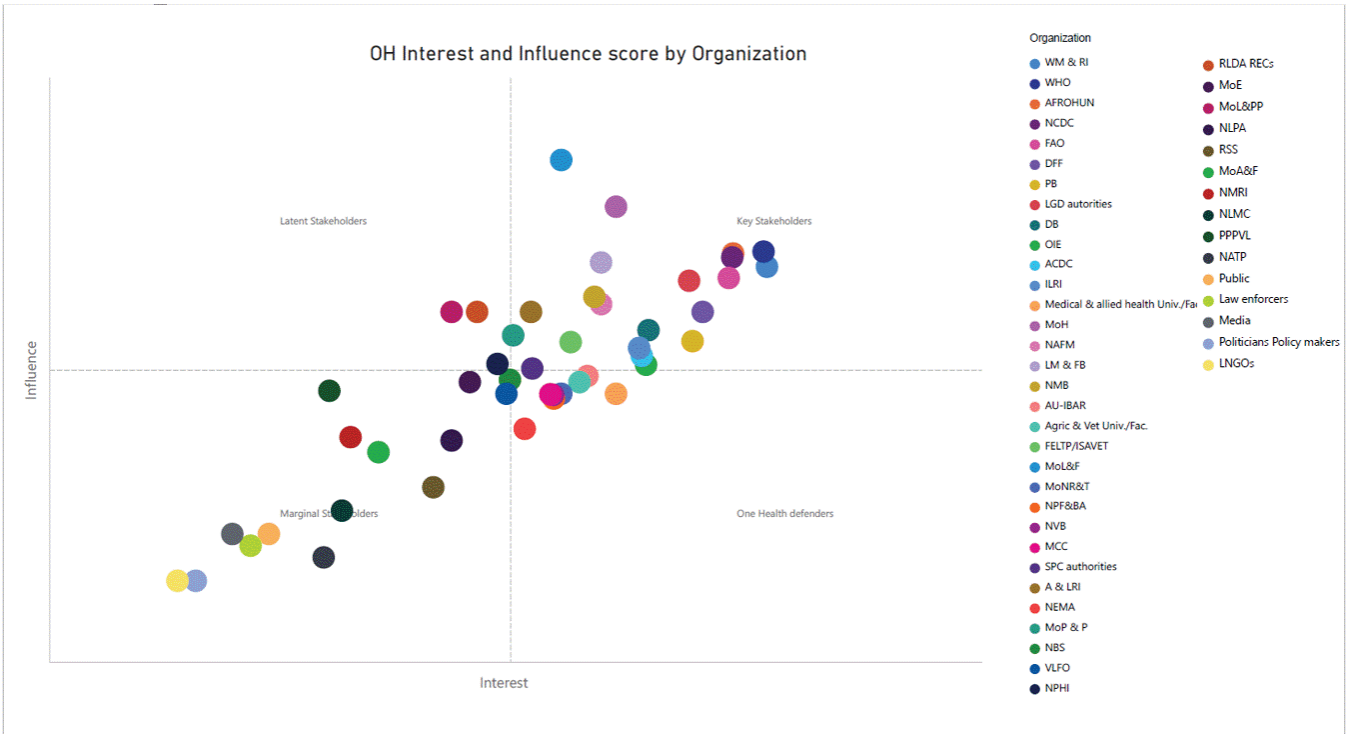
| No. | Organizations and groupings | Likely impact on One Health initiatives (low–moderate–high) | Mean influence score (0–10) | Standard Deviation | Mean interest score (0–10) | Standard deviation | One Health policy power score (0–10) |
|---|---|---|---|---|---|---|---|
| 1 | National livestock marketing councils | Moderate | 6.3 | 1.7 | 6.6 | 2.5 | 6.4 |
| 2 | National livestock producers associations | Moderate | 6.9 | 1.1 | 7.2 | 3.1 | 6.7 |
| 3 | National associations of traders and processors | Moderate | 6.3 | 2.2 | 5.9 | 2.3 | 6.5 |
| 4 | National research support systems like NRF, ETF, COSTECH, ARC and others | Moderate | 7.1 | 2.4 | 6.5 | 2.4 | 7.1 |
| 5 | Veterinary, environmental and other field officers working in clinics, holding grounds, livestock markets and quarantine stations | High | 7.5 | 1.8 | 7.3 | 1.7 | 6.9 |
| 6 | Medical health care staff (clinics, hospitals) | High | 8.1 | 1.9 | 7.7 | 2.0 | 2.0 |
| 7 | General public | Moderate | 6.2 | 2.7 | 6.2 | 2.8 | 6.0 |
| 8 | Ministry responsible for agriculture and forestry | High | 6.8 | 2.0 | 6.8 | 1.7 | 6.7 |
| 9 | Ministry responsible for livestock and fisheries | High | 9.3 | 1.7 | 7.8 | 1.7 | 8.0 |
| 10 | Ministry responsible for natural resources and tourism | High | 7.3 | 2.1 | 7.8 | 1.8 | 6.9 |
| 11 | Ministry responsible for environment | High | 7.4 | 1.7 | 7.3 | 1.8 | 7.2 |
| 12 | National Environment Management Authority | High | 7.0 | 1.9 | 7.6 | 2.1 | 7.2 |
| 13 | Ministry responsible for lands and physical planning | Moderate | 8.0 | 2.2 | 7.0 | 2.0 | 7.0 |
| 14 | Ministry responsible for public health | High | 8.9 | 2.0 | 8.1 | 1.6 | 7.4 |
| 15 | Agricultural and veterinary universities /faculties/colleges | Moderate | 7.4 | 1.5 | 7.9 | 1.4 | 6.9 |
| 16 | Medical and allied health universities/faculties/colleges | Moderate | 7.3 | 2.1 | 8.1 | 2.0 | 7.1 |
| 17 | Agency/directorate responsible for medicine control | High | 7.3 | 1.6 | 7.7 | 1.6 | 7.0 |
| 18 | Development partners, funders and financial institutions (e.g. USAID, EU, UKAid, World Bank) | High | 8.0 | 1.5 | 8.6 | 1.5 | 7.4 |

| No. | Organizations and groupings | Likely impact on One Health initiatives (low–moderate–high) | Mean influence score (0–10) | Standard Deviation | Mean interest score (0–10) | Standard deviation | One Health policy power score (0–10) |
|---|---|---|---|---|---|---|---|
| 19 | Public and private financial institutions | Low | 5.2 | 1.5 | 5.1 | 1.5 | 1.5 |
| 20 | National medical research institute | High | 6.9 | 2.7 | 6.6 | 1.9 | 6.9 |
| 21 | National plant health inspectorate service | Moderate | 7.6 | 2.5 | 7.5 | 2.3 | 6.5 |
| 22 | National poultry farmers and breeders association | Moderate | 7.3 | 2.5 | 7.8 | 2.5 | 7.1 |
| 23 | National association of animal feed manufacturers | Moderate | 8.1 | 1.6 | 8.0 | 1.1 | 7.1 |
| 24 | African Union-IBAR | Moderate | 7.5 | 2.4 | 7.9 | 1.9 | 7.4 |
| 25 | Regional livestock development agencies/ organization and regional economic communities | High | 8.0 | 1.6 | 7.3 | 1.5 | 6.8 |
| 26 | Africa Centers for Diseases Control and Prevention | Moderate | 7.6 | 2.3 | 8.2 | 1.6 | 7.4 |
| 27 | National medical board | High | 8.1 | 1.6 | 8.0 | 1.6 | 7.5 |
| 28 | National veterinary board | High | 7.3 | 2.4 | 7.8 | 1.8 | 7.2 |
| 29 | Ministry responsible for policy and planning | High | 7.8 | 1.7 | 7.5 | 1.9 | 6.6 |
| 30 | National bureau of Standards | Moderate | 7.4 | 2.0 | 7.5 | 1.6 | 7.2 |
| 31 | National agricultural and livestock research institute | High | 8.0 | 1.5 | 7.6 | 1.6 | 7.7 |
| 32 | Dairy board | High | 7.8 | 1.4 | 8.3 | 1.4 | 7.5 |
| 33 | Livestock meat and food board | High | 8.4 | 1.0 | 8.0 | 1.6 | 7.3 |
| 34 | Pharmacy board | Moderate | 7.8 | 1.8 | 8.5 | 1.3 | 7.7 |
| 35 | Field Epidemiology and Laboratory Training Program (FELTP)/ In-service applied veterinary epidemiology | High | 7.7 | 2.0 | 7.9 | 2.1 | 7.3 |
| 36 | State/province/county authorities | High | 7.5 | 2.2 | 7.6 | 2.0 | 7.9 |
| 37 | Local government/district authorities | Moderate | 8.3 | 1.5 | 8.5 | 1.3 | 7.8 |
| 38 | World Organisation for Animal Health | Moderate | 7.5 | 2.0 | 8.3 | 1.2 | 7.5 |
| 39 | International Livestock Research Institute | Moderate | 7.7 | 2.2 | 8.2 | 1.5 | 7.2 |
| 40 | Wildlife management and research institutions and services | High | 8.4 | 2.1 | 8.9 | 0.9 | 7.8 |
| 41 | Food and Agriculture Organization of the UN | Moderate | 8.3 | 1.2 | 8.7 | 1.0 | 7.8 |
| 42 | National Centers for Diseases Control and Prevention | High | 8.5 | 1.3 | 8.7 | 0.9 | 7.8 |
| 43 | Africa One Health University Network | Moderate | 8.5 | 1.4 | 8.7 | 0.8 | 7.9 |
| 44 | World Health Organization | High | 8.5 | 1.5 | 8.9 | 0.7 | 7.9 |

| No. | Organizations and groupings | Likely impact on One Health initiatives (low–moderate–high) | Mean influence score (0–10) | Standard Deviation | Mean interest score (0–10) | Standard deviation | One Health policy power score (0–10) |
|---|---|---|---|---|---|---|---|
| 45 | Local NGOs, CBOs and FBOs | Moderate | 5.7 | 1.8 | 5.7 | 1.4 | 6.3 |
| 46 | Public and private public and veterinary laboratories | High | 8.2 | 1.1 | 8.0 | 1.7 | 6.5 |
| 47 | US CDC | Moderate | 8.5 | 1.3 | 8.7 | 0.9 | 7.8 |
| 48 | Government boards | Moderate-high | 6.5 | 2.1 | 6.8 | 2.1 | 7.2 |
| 49 | Law enforcers (police, military, customs) | Low-moderate | 6.0 | 2.1 | 6.1 | 1.3 | 5.2 |
| 50 | Input providers (veterinary, medical, pharmaceuticals, chemicals, biologicals, feed and equipment suppliers) | High | 7.2 | 1.6 | 6.9 | 1.7 | 5.5 |
| 51 | Meat inspectors | High | 8.4 | 1.6 | 7.9 | 2.2 | 2.2 |
| 52 | Media (print, electronic and social) | Moderate | 7.3 | 1.8 | 7.7 | 1.8 | 1.8 |
| 53 | Politicians/policymakers | High | 7.5 | 2.1 | 9.0 | 1.7 | 1.7 |
| 54 | Environmental health officers and researchers | High | 6.0 | NA | 6.0 | NA | NA |
| 55 | Climate office and experts | High | 6.0 | NA | 8.0 | NA | NA |

A total of 57 experts from the following fields responded to the questionnaire: global One Health leaders, veterinarians, physicians, animal scientists, public health professionals/epidemiologists, butchers, infectious disease experts, aquaculture expert and animal health technician. Responses were provided through feedback online or in hard copies on paper. No physical meeting was engaged in view of the risk of COVID-19 infection.

Figure 3. Quadrant analysis of One Health stakeholders' interest and influence matrix in One Health initiatives




National Livestock Marketing Council (LMC), National Livestock Producers Association (LPA), National Associations of Traders and Processors (NATP), Research Support Systems like NRF, COSTECH, ARC, others (RSS), Ministry responsible for agriculture and forestry (MoA&F), Ministry responsible for livestock and fisheries (MoL&F), Veterinary and livestock field officers working in holding grounds, livestock markets and quarantine station (VLFO), Ministry responsible for Natural Resources and Tourism (MoNR&T), Ministry responsible for environment (MoE), National Environment Management Authority (NEMA), Ministry responsible for lands and physical planning (MoL&PP), Ministry responsible for public health (MoH), Agricultural and veterinary universities/faculties/colleges (Agric & Vet Univ./Fac.), Medical and allied health universities/faculties/colleges, Agency/directorate responsible for medicine control (MCC), National Medical Research Institute (NMRI), National plant health inspectorate service (NPHI), National poultry farmers & breeders association (NPF&BA), National association of animal feed manufacturers (NAFM), African Union-IBAR (AU-IBAR), Regional livestock development agencies/organization and regional economic communities (RLDA/RECs), Africa Centers for Diseases Control and Prevention (ACDC), National medical board (NMB), National veterinary board (NVB), Ministry responsible for policy and planning (MoP&P), National bureau of standards (NBS), Agricultural and livestock research institute (A&LRI), Dairy board (DB), Livestock meat and food board (LM&FB), Pharmacy board (PB), Field Epidemiology and Laboratory Training Program (FELTP)/ In-service applied veterinary epidemiology program (ISAVET), State/province/county authorities (SPC authorities), Local government/district authorities (LGD authorities), World Organisation for Animal Health (OIE), Donors, funders and financial institutions like USAID, EU, UKAid, World Bank (DFF), International Livestock Research Institute (ILRI), Wildlife management and research institutions and services (WM&RI), Food and Agriculture Organization of the United Nations (FAO), National Centers for Diseases Control and Prevention (NCDC), One Health Central and Eastern Africa (AFROHUN), World Health Organization (WHO), Local NGOs, CBOs and FBOs (LNGOs), Public and private public and veterinary laboratories (PPPVL).

Table 3. Common themes originating from selected One Health stakeholders on important questions on One Health initiatives

| No. | Observed weakest link in the sub-Saharan African countries that have prevented or limit the successful implementation of One Health at local, national or regional level | Suggested area of best invest towards improving One Health implementation in African countries |
|---|---|---|
| 1 | Weak collaborations between the various sectors that should implement One Health. Unhealthy rivalry and competition amongst the various sectors sometimes hamper developments in One Health. One Health integration among the various sectors of One Health is still somewhat weak. Reductionism. | Strengthening collaboration between the various sectors at national and subnational levels (see Appendix 4 for example). This may also have regional ramifications. |
| 2 | Inadequate human, material and financial resources from the government. There is oftentimes inter-sectoral discrimination in funding and budget provisions among key disciplines hence the lack of funds to finance projects. The government could facilitate a Theory of Change process for different (One) health problems and engage all sectors and disciplines in developing their roles and contribution in the big puzzle | Capacity development of the staff at central (national) and subnational level – on management, coordination, communication and resource mobilization. Such examples include but are not limited to the HEAL curriculum. |
| 3 | Decentralization of One Health activities to subnational level for implementation should be prioritized. | Investing in research and software development for easy reporting and collation of data in the field of One Health. |
| 4 | Low level of One Health awareness among policymakers and the public on burden of zoonoses and benefits of One Health. | Developing strategies and guidelines for zoonoses and relevant One Health issues like antimicrobial resistance, toxins, environmental issues etc. |
| 5 | There are limited data on burden of zoonoses and other One Health challenges to influence policy. Even where data from vital research outputs exist, sharing among the various One Health stakeholders and end users/beneficiaries may be problematic. | Mapping of One Health stakeholders/actors and activities implemented in the country. |
| 6 | Relatively weaker management of wildlife sector compared to public and animal health. | Joint (inter-ministerial and intersectoral) field activities (e.g. outbreak investigations). |
| 7 | Cross-border implementation of One Health initiatives is always challenging in view of different policies, legislations and uneven finance/ sponsorship among countries that share borders. Ineffective cross-border One Health implementation. | Supporting advocacy on One Health approach and associated activities (including good practices documented so far) to ensure enhanced understanding among policymakers and actors. Promoting One Health education among reputable political leaders. |
| 8 | Coordination mechanism at both national and subnational levels is still weak and often non-committal. This is as a result of not having adequate staff fully committed to implementation of One Health activities. | Lobby for adequate number of qualified staff (experts in public health, animal health and environment health/metrological, geographic information systems (GIS)/data and information management specialist and risk communication expert) at the central coordination office to ensure implementation of the agreed work plan. |
| 9 | Wildlife health is currently not well captured in the principles of One Health. The human medical practitioners are sometimes at loggerheads with veterinary practitioners over supremacy of disciplines. | Utilize fund for human resource development and capacity development, especially for the professionals left behind in previous One health training so that they will be better positioned to perform optimally in the One Health initiatives. |
| 10 | Poor representation of other experts/fields like the animal scientists, biologists, relevant biomedical and natural sciences, and social sciences and policy related fields in the One Health teams. Wildlife health and EcoHealth are also still very deficient and left behind in One Health initiatives. | Equipping the coordination office to facilitate data collection, processing and timely information sharing |

| No. | Observed weakest link in the sub-Saharan African countries that have prevented or limit the successful implementation of One Health at local, national or regional level | Suggested area of best invest towards improving One Health implementation in African countries |
|---|---|---|
| 11 | The career civil servants often want to take the forefront role in new initiatives like One Health without consideration for professional fits, hence the lack of competence and administrative lapses to lead One Health teams. | The payment of ad-hoc staff to support substantive staff in ramping up capacity for One Health. |
| 12 | Foreign partnership on One Health joint activities is dwindling and insufficient external funding is available. | Training on One Health through various means and innovations like online platforms, remotely accessed training, localized training initiatives, and nationally institutionalized training on resource mobilization and establishing global collaborations. |
| 13 | Inferiority and/or superiority complexes among the various professionals and institutions. In some high-profile organizations and institutions, some persons see their role as more important than that of others. This mindset and insular attitude generates resistance to collaborate and refusal to give due credit to other productive groups/organizations with counterproductive consequences for the noble One Health concept/ approach. | Assembling a team comprising various professional bodies and stakeholders like veterinarians, animal health technologists, epidemiologists, public health specialists, print and electronic media practitioners etc. to propagate the concept and importance of One Health in the representative local government areas in all the regions of the country. During this exercise, data should be obtained simultaneously to ascertain the level of awareness of the One Health concept in the country. |
| 14 | Concealment and denial of information and data among the various One Health stakeholders, hence the obvious inter-sectoral communication gap. Information and data sharing among sectors may also be met with some level of resistance or officially barred. | Form a team of different professionals across disciplines to start a large One Health national team, with subnational formats replicated at the secondary and tertiary levels of administration. The team will be expected to develop proposals and jointly implement different activities including research, awareness creation, training and field implementation for different stakeholders. |
| 15 | Misconceptions of One Health approach. Prevailing uni-disciplinary research and weak understanding of the essence of One Health. For example, public health clinicians still think largely of it as a clinical approach, the veterinarians think of a population medicine approach and the environmentalists and ecologists think of it as the environment and wildlife/habitat/ecosystem health primarily. | Carry out gap assessments to determine the core areas with obstacle for the development of One health initiatives in the country. This will be followed by the presentation of the positive impact of one health to the stakeholders in the country. The outcome will be presented to higher officials, policymakers and influencers for purpose of advocacy. |
| 16 | Administrative challenges and inter-sectoral bureaucratic bottlenecks may sometimes make One Health impracticable. For example, some line ministries cannot pull funds together inter-ministerially to jointly implement activities. | To finance research on public health, food-borne diseases, meat contamination, food preservation, food security, livestock genetic improvements and evidence generation. |
| 17 | Undefined or not clearly defined roles, responsibilities and functions of the various stakeholders hence encroachments and duplication of functions and activities. Lack of policy framework and system that will enable the effective coordination of relevant stakeholder institutions. | To sponsor projects related to AMR and resistance gene transfer amongst human, animal and their environment. |
| 18 | There is no unified database on One Health as the different sectors prefer their independence. | Construction of a good slaughterhouses, and proper remuneration of meat inspectors to showcase proof of concept. |
| 19 | Poor advocacy to policymakers hence lack of One Health approaches at subnational levels. | Injection of funds into areas and projects starved of funds. |
| 20 | Poor knowledge of relevant One Health initiatives among relevant stakeholders (the general public) as well as inadequate/archaic knowledge of concept roles, importance and contributions of One Health. | To attend workshops and relevant seminars that clearly put into perspective enlightenment and acquisition of knowledge on One Health programs, initiatives and activities, as well as the establishment of communities of practice (CoPs) |
| 21 | Prioritization of other emergency issues (e.g. the ongoing COVID-19, Ebola, natural disasters etc.). | Money will be used to prepare the MOUs or legislations for partnership, which clearly define the roles of every professional partaking in One Health activities. Such investment should focus on preventive rather than responsive outbreak response. |

| No. | Observed weakest link in the sub-Saharan African countries that have prevented or limit the successful implementation of One Health at local, national or regional level | Suggested area of best invest towards improving One Health implementation in African countries |
|---|---|---|
| 22 | The non-existent of relevant One Health policies and robust understanding of the topic by legislators and regulators. | Establishment of One Health administrative offices at subnational level for proper organization. |
| 23 | Poor monitoring and evaluation of One Health activities and initiatives. | Boosting capacities of different constituents of One Health and setting up necessary M&E structures to monitor progress closely. |
| 24 | Endemic poverty prevents making informed One Health decisions. | Investment into One Health education and curricula at university/ college levels. Promote One Health approaches among undergraduate medical and veterinary students, in diploma colleges and or fund MSc projects utilizing One Health approaches. Such is also important at primary education level (e.g. teaching the concepts of good hygienic practices, how health of animals and humans and environment are interconnected) including the supportive training to teachers. |
| 25 | Access to direct local funding to support research/ implementation of One Health approaches are inconsistent. Most of the present One Health activities are donor-driven. | Establish undergraduate and postgraduate training and research in the One Health approach with practical and applicable field attachments for all cadres of practitioners using modern information and communication and technology (ICT) techniques. This should be tied to local, subnational and national resource mobilizations. |
| 26 | The lack of formal education of stakeholders. For instance, the farmers, herders, butchers, smallholder farmers, roadside drug shop owners, food vendors and other artisans may be important stakeholders but are not formally educated in hygiene, biosafety and biosecurity, One Health, AMR and related health issues; hence they will continually serve to limit milestones and achievements in One Health. | To support the implementation of a policy framework that mandates One Health collaboration and integration at all relevant stakeholder institutions. Integration of One Health into relevant stakeholder institutions through the establishment of One Health desks in every institution that will cater to issues or projects that require multidisciplinary and transdisciplinary actions/contributions. |
| | | To strengthen coordination and empower subnational One Health actions (implementation). |
| | | Conduct community sensitization using established fronts like the political and religious leaders. |
| | | Conduct community sensitization at one of the hotspots and interfaces for diseases (e.g. points of entry [POE]). |
| | | Strengthen preparedness planning and improve the ability to respond to zoonotic diseases, AMR and other public health events outbreak at all levels. |
| | | Strengthens animal and public health reporting systems and their interoperability. |
| | | Initiate the collaboration of different professionals to research into climate-smart agriculture for increased food production, ecofriendly utilities and vibrant blue economy due to the fact that humans now encroach into the natural forests and their rich and diverse fauna which expose humans and domestic animals to new pathogens. |
| | | Initiate transdisciplinary research where veterinarian, public health, social science, laboratory and environment health experts and local community opinion leaders could work together on shared objectives. |
| | | To support centralization of tools for reporting of zoonotic infectious disease and related One Health issues once detected and ensuring that this platform is available to all key parastatals and stakeholders involved in One Health. |

| No. | Observed weakest link in the sub-Saharan African countries that have prevented or limit the successful implementation of One Health at local, national or regional level | Suggested area of best invest towards improving One Health implementation in African countries |
|---|---|---|
| | | Promotion of biosecurity amongst veterinarians, rangers, health workers and other stakeholders. |
| | | Start a project that would incorporate transdisciplinary approaches with contributions from a wide range of professionals. Such a project would target the integration of the One Health approach and target the vulnerable (unemployed youth and women) in the society. These individuals make the larger part of the population. The project's goals will include:<br><br>Improvement of livelihoods of the target populations through the creation of awareness on the One Health approach.<br><br>Empowerment of the vulnerable by creating sustainable One Health practices.<br><br>Use the target subset of the population to disseminate the acquired information and benefits as proof of concept to the rest of the community.<br><br>Establish a national one health task force or network multiple professionals.<br><br>Recruit community leaders and members and train them on the One Health approach and use them as ambassadors and champions to preach the One Health approach at the community level.<br><br>Establishment of or strengthening of One Health administrative offices at subnational levels for proper organization of national-subnational integration and to secure future funding. |
| | | Such money will be invested to promote wildlife health involvement in One Health. |
| | | The money will be used to augment budget deficits wherever there is genuine interest in One Health administration. |
| | | To address poorly-coordinated One Health activities by running an office. |
| | | To sponsor bills for legislations and policies on One Health initiatives. |

Responses were obtained from individuals and groups of professionals from various fields and disciplines including public health, animal health, environmental health, fisheries, and other stakeholders, cutting across multiple African countries and from experts who have worked in the field of One Health in Africa but reside within or outside the continent. The snowballing method was utilized to gather this information until the saturation point was reached when no new theme was mentioned. See Appendix 6 for details of the summary in Table 3.

# Strengths, weaknesses, opportunities and threats (SWOT) analysis

Although One Health has made a lot of inroads in SSA countries, it is necessary to evaluate the One Health approach in relation to its enablers and hindrances (gaps) in Africa so that future engagements and implementation of the approach can avoid pitfalls that limit the benefits associated with the current level of One Health implementation. Such an evaluation will provide additional benefits to the health system to tackle the burden of re-emerging infectious diseases, AMR, and environment health (Kimani et al. 2019; Yasobant et al. 2019). A strengths, weaknesses, opportunities and threats (SWOT) analysis of One Health implementation in SSA arms us with an empirical strategy for prioritizing future areas of concentration for works that need to be done to grow the field.

In a study to evaluate the SWOT of the One Health approach elsewhere, Hinjoy et al. (2017) have identified three priorities including the following: (1) building awareness of One Health among multisectoral units for preparedness and response of endemic and emerging infectious diseases, (2) coordinating and sharing surveillance data of zoonoses with database development by using innovative information technology, and (3) developing strategies for prevention and control measures covering human, animal and wildlife welfare at the ports of entries and suggested the inclusion of these three main strategies in policy decisions for national disease prevention and control framework using the One Health approach. Details of reviews of the strengths, weaknesses, opportunities and threats associated with One Health initiatives in SSA and elsewhere are given in Table 4.

# Summary of the gaps observed in One Health implementation

1. Information sharing, communication and collaborations among the various sectors of One Health is poor or very poor, especially between the medical and veterinary personnel, and even within each discipline. Giving notice to the other sectors is not the same as information sharing. Shared responsibilities by all stakeholders after information sharing is an effective actioned sharing of information. No one stakeholder should be left in the fringe of participation. Furthermore, such information sharing should not be seen in the context of 'health' alone. All scenarios must be evaluated comprehensively, and all necessary stakeholders must be brought in as active players in interdisciplinary engagement for problem assessment, stakeholder mapping and in the design and implementation of One Health solutions. Oftentimes, the environment sector, social sciences and policymakers, as well as the communicators are completely neglected in 'health' matters. For instance, in non-communicable health issues, soil degradation may limits crop productivity with a consequential malnutrition leading to increased susceptibility to infectious diseases. In addition, such gaps in communication and collaboration are a result of the absence of formal or legal linkages, structures or policies to guide collaboration. One Health bodies and communication should be formal, structured and trackable with good storage and retrieval systems for future reference and learning. Where necessary, and where unavailable, environment ministries/wildlife institutions and those that take care of other One Health roles must be created and stimulated to be active players.
2. Proliferation of data and multiple platforms for information capturing that are mostly dichotomous. This largely emanates from the data capture systems created differently for each sector without a consideration for other field. For instance, AMR data is captured on the Global Antimicrobial Resistance Surveillance System (GLASS) database for the public health system but this data is not completely compatible with the animal and environment health systems because it is clinically focused and not population-health focused and definitions between the fields are sometimes different. Similarly, while the public health focuses on clinically oriented data, the animal and sometimes environmental health fields focus on population-level data which creates lack of harmony. Hence the databases for human, veterinary and environment health may often be misleading and may be difficult to harmonize. There is a need for system thinking long before national implementation of One Health platforms so that sectoral information capture can draw parallels in similar areas. Quality data must be accessible and verifiable from a centralized source and have the similar reporting formats.
3. Preparedness and response to disease outbreaks, emergency interventions, disaster interventions and recoveries, policy development, advocacy, community engagement and monitoring and evaluation for One Health initiatives are dissimilar across African countries or are inexistent in some countries, especially those without external assistance to develop such interventions. Where these preparedness and response documents are available, they are often not tested or subjected to evaluations through drills, simulations, after-action reviews and other evaluation methods.
4. Lack of institutional development and inadequate human resources as well as lack of capacity development in the different sectors. Usually, in most SSA countries, public health capacities (human resources, availability of facilities, financial resources, budgetary allocations and reporting platforms) are ahead of the animal health and environment health capacities. These discrepancies often serve as barriers to harmonized interventions between sectors. Furthermore, most SSA countries ration staff because the number of staff to man the health services (human, animal and environmental) is inadequate. This makes it difficult to build specific competencies for each staff as they are often rotated among several assignments and can be redeployed without notice.

5. Duplication of roles and efforts among sectors could hinder effective implementation of One Health initiatives and effective participation of government ministries. For instance, the issue of AMR cuts across the public, animal and environment health sectors. It also has policy, economic, regulatory and political angles to its national implementation. It is convenient for the ministries and parastatals involved to set up their own structure to address the issues of AMR. For example, in Ethiopia, there is a National Health Security Council (NHSC), which duplicate the mandates of the National One Health Steering Committee (NOHSC); in Kenya, the Zoonotic Disease Unit's (ZDU) roles (coordination and implementation of One Health activities) are largely exclusive of AMR and food safety/aflatoxins issues; in Tanzania, activities under the Multisectoral Coordinating Committee (MCC), which is the central national steering body for overseeing and coordinating all AMR-related activities in all sectors and the One Health Coordination Desk (OHCD) as well as the public and animal health ministries often have parallel and conflicting roles on AMR, surveillance and One Health thus facilitating duplication. This situation is similar across many African countries. Having a centralized and harmonized multisectoral platform in each country will promote interdisciplinary facilitation of One Health and drive one healthiness in addressing AMR, surveillance and other issues in SSA. Similar interventions should be focused on zoonotic diseases that have environmental and wildlife perspectives (e.g. anthrax, brucellosis, rabies and haemorrhagic viral infections).
6. Many ministries and government departments and parastatals are understaffed. Majority of the personnel though may also be qualified in their professional disciplines but are not always competent or skilled enough in the utilization of One Health approach, and where they are competent, they may lack the wherewithal to perform/implement One Health effectively. As an example, all ministries and government departments had line budgets that may be directed at disease control, policy, planning, communication and many One Health-related issues but hardly was there a ministry or parastatal that has a dedicated budget to facilitate cross-sectoral and interdisciplinary engagements. Similarly, strategy for workforce capacity development must be put in place and implemented and reviewed regularly to meet national objectives. It is necessary to put in place government financing systems that support scheduled staffing, capacity building and institutional development in a sustainable manner.
7. It appears that the majority of One Health stakeholders continue to depend on external funding and sponsorship. Although governments may have some budget dedicated to some One Health issues, there is paucity of national sponsorship and partnership in the field of One Health. In the same vein, over-reliance on technical assistance and subject matter experts/specialists from international organizations and foreign countries can become a limitation and create dependency.
8. Absence of, or deficiency of, regulations, policies, legal instruments and memorandums of understanding on the involvement stakeholders in vertical and horizontal engagements including inter-ministerial, intergovernmental and cross-sectoral engagements as well as in public-private partnerships.
9. In most countries in SSA, quality laboratory services, which is an essential component of a health care system, remains weak due to several factors. Most national laboratories do not meet the accreditation standards under the quality management system, capacities are limited, skills and competencies are not regularly updated and laboratory diagnostic facilities are limited and unavailable to deliver efficient and prompt diagnosis of infectious diseases, particularly, during emergencies and in outbreak situations. This is particularly so in the subnational systems of low-income, lower-middle income and conflict-impacted countries in SSA (Sallu et al unpublished; Mesfin et al. 2017). This observation has limited the contributions of medical, veterinary and environmental health services as stakeholders in One Health implementation and can sometimes create gaps between sectors with regards to efficient deliveries of multisectoral outputs. Furthermore, regional and subregional-level reference laboratories that support national efforts in delivering rapid and competent laboratory-based diagnostic services across sectors are necessary to contribute to One Health efforts in SSA.

10. Whereas cross-border One Health initiatives and efforts have been launched in many border areas across Africa, and are largely championed by continental or regional economic commissions (RECs) such as the African Union (AU), African Union Inter-African Bureau for Animal Resources (AU-IBAR), African Centers for Disease Control and Prevention (ACDC), Economic Community of West African States (ECOWAS), West African Economic and Monetary Union (WAEMU), Mano River Union (MRU), Economic Community of Central African States (ECCAS), Economic and Monetary Community of Central Africa (CEMAC), Common Market for Eastern and Southern Africa (COMESA), Intergovernmental Authority on Development (IGAD), Arab Maghreb Union (AMU), East African Community (EAC), South African Development Community (SADC), South African Customs Union (SACU) and the Permanent Inter-State Committee for Drought Control in the Sahel (CILSS). The follow-up actions and implementation of outcomes arising therefrom have often suffered neglect because of lack of interest, differences in country-level policies and lack of political will. Sometimes, the absence of memorandums of understanding to drive such One Health agendas between countries and challenges arising from shared ownership of intellectual properties or benefits arising from such initiatives limit the success of such efforts. These subregional and regional-led efforts can be utilized to promote One Health and both the national and subnational systems can take advantage of these bodies to implement national-level One Health initiatives.
11. Since the ministries implement their activities based on dedicated and gazetted budget lines, and because One Health is a relatively new concept compared to traditional public, animal and environmental health implementation frameworks, and policy and socio-economic environments; One Health platforms often have insufficient budget allocation or none to actualize approved One Health activities thereby hindering implementation or contributing to poor delivery. There is no formal or specific budget to implement One Health plans/activities in the government systems resulting in poor implementation of the pertinent policies and strategies by the respective government authorities. Currently, the formal budgets dedicated to One Health initiatives and activities are donor-funded, this is unsustainable because the future funding environment may be inconsistent and uncertain. Necessary legal and policy instruments for prioritized national funding for planning and implementation of One Health initiatives must be put in place.
12. There are no disease surveillance systems and where present, the communication and information exchange between the systems and the reporting channels is less than desired, especially within the wildlife and livestock health sectors.
13. While selected African countries have functional One Health platforms, sometimes, the lack of subnational platforms hinders the activities of these national platforms. In addition, most subnational government systems in Africa have limited competencies and subject matter expertise in the workforce to implement the One Health approach and integrate multisectoral work. Furthermore, it should be understood that while formulation and coordination as well as legal backing often take place at the national level, field-level implementation resides with the subnational system. It is therefore of utmost importance that the subnational system is included in the national One Health platform. Similar structures in surveillance, preparedness, response and communication should be established at the subnational level for prompt risk mitigation and early response. Similarly, for cross-border One Health challenges, an ineffective supranational system or one that does not focus on One Health issues will limit or hinder the deliveries arising from the national system.
14. With multiple One Health initiatives in SSA, there is a need to set up and formalize joint coordination mechanisms and plans of action for emergencies, zoonotic disease outbreaks, AMR, toxins, food safety and other issues needing One Health intervention.
15. The set-up costs, as well as the cost of acquisition, implementation and maintenance of ICT infrastructure and modern technologies are usually high and untenable in most SSA. Furthermore, the backup infrastructure like electricity is inconsistent in several African countries to support sustained technological implementation. In SSA, many countries operate with complex organizational and political systems. This may have originated

from past ties to colonial arrangements in setting up such systems with implications on the health systems, policies and frameworks for implementation nationally.

16. Some countries face many competing interests (hunger, malnutrition, food insecurity) and sociopolitical instabilities/insecurities. In such countries, prioritizing One Health initiative is hardly given any consideration because of limited access to service delivery and lack of resources even though those populations may be more vulnerable to disease events.

17. Innovative approaches for delivering One Health in the veterinary, medical, public health, environment, ecology, socioeconomics, policy and anthropology schools appears lacking. There is a need to improve capacity of the teaching workforce and partner with curriculum development partners like One Health Central and Eastern Africa (OHCEA), which is now referred to as the Africa One Health University Network (AFROHUN). Previously, OHCEA supported the development of a common One Health academic curriculum particularly for the east and central African countries who were members of OHCEA. However, the curriculum has taken a reductionist approach focusing on public and animal health with some leverage in the environmental sector. It is doubtful if social science, communication, policy and anthropological considerations were included and whether the curriculum's implementation has been broad-based. A future revision of the curriculum should factor in the social science angle of One Health and its implementation should include the humanities and social science faculties.

18. Currently, the private practitioners outside of the government systems contribute minimally or do not contribute to, and participate in, One Health initiatives. Stimulus to facilitate inclusion of private stakeholders should be implemented by national One Health champions.

19. Presently, policymakers at the national and subnational levels of governments have a somewhat poor understanding of, and are not familiar with, concepts of One Health. Right sets of information should be packaged to target these cadres for purposes of advocacy and adequate information. This should address the issue of low prioritization and poor funding of One Health initiatives.

20. To date, most One Health initiatives and networks in SSA started as a fall-out of project or a sporadic sequelae of single or few One Health activities. In these situations, the governance and management structure of these initiatives may not have been thought through and the existing government policies, legal documents, standard operating procedures and strategies may not have been thoroughly considered before the implementation of national One Health initiatives and platforms. Where this is the case, a review of the foundational basis for the national One Health platforms is necessary to fix outstanding issues so that they can gain broad-based support and goodwill of all stakeholders.

21. Operational research (OR) in One Health is lacking largely. There is a need to implement OR that considers transdisciplinary and interdisciplinary engagements and activities. Such initiative must be based on real-life problems and not abstract. For instance, the ongoing pandemic of COVID-19 is a good opportunity to engender One Health and showcase an interdisciplinary response to public health issues. In addition, the inclusion of outcome-based engagement that utilizes monitoring and evaluation as a basis for One Health program design is warranted.

22. Details of these gaps are available in peer-reviewed repositories and national documents including Okello et al. (2014), Queenan, K et al. (2017); Mesfin et al. (2017); Berthe et al. (World Bank) (2018); Onyango et al. (2019); Kimani et al. (2019) and Sallu et al. (unpublished).

Table 4. Specific strengths, weaknesses, opportunities and threats (SWOT) in One Health in sub-Saharan Africa

| Strengths | Weaknesses |
|---|---|
| Stakeholders have varied levels of responsibilities and interest. | Lack of multisectoral working mechanisms to respond to disease outbreaks and weak preparedness and prevention plans. |
| Existing national and subnational zoonotic disease committees in some countries. | Poor information sharing and communication across the relevant sectors. |
| Availability of disaster and emergency committees. | Poor coordination mechanism inter-sectorally. |
| Existence of basic infrastructure and resources for research. | Very low involvement of the environmental sector in One Health initiatives. |
| Proper channels for co-ordination and dissemination of information | Lack of skilled professionals/experts in government workforce on the One Health approach and the integration of sectoral work. |
| There is power of resource mobilization. | Bureaucratic barriers among the different sectors. |
| Legislation to co-ordinate and command/enforce One Health strategies. | Lack of One Health policy and communication guidelines or strategies in many African countries. For example, Uganda has a national One Health risk communication strategy. |
| Functioning systems at each administrative level. | Each institution conducts research in isolation and does not regularly report back. |
| Existence of research information sharing systems. | Insufficient multidisciplinary research experts. |
| Availability of experts from the different sectors. | National research agendas do not address One Health issues. |
| Vertical integrated surveillance systems (national and subnational) are in place. Some also have horizontal surveillance systems (cutting across disciplines of epidemiology and the laboratories). | There are huge disparities and inconsistencies in the structures, platforms, mandates and institutions across SSA countries. |
| Existence of national task force committees in various sectors to respond to public health events including zoonotic diseases. | Majority of the existing platforms are not institutionalized within the government system with dedicated budget and depend largely on donor funds. |
| Some countries have institutionalized One Health platforms for national coordination and/or implementation. | Lack of institutionalized memorandum of understanding to operationalize One Health, hence the sectors hold back from sharing across sectors. |
| Several institutions and countries have medical and veterinary programs at training institutions and governmental levels | Lack of adequate training in areas of One Health approach and the benefits thereof. |
| Some ministries and departments within the public, animal and environmental health have specific funds budgeted annually to support One Health issues like zoonoses, AMR, joint outbreak investigation. | Many of the national and subnational One Health platforms are active and coordinated only during reported outbreaks. |
| | Noticed sectoral or discipline-specific preservation and overprotection. |
| | Lack of home-grown One Health initiatives across countries. |
| | Data collected by individual departments or sectors is most times not shared across sectors making integrated risk analysis difficult. |
| | The strength and numbers of animal and environmental health facilities often does not match those of the public health thereby entrenching disparities. |
| | Lack of adequately skilled human resources in many countries (many posts remained vacant) hence the current staff are overstretched and advanced in age. |
| | Misconceptions leading to narrowing of the One Health approach. It is often seen as a distinct field or confused for zoonoses instead of being seen broadly; notification instead of collaboration between stakeholder in One Health. |
| Presence of emerging and re-emerging zoonotic diseases (avian influenza, Ebola). | Outputs of One Health research are not used to inform appropriate policies. |

| Strengths | Weaknesses |
|---|---|
| Inclusion of One Health approach issues within the government sectors and university training curricula. | Several training institutions still largely operate in their traditional single line discipline training methods and are not incorporating One Health approach. |
| Existence of potential development partners and local support. | Improper plans for surveillance, preparedness and response. |
| Activities of multisectoral co-ordination. | Inadequate support by policymakers. |
| Availability of surveillance system in related ministries. | Reporting platforms and systems across sectors need to be similar or inter-operable. |
| Availability of contingency plans. | Absence of comprehensive national One Health strategic plans in most countries. |
| Presence of political will and stability. | Challenges in acquiring sufficient government funding. |
| The recognized need for multisectoral collaboration. | Limited laboratory-based diagnostic capacity which will result in poor detection of outbreaks/causative agents on time. |
| Baseline information on One Health exists in different collaborating institutions. | Lack of clearly defined legislation on the engagement of public-private partnership pertinent to One Health. |
| | Available baseline information needs consolidation or joint evaluation. |
| Existence of external funding agencies. | Poor economy and global economic crisis. |
| Interest of development partners and the changing government system in adopting new innovations or technologies. | Lack of empirical and validated population-level data. |
| Existence of different forums for policy briefing. | Lack of political good will. |
| Workers in different ministries/institutions are often keen to work together. | No involvement of governmental departments and broad-based stakeholders in transdisciplinary research activities (mainly done by NGOs and research institutes). |
| | Guidelines for collaboration between institutions and ministries are required. For example, some ministries cannot share information except approved by the higher authorities. |
| Other departments have proved to work collaboratively, and examples exist across SSA. | Insufficient co-ordination units and insufficient funds to support the coordination units. |
| Collaborative One Health education and research is happening and many externally-funded nationally implemented projects and funders are supporting/displaying the concept of One Health | Lack of a centralized verifiable database for existing surveillance monitoring and response system related to One Health government. |
| The field is opening up and nowadays multiple disciplines are working in line ministries and parastatals not traditionally theirs (e.g. veterinarians and environmentalists are in current human surveillance system in some countries). | No inclusion of One Health-based courses in the curriculum of human medicine, veterinary medicine and other related disciplines in universities. |
| National documents for health issues (NAPHS, OHSP, NAP for AMR, surveillance guidelines for PZDs, surveillance and stewardship of antimicrobials, disease control strategies, and country programming documents)* as well as evaluative tools/reports (JEE of IHR, SET, PVS, ATLASS, bridging workshop reports and gap analysis) are developed or adopting One Health approach. | Lack of similar or comparable guidelines across sectors (e.g. standard treatment guidelines are lacking for the veterinary sector in most countries, biomedical waste guidelines for veterinary hospitals/clinics are mostly unavailable and most medical doctors largely consider clinical approach than a population medicine approach). |
| | Lack of guidelines for the use of pesticides, antimicrobials and inclusion chemicals/preservatives in food systems. |

| Strengths | Weaknesses |
|---|---|
| | Lack of adequate involvement of environmental/crop agriculture departments, parastatals and ministries. |
| | Donor funded projects are time bound and not easy to institutionalize. |
| | Duplication of roles and efforts hinder the implementation of One Health initiatives and the participation of ministries |

Adapted from Lee and Brumme (2013); URT, (2015); Onyango et al. (2019)

*NAPHS = National Action Plan for Health Security; OHSP = One Health Strategic Plan; NAP = National Action Plan; AMR = Antimirobial resistance; PZDs = Prioritized zoonotic diseases; JEE = Joint External Evaluation; IHR = The International Health Regulations; SET = Surveillance Evaluation Tool; PVS = Performance of Veterinary Services; ATLASS = Assessment Tool for Laboratories and Antimicrobial resistance Surveillance Systems.*

Similarly, the enablers/facilitators and the hindrances and limitations of One Health implementations are detailed in Tables 5 and 6 below.

Table 5. Identified enablers to One Health implementation

| No. | Enabling factors | References |
|---|---|---|
| 1. | The development of an integrated framework which will be specific to a selected interface that will be evidence based to inform decision-making (PH-AH-EH-WH). | WHO 2016<br>Baum et al. 2016 |
| 2. | Proper monitoring of every phase of the framework will lead to early recognition of problems and will lead to prompt modification and hence lasting solutions. | Destoumieux-Garzon et al. 2018 |
| 3. | The integration should address potential health effects at the respective interfaces leading to enhancement of resilience of local communities and better disease prevention. | Ruscio et al. 2015 Heymann et al. 2017 |
| 4. | An efficient public health system and better understanding of disease risks. | Baum et al. 2016 |
| 5. | WHO emphatically recommended a Global Action Plan (GAP) based on One Health principles. | WHO 2015 |
| 6. | Well-instituted biosecurity measures, hygiene and preventive techniques are more effective control solutions than anti-infectives and vaccines. | Destoumieux-Garzon et al. 2018 |
| 7. | Access to grants/funds and proper funding of projects from start to end. | |
| 8. | The inclusion of certain courses during training in the curriculum of medical, veterinary and agronomy students and others as it may deem fit. | Nesse et al. 2010<br>Guegan et al. 2012 |
| 9. | Cordial relationship with, and integration of understanding of, other disciplines using a multidisciplinary approach and conditions of their implementation. | Destoumieux-Garzon et al. 2018 |
| 10. | Strengthening inter-sectoral communication and collaboration | Adamson et al. 2011 |
| 11. | Understanding disease transmission/epidemiology of disease concerned. | Johnson et al. 2018 |
| 12. | Organizational leadership is sacrosanct to One Health implementation and creation of awareness. | Yaghoubi et al. 2017 |
| 13. | Training and capacity development (workshops, conferences and seminars) of personnel on practical application of the One Health approach. | Yaghoubi et al. 2017 |

Table 6. Identified limitations and hindrances to One Health implementation

| No | Limitation/hindrance | References |
|---|---|---|
| 1. | Sociopolitical considerations. | Degeling et al. 2015<br>Destoumieux-Garzón et al. 2018 |
| 2. | Ethical considerations. | Degeling et al. 2015<br>Destoumieux-Garzón et al. 2018 |
| 3. | Legal considerations. | Degeling et al. 2015<br>Destoumieux- Garzón et al. 2018 |
| 4. | Barriers related to administration and regulations. | Auschra 2018 |
| 5. | Barriers related to funding. | Auschra 2018 |
| 6. | Barriers related to inter-organization (human medicine versus veterinary medicine, agronomy and ecological, environmental and evolutionary science). | Huxham and Vangen 2005, Destoumieux-Garzón et al. 2018, |
| 7. | Barriers related to service delivery. | Auschra 2018 |
| 8. | Size and complexity of research and inevitable research bias. | Dhama 2013 |
| 9. | Historical context, economic inequalities and cultural phenomenon. | Ezenwa et al. 2015,<br>Mwangi et al. 2016 |
| 10. | Lack of standardized One Health metrics has limited objective evidence on potential benefits of this program. | Hasler et al. 2014 |
| 11. | Globalization of trade and exchange, and industrialization of agriculture, aquaculture and farming practices. | Destoumieux-Garzón et al. 2018 |
| 12 | Some components of One Health are still neglected; environmental sciences (soil and climate), so also are social, legal and economic sciences. | Hall 2015<br>Barrett and Bouley 2015<br>Lapinski et al. 2015 |
| 13. | Actual organization of research and sectoral allocation of resources limit transdisciplinary approaches and integrated operational actions. | Destoumieux-Garzón et al. 2018 |
| 14. | The usual dichotomy between practitioners of human and veterinary health, and the need for formal governance, which is an independent and non-partisan role. | Johnson et al. 2018 |
| 15. | The reality of planning, implementation and budgeting for joint interventions, particularly at the national and regional level prove very difficult. | Okello et al. 2013 |

# Discussion

To date, one of the main challenges for effective take-off of One Health in Africa remains inter-ministerial protection of mandates and inadvertent but underlying turf wars. Ministries, government departments and parastatals will need to consider the issue of One Health as one beyond territorial protection and open up to other disciplines so that they can jointly deliver cost-effective solutions. Okello and colleagues (2014) have shown evidence that zoonotic diseases and threats of potential epidemics can facilitate the national and regional emergence of One Health initiatives. Professionals must learn to utilize such opportunities and adopt One Health approaches and take ownership of them. A clear road map will need to be developed in the delivery of One Health concepts to avoid the pitfalls and setbacks such as those that have been observed with a return to the 'business-as-usual' approach in Nigeria's NISCAI and NTCAI, which were created to fight the scourge of HPAI H5N1, institutions that seemed to disappear with the end of the outbreaks (Okello et al. 2014). Successful multi-institutional interventions are possible as has been exemplified by the development of performance monitoring plans (PMPs) and national rabies control strategies in some countries (FAO 2020; OIE 2019).

National effort should transcend the rolling out of interventions in piecemeal and small scale. Even where projects are delivered as proofs of concepts, they should fit and align closely into a well-coordinated national plan for effective tracking, monitoring and evaluation to prevent unnecessary duplication of efforts. National One Health platforms will continually suffer setbacks, deliver externally programmed outcomes and risk unsustainability if they depend entirely on donor-funding (Okello et al. 2014; Khan et al. 2018).

The necessary policy and legal instruments will need to be put in place in each country, regionally and continentally to facilitate the push towards full implementation of One Health in SSA. Such may include a continent-wide legal and policy analysis and review to assess gaps and limitations in implementing One Health across Africa. The identified gaps should then be prioritized and met to set the template for One Health work in the continent. Connolly (2020) discussed the One Health in the context of urbanization and global disease threats, and emphasized that One Health implementation is possible in Africa and elsewhere if there is strong mutuality of commitment to the One Health agenda at the supranational (global and continental) and micro (national and subnational, including individual) levels globally. Short-term

political consideration should give way to long-term commitment to, and collaborations in, One Health across disciplines, sectors and stakeholders. Urban planners and policy implementation should consider the animal and environmental impacts of the strategic and perspective decisions they make. Of particular interest is the poverty intermix and peri-urban/rural development, which are important interfaces where intense human-animal-environment interactions are occurring. In addition, these locations also have poor service delivery, poor sanitation, high human and animal population densities, poor living standards and huge social inequalities (Connolly 2020). National and subnational authorities should concentrate on improving local capacities and implementing infrastructural developments that align with One Health objectives or can facilitate its implementation at local levels. Such interventions may be blended with the identification of local and national champions (individuals, national organizations and multilateral agencies) who can serve as launching pads and setting up delivery systems for One Health concepts (Okello et al. 2014; Khan et al. 2018).

Human capacity development at the local level and integrating the concepts of One Health at all levels of informal and formal trainings—right from primary up to tertiary levels—as well as in periods of in-service training will assist in ingraining the concept of One Health. Such training should be broad (by including health, policy, economics, planning and environment etc.) and examples of subtertiary One Health concept are already in parts of North America where curricula are in place for facilitating the One Health approach at primary and secondary levels of education

Africa has been considered as hotspot for various emerging infectious diseases and future global pandemic threats particularly because of its forested tropical regions, land use changes, socio-economic changes and wildlife biodiversity (Jones et al. 2008; Morse et al. 2012; Moore et al. 2016; Allen et al. 2017). Whereas, One Health can deliver the most efficient and cost-effective policies for disease prevention, policy interventions, environmental-friendly consideration and socio-politically-adapted management; if its agenda in Africa continues to be driven by donor's interest, the delivery focus may not always be suitable to the African context. From the African perspective, three reasons why One Health remains a viable solution for SSA have been identified including the following:

1. Africa has a high burden of infectious and zoonotic diseases at the human-animal-environment interfaces coupled with growing food insecurity, threatened livelihoods, endemic poverty, desertification and flooding, which portend threats to national and continental economic growth.
2. The growing convergence of technology and strategy in surveillance, prevention and management of diseases can be leveraged using the One Health approach. Evidence of economic benefits in poor settings arising from such intervention has been shown by Zinsstag et al. (2017) and Fasina et al. (2020). In addition, others have also provided an economic logic for investment in One Health especially at the interfaces, where human and material resources are scarce, and where current resources are underutilized (Rushton et al. 2012; Häsler et al. 2012). Such logic provides additional impetus for implementing One Health, particularly in resource-constrained settings.
3. The best interventions remain those that are regional-led and all-inclusive. This is the strongest detection, prevention and defence mechanism that can be built against emerging threats posed by those drivers of the biological threats identified above (SACIDS 2020).
4. There will be a need to consider comprehensive broad-based One Health approach in all instances and in the delivery of One Health initiatives. Policymakers, politicians, communication experts, socio-economists, social scientists and experts in other fields cannot be considered as necessary only during the implementation and post-mortem analysis of One Health issues. They should be included

right through the whole One Health approach, from the planning to execution thereof so that there is continued sustenance of One Health implementation in Africa. Finally, One Health has the key advantage of being an anticipatory approach that is not only focused on responsive methods. Because of this, it can significantly benefit effective budgeting and outbreak control costs. For example, a case of animal zoonoses like animal influenza or the Middle East respiratory syndrome coronavirus (MERS CoV), if effectively detected early and curtailed in the wildlife or domestic animals using a shared costs and multidisciplinary approach, may not develop into clinical infection in animals with potential exposure in humans, followed by human clinical manifestations and increased cost of hospitalization, disability-adjusted live year (DALY) lost, other health consequences and potential deaths (World Bank 2012).

# Conclusion

The national and subnational ministries that are relevant in the One Health context in the different African countries should consider developing their own One Health databases. The education system should consider prioritizing and integrating key One Health concepts in the primary and secondary school education curricula to facilitate systems thinking (for example, why should we even wash hands or use toilet instead of an open field?). Such initiative is now being implemented by organizations like the One Health Lessons (http://www.onehealthlessons.com/). An interdisciplinary problem-solving approach including documentation and regular brainstorming should be applied at all levels. Effort should be placed on emphasizing the fact that in social organizations, single viewpoint approach will never comprehensively solve any problem. In typical dogma, a solution is chosen first before consideration for the problem. However, in science, effort is made to first identify and analyse a problem before proposing a solution, and this should be followed-up by permanently re-evaluating, deconstructing and reconstructing the proposed solutions (e.g. through revisiting the theory of change of One Health programs). Finally, it should be known that One Health does not aim at providing one single final solution to a health challenge but rather offers a set of solutions, whose implementation needs regular review and re-evaluation.

# Recommendations

In the current scenario of 1) rapidly-spreading infectious diseases that have ravaged Africa such as the ongoing COVID-19 pandemic and past highly pathogenic avian influenza H5N1 among others, and in view of 2) available communication technologies (e.g. Skype, Microsoft Teams, Zoom, Google Hangouts and other platforms), and 3) limited resources available in Africa to facilitate travels, gathering and conferencing; online collaborative meetings may be utilized to facilitate, strengthen and hold functional One Health-related meetings. Such online communication platforms and networks can bring together individuals from different backgrounds to share diverse perspectives on topic and issues related to One Health. These multiple sources of information should enable the reconsideration and re-evaluation of the positions and ideologies of disciplines working in One Health. Such re-valuation should aim to positively push boundaries of understanding beyond the confines of a particular discipline and facilitate the gathering of views and contributions from those whose voice may have been drowned in physical meetings.

In addition, the mode of delivery for One Health should be through the problem-based discussion forum or problem-based learning method (Tukamushaba and Musinguzi 2016). The evaluation of complex health problems and delivery of people-oriented solutions in a collaborative manner using the multi-pronged approach of health (medical, veterinary, environmental), geography, communication, policy, financing and other fields should be the goal of each One Health initiative that is undertaken (Little 2012; Fasina et al. 2020). Such discussions should transcend political, ethnic, religious and other primordial considerations.

Currently, most traditional academic programs both at undergraduate and postgraduate levels confine students to working within the expectations of their original departments, and these are often not aligned with the delivery of interdisciplinary, multidisciplinary and cross-sectoral outputs (Manlove et al. 2016). Regular reviews and re-curriculation of all tertiary institution programs to strengthen the concept of One Health and facilitate cross-learning outcomes should be adopted across Africa. Furthermore, postgraduate training should incorporate cross-disciplinary delivery of research outcomes. Online training modules and physical joint classes can be used to facilitate commitments, collaborations and synergies among students and professionals to push the frontiers of transdisciplinary networks. Finally, the adoption of elements of interdisciplinary training at junior levels of education (primary and secondary schools) should

be implemented. Example of such training is already being used in North America. The implementation of these recommendations should assist in remodelling the current workforce and producing future professionals whose thinking and approach is multidisciplinary in the delivery of One Health solutions.

The WHO, FAO and OIE, as well as the United Nations Environmental Programme (UNEP) are working together to facilitate cross-sectoral collaboration at the global level to manage health risks at the human-animal-environment interface and improve global health security (WHO 2020a). The regional and national authorities in sub-Saharan Africa should adopt this type of joint working relationships and collaborations to 1) foster cross-sectoral collaboration at the human-animal-environment interface among the different relevant sectors; 2) develop capacity and promote practical, evidence-based, and cost-effective implementation of tools and mechanisms for zoonoses prevention, surveillance and detection, reporting, epidemiological and laboratory investigation, risk assessment, and control, and assisting countries in their implementation; and 3) support the development of relevant policies, strategies and sustainable programs to prevent and reduce risks and manage outbreaks (WHO 2020a).

A recent report had identified areas of One Health intervention in Africa including the following:

5. Interface of human and animal health with emphasis on zoonoses, AMR and other broader issues identified in this report.
6. Policy science interface both in the field and at policy level.
7. Basic research and the respective field implementations.
8. Multidisciplinary and interdisciplinary research to provide a more comprehensive yet inclusive understanding of One Health.
9. Interinstitutional communication and coordination, and not just information sharing.
10. Awareness-raising and advocacy campaigns (media campaigns).
11. Ecosystem health in relation to the interface of wildlife diseases with human and animal health.
12. Human resources capacity development (science-practice-dialogue in the sense of knowledge management, partnerships with universities etc.)
13. Risk communication taking into account One Health and gender perspectives.
14. Digitalized surveillance, taking advantages of emerging technologies and disease outbreak management systems.
15. Complementary approach of financial support and technical cooperation.
16. Bilateral and multilateral commitment
17. South-South exchange and partnership (Herrmann and Münstermann 2020).

We identified and agreed with these findings as similar issues have been identified in this report. In conclusion, the outputs from the current work should be combined with previous findings cited in this document for the benefit of One Health implementation and health systems in Africa.

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# Additional resources


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**Constituents of One Health is beyond the narrow perspective of zoonoses, or human-animal-environment interfaces only. It includes but is not limited to the various health risks zoonotic diseases, neglected diseases, emerging diseases, re-emerging diseases, poisoning, food safety, antimicrobial resistance, vector-borne issues, toxicosis, pesticides, environment, economics, policy and planning, financing and budgeting and various other intersectoral and cross-sectoral fields and engagements.

# Appendix 1. List of African countries and politico-economic classifications

| Africa | Transition countries | LDC | LLDC | SIDS | World Bank income group |
|---|---|---|---|---|---|
| Northern Africa | | | | | |
| Algeria # | | | | | Lower middle |
| Egypt # | | | | | Lower middle |
| Libyan Arab Jamahiriya # | | | | | Upper middle |
| Morocco # | | | | | Lower middle |
| Tunisia # | | | | | Lower middle |
| Western Sahara # | | | | | |
| sub-Saharan Africa | | | | | |
| Angola | | x | | | Low |
| Benin | | x | | | Low |
| Botswana | | | x | | Upper middle |
| Burkina Faso | | x | x | | Low |
| Burundi | | x | x | | Low |
| Cameroon | | | | | Low |
| Cape Verde | | x | | x | Lower middle |
| Central African Rep | | x | x | | Low |
| Chad | | x | x | | Low |
| Comoros | | x | | | Low |
| Congo | | | | | Low |
| Cote d'Ivoire | | | | | Low |
| Dem Rep of the Congo | | x | | | Low |
| Djibouti | | x | | | Lower middle |
| Equatorial Guinea | | x | | | Low |
| Eritrea | | x | | | Low |

| Africa | Transition countries | LDC | LLDC | SIDS | World Bank income group |
|---|---|---|---|---|---|
| Ethiopia | | x | x | | Low |
| Gabon | | | | | Upper middle |
| Gambia | | x | | | Low |
| Ghana | | | | | Low |
| Guinea | | x | | | Low |
| Guinea-Bissau | | x | | x | Low |
| Kenya | | | | | Low |
| Lesotho | | x | x | | Low |
| Liberia | | x | | | Low |
| Madagascar | | x | | | Low |
| Malawi | | x | x | | Low |
| Mali | | x | x | | Low |
| Mauritania | | x | | | Low |
| Mauritius | | | | x | Upper middle |
| Mayotte | | | | | Upper middle |
| Mozambique | | x | | | Low |
| Namibia | | | | | Lower middle |
| Niger | | x | x | | Low |
| Nigeria | | | | | Low |
| Réunion | | | | | |
| Rwanda | | x | x | | Low |
| São Tomé and Príncipe | | x | | x | Low |
| Senegal | | x | | | Low |
| Seychelles | | | | x | Upper middle |
| Sierra Leone | | x | | | Low |
| Somalia | | x | | | Low |
| South Africa | | | | | Lower middle |
| Sudan | | x | | | Low |
| Swaziland | | | x | | Lower middle |
| Togo | | x | | | Low |
| Uganda | | x | x | | Low |
| United Rep of Tanzania | | x | | | Low |
| Zambia | | x | x | | Low |
| Zimbabwe | | | x | | Low |

*LDC: Least developed countries; LLDC: Landlocked developing countries; SIDS: Small island developing States; # African countries not listed in the sub-Saharan African*

The designations employed and the presentation of country or area names in these listings do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The user of any particular dataset should consult the dataset documentation to determine the exact coverage of statistics for the country or area entities in the dataset. Various datasets may or may not include coverage of outlying and overseas areas, depending on the type of data and source. For further information refer to Standard Country or Area Codes for Statistical use (United Nations publications, Sales No. 17.98.XVII.9), table 2, updated at ST/ESA/STAT/SER.M/49/Rev.4 http://unstats.un.org/unsd/methods/m49/m49regin.htm. Copyright: UN, 2003 (Accessed 29.04.2020).

# Appendix 2. Relevant materials and useful One Health initiatives

| Name of One Health initiative | Type of initiative | Coverage | Country(ies) | 1° field | 2° field | 3° field | Others (list if any) |
|---|---|---|---|---|---|---|---|
| One Health Rapid Response Team (OHRRT) | Organization and implementation | National | Tanzania | PH | AH | EH | Welfare, AMR |
| One Health Coordination Desk (OHCD) | Coordination | National | Tanzania | PH | AH | EH | Welfare, AMR |
| Zoonotic Disease Unit (ZDU) | Coordination, organization and implementation | National | Kenya | PH | AH | EH | AMR, welfare |
| Southern African Centre for Infectious Disease Surveillance (SACIDS) Foundation for One Health | Multipurpose | Regional | Southern and east Africa | PH | AH | EH | AMR |
| One Health Central and Eastern Africa (OHCEA) (linked with OHW) (Cameroon, DRC (Congo), Ethiopia, Kenya, Uganda, Rwanda, Tanzania, Senegal). | Capacity development, organization | Regional | East and central Africa | AH | PH | EH | Welfare, AMR |
| Africa One Health University Network (AFROHUN), Formerly OHCEA (linked with OHWNG) | Capacity development, organization, research | Continental | East and central Africa | AH | PH | EH | Welfare, AMR |

| Name of One Health initiative | Type of initiative | Coverage | Country(ies) | 1° field | 2° field | 3° field | Others (list if any) |
|---|---|---|---|---|---|---|---|
| RESPOND Project | Capacity development | Regional | Congo, Uganda | AH | PH | EH | Welfare, |
| One Health Systems Mapping and Analysis Resource Toolkit (OH-SMART) | Tool | Global | World | PH | AH | AMR | EH |
| One Health Workforce (OHW) (Comprised of OHCEA and SOHUN - Southeast Asia One Health University Network) | Capacity development, research | Global | East and central Africa | AH | PH | EH | Welfare, AMR |
| One Health Workforce - Next Generation (OHWNG) | Capacity development, organization, research | Global | East and central Africa | AH | PH | EH | Welfare, AMR |
| One Health Regional Network (HORN) for the Horn of Africa | Capcity building, Research | Regional | Kenya, Ethiopia, Djibouti, Eritrea and Somalia | AH | PH | Social Science | Welfare |
| One Health Development Initiative (OHDI) | capacity development, Research | Nigeria | Nigeria | AH | PH | EH | AMR |
| Africa Centres for Disease Control and Prevention (Africa CDC) | Multipurpose | Continental | All African countries | PH | AH | EH | AMR |
| Afrique One Alliance. African Science Partnership for Intervention Research Excellence (Afrique One-ASPIRE). One Health initiative - African Research Consortium on Ecosystem and population health | Multipurpose | Continental | 14 African countries | PH | AH | AMR | EH |
| One Health National Network for enhanced Research in Infectious Diseases (NRN-Biomed) | NA | Global | NA | PH | AH | | |
| Cysticercosis Working Group in Eastern and Southern Africa (CWGESA) | Research, implementation | Regional | East and southern Africa | PH | AH | EH | |
| Southern African Development Transboundary Animal Diseases (SADC TADs) | Organization, coordination | Regional | East and southern Africa | PH | AH | EH | TADs |
| Training Health Researchers into Vocational Excellence (THRIVE) | Capacity development | Global | NA | PH | | | |
| Consortium for Advanced Research Training in Africa (CARTA) | | Continental | NA | PH | | | |

| Name of One Health initiative | Type of initiative | Coverage | Country(ies) | 1° field | 2° field | 3° field | Others (list if any) |
|---|---|---|---|---|---|---|---|
| Ecole inter-Etats des Sciences et Medecine Veterinaires (EISMV) | Capacity development | Regional | West and central Africa | PH | AH | EH | AMR |
| Jimma University One Health Students' Innovation Club (OHSIC) | Capacity development | National | Ethiopia | PH | AH | EH | AMR |
| Mekelle University Students One Health Innovation Club (SOHIC) | Capacity development | National | Ethiopia | PH | AH | EH | AMR |
| Makerere University Student One Health Innovation Club (SOHIC) | Capacity development | National | Uganda | PH | AH | EH | AMR |
| Universite des Montagnes One Health Students' Club | Capacity development | National | Cameroon | PH | AH | EH | AMR |
| Moi Uiversity One Health Students' Club. | Capacity development | National | Kenya | PH | AH | EH | AMR |
| Muhimbilli University of Health and Allied Sciences One Health Students' Club. | Capacity development | National | Tanzania | PH | AH | EH | AMR |
| Sokoine University of Agriculture One Health Students' Club. | Capacity development | National | Tanzania | AH | PH | EH | AMR |
| University of Rwanda One Health Students' Club. | Capacity development | National | Rwanda | PH | AH | EH | AMR |
| University of Addis Ababa | Capacity development | National | Ethiopia | PH | AH | EH | AMR |
| University of Buea, Faculty of Health Sciences, and Faculty of Agriculture and Veterinary sciences | Capacity development | National | Cameroon | PH | AH | EH | AMR |
| University of Kinshasa, the school of Public Health | Capacity development | National | Democratic Republic of Congo | PH | AH | EH | AMR |
| University of Lubumbashi, the Faculty of Veterinary Medicine | Capacity development | National | Democratic Republic of Congo | PH | AH | EH | AMR |
| University of Nairobi, Faculty of Veterinary Medicine and School of Public Health | Capacity development | National | Kenya | PH | AH | EH | AMR |
| Stellenbosch University, Medical School | Capacity development | National | South Africa | PH | AH | EH | AMR |
| University of Ibadan, Nigeria | Capacity development, coordination and research | National | Nigeria | AH | PH | EH | AMR |

| Name of One Health initiative | Type of initiative | Coverage | Country(ies) | 1° field | 2° field | 3° field | Others (list if any) |
|---|---|---|---|---|---|---|---|
| University Nangui Abrogoua | Capacity development | National | Ivory Coast | PH | AH | EH | AMR |
| University of Pretoria, Faculty of Veterinary Science | Capacity development | National | South Africa | PH | AH | EH | AMR, welfare, wildlife |
| South Africa Regional Global Disease Detection Center | Capacity development, research | Regional | South Africa | PH | AH | EH | AMR |
| PREDICT consortium-One Health Institute | Capacity development, research | Global | Tanzania | PH | AH | EH | |
| African Field Epidemiology Network (AFENET) and FELTP | Capacity development and research | Continental | All African countries | PH | AH | EH | Welfare, |
| University of Zambia, Schools of Medicine and Veterinary Medicine | | National | Zambia | AH | PH | EH | AMR, Welfare |
| Central Veterinary Research Institute | Research, implementation | National | Zambia | AH | PH | EH | AMR |
| The Centre for Environmental Stewardship (CES) | Capacity development and research | National | Kenya | EH | | | |
| Centre Suisse de Recherches Scientifiques en Directorate of Animal Science | Research and capacity development | National | Ivory Coast | AH | EH | PH | Risk analysis, food safety |
| Institute of Agricultural Research of Mozambique - Ministry of Agriculture | Implementation | National | Mozambique | AH | AMR | EH | Welfare, PH |
| Eduardo Mondlane University | Capacity development and research | National | Mozambique | AH | PH | EH | AMR, Welfare |
| Ifakara Health Institute (IHI) | Capacity development and research | National | Tanzania | PH | AMR | EH | AH |
| Institut de Recherche en Elevage pour le Development | Research and capacity development | National | Chad | PH | AH | | |
| National Health Institute - Ministry of Health (NHI) | Multipurpose | National | Mozambique | PH | AH | | |
| National Institute of Biomedical Research (NIBR) | Research and capacity development | National | Democratic Republic of Congo | PH | AH | | |
| National Institute for Communicable Diseases, National Laboratory Services (NICD NLS) | Research and capacity development | National | South Africa | PH | AH | EH | AMR |
| National Institute for Fisheries Inspection (INIP) | Research and capacity development | National | Mozambique | EH | AH | PH | Food safety |
| National Institute for Nature Conservation (NINC) | Research and capacity development | National | Democratic Republic of Congo | EH | PH | AH | Welfare, |

| Name of One Health initiative | Type of initiative | Coverage | Country(ies) | 1° field | 2° field | 3° field | Others (list if any) |
|---|---|---|---|---|---|---|---|
| Naguchi Memorial Institute of Medical Research (NMIMR) | Research and capacity development | National | Ghana | PH | AH | EH | Welfare, |
| Tanzania Wildlife Research Institute (TAWIRI) | Research and capacity development | National | Tanzania | EH | AH | PH | Ecology |
| The Tanzania Veterinary Laboratory Agency, Central Veterinary Laboratory (TVLA) | Research, implementation and capacity development | National | Tanzania | AH | EH | AMR | PH |
| The Central Veterinary Laboratory in Kinshasa | Research and capacity development | National | Democratic Republic of Congo | AH | EH | AMR | PH |
| National Institute for Medical Research (NIMR) | Research and capacity development | National | Tanzania | PH | AH | AMR | EH |
| Tropical Diseases Research Centre (TDRC) | Research and capacity development | National | Zambia | PH | AH | EH | Welfare, |
| International Centre for Insect Physiology and Ecology (ICIPE) | Research and capacity development | Regional | Kenya, Tanzania | EH | AH | PH | |
| Zoonotic and Emerging Diseases Group | Research and capacity development | Regional | East Africa | AH | PH | EH | AMR |
| Kenya Medical Research Institute (KEMRI) | Research and capacity development | National | Kenya | PH | AH | EH | |
| One Health Resource Centre | Implementation | National | Kenya | PH | AH | | |
| Touch Foundation | Organization | National | Tanzania | PH | | | |
| National One Health Steering Committee (MoH, MoLF, MoCT, MoFTCC (zoonosis) | Coordination | National | Ethiopia | PH | AH | EH | AMR |
| MoH, MoLF, MoCT, MoFTCC (zoonosis) | Implementation | National | Ethiopia | PH | AH | EH | AMR |
| One Health Desk, ILRI | Research and capacity development | Global | East Africa | AH | PH | EH | AMR |
| National Public Health Institute/ One Health Desk | Multipurpose | National | Liberia | PH | AH | EH | |
| National Directorate of Veterinary Services | Multipurpose | National | Mali | AH | PH | EH | Welfare, |
| University of Free State, ARC-OVR, GDARD joint initiative | Research and capacity development | National | South Africa | PH | AH | EH | Welfare, |
| One Health Innovative student's club | Capacity development | National | Uganda | PH | AH | EH | AMR |

| Name of One Health initiative | Type of initiative | Coverage | Country(ies) | 1° field | 2° field | 3° field | Others (list if any) |
|---|---|---|---|---|---|---|---|
| Global Alliance for Rabies Control (GARC) | Implementation, research, organization and coordination | Global | World | AH | PH | EH | |
| Mission Rabies (MR) | Implementation, research, organization and coordination | Global | World | AH | PH | EH | Welfare |
| Mbwa wa Africa | Implementation, research, organization and coordination | National | Tanzania | AH | PH | EH | Welfare |
| Global One Health Initiative, Ohio State University | Research and capacity development | Global | World | AH | PH | EH | AMR |
| One Health Institute, University of California Davis | Research and capacity development | Global | World | AH | PH | EH | AMR |
| EcoHealth Alliance | Research and capacity development | Global | World | EH | AH | PH | AMR |
| Rwanda Institute for Conservation Agriculture (RICA) | Research and capacity development | National | Rwanda | PH | AH | EH | Welfare, |
| African Institute for One Health Research and Diagnostics | Research, implementation and capacity development | National | Nigeria | AH | PH | EH | |
| University of Global Health Equity | Research and capacity development | National | Rwanda | PH | AH | EH | AMR |
| University of Ilorin Students' One Health Initiative (UNILOSOHI) | Capacity development | National | Nigeria | PH | AH | EH | AMR |
| University of Edinburgh MSc One Health program (with scholarship) | Research and capacity development | Global | World | AH | PH | EH | AMR |
| Transdisciplinary Consultants | Implementation | National | Kenya | AH | PH | EH | Welfare, AMR |
| Action Plan Guide towards slowing down the rising AMR trends and their attendant impact. (Global initiative) | Coordination, implementation | National | Nigeria | PH | AH | EH | Welfare, |
| Global Antibiotics Research and Development Partnership (GARDP) | Coordination, organization and implementation | Global | World | PH | AH | AMR | EH |
| National Action Plans (NAP) on AMR and Ntional Policy on AMR | Tool, coordination and organization | Global | World | PH | AH | EH | AMR |
| Centre for Disease Dynamics Economics and Policy (CDDEP) | Organization, implementation, research | Global | World | AMR | PH | AH | EH |

| Name of One Health initiative | Type of initiative | Coverage | Country(ies) | 1° field | 2° field | 3° field | Others (list if any) |
|---|---|---|---|---|---|---|---|
| Antibiotic Guardian: South Africa | Organization, coordination, implementation | National | South Africa | AMR | PH | AH | EH |
| Development of National AMR surveillance plan (NAMRSP). Prioritization of microorganisms for reporting and linked to National Reference laboratory with surveillance sentinel sites | Coordination, implementation | National | Ethiopia | AMR | PH | AH | EH |
| Training program in Epidemiology and Public Health Intervention Network (TEPHINET) | Capacity development, research | Global | World | PH | AH | AMR | EH |
| Finnish Science and Technololgy coperation with Europe Africa Asia and LAC Region (FinCEAL) | Capacity development, research | Regional | World | PH | AH | EH | |
| Surveillance for AMR and antibiotics consumption in South Africa | Coordination, implementation and organization | National | South Africa | AMR | PH | AH | EH |
| African innovators tackle AMR | Tool (grant) | Global | Africa | AMR | PH | AH | EH |
| Emergency Centre for Transboundary Animal Diseases (ECTAD): One Health, zoonosis and AMR themes | Multipurpose | Global | World | AH | AMR | PH | |
| Global One Health paradigm: Challenges and opportunities for tackling infectious diseases of human-animal-environment interface in low-resource setting | Organization, coordination | Global | World | PH | AH | EH | AMR |
| GHP: Promotion of increased international collaboration especially research in infectious diseases and AMR | Organization, coordination | Global | | PH | AH | EH | AMR |
| Global Antibiotics Research Partnership (GARP) | Multipurpose | Global | Kenya, South Africa, Mozambique, Tanzania, Uganda, Namibia, Nigeria, Seychelles and Zimbabwe | AMR | PH | AH | EH |
| World Alliance Against Antibiotics Resistance (WAAAR): A major player in global drive to protect human health. | Multipurpose | Global | World | AMR | PH | AH | EH |

| Name of One Health initiative | Type of initiative | Coverage | Country(ies) | 1° field | 2° field | 3° field | Others (list if any) |
|---|---|---|---|---|---|---|---|
| One Health - One health approaches for health, disaster risk reduction | Coordination and organization | Regional | NA | PH | AH | EH | AMR |
| Students' One Health Innovation Club (SOHIC-CHS) | Capacity development | National | Nigeria | PH | AH | EH | AMR |
| EcoHealth (ILRI) - Effective management and elimination of livestock zoonotic and food-borne diseases that matter to the poor | Implementation, research, organization and coordination | National | Kenya | PH | AH | EH | |
| EcoHealth - Identification of Anthrax hotspots and associated ecological factors predicting infections and exposure risk in Kenya | Implementation, research, organization and coordination | National | Kenya | AH | PH | EH | |
| EcoHealth (ILRI) - Active surveillance to determine the prevalence of Rift Valley fever, Brucellosis and Q-fever, and their co-infections in humans, livestock and wildlife | Implementation, research, organization and coordination | National | Kenya | AH | PH | EH | Wildlife |
| Climate change and animal health in Africa | Research, organization | Continental | Continental | EH | AH | PH | Wildlife |
| African Livestock Productivity and Health Advancement (ALPHA) Initiative | Implementation | Continental | Nigeria, Ethiopia, Uganda | AH | Food security | Animal production | Welfare, |
| Livestock production and Animal health management system in communal farming areas at the wildlife-livestock interface in South Africa | Capacity development and research | National | South Africa | PH | AH | EH | Welfare, |
| Ecohealth (ILRI): Approaches linking human and environmental health in Kenya | Capacity development and research | National | Kenya | PH | AH | EH | Welfare, |
| ILRI/BMZ One Health Research, Education, Outreach and Awareness Centre (OHRECA) | Coordination, organization, capacity development and Implementation | Continental | All African cuntries | PH | AH | Food safety | AMR |
| The One Health Units for Humans, Environment, Animals and Livelihoods (HEALS) project | Capacity development and implementation | Regional | Ethiopia, Somalia and Kenya | AH | PH | EH | AMR, welfare |
| Coalition of European Lobbies for Eastern African Pastoralism (CELEP) | | | | | | | |

| Name of One Health initiative | Type of initiative | Coverage | Country(ies) | 1° field | 2° field | 3° field | Others (list if any) |
|---|---|---|---|---|---|---|---|
| Health of Ethiopian Animals for Rural Development (HEARD) | Capacity development and implementation | National | Ethiopia | AH | Food safety | EH | PH |
| Wildlife Conservation Society | Coordination, implementation, research | Global | World | EH | AH | PH | Welfare, wildlife |
| Conservation through Public Health in Uganda | Coordination, implementation | National | Uganda | EH | PH | AH | Welfare, |
| One Health: Connecting Humans, Animals and the Environment | Capacity development | Global | World | PH | AH | AMR | EH |
| Specialized Master in Integrated Management of Health Risks in the Global South (IManHR) | Capacity development and implementation | Global | All African cuntries | PH | AH | EH | AMR |
| Taking a multisectoral, one health approach: A tripartite guide to addressing zoonotic diseases in countries | Coordination and organization | Global | World | PH | AH | EH | AMR |
| One Health Global Network (OHGN) | Organization, research and capacity development | Global | World | PH | AH | AMR | Food safety |
| Global Risk Forum Davos One Health | Organization, research and capacity development | Global | World | PH | AH | Food safety | AMR |
| Environmental Health Perspectives: Fall in fish catch threatens human health | Research | Continental | Africa | PH | AH | EH | |
| Madagascar Health and Environmental Research (MAHERY) | Research and capacity development | National | Madagascar | PH | EH | AH | Animal production |
| Environmental Health Perspectives: Estimated effects of future atmospheric CO2 concentration on protein intake | Research | Regional | North Africa | EH | PH | | |
| Geohealth: Potential rise in Iron deficiency due to future anthropogenic CO2 emission | Research | Continental | Africa | EH | PH | | |
| WASH (Water Sanitation and Hygiene):Freshwater conservation, improved livestock farming and restoration efforts | | National | South Africa | PH | AH | | interdisciplinary |

| Name of One Health initiative | Type of initiative | Coverage | Country(ies) | 1° field | 2° field | 3° field | Others (list if any) |
|---|---|---|---|---|---|---|---|
| One Health profile of a community at the wildlife-domestic Animal interface, Mpumalanga, South Africa | Research and capacity development | National | South Africa | AH | PH | EH | AMR |
| A One Health approach to transfrontier conservation - The Limpopo TFCA | | Regional | Southern Africa | AH | PH | EH | Land use and policy |
| One Health Zoonotic Disease Prioritization (OHZDP) | Tool, capacity development | Global | World | PH | AH | Zoonoses | |
| Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) Disease Priotritization tool | Tool, capacity development | Global | World | PH | AH | AMR | |
| Network for Evaluation of One Health (NEOH) | Tool, capacity development | Global | World | PH | AH | AMR | EH |
| AVENIR Health: One Health Tool | Tool | Regional | East, west and southern Africa | PH | | | |
| AWF (African Wildlife Foundation): Conservation and Environmental protection | Organization, research and capacity development | Continental | Africa | EH | AH | PH | Conservation |
| One Health: Basics of multisectoral collaboration at the Human - Animal - Environment interface | Capacity development | Global | World | PH | AH | EH | AMR |
| Pan African Tsetse and Trypanosomiasis Eradication Campaign | Organization, coordination, implementation | Continental | Africa | PH | AH | EH | |
| Coordinating Office for the Control of Trypanosomiasis in Uganda | implementation, coordination | National | Uganda | AH | PH | EH | |
| One Health Training Manual | Organization, capacity development | National | Tanzania | PH | AH | EH | Wildlife, AMR |
| One Health Commission | Capacity development, organization | Global | World | PH/AH | EH | AMR | Food safety |
| One Health Strategic Plan | Multipurpose | Continental | NA | PH | AH | EH | Wildlife |
| Global Health at the Human-Animal-Ecosystem Interface | Capacity development | Global | World | Global Health | Zoonoses | EID | AMR, PH |
| Swiss Tropical and Public Health Institute | Capacity development and research | Regional | West and central Africa | PH | AH | EH | |

| Name of One Health initiative | Type of initiative | Coverage | Country(ies) | 1° field | 2° field | 3° field | Others (list if any) |
|---|---|---|---|---|---|---|---|
| One Health Antibiotic Stewardship/AMR | Capacity development | Global | World | AMR | AH | PH | EH |
| One Health Research Foundation | Capacity development and research | Global | RUSVM, St. Kitts and Nevis and tropical countries globally | AH | PH | EH | AMR |
| One Health Foundation | Implementation | Global | NA | AH | PH | Animal welfare | |
| One Health Social Sciences (OHSS) Webinar | Capacity development and tools | Global | World | PH | AH | EH | Wildlife, AMR |
| One Health capacity building in sub-Saharan Africa | Research | Continental | All African cuntries | AH | PH | EH | AMR |
| One Welfare | Organization, coordination and implementation | Global | World | Animal welfare | Human well-being | EH | |
| One Health Platform | Organization, capacity development | Global | World | PH | AH | AMAR (agents and resistance) | Science policy interface |

# Note that details of these initiatives are available in the database link provided. It should be understood that the field of One Health, One Medicine, Conservation Health and Global Health and their variants are constantly evolving, hence the list provided in this table is not exclusive

# Appendix 3: Correlation analysis of One Health interest, influence and policy power

| No. | Variable | Interest | Influence | Policy power |
|---|---|---|---|---|
| 1 | Interest | 1.0000 | | |
| 2 | Influence | 0.7138* | 1.0000 | |
| 3 | Power-Policy | 0.1725 | 0.1809 | 1.0000 |

*Significant at < 0.0001

# Appendix 4: Sample relationship between One Health related organizations, Kenya

| | | Livestock | Public health | Environment | Social development | Other |
|---|---|---|---|---|---|---|
| One Health stakeholders | Public sector | Ministry of Agriculture, Livestock , Fisheries and Irrigation - State Department of Livestock- DVS , DLP and SAGAS ( MALF&I) | Ministry of Health(-MoH) | Ministry of Environment and Forestry (ME&F) | | Tegemeo Institute of Agricultural Policy and Development, Egerton University |
| | | Directorate of Veterinary Services (DVS) | Directorate of Veterinary Services (DVS) | National Environment Management Authority (NEMA) | | Kenya Bureau of Standards (KEBS) |
| | | Kenya Agricultural and Livestock Research organization (KALRO) | County Governments | Ministry of Lands and Physical Planning | | |
| | | Kenya Dairy Board (KDB) | Pharmacy and Poisons Board of Kenya ( PPBK) | Kenya Plant Health Inspectorate Service -AMR issues (KEPHIS) | | |
| | | Kenya Veterinary Board (KVB) | Kenya Plant Health Inspectorate Service -AMR issues (KEPHIS) | | | |
| | | Kenya Veterinary Medicine Directorate | | | | |
| | | County Governments | | | | |
| | | Kenya Wildlife Service (KWS) | | | | |

| | | Livestock | Public health | Environment | Social development | Other |
|---|---|---|---|---|---|---|
| | Private sector | Kenya Poultry Breeders Association (KPBA) | | | | |
| | | Kenya Poultry Farmers Association (KPFA) | | | | |
| | | Association of Kenya feed manufacturers (AKEFEMA) | | | | |
| | | Kenya Livestock Marketing Council (KLMC) | | | | |
| | | Kenya Livestock Producers Association (KLPA) | | | | |
| | International | World Organization for Animal Health (OIE) | Centres for Diseases Control and Prevention (CDC Kenya ) | | | |
| | | Food and Agriculture Organization of the United Nations (FAO) | OHCEA | | | |
| | | One Health central and Eastern Africa (OHCEA) | World health Organization (WHO) | | | |
| | | IGAD - ICPALD | Africa Canters for Diseases Control and Prevention (ACDC) | | | |
| | | | FAO | | | |
| | | Donors (USAID, UKAid, EU and World Bank) | Donors (USAID, UKAid, EU and World Bank) | Donors (USAID, UKAid, EU and World Bank) | Donors (USAID, UKAid, EU and World Bank) | |
| | NGOs | | World Vision | World Vision | World Vision | |
| | | | | | | |
| | Research / Academia | Colleges (Agriculture and Veterinary Sciences) - multiples | Medical school- (FELTP) - multiples | | | |
| | | International Livestock Research Institute (ILRI). | Kenya Medical Research Institute (KEMRI) | | | |
| | | KALRO | | | | |

NB: DLP = Directorate of Livestock Production, SAGAs = Semi-Autonomous Government Agencies, IGAD – ICPALD = Intergovernmental Authority on Development – IGAD Centre for Pastoral Areas and Livestock Development, USAID = United States Agency for International Development, UKAid = United Kingdom Aid Direct, EU = European Union.

# Appendix 5: Comments from selected One Health stakeholders on two important questions on One Health initiatives

| | Q1: What do you consider the weakest link in your country leading to a successful implementation of One Health approaches? | Q2: If you had USD50,000 how would you best invest it towards One Health implementation in your country? |
|---|---|---|
| Response | Weak collaborations between the sectors. Inadequate resources by government. Decentralization of One Health activities should be a must. Low level of One Health awareness among policymakers and the public on burden of zoonoses. There are limited data on burden of zoonoses to influence policy. Inadequate human resources, especially the animal health sector. Weak wildlife sector | Strengthening collaboration between the various sectors. Joint activities (e.g. outbreak investigations).<br><br>Training on One Health. Developing strategies and guidelines for zoonoses. |
| | Coordination mechanism at both national and subnational levels is still weak. This is as a result of not having adequate staff fully committed to implementation of One Health activities | Strengthening of coordination at national and subnational levels. Mapping of One Health stakeholders/actors and activities implemented in the country. Support advocacy on One Health approach and associated activities (including good practices documented so far) to ensure enhanced understanding among policymakers and actors. Lobby for adequate number of qualified staff (experts in public health, animal health and environment health/metrological, GIS/data and information management specialist and risk communication expert) at the central coordination office to ensure implementation of the agreed work plan. Capacity building of the staff at central and subnational level – on management, coordination, communication and resource mobilization. Equipping the coordination office to facilitate data collection, processing and timely information sharing |
| | Funding has always been a challenge. Unhealthy rivalry and competition amongst the various sectors of One Health. | It will be utilized for human resource development and capacity building, especially for the Animal scientist so that they will be better positioned to perform optimally in the One Health initiatives. |

| | Q1: What do you consider the weakest link in your country leading to a successful implementation of One Health approaches? | Q2: If you had USD50,000 how would you best invest it towards One Health implementation in your country? |
|---|---|---|
| Response | There is usually the problem of implementation of One Health initiatives among countries that share borders. There is problem of finance/sponsorship. | Sponsorship of One Health researches in the area of food security and safety as it relates to livestock production. The payment of ad hoc staff to support substantive staff. |
| | Wildlife health is not well captured in One Health. The human medical practitioners are often at loggerheads with veterinary practitioners or engaged in supremacy battles. | This money will be invested to promote wildlife health involvement in One Health.<br><br>Money will be used to augment budget deficit wherever there is genuine interest in One Health administration. |
| | Poor representation of animal scientist in One Health teams. The civil servants usually want to take the forefront but are not competent enough to lead. | To address poorly coordinated One Health activities by running an office.<br><br>To sponsor bills for legislation on One Health initiatives. |
| | Foreign partnership on One Health is dwindling. There is no sincerity of purpose in the administration and coordination of One Health activities | To finance researches that are related to meat contamination and preservation |
| | One Health programs are poorly funded. There is lack of proper integration between the various sectors of One Health | To sponsor projects related to AMR and resistance gene transfer among humans, animals and their environment. |
| | Insufficient money to run One Health programs. There is no cooperation among the stakeholders. | Construction of a good slaughterhouse, and proper remuneration of meat inspectors. |
| | Sponsorships lacking, competition among the different sectors instead of teamwork. | Injection of fund into areas starved of funds, conducting research on food safety. |
| | Insufficient funding and administrative lapses. | This money given will be used to correct all these deficiencies. |
| | Lack of coordination of the One Health activities at every level. The human health personnel are always at loggerheads with veterinary personnel when it comes to project leadership. | Money will be used to sponsor and promote bills to form legislature to define the roles of every professional partaking in One Health activities and also to prepare the MOU in every partnership. |
| | Inferiority complex among the various professionals. Most of the civil servants involved in One Health activities are not qualified to occupy such offices. | Money will be spent on research that relates to food security and livestock genetic improvement. |
| | Inter-sectoral discrimination, lack of fund to finance projects. | Money will be used to finance projects starved of funds. |
| | Concealment and denial of information and data among the various One Health sectors. There is inter-sectoral communication gap. | To attend workshops and seminars on the proper enlightenment and acquisition of knowledge on One Health programs and activities |
| | Inter-sectoral bureaucratic bottlenecks, unhealthy rivalry among various sectors | Establishment of One Health administrative offices at subnational level for proper organization. |
| | The government is not giving enough support to One Health programs, and insufficient external funding. | Sponsorship of One Health research in the area of public health and food-borne diseases |
| | Insufficient funding to finance One Health projects. Cross-border One Health initiative is not effective | Provision of funds to finance projects and researches. |
| | Information and data sharing among sectors is met with some level of resistance. Majority of the personnel in position are not qualified | Money will be used for human resource development (seminar, workshop, symposium). |
| | The roles and functions of the various sectors are not usually defined and hence encroachment and duplication of functions | Promotion of bills to form legislation to define the roles of every sector/professional partaking in One Health activities. |
| | There is no unified database, the different sectors prefer to be independent. Sponsorship of One Health activities remains an issue | For sponsorship of research and projects. |
| | Poor advocacy to policymakers hence lack of One Health approaches at subnational levels | I will take all of them to One Health implementation and in turn I will save a lot money due to adverse health effects averted which would cost money to manage. |

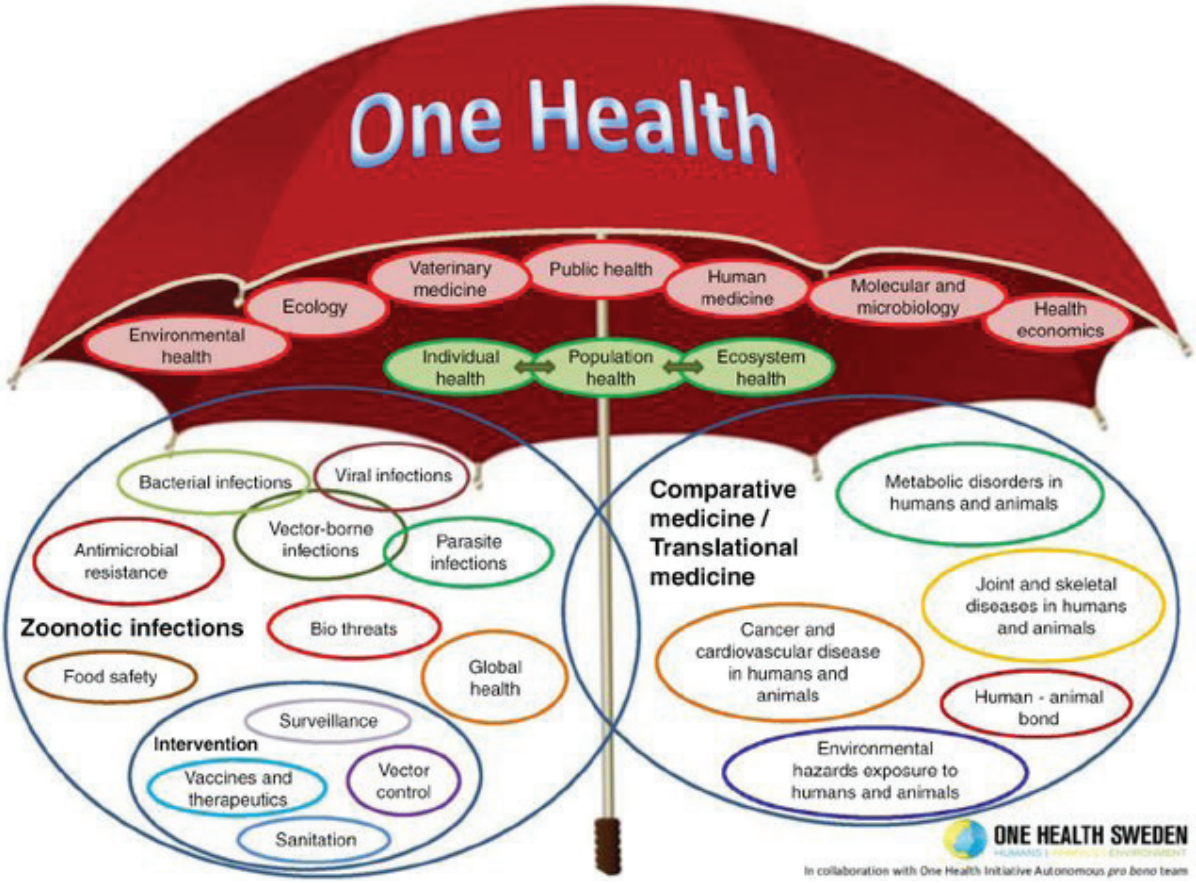
| | Q1: What do you consider the weakest link in your country leading to a successful implementation of One Health approaches? | Q2: If you had USD50,000 how would you best invest it towards One Health implementation in your country? |
|---|---|---|
| Response | Poor knowledge of One Health among relevant stakeholders and inadequate knowledge of roles and contribution to One Health. Lack of policy framework and system that will enable the effective coordination of relevant stakeholder institutions. | Advocacy and policy influencing for establishment and implementation of a policy framework that mandates One Health collaboration and integration at all relevant stakeholder institutions. Integration of One Health into relevant stakeholder institutions through the establishment of One Health desks that will cater to issues or projects that require multidisciplinary actions/contributions. Investment into One Health education and curriculums at university/ college levels. |
| | Preservation of discipline interest and never wanting to yield ground to other field, weak commitment from the government in terms of financing and human/ material resources, misconception of One Health approach and lack of central coordination with no One Health implementation at the subnational level | Strengthen central coordination and empower subnational One Health actions. Conduct community sensitization using established front like the political and religious leaders. |
| | Commitment of government – Financial and human. Misconception of One Health approach. Central coordination still a challenge. | Conduct community sensitization at one of the hot spots (e.g. points of entry [POE]). |
| | One of the setbacks in the implementation of One Health is that actors in different sectors prefer working in silos. There are limited networks for sharing of reports between public and animal health sectors. Inadequate communication and collaboration among the sectors (human, animal and environment). | Increase awareness on One Health for professionals, policymakers and the community. Strengthen preparedness planning and improve the ability to respond to zoonotic diseases, AMR and other public health events/outbreak at all levels (community, district, regional and national). Improve the health of human, animal and environment through evidence-based research. Strengthen animal and public health reporting systems and their interoperability. |
| | Poor or limited synergies among different professionals. | Since the increase in the human population globally has been exposing the land to great pressure with further encroachment on natural forests and their rich and diverse fauna, which have led to exposure of humans and domestic animals to new pathogens, I will initiate the collaboration of different professionals to research into climate-smart agriculture for increased food production, ecofriendly utilities and vibrant blue economy. |
| | Starvation of funds and lack of qualified personnel. | Spending on human development in terms of training. |
| | There is usually inter-sectoral skirmishes and unhealthy rivalry. | Investment in research on food security and protection. |
| | Inter-sectoral discrimination and insufficient of fund to finance projects. | Fund will be used to finance projects starved of funds. |
| | A silo mentality continues to exist in some high profile activist organizations and institutions and individuals involved in the One Health movement. Regrettably, a mindset has evolved where some resist sharing of information and resources with others while refusing to give due credit to other productive groups/organizations on the scene, past and present. A tribalistic, insular attitude is counterproductive when seeking to expand and implement the noble One Health concept/approach to benefit all national and worldwide communities. A unity of purpose is essential. | Concentration on promoting One Health education among reputable political leaders would be ideal. |
| | Before COVID-19, I would have said political will and resource limitations. At this point, resources dominate, as all are now aware of the consequences of not using the One Health approach. | Making sure that there is a One Health coordinating platform that includes stakeholders (academia), as well as government. |
| | The silo implementation and poor monitoring of activities. | I will invest it on capacity development mainly of individuals and staff in institutions. |

| | Q1: What do you consider the weakest link in your country leading to a successful implementation of One Health approaches? | Q2: If you had USD50,000 how would you best invest it towards One Health implementation in your country? |
|---|---|---|
| Response | Professional bodies sometimes serve as limitation. Getting all the responsible parastatals to work together harmoniously will help the One Health initiative. | I would invest in research and software development for easy reporting and collation of data in the field of One Health. There will be a centralized tool for reporting and zoonotic infectious disease once it is detected. This platform will be available to all key parastatals involved in One Health. |
| | The lack of cooperation between the principal Ministries (primarily health and agriculture) in the implementation of One Health. | Increase awareness and sensitization on one health amongst policymakers.<br><br>Increased surveillance by boosting laboratory capacity on one health approach<br><br>Promotion of biosecurity amongst veterinarians, rangers and health workers. |
| | Illiteracy – the large majority of populations in Africa are either illiterate or semi-literate and this could hinder One Health implementation because many may not embrace the approach easily. Poverty denies the majority of people in the community from making informed choices about appreciation of One Health approaches. | Start a project that would incorporate transdisciplinary approaches with contributions from a wide range of professionals. Such project would target the integration of One Health approach and target the vulnerable (unemployed youth and women) in the society. These individuals make the larger part of the population. The projects objectives will include: |
| | Uncoordinated policies of the government | Improvement of livelihoods of the target populations through the creation of awareness on one health approach.<br><br>Empowerment of the vulnerable by creating sustainability.<br><br>Use the target subset of the population to disseminate the acquired information and benefit as proof of concept to the rest of the community. |
| | Under funding of the livestock and other sectors in comparison with the public health. | Invest the training of front line staff in the relevant ministries on aspects of One health aspects. Sensitization of the policymakers in the ministries of planning, health and livestock on prioritizing One Health activities. |
| | The weakest link could be the lack of government initiative. | I will carry out a gap assessment to determine the core areas with obstacle for the development of One health initiatives in the country. This will be followed by the presentation of the positive impact of one health to the stakeholders in the country. The outcome will be presented to higher officials, policymakers and influencers for purpose of advocacy.<br>I will also like to form a team of different professionals across disciplines to start a large One health national team, with subnational formats too. The team will expected to develop proposals and jointly implement different activities together including research, awareness creation, training and field implementation for different stakeholders. |
| | Inadequate linkage between the three primary pillars in particular human and animal health with environment health almost absent from the equation in most cases. | Establish undergraduate and postgraduate training and research in the One Health approach with practical field attachments for all cadres of practitioners using modern ICT techniques |
| | Harmonizing the working relationship among professional bodies to get all the responsible parastatals and agencies utilizing the professions to work together and harmoniously should help the One Health initiative. | I would invest in research and software development for easy reporting and collation of data in the field of One Health. There will be a centralized tool for reporting and zoonotic infectious disease once it is detected. This platform will be available to all key parastatals involved in One Health. |
| | Prevailing uni-disciplinary research and weak understanding of the essence of One health. | I would initiate transdisciplinary research where veterinarian, public health, social science, laboratory and environmental health experts and local community opinion leaders could work together on shared objectives contributing to shared objectives. |

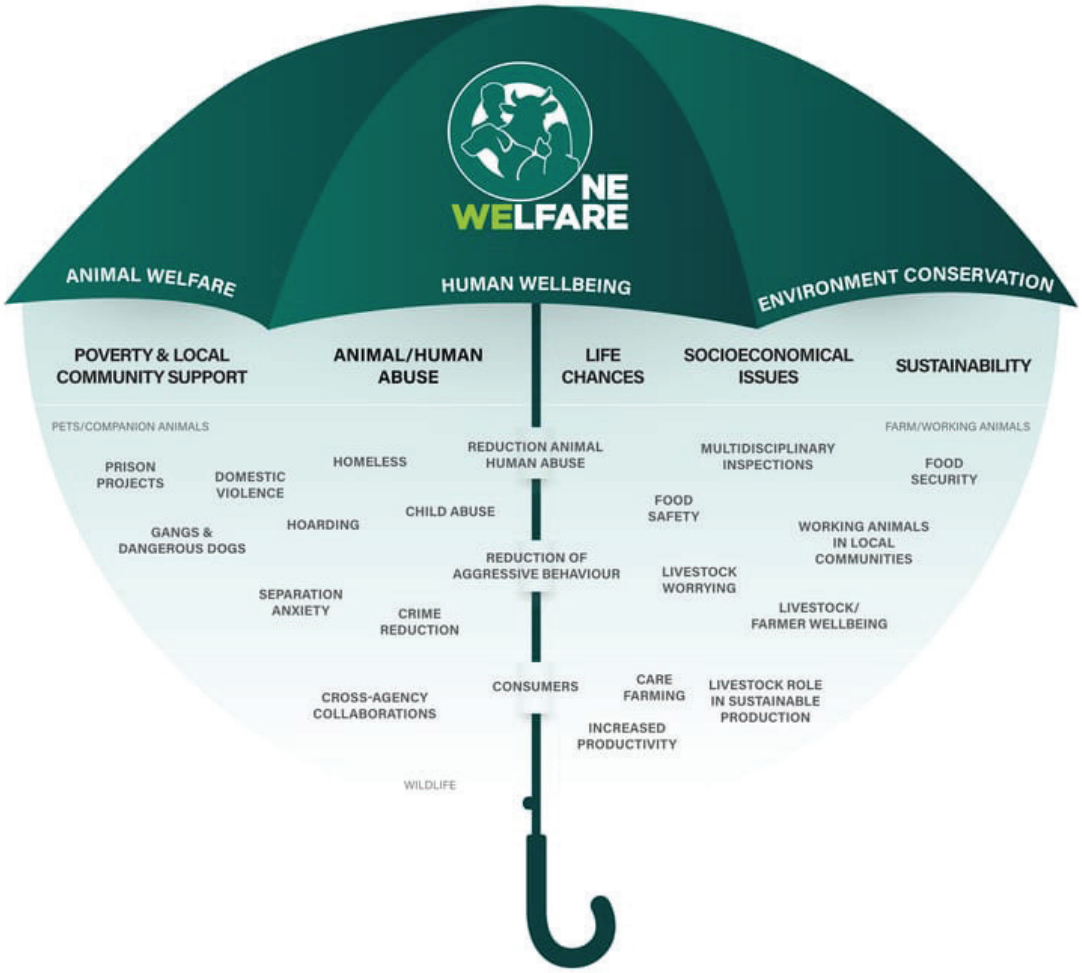
| | Q1: What do you consider the weakest link in your country leading to a successful implementation of One Health approaches? | Q2: If you had USD50,000 how would you best invest it towards One Health implementation in your country? |
|---|---|---|
| Response | Many professionals do not still understand much of the importance of One Health approach. For example, public health clinicians still think largely of clinical approach, the veterinarians think of population medicine approach and the environmentalists and ecologists think of the environment and nature primarily. | I would initiate establishing national one health task force or network comprising vets, medical and environmental professionals, so they can understand more of one health through training and workshops, and then they will implement many one health activities in the countries. |
| | The non-existent of relevant One Health policies and robust understanding of the topic by lawmakers remain the weakest link. Implementers of the adaptable One Health policies may also be working in silos thus complicating the implementation plans. | I would train the stakeholders on the One Health approach and the importance of working together with one objective in a multidisciplinary approach .I would also train the policymakers and lawmakers on the same subject. I would then recruit community leaders and members and train them on this approach and use them as ambassadors and One Health champions to preach the one health approach at the community level. |
| | The lack of government goodwill and budget provision to implement One Health as well as the lack of collaborative efforts between government ministries and necessary professionals. | I will invest this money in providing one health training to various groups of professionals. I believe there is a gross misconception about what one health is, one health does not involve each group of professionals doing their part in the complex puzzle. One health involves collective thinking, something I think we often do not do. The provision of this kind of training will expand our thinking beyond the realms of our traditional thinking. |
| | Access to local funding to support one health approaches are inconsistent. Most of the present One Health activities are donor-driven. | Promote One Health approaches among undergraduate medical and veterinary students, in diploma colleges and or fund MSc projects utilizing One Health approaches. |
| | Keeping to the professional discipline in the midst of One Health and reductionism. | I will strengthen central and subnational coordination of One Health. |
| | International collaboration on One Health is poor. There is observable bias in the coordination of One health activities. | To finance researches that are related to food safety and preservation. |
| | Poor funding of One Health projects exist and there is no proper integration between the various sectors relevant to One Health. | To promote projects on AMR and resistance gene transfer as it relates to One Health. |
| | Starvation of funds for the One Health programs. Lack of cooperation among the stakeholders. | Construction of a model slaughterhouse for the training of students. Organization of workshops on meat inspection and hygiene. |
| | International sponsorship is not easy to get for One Health, unhealthy inter-sectoral rivalry and competition exist and these affect team work and progress in One Health activities. | Injection of fund into areas relevant to One Health that are starved of fund, conducting researches on food safety. |
| | Insufficient funding and administrative lapses. | I will use the allocations and subventions to identify and correct all anomalies and deficiencies related to the One health approach. |
| | There is difficulty in bringing the different parastatals to work together harmoniously as a team. | Proper investment in surveillance of zoonotic and infectious diseases in livestock before it spreads to human. |
| | The lack of cooperation between the necessary Ministries (health, environment, tourism and agriculture). | Increase awareness and sensitization of one health activities amongst the general populace , and promote the culture of hygiene and biosecurity among the various stakeholders. |
| | Inter-sectoral discrimination, lack of fund to finance projects | Money will be used to finance projects starved of funds. |
| | Vital research outputs (information and data) among the various One Health sectors are not revealed or made available to all end users or beneficiaries. There is inter-sectoral communication gap | Subvention will be utilized for attending workshops and seminars on the proper enlightenment and acquisition of knowledge on One Health programs and activities. |

| | Q1: What do you consider the weakest link in your country leading to a successful implementation of One Health approaches? | Q2: If you had USD50,000 how would you best invest it towards One Health implementation in your country? |
|---|---|---|
| Response | Administrative challenges may sometimes make One Health impracticable. For example, some line ministries cannot pull funds together inter-ministerially to jointly implement activities | Establishment of One Health administrative offices for proper organization and its future funding. |
| | The wildlife health is still very deficient and left behind in One Health, The human medical and veterinary practitioners are often at loggerheads for supremacy battle | For the promotion of wildlife health involvement in One Health, Money will be used to augment budget deficit wherever there is genuine interest in One Health administration |
| | There is poor representation of environmentalist/ animal scientists/geneticists, etc. in the One Health teams.<br><br>The civil servants usually want to take the forefront but are not competent enough to lead | To address poorly coordinated One Health activities by running an office, To sponsor bills for legislation on One Health initiatives |
| | There is some lack of awareness by the general public on the concept and importance of one health. Secondly, the failure of Government to show commitment and seriousness to the concept. | Assembling a team comprising various professional bodies and stakeholders like veterinarians, animal health technologists, epidemiologists, public health specialists, print and electronic media practitioners etc. This team will work assiduously to propagate the concept and importance of one health concept in the representative local government areas in all the regions of the country. During this exercise data will be obtained simultaneously to ascertain the level of awareness of one health concept in the country for future use. |

# Appendix 6: Selected pictograms of global One Health and related initiatives

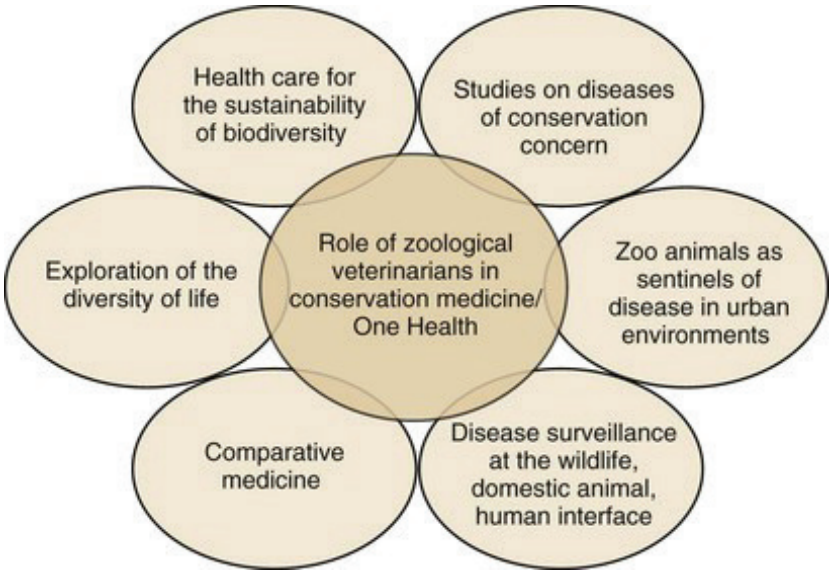



Courtesy: One Health Sweden; Lerner and Berg 2015

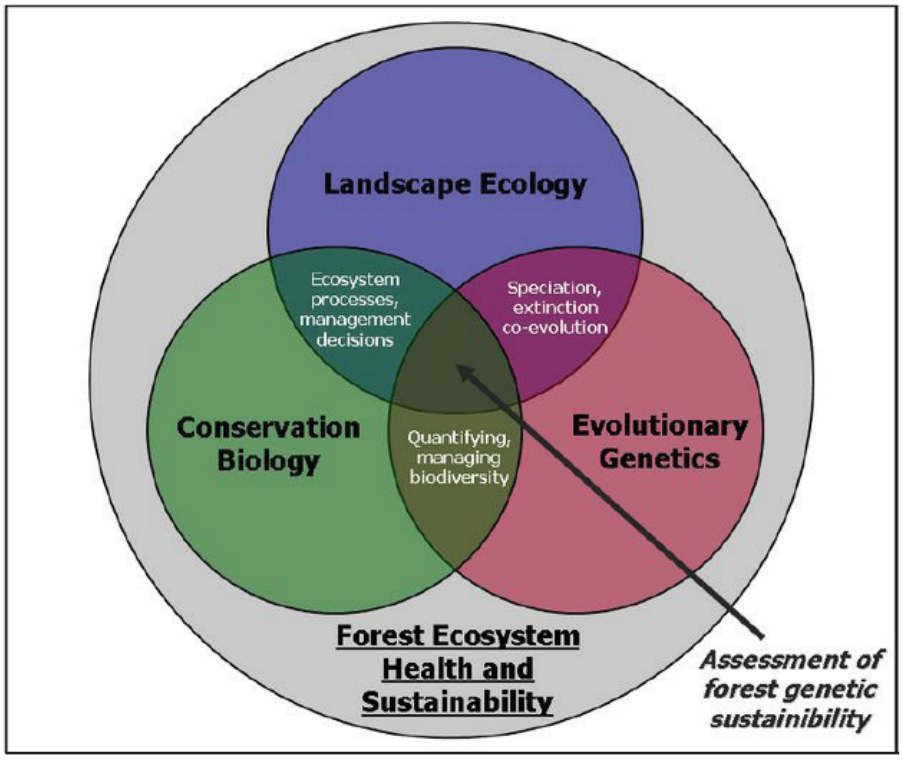



Courtesy: One Welfare (https://www.onewelfareworld.org/). Pinillos et al. 2016.


Courtesy: One Welfare (https://www.onewelfareworld.org/).




Courtesy: Conservation Medicine to One Health (https://veteriankey.com/conservation-medicine-to-one-health/).




Courtesy: Conservation Medicine, Potter KM (2009). From Genes to Ecosystems: Measuring Evolutionary Diversity and Community Structure with Forest Inventory and Analysis (FIA) Data. In: n: McWilliams, Will; Moisen, Gretchen; Czaplewski, Ray, comps. Forest Inventory and Analysis (FIA) Symposium 2008; October 21–23, 2008; Park City, UT. Proc. RMRS-P-56CD. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 16 p. (https://www.fs.usda.gov/treesearch/pubs/33377).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