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One Health Economics approach to prevention and control of zoonotic and animal diseases - considerations for South Africa

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Abstract

Outbreaks of animal and zoonotic diseases in South Africa are costly and raise concerns about national biosecurity. The interconnectedness of humans, livestock, wildlife and their social and ecological environment necessitates a holistic approach to prevention, preparedness and response to zoonotic and animal diseases. One Health is an increasingly accepted approach in contemporary science and policy spheres, but with limited consideration for economic dimensions. To more fully estimate costs of animal and zoonotic diseases in the country and to explore further scope for applying a One Health economics lens, the Agricultural Research Council of South Africa, in collaboration with partners, held a One Health Economics mini-congress to provide a platform where multidisciplinary stakeholders discussed practical examples, primarily from the Southern African region. Discussions at the mini-congress centred around One Health economics and opportunities, economic insights on prevention and control of Rift Valley fever (RVF), avian influenza and other zoonotic diseases, return on investment for One Health approaches, and insights from the natural resources and animal and human health sectors. Regional and international perspectives on multi-sectoral economic analysis and financing were also shared. Key recommendations from the mini-congress included promoting coordination, co-creation and co-implemented efforts to minimize effects of One Health challenges, and including economic aspects of multi-sectoral engagement to identify and reduce trade-offs and maximize co-benefits of strategies and programmes. Integration of economics in One Health fora, research and collaboration, and promotion of communities of practice and applied training to enhance learning and knowledge exchange were also identified as important.

Keywords Prevention and control of zoonotic diseases, One health, One Health Economics, Mini-congress, South Africa

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Introduction

South Africa has continued to experience numerous zoonotic disease outbreaks with varying consequences for different stakeholders [1–2], including livestock farmers, farm workers, agribusinesses, retailers and consumers. These outbreaks have exposed weaknesses in the country's biosecurity, namely insufficient ability to diagnose diseases on time and lack of preparedness of the country for putting in place realistic and scientifically justifiable remedial biosecurity measures. These weaknesses were flagged out by a Task Team on Animal Health Biosecurity (TT-AHB) delegated by the Minister of Agriculture, Land Reform and Rural Development (DALRRD) to assess the state of biosecurity and animal disease, including zoonotic disease control in the country in 2019². These outbreaks also created major challenges for the South African livestock industry, with concerns over losses and interruptions in production and trade [1–2]. In 2022, a foot-and-mouth disease (FMD) outbreak reported in six of the nine provinces resulted in a 12% and 21% decrease in beef and wool exports, respectively, in that year primarily due to temporary closure of various export markets [3]. Similarly in 2021, the country experienced an import ban of poultry products into Mozambique and Botswana. According to Mdlulwa [4] the 2010 RVF outbreak resulted in production losses of about R5.4 million among the surveyed farmers. At the district level, losses ranged between R625 444 and R51.7 million in the Eastern Cape, Free State and Northern Cape provinces. These were conservative estimates which only accounted for livestock production.

While the TT-AHB recommended several plans of action and called for a multidisciplinary approach, implementation of such plans is yet to happen. Generally, policy making in South Africa must be informed by stakeholder engagement and empirical findings [5] and therefore requires more evidence and lessons locally and from other countries in order to identify robust and successful policies.

Concurring with the TT-AHB's recommendation on a multidisciplinary approach in dealing with animal disease outbreaks, this brief commentary considers the prospects of adopting a One Health Economics approach, which is an emerging scientific approach used to account for the complex interrelationships between animal and human disease, environment and human livelihoods (as described more below).

In doing so, we synthesise views and findings from the first 'One Health Economics mini-congress' in South Africa which was organized by the Agricultural Research Council (ARC) in collaboration with researchers from several institutions. The congress was attended by various stakeholders, which included veterinarians, public health and laboratory experts, environmental managers,

agricultural economists, government officials, regional and intergovernmental agencies, and farmers. Having these stakeholders in one room provided a rich platform for a meaningful presentation of facts and experiences, and extensive discussion. This article summarises these discussions and the consensus reached, as well as recommended plans of action.

The One Health Economics approach—a brief background and overview

In a world faced by complex patterns of global climate change, the interconnection of humans, livestock, wildlife and other animals, and their social and ecological environment, there is no doubt that there is a need for a holistic approach in addressing these complexities [6]. 'One Health' is popularly known as an interdisciplinary approach that is embedded within a range of various applied models to account for complexities inherent in ecosystems and societal life [7]. The definition endorsed by the Food and Agricultural Organization of the United Nations (FAO), United Nations Environment Programme (UNEP), World Health Organization (WHO) and World Organisation for Animal Health (WOAH) in 2021 includes, "One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems", mobilizing "multiple sectors, disciplines and communities at varying levels of society to work together" toward wellbeing, tackling threats, and addressing needs spanning food, water, and sustainable development [8]. The definition is underpinned by a set of underlying principles, among them transdisciplinarity and multi sectoral collaboration that involves policy and planning, modeller and other stakeholders based on the context. Taken as a whole, it can readily be seen as a framework to understand the scope of impacts across sectors and society toward avoiding trade-offs and increasing co-benefits.

Part of this complexity and the interdisciplinarity in the approach involves understanding impacts, including estimating the cost of ensuring the health of animals, the environment and humans and the consequences of inaction and this aspect can be examined through the scope of 'One Health Economics'. In this paper 'One Health Economics' loosely refers to a concept of estimating costs and benefits (whether in monetary terms or otherwise) that account for multiple sectors in line with a One Health lens to provide a more comprehensive understanding of human, animal, and environment links than can be achieved with single-sector economic analyses alone. For example, Zinsstag et al. [6] argue that the cost estimation of zoonoses requires in-depth understanding of the ecology of disease. Detailed knowledge about transmission pathways helps identify sectors contributing to the cost of disease and is essential for determining

effective interventions for interruption of the disease cycle. One Health Economics is key to providing the necessary evidence in support of One Health policies being considered by decision makers.

One Health calls for resource allocation based on evidence and context, and not necessarily for everyone working together all the time. It requires strong human, animal and environmental health systems to determine relevant sectors for a given objective, disease, or situation, to identify entry points for risk reduction, early detection, response and investment. In addition, the approach requires monitoring, evaluation and learning frameworks for One Health. It calls for moving away from siloed analyses of data evaluations and investigations to multi-sectoral and multi-disciplinary integration of information and decision-making. This would include informing and evaluating One Health surveillance and monitoring of disease threats, outbreaks, and disease spread, among other possible scope.

Zoonoses control is unique in that effective interventions may lie outside the human health sector, because transmission often does not occur between humans, but from animals to humans, such as in rabies, Rift Valley fever (RVF) and brucellosis. Economic impacts from zoonotic and animal diseases extend beyond the cost of control and include direct decreases in household income because of lower livestock/product sales, consumption impacts from reduced food security, and increased household vulnerability where livestock serve as a risk-coping mechanism and affect household wealth [9–10].

Through integrated analysis, the full cost of zoonotic disease and disease avoidance can be estimated, linking an animal-human transmission model to cross-sector economic analysis, informing scenarios (e.g., prevention at source versus ‘wait-and-see’ treatment and control in humans) and explore public (i.e., government) and private costs. This differs from analyses which only consider private costs, such as costs to individual farmers, farm workers, consumers etc. Full societal costs include both private and public costs across health, agriculture and the environment, and include costs to households [9, 11]. Zoonotic and animal disease outbreaks also often result in negative externalities such as impacts on the livestock of other producers, on human health and on animal welfare, which should also be considered [12]. When the value of these unpriced negative externalities is considered, full societal costs and losses increase [13]. Such an inclusive analysis should be undertaken when assessing the value of intervention options, which may require a cost (e.g., for livestock mass vaccination) which may potentially generate benefits in multiple sectors. Some studies provide frameworks to quantify the costs and benefits of One Health programmes [9, 14]. Such a complete understanding of the costs of the disease and

the costs and benefits of control measures would promote broader implementation of the most efficient and effective control measures, contributing to improved animal and human health, better livelihood outcomes, and macroeconomic growth. One Health Economics is key to providing the necessary evidence in support of One Health policies being considered by decision makers. However, in South Africa, little work on One Health Economics has been done, although One Health has been embraced by many stakeholders.

One health in South Africa

In 2014 the One Health Program was established in South Africa to enhance capacity to detect and respond to zoonotic disease threats [15]. Key partners in the program included the National Institute for Communicable Diseases (NICD) of the National Health Laboratory Service (NHLS), South Africa, the South African National Department of Health (SANDOH), the University of Pretoria (UP), and the CDC’s National Center for Emerging and Zoonotic Infectious Diseases (NCEZID). Part of the program included participation in key global One Health meetings. Since then, various ministries such as human health, animal health, agriculture and the environment continue to engage in One Health initiatives such as the One Health Framework workshop led by the WHO South Africa country office, which sought to fortify the country’s preparedness for zoonotic diseases while also reinforcing the interconnection between human and animal health services [16] as well as the FAO-led workshop to strengthen One Health approach in Southern Africa [17].

Academic institutions such as UP have also embraced One Health, by leading various one health initiatives through the Centre for Viral Zoonoses and the Southern Africa Bat Research Network (SABReNet) [18]. Additionally, UP also supports the implementation of Capacitating One Health in Eastern and Southern Africa (COHESA) in Southern Africa [19].

At the policy level, South Africa established a National One Health Forum in 2014. The Forum developed a One Health Implementation Framework which was aligned with the Global Joint Plan of Action [20]. The framework is important for advancing collaboration among stakeholders driving national efforts towards a unified One Health approach [20].

South Africa also adopted the Antimicrobial Resistance (AMR) National Framework using a One Health approach. The framework outlines key strategic objectives to slow the development and spread of AMR, and improve patient outcomes, animal health and food production through better use of antimicrobials [21].

One of the very few studies incorporating economics in One Health identified trade-offs between interventions

Table 1 Summary of the active and resolved outbreaks of foot-and-mouth disease in South Africa between 2022 and 2023

Out-break event	Province	Number of open outbreaks	Number of resolved outbreaks	Total number of outbreaks	Last reported outbreak
1	KwaZulu-Natal	120	2	123	31 January 2023
2	Limpopo (previous disease-free zone)	7	1	10	13 June 2022
3	North-West	17	2	17	31 January 2023
	Free State	40	2	41	31 October 2022
	Gauteng	4	3	7	15 September 2022
	Mpumalanga	1	0	1	5 August 2022
Total		185	10	195	

Source: Department of Agriculture, Land Reform and Rural Development [23]

Table 2 Avian influenza case reports in South Africa, 29 May to 15 November 2023

Province	Type of birds	Total epidemics	Farm units
Free State	Domestic	3	3
Gauteng	Domestic	61	62
Gauteng	Wild birds	2	2
Limpopo	Domestic	4	6
Mpumalanga	Domestic	13	15
Northwest	Domestic	14	17
Western Cape	Domestic	1	1

Source: South African Poultry Association [24]

aimed at improving on-farm nutrition and disease management capacity and impact on One Health parameters of human, animal and environmental health to improve productivity of the emerging smallholder cattle production system [22]. This work established that it is challenging to identify interventions that would improve the overall One Health productivity of this sector without holistic modelling approaches. Further, the emerging smallholder cattle production study presented an opportunity to expand on One Health research in this field and further examine the One Health trade-offs to improve the health of humans, animals and the environment associated with this production system [22].

Animal disease outbreaks in South Africa and One Health Economics

In recent years South Africa has had numerous outbreaks of both animal and zoonotic diseases. Tables 1 and 2 provide some examples. Some analysts [3] suggest that such frequent outbreaks indicate weaknesses in the country's biosecurity system.

A report compiled by the TT-AHB in 2021, which was appointed by the Minister of Agriculture, Land Reform, and Rural Development, revealed that South Africa's animal production and health system is indeed weak in the following aspects: the evolving epidemiology of animal diseases, the country's ability to diagnose diseases promptly, and the preparedness to implement effective biosecurity measures based on scientific justifications [2]. In 2023 alone, South Africa reported outbreaks of three WOA-reportable animal diseases: FMD in cattle and sheep, African swine fever (ASF) in pigs, and avian influenza in poultry and wild birds.

In dealing with animal disease outbreaks, a holistic approach is necessary, and part of this entails analysing the costs and benefits of the intervention and the counterfactual.

Previous studies from South Africa have provided estimates on the economic returns of vaccine development, including ways to tackle multiple threats to livestock health. For example, Mdlulwa et al. [25] conducted a cost-benefit analysis and 15-year simulation on investing in a two-in-one RVF virus and lumpy skin disease (LSD) virus vaccine, showing a positive net present value. The results of the study provided decision makers with solid economic arguments regarding the potential benefits of investing in a new generation of combination vaccines for control of RVF and LSD. Given that vaccines are a viable strategy for controlling both diseases, investing in the two-in-one RVF-LSD vaccine would provide material and production, distribution (e.g. transport and cold storage), and time savings and result in minimizing losses of animals, impacts to the value chain, possible infection of humans, and the effect on the environment through disposal of infected animals. The return-on-investment (ROI) work was focused on tackling agricultural losses from livestock diseases, but could also have implications for food security, nutrition, human health protection against zoonotic disease in the case of RVF, antibiotic use, and antimicrobial resistance related to secondary infections often associated with LSD. Expanding the scope of the analysis to include these or other relevant impacts could bring in additional sectors and potentially increase the societal value in investing in new vaccine technologies as well as provide an indirect public health benefit not delivered by the existing LSD vaccine.

The recent One Health Economics mini-congress held in South Africa served to ignite discussions between key stakeholders across the relevant One Health sectors and will potentially lead to new collaborations to establish a One Health Economics platform or community of practice to raise up One Health as the approach to cost-effectively improve the health of people, animals and the environment.

Among the benefits of a One Health approach have been increased efficiency and cost effectiveness through shared control and detection effort [26], which can often be translated into economic terms. While the field of One Health Economics is still emerging, a body of literature provides compelling, context-specific proof of concept. In Italy for example, Paternoster et al. [27] provided evidence that the interventions to mitigate the risk of West Nile virus transmission via blood transfusion were more cost effective when a One Health approach was followed compared to a uni-sectoral approach. The One Health approach resulted in cost savings in terms of avoided tests, short-term costs of hospitalization and compensation for transfusion-associated disease potentially avoided. An analysis based on avoided impacts of six zoonotic diseases estimated that mitigation in line with a One Health approach could generate expected global benefits of ~US\$30 billion per year from ~US\$3.4 billion investments in human and animal health systems [28]. Returns for rabies and brucellosis vaccination have also been examined beyond animal health benefits in a number of studies. For example, Roth et al. [11], calculated the expected shared benefits from brucellosis in Mongolia and the proportional costs of prevention if distributed according to benefit to each sector, and Bucher et al. [29] estimated welfare benefits of rabies vaccination for the African continent [11, 29].

The One Health economics mini-congress

The ARC of South Africa in collaboration with partners hosted an inaugural One Health Economics Mini-congress in Pretoria, South Africa from November 15–16, 2023. The event aligned with the launch of the One Health Joint Plan of Action (OHJPA) in 2022 by the Quadripartite (Food and Agriculture Organization of the United Nations: FAO, UN Environment Programme: UNEP, World Health Organization: WHO, and World Organisation for Animal Health: WOA). The OHJPA has six action tracks that can all potentially benefit from One Health Economics in its implementation and prioritization. The congress aimed to reinforce the efforts of the National One Health Forum, South Africa's multi-sectoral coordination mechanism, advancing collaboration among stakeholders driving national efforts towards a unified One Health approach. The congress also built on ARC's economic research in this area and a national cost-benefit analysis. This activity was developed under the U.S. Defense Threat Reduction Agency (DTRA)-supported "Reducing the Threat of Rift Valley Fever through Ecology, Epidemiology and Socioeconomics" project.

The congress covered themes, including economic insights on prevention and control of RVF and other livestock and zoonotic diseases, and the economic perspectives in the animal health sector and One Health Forum,

and overall needs for advancing One Health in South Africa and the region, including through economics. Additional themes included ROI for One Health, insights from natural resources, animal and human health, as well as regional and international perspectives on multi-sectoral economic analysis and financing.

Using a hybrid event (physical location at the ARC, Hatfield, Pretoria with the online engagement on Zoom and livestream on YouTube)^{1,2}, the speakers were from various international and national organizations, with representations from the World Bank, DTRA, EcoHealth Alliance, FAO, WOA, UNEP, WHO, and the French Agricultural Research Centre for International Development (CIRAD), USDA/National Wildlife Research, Tanzania Livestock Research Institute, and the Southern African Development Community (SADC) Secretariat. The national organizations included the NICD, UP, National Wool Growers Association, ExecuVet, Rabies Advisory Board, DALRRD, NDOH, Department of Forestry, Fisheries and the Environment, the National One Health Forum, and the ARC.

The two days of presentations and discussions elaborated on the topics mentioned above. In summary, the benefits and opportunities of One Health Economics, challenges of embracing One Health in practice and proposed steps to formulate a one-health policy were discussed. The discussions concluded with recommendations and key next steps as well as action points for a way forward within One Health for economics professionals.

Opportunities and benefits of One Health economics

The field of One Health Economics provides an opportunity for the integration of economics in human, animal and environmental sciences. It also provides an opportunity to consider the broader impacts of disease outbreaks and control beyond one sector, inform planning and budget strategies, and assess cost-effectiveness of programmes. It can further expand One Health platforms from a human and animal health focus to a wider sustainable development scope. The field has wide utility beyond emerging infectious diseases alone. Relevant examples were presented on economic data collection, economic models and decision-making related to waste management, invasive species and production, among other topics. The application to waste management highlighted the link between the health of the environment, animal health and human health through a case of environmental pollution from dumping disposable diapers in rural communities [30]. Similarly, the application to invasive species highlighted the intersection between wildlife

¹ Day 1: <https://youtube.com/live/n1dQWpYnZaY?feature=share>

² Day 2: <https://youtube.com/live/ZRjR1Hkmpng?feature=share>

health, livestock health and human health through a case study of invasive wild pigs [31].

The case of rabies control in KwaZulu-Natal between 2007 and 2014 clearly demonstrated how a holistic One Health approach can reduce incidence of disease and increase public awareness [32] by coordinating activities of the provincial Department of Environment, Agriculture and Rural Development, animal welfare groups, academics, nongovernmental organizations and the human health-care sector. Policy makers require information that will assist them in justifying the use of public resources as well as to inform research and development's investment decisions. Such information includes technical and economic feasibility of the proposed interventions, costs of treatment and control options, wider impact of the diseases, possible gains from investing in the proposed interventions, and post-implementation activities [16–17].

Real-time data and information on disease outbreak surveillance, can help to inform economic models such as simulation and cost benefit analysis, decision analysis, network analysis and mathematical programming to help decision making of appropriate animal health and disease control, prevention or eradication strategies [33–34]. It can also guide decisions to promote efficient planning and access to resources, including to mitigate impacts as well as to reduce the underlying risk of outbreaks. Laboratory diagnoses and surveillance during the 2023 avian influenza outbreak carried out at Agricultural Research Council-Onderstepoort Veterinary Research (ARC-OVR) was an example of this. It highlighted the importance of developing affordable diagnostic tools and vaccines given the high cost of diagnosing infectious diseases and follow-up tests in the event of outbreaks or post-vaccination [35]. In addition, several methods such as cost-benefit analysis, choice modelling, cost-effectiveness analysis and simulation models used for agricultural economics were explored through a One Health Economics lens to identify additional sector inputs. Multi-sectoral analyses were presented as case studies from Tanzania (*Taenia solium*) [36], USA (invasive wild boar) [31], and South Africa (RVE) [37]. In general, these were tailored to relevant context (topic, stakeholders, and available data), demonstrating flexibility in methods as well as the benefits of a structure to assist stakeholders in One Health economic analysis. The results of a systematic literature review on One Health economic evaluations by members of the Quadripartite organizations [38] and earlier works carried out by Agricultural Research Council-Economic Analysis Unit (ARC-EAU) [4, 10, 25, 39] on the prevention and control of zoonotic diseases reinforced that there are different methods that can be used in operationalizing One Health Economics. Selection of methods should be contextualised and requires further study to

identify which one fits a current issue and is acceptable to stakeholders.

The benefits derived from a One Health Economics approach can result from coordinated activities, joint efforts, and a more complete understanding of risks and contexts as well as possible solutions. These include finding cost-effective entry points for action, having more partners to contribute to solutions, identifying and reducing trade-offs and maximizing co-benefits. The approach also has the potential to reduce resource wastage (thereby saving money) and to save lives in cases of disease outbreaks. In addition, a One Health Economics approach ensures that potential costs and benefits to other sectors and stakeholders are not overlooked. A case of the ASF outbreak in Limpopo demonstrated this, wherein multiple stakeholders, including the provincial Department of Agriculture, the producers' association, the provincial Department of Social Development as well as the local municipality collaborated, shared each other's resources and contributed towards a solution, recognizing the potential impacts across sectors and society. The collaboration resulted in an efficient use of resources and effective management of the outbreak.

Moreover, accounting for the economic costs of a zoonotic disease outbreak in a single sector may miss far-reaching impacts on livelihoods and national food security, which would be accounted for under a One Health Economics approach. For example, bans of animal movement will impact the purchase or sale of animals for meat and milk for consumption and restrict animal and animal product exports; it may also result in the inability to plough fields for crops (where animals are used for draught power), thus affecting the income generation capacity and impacting the livelihoods of crop farmers and other people in the downstream sectors.

The Congress also demonstrated a lack of a standardized framework or system to aggregate costs and impacts for One Health economic accounting in South Africa, even for long standing disease issues in the country such as rabies, RVE, and avian influenza.

Formulation of one health policy

To coordinate, facilitate and guide One Health activities and actions, there is a need for a One Health policy and strategy at the national level to provide a legislative framework and road map to reach the intended outcomes. The coordination and mobilization of resources is necessary at the national, provincial and local levels. This will enable inclusion of a community-centred view to promote uptake on the ground to tackle threats at their source and directly serve affected communities. The policy should be developed based on the needs and joint activities from all relevant departments including health, agriculture and the environment and be aligned to the

extent possible. Development of a One Health Policy will require partnerships, both public and private, in knowledge transfer, joint planning and funding, and implementation and evaluation for optimal outcomes and learning, and will benefit from lessons from existing policies in countries where such exist. An innovative budget framework - such as a One Health pooled budget - can contribute to ensuring resource availability to support One Health initiatives as needs are identified, both in peacetime and in emergencies. The national government, particularly the national treasury, is well positioned to oversee such a budget with an objective view based on evidence of resource effectiveness and efficiency. The World Bank already has a Pandemic Fund in place, which serves as a dedicated stream of grants used to develop capacity in low and middle-income countries for critical pandemic prevention, preparedness, and response [40]. This provides an opportunity for knowledge sharing and for countries (including African countries) to access financial support for One Health initiatives.

Challenges to embracing one health within South Africa

Adopting a One Health approach offers several benefits, but also has challenges for its practical implementation. The participants of the congress identified a few challenges with implementation of One Health. These were also consistent with what has been found in literature. The challenges include:

- i) The need for champions and to identify which sector to lead, as it is often not clear which department is responsible for One Health. In their systematic review of barriers and enablers to the implementation of One Health strategies, Yopa et al. [41] highlight good coordination between different sectors at various levels as key. For this coordination to take place, a lead or champion is required. This will include communication with, and coordination of stakeholders as multisector planning and budgeting processes take time since there is a need to communicate with and engage various sectors. The leadership of One Health in handling specific issues may be dynamic and fluid depending on the issue under consideration e.g. disease outbreaks in animals or humans, plant-related toxicosis, AMR, environmental pollution, or poisoning. This will imply having a standing committee and some ad-hoc committee members based on scenarios at hand.
- ii) Lack of sustained investments emanating from budget competitions for other priorities and lack of agreement on the flow of funds and implementation, including across departments. dos S Ribeiro et al. [42] highlight that when it comes to funding, One Health initiatives often compete for scarce resources

with single disciplinary and specialized projects. In addition, One Health initiatives require large-scale investments which are difficult to acquire and coordinate and this often leads to the preference of funding for disease-specific programs [42].

- iii) Continued focus on response and reactive investments. Kelly et al. [43] highlight this challenge, indicating that currently responses to outbreaks around the world are highly reactive and control measures only employed once an outbreak in humans has been detected. The authors further point out that monitoring for zoonotic viruses in wild animals can be an important early detection tool for preventing disease outbreaks [43].
- iv) Limited operationalization of One Health because of lack of understanding of the approach and of how to put it into action. Pepin et al. [44] indicate that part of the limited operationalization is that One Health approaches require dedicated resources and personnel so that sustainable response plans can be operationalized, while change is implemented. In addition, there is a lack of skills for effective systems thinking which requires cross sector methodologies and training [44]. This lack of skill, training and experience can lead to mistakes and inadequate implementation [41].
- v) Lack of a One Health Policy, One Health Strategy and One Health Implementation Framework with One Health indicators. Lack of political will and unsupportive policies, and lack of organized institutions and proper legal frameworks were also identified by Yopa et al. [41] as key challenges in adopting a One Health approach. Without these, Ministries usually shift to prioritise single diseases during emergency situations [42].

At the African continent level, there is also a need to link researchers with policy makers to identify One Health priorities and resource needs as well as to formulate and implement One Health policies for harmonized continental understanding of Africa's unique One Health contexts and challenges [45].

The SADC region has One Health initiatives taking place. These include (i) the development of a SADC One Health Coordination Framework and Road map in collaboration with World Bank; (ii) development of the next cycle of the Livestock Development Program [46] which also addresses climate change and One Health; and (iii) collaboration with the Quadripartite agencies on One Health in the region, including to translate the global OHJPA to the regional level.

Other African countries such as Rwanda have developed a One Health Policy, One Health Strategic plans and One Health Platform leading to the adoption of the

One Health approach by the East African Community (EAC) of Ministries in 2014 [47]. Other countries such as Senegal and Tanzania have used legislative frameworks and administrative structures to efficiently mobilize One Health, such as Endorsement of the One Health Policy and Establishment of a One Health Multisectoral Coordination Mechanism.

At the national level, South Africa has formed the National One Health Forum, which brings together various sectors, i.e. health, agriculture, forestry, fisheries, and environmental health [48]. However, to date, there has been limited inclusion of economic inputs in One Health coordination platforms in South Africa, the region and elsewhere in the world. This could potentially be enhanced through participation in communities of practice that are actively bringing in One Health economics considerations, such as the ROI community of practice [49] launched through the Quadripartite organizations. These can provide a space for further learning and knowledge exchange. Such initiatives and platforms can contribute to overcoming some of the challenges in adopting and embracing One Health and be key mechanisms for integrating economics in One Health research, policy and practice in South Africa.

Key recommendations and next steps

In view of the ongoing discussion, the following recommendations were highlighted by the congress, for One Health in general and economics more specifically:

Actions for South Africa to integrate one health economics

- Emphasis should be on preventing or at the very least limiting the detrimental effects of One Health challenges when they arise, through prompt coordination and joint efforts.
- The National One Health Forum (government-focused) and National Animal Health Forum (industry-focused), among other stakeholder groups at national and local levels, should include One Health Economic considerations to identify and reduce trade-offs (allowing for integration of related aspects e.g. sustainability, animal welfare) and identify and maximize co-benefits of strategies and programmes.
- The SADC regional roadmap for One Health should encourage countries to include financing, trade, production, and other economic sectors (e.g. public health externalities, whether positive and negative) to make cost-informed considerations, especially when considering relevant sectors to engage and incentives for prevention and effective response.
- Economics should be included as a priority component of One Health research and collaboration

in the country, region and continent, providing an additional input to understand the ecology, epidemiology and economics of threats to human, animal and environment health.

- Comparative analysis of different economic methods should be encouraged to better understand possible differences in model outcomes, potentially helping to optimize inputs and outputs of models and determine acceptability for the specific question and target audience. Greater focus on field-based data collection and validation of economic impacts will help to identify tangible impacts of importance to communities and stakeholders, including cascading connections and more precise downstream impacts.
- Communities of practice and applied training opportunities should be promoted to enhance further learning and knowledge exchange.
- Awareness creation and knowledge dissemination on the importance of the One Health Economics approach amongst academics, policy makers, and development practitioners.

Action points for a way forward within one health for economics professionals

- Economists are encouraged to proactively join One Health platforms such as the Africa One Health Network (AFOHNET) [50], which seeks to bring a coordinated response to One Health challenges on the African continent, leveraging knowledge and innovations from research and academia across a wide range of fields.
- Economists can demonstrate the value and contribution that the discipline brings and provide practical solutions to operationalize One Health and advocate for improved sustainable development outcomes.
- Economists are encouraged to consult other disciplines under the One Health umbrella to conduct an impact inventory to understand the context and affected sectors in their work, helping to more robustly estimate costs and impacts (both positive and negative).
- Economists can amplify the economics discipline in existing and new One Health platforms, events, conferences and research projects. For example, organizations can enforce the inclusion of socio-economic considerations in all research proposals and projects.
- Continue with existing and expanded collaborations to build technical capacity for postgraduate student training in One Health approaches. This can also include exchange programmes for students, staff and champions of One Health. Champions

should include economists to amplify the voice of economics in One Health. Technical capacity building should include tools for economic analyses that can be easy to understand and be applied.

The mini congress served as a build-up for the 8th World One Health Congress held in 2024 in Cape Town, South Africa. The Congress provided an opportunity to build on the discussions and recommendations on One Health Economics shared during this inaugural mini congress, including a pilot “Masterclass” that could help to strengthen practical capacity for embedding One Health economics into government and development bank processes. Working One Health economics into operationalization of One Health, including in relevant training and action plans, can help to ensure economic analyses reflect the wide scope of sectors at the human-animal-environmental health nexus. In South Africa, this could provide a significant boost to the progress and value delivered by One Health initiatives.

Abbreviations

AFOHNET	Africa One Health Network
ARC	Agricultural Research Council
ARC	EAU-Agricultural Research Council-Economic Analysis Unit
ARC	OVR-Agricultural Research Council-Onderstepoort Veterinary Research
CIRAD	French Agricultural Research Centre for International Development
DALRRD	Department of Agriculture, Land Reform and Rural Development
DTRA	U.S. Department of Defense Threat Reduction Agency
EAC	East African Community
FAO	Food and Agriculture Organization of the United Nations
LSD	Lumpy Skin Disease
OHJPA	One Health Joint Plan of Action
ROI	Return on Investment
RVF	Rift Valley Fever
SADC	Southern African Development Community
UNEP	United Nations Environment Programme
USDA	United States Department of Agriculture
WHO	World Health Organization
WOAH	World Organisation for Animal Health

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Author contributions

MM and CM conceptualized the paper, writing initial draft, writing revisions, provided project leadership and read and approved final version. SZ wrote the initial draft and read and approved final version. MR wrote revisions, provided project leadership, read and approved final version. WK conceptualized the paper, wrote revisions, provided project leadership, read and approved final version. PT wrote revisions, read and approved final version. PC conceptualized the paper, wrote revisions provided project leadership, read and approved final version. All authors reviewed the final manuscript.

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The authors declare no competing interests.

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