



# Unlocking animal welfare potential

in implementing One Health solutions  
for livestock in agrifood systems

A science-policy brief by Compassion in World Farming, the International Livestock Institute, and the University of Edinburgh, with contributions by the Federal University of Paraná and the Council for Agricultural Research and Economics (CREA) Italy.

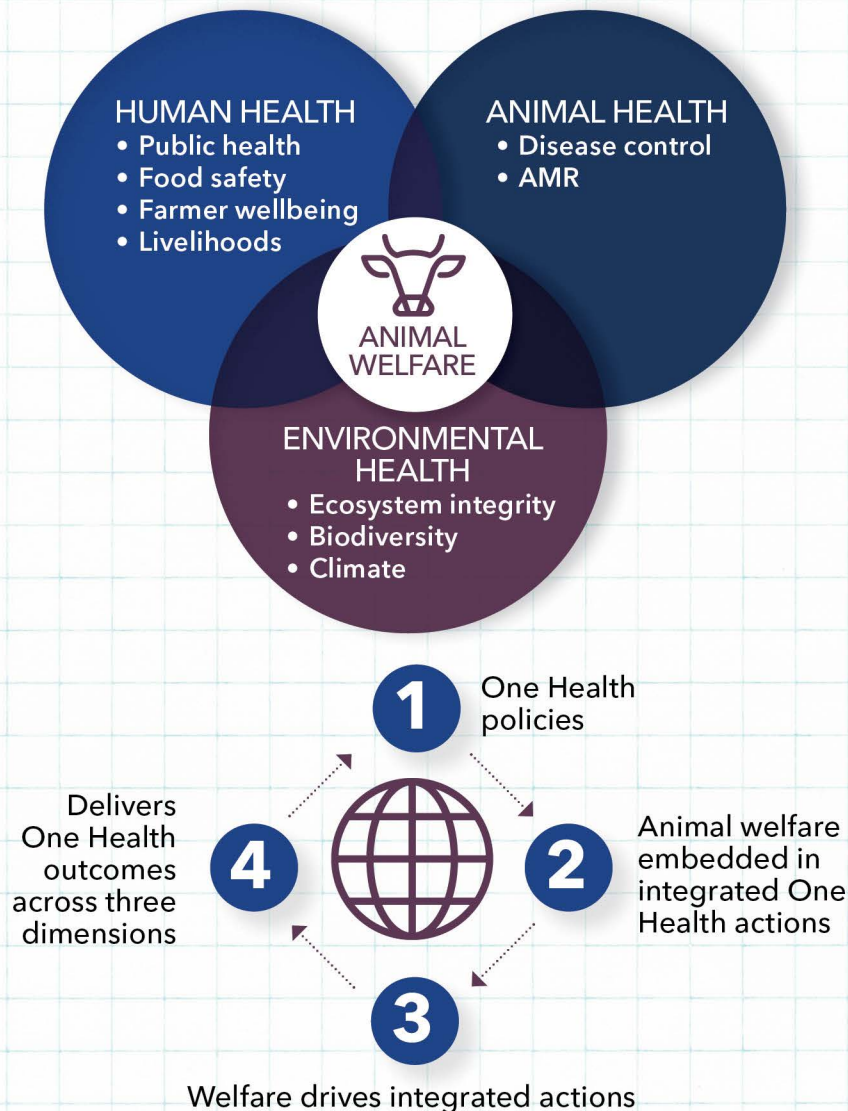
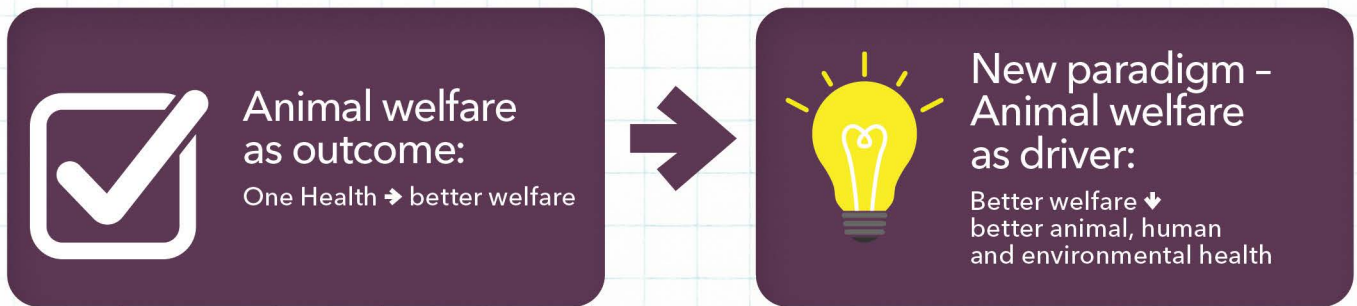
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# Animal welfare as a driver of One Health

## From Outcome to Driver



One Health approach | Animal welfare as a driver  
For sustainable, healthy systems

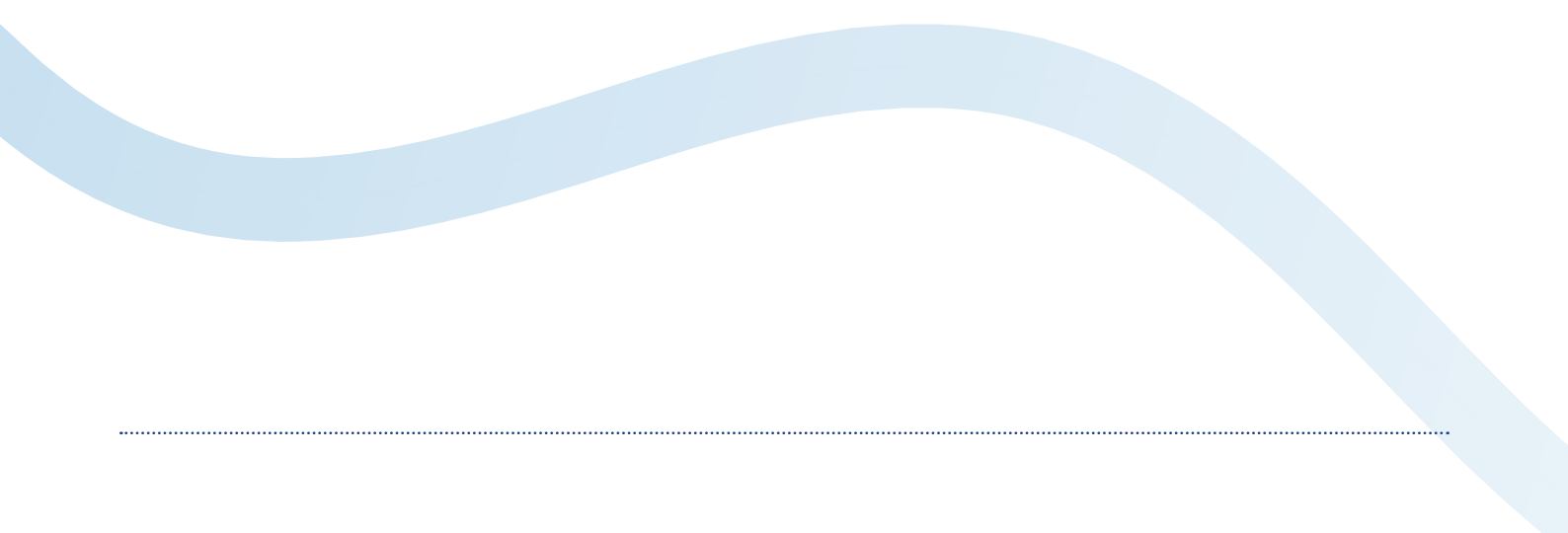
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## Aim of this document

The interconnection of human, animal and environmental health is now a well established fact, recognised in the concept of One Health. In 2026 alone, the One Health Summit which took place in Lyon, France, the new Food and Agriculture Organization (FAO)'s Framework on One Health in Agrifood Systems, discussed at the 30th Session of the FAO Committee on Agriculture, the 9th One Health Congress, which took place in Lisbon under the patronage of UNESCO, and the FAO Global Conference for Actions on One Health in Agrifood Systems, are all examples of how Member States-led processes and multistakeholder platforms are working to accelerate the practical application of One Health.

As governments and other stakeholders seek to translate One Health principles into action, it is important to identify the drivers for implementation. This brief aims to contribute to this multistakeholder debate, focusing on the role of animal welfare in the One Health context. While initially considered as an outcome of the One Health implementation, animal welfare is now increasingly viewed as a driver of integrated actions in agrifood systems. In this brief we showcase through evidence and case studies the relevance of animal welfare for the three dimensions of One Health and we provide recommendations for policy makers on embedding animal welfare in policy and actions on One Health.

Livestock production sits at the center of agroecosystems, where the health and wellbeing of animals, humans, and the environment interconnect. Within livestock systems, strengthening animal welfare can be a powerful lever for delivering One Health outcomes through the reduction of systemic risks and the acceleration of sustainable development. The integration of key features of animal welfare into One Health should always be done in consideration of local environmental, socio-economic, cultural and production contexts, while remaining grounded in science-based principles and aligned with the overarching aim of improving the health of people, animals, and ecosystems.



## The evolution of One Health and animal welfare in the global policy landscape

Animal welfare is now a well-established and important contributor to the One Health framework in global policy. The One Health High-Level Expert Panel (OHHLEP), as the scientific and strategic advisory group to the Quadripartite, defines One Health as “an integrated, unifying approach that aims to sustainably balance and optimise the health of people, animals, and ecosystems”<sup>1</sup>.

The Panel advocates the following underlying principle: “stewardship and the responsibility of humans to change behaviour and adopt sustainable solutions that recognise the importance of animal welfare and the integrity of the whole ecosystem”. The OHHLEP also recognises that “Poor conditions and standards of animal welfare and protection” are a challenge for the implementation of the One Health approach<sup>2</sup>. In 2022, the UN Environment Assembly (UNEA) adopted a resolution requesting that the UN Environment Programme (UNEP) produce a report on the nexus between animal welfare, the environment, and sustainable development. In the resolution, Member States explicitly acknowledge that “animal welfare can contribute to addressing environmental challenges, promoting the One Health approach”<sup>3</sup>.

In 2022, the Quadripartite organisations (FAO, UNEP, WHO and WOA) launched the One Health Joint Plan of Action (2022-2026)<sup>4</sup>, now extended to 2029<sup>5</sup>, the first common implementation framework designed to operationalise the One Health approach globally, and support countries in addressing health risks at the human-animal-environment interface. The Plan recognises animal welfare as a consideration within One Health, noting that it can be affected by factors such as zoonotic disease emergence and spread, increasing disease burdens, and unsustainable food production practices.

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<sup>1</sup> One Health High-Level Expert Panel (OHHLEP) (2023) *One Health definition and principles*. Geneva: World Health Organization.

<sup>2</sup> One Health High-Level Expert Panel (OHHLEP) (2022) *One Health Theory of Change*. Geneva: World Health Organization.

<sup>3</sup> United Nations Environment Assembly. (2022). Animal welfare–environment–sustainable development nexus: Resolution / adopted by the United Nations Environment Assembly (UNEP/EA.5/Res.1).

<sup>4</sup> FAO, UNEP, WHO and WOA (2022) *One Health Joint Plan of Action (2022-2026): Working together for the health of humans, animals, plants and the environment*. Rome: Food and Agriculture Organization of the United Nations.

<sup>5</sup> World Health Organization (WHO) (2026) Quadripartite collaboration extends the *One Health Joint Plan of Action to 2029*. Departmental update, 14 August. <https://www.who.int/news/item/14-08-2026-quadripartite-collaboration-extends-the-one-health-joint-plan-of-action-to-2029> (Accessed: 4 September 2026).

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By promoting more sustainable and health-oriented approaches to animal production and disease prevention, the Plan acknowledges the interconnectedness of animal welfare, animal health, human health and environmental sustainability.

In July 2025, the members of the FAO Conference adopted a resolution aimed at addressing antimicrobial resistance (AMR) in agrifood systems, which notes the relevance of animal health and welfare for tackling AMR<sup>6</sup>.

A further milestone was achieved in 2026 with the adoption of the FAO Global Plan of Action for Sustainable Livestock Transformation (GPA), the first globally-negotiated framework dedicated to guiding the sustainable transformation of the livestock sector. The GPA was negotiated by Member States through the Third and Fourth Sessions of the FAO Sub-Committee on Livestock and subsequently adopted by the 30th Session of the Committee on Agriculture (COAG) in July 2026. Significantly, the Plan recognises animal welfare as an integral component of sustainable livestock transformation and includes a dedicated Strategic Priority (SP 3.3) on promoting animal welfare within Priority Area 3, “Animal health through a One Health approach”. The GPA explicitly acknowledges the close interlinkages between animal health and animal welfare and sets out concrete actions for Member States to strengthen animal welfare policies, capacities, monitoring systems, and management practices under a One Health approach.

## One Health in practice

One Health recognises the close interconnection between human, animal, and environmental health. Challenges such as zoonotic diseases, antimicrobial resistance, biodiversity loss, and climate change therefore require coordinated and cross-sectoral responses.

In agrifood systems, One Health promotes integrated solutions that improve animal and public health, support food security and livelihoods, and protect ecosystems. Because livestock systems differ widely across regions and contexts, interventions must be adapted to local needs and circumstances.

By fostering collaboration among governments, researchers, farmers, veterinarians, and local communities, One Health provides a practical framework for building more resilient and sustainable agrifood systems. Increasingly, animal welfare is being recognised as an important contributor to this approach, with relevance across all One Health domains.

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<sup>6</sup> FAO. 2025. Addressing Antimicrobial Resistance in Agrifood Systems. Resolution 14/2025, 44th Session of the FAO Conference, Rome, 28 June – 4 July 2025

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# Animal welfare's relevance for the One Health approach

In this section, we provide evidence to demonstrate how animal welfare directly affects human and animal health, disease transmission, the environment, and human well-being, to illustrate not only why animal welfare is relevant to One Health, but also how welfare-focused actions can contribute to the implementation of One Health in practice, by delivering benefits across multiple interconnected domains. This presents a strong rationale for systematically incorporating animal welfare considerations into One Health policies and programmes.

## Animal health and animal welfare interconnections

Animal health is a major component of animal welfare, and good welfare can significantly improve animal health<sup>7</sup>. While the relationship between animal health and animal welfare is often presented as a one-way process, where good health is seen as a prerequisite for good welfare, evidence shows that animal welfare can also contribute to animal health<sup>8</sup>. Animals kept in environments that allow them to express their natural behaviours, experience positive mental states, have low stress levels, and receive appropriate care are generally more resilient to disease and injury<sup>9</sup>. Good welfare practices can strengthen immune function, support disease prevention, and reduce the need for interventions such as antimicrobial treatments<sup>10 11</sup>.

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<sup>7</sup> Döpjan S, Dawkins MS. Animal Welfare and Resistance to Disease: Interaction of Affective States and the Immune System. *Front Vet Sci*. 2022 Jun 14;9:929805. doi:10.3389/fvets.2022.929805

<sup>8</sup> Doyle, R., Cripps, A., Marry, A., Wieland, B., Whay, B., Lindsay, B., Munoz Gallardo, C., Di Leonardo, F., Huang, H., Stark, J., Keeling, L., Sánchez Mainar, M., Merridale-Punter, M., Petre, R. & Zafra, S. 2025. *Animal welfare for production and working animals: evidence and need for action*. Rome, FAO. <https://doi.org/10.4060/cd6930en>

<sup>9</sup> Döpjan, S., & Dawkins, M. S. (2022). Animal Welfare and Resistance to Disease: Interaction of Affective States and the Immune System. *Frontiers in Veterinary Science*, 9, 929805. <https://doi.org/10.3389/fvets.2022.929805>

<sup>10</sup> Döpjan, S., & Dawkins, M. S. (2022). Animal welfare and resistance to disease: Interaction of affective states and the immune system. *Frontiers in Veterinary Science*, 9, 929805. <https://doi.org/10.3389/fvets.2022.929805>

<sup>11</sup> Rodrigues da Costa, M., & Diana, A. (2022). A systematic review on the link between animal welfare and antimicrobial use in captive animals. *Animals*, 12(8), 1025. <https://doi.org/10.3390/ani12081025>

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The widely recognised *Five Domains Model* conceptualises animal welfare through the domains of nutrition, physical environment, health, behavioural interactions, and mental state, recognising that an animal's subjective experiences are shaped by conditions across all these areas<sup>12</sup>. Without good health, good welfare cannot be achieved; however, good health alone does not guarantee good welfare. Farmers, consumers, and society at large<sup>13</sup> consistently report animal welfare being beyond the absence of disease, including comfort, the expression of species-specific behaviours and also the possibility to have positive experience<sup>14</sup>.

The Animal Welfare Antimicrobial Resistance Nexus Action Group of the Multistakeholder Partnership Platform on Antimicrobial Resistance (MSPP on AMR), has highlighted that improving animal welfare, including husbandry practices, better nutritional and health status, is a practical strategy for disease prevention and responsible antimicrobial stewardship<sup>15</sup>. Alongside actions like reducing disease pressure at the source, and supporting resilient livestock systems, improving animal welfare conditions can help curb the development of AMR, keeping antimicrobials effective, and contributing to more sustainable agrifood systems. Explaining the link between managing AMR and the 'quality of human and animal health' has been found to be an important way of engaging communities in AMR projects<sup>16</sup>, demonstrating again where this issue intersects with the human element of One Health. It has been well

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<sup>12</sup> Mellor, D. J., Beausoleil, N. J., Littlewood, K. E., McLean, A. N., McGreevy, P. D., Jones, B., & Wilkins, C. (2020). *The 2020 Five Domains Model: Including human-animal interactions in assessments of animal welfare*. *Animals*, 10(10), 1870. <https://doi.org/10.3390/ani10101870>

<sup>13</sup> European Citizens' Initiative (ECI) 'End the Cage Age' - [https://food.ec.europa.eu/animals/animal-welfare/eci/eci-end-cage-age\\_en](https://food.ec.europa.eu/animals/animal-welfare/eci/eci-end-cage-age_en)

<sup>14</sup> Doyle, R., Cripps, A., Marry, A., Wieland, B., Whay, B., Lindsay, B., Munoz Gallardo, C., Di Leonardo, F., Huang, H., Stark, J., Keeling, L., Sánchez Mainar, M., Merridale-Punter, M., Petre, R. & Zafra, S. 2025. Animal welfare for production and working animals: evidence and need for action. Rome, FAO. <https://doi.org/10.4060/cd6930en>

<sup>15</sup> AMR Multi-Stakeholder Partnership Platform (MSPP) Action Group on Animal Welfare-AMR Nexus (2025) *Embedding animal welfare in the IPEA mandate: a One Health imperative for curbing antimicrobial resistance (AMR)*. Geneva: Quadripartite Joint Secretariat on Antimicrobial Resistance

<sup>16</sup> Mitchell, J., Arjyal, A., Baral, S., Barrington, D., Cooke, P., Fieroze, F., Huque, R., Hamade, P., Hawkings, H., Jones, N., Latham, S., Parajuli, A., Saify, M.B. and King, R. (2023) *Co-designing community-based interventions to tackle antimicrobial resistance (AMR): what to include and why*. *BMC Research Notes*, 16(1), 290. <https://doi.org/10.1186/s13104-023-06449-1>

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established that the majority of human pathogens (60%) are of zoonotic origin, whilst this proportion increases to 75% when considering emerging diseases<sup>17 18 19</sup>. The risk of pathogen transmission can be increased under conditions of poor animal welfare due to immune suppression, increased contact between hosts, and the mixing of unfamiliar animals during transport and processing. This increased transmission risk can also increase the risk of mutation and spillover<sup>20</sup>.

While tightening of biosecurity is an approach used to address these risks, it can be associated with other consequences including expensive infrastructure, and potentially lead to systems that restrict other welfare domains including the domains of *behavioural interactions and physical environment*.

Within these overarching themes, in all of the main production species, evidence can be found where welfare-focused interventions can make a positive contribution towards reducing the risks of critical animal health elements of One Health, including risks of AMR and zoonotic disease outbreak and spread.

## Animal welfare and the environmental dimension of One Health

Growing evidence shows that animal welfare has a potential to drive improved environmental health. Recognising it can create opportunities to address multiple challenges simultaneously. To realise these benefits, animal welfare should be integrated into practical actions towards better environmental health, which should be adapted to different livestock systems and local contexts.

Emerging evidence shows that poor animal health and welfare can increase the greenhouse gas (GHG) emissions associated with the production of animal-sourced foods. This occurs because welfare problems may arise from poor health, including conditions such as lameness, parasitic infections and mastitis, as well as from inadequate nutrition, poor housing and environmental conditions, chronic stress and increased mortality. These factors reduce biological efficiency, meaning that more

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<sup>17</sup> Woolhouse, M.E.J. and Gowtage-Sequeria, S. (2005) *Host range and emerging and reemerging pathogens*. *Emerging Infectious Diseases*, 11(12), pp. 1842-1847.

<https://doi.org/10.3201/eid1112.050997>

<sup>18</sup> Taylor, L.H., Latham, S.M. and Woolhouse, M.E.J. (2001) *Risk factors for human disease emergence*. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 356(1411), pp. 983-989.

<https://doi.org/10.1098/rstb.2001.0888>

<sup>19</sup> Jones, K.E., Patel, N.G., Levy, M.A., Storeygard, A., Balk, D., Gittleman, J.L. and Daszak, P. (2008) *Global trends in emerging infectious diseases*. *Nature*, 451(7181), pp. 990-993.

<https://doi.org/10.1038/nature06536>

<sup>20</sup> Dawkins, M.S. (2021) *Does sustainable intensification compromise animal welfare?* *Animal*, 15(1), 100109.

<https://doi.org/10.1016/j.animal.2020.100109>

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feed, water, land and energy are required to produce the same amount of milk, meat or other livestock products. This, in turn, lowers environmental efficiency, increases emissions per unit of product and may result in reduced willingness for consumers to buy the product due to changes in its characteristics (e.g. alterations in the product, texture and colour). According to FAO projections, improvements in animal welfare could lead to a reduction in GHG emissions up to 10% by 2050<sup>21</sup>. However, in order to reach that target, the animal welfare-health mitigation pathway should take into account species-specific differences and local relevance of the animal welfare priorities. For instance, research on dairy cattle has demonstrated that improving animal health and welfare enhances productivity and resource-use efficiency while reducing emission intensity<sup>22</sup>.

Recent evidence from sheep farming further reinforces this relationship. Lanzoni *et al.* (2025)<sup>23</sup> quantified the GHG impact of impaired welfare and found that welfare challenges such as lameness, parasite infestations, inadequate shelter, poor feeding management and high lamb mortality consistently increased emission intensity because they reduced productivity and resource-use efficiency. Lameness alone increased emission intensity by 1.3% to 18%. Conversely, addressing these welfare constraints could deliver meaningful reductions in emission intensity, with the magnitude of the mitigation benefit depending on the specific welfare issue, production system and local context.

Integrating welfare-centred management into livestock systems can therefore generate One Health co-benefits by improving animal health, enhancing farm resilience and reducing the environmental impact of livestock production.

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<sup>21</sup> FAO. 2023. Pathways towards lower emissions – A global assessment of the greenhouse gas emissions and mitigation options from livestock agrifood systems. Rome  
<https://doi.org/10.4060/cc9029en>

<sup>22</sup> Džermeikaitė K, Krištolaitytė J, Antanaitis R. Relationship between Dairy Cow Health and Intensity of Greenhouse Gas Emissions. *Animals* (Basel). 2024 Mar 7;14(6):829. doi: 10.3390/ani14060829. PMID: 38539927; PMCID: PMC10967422

<sup>23</sup> L. Lanzoni, M.C. Reeves, K. Waxenberg, R. Ramsey, A.S. Atzori, J. Bell, R.M. Rees, G. Vignola, C.M. Dwyer, The carbon cost of impaired welfare on sheep farms, *animal*, Volume 19, Issue 2, 2025, 101390, ISSN 1751-7311, <https://doi.org/10.1016/j.animal.2024.101390>.

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The relationship between livestock, animal welfare and climate change is bidirectional. While livestock systems contribute to greenhouse gas emissions and therefore to climate change, animals and livestock-dependent communities are themselves increasingly exposed to climate change consequence. Rising temperatures and adverse climate conditions, such as droughts and extreme heat waves, can severely impact animal welfare, reduce productivity and generate substantial economic losses for farmers, especially those whose livelihoods rely completely on livestock<sup>24 25</sup>. Therefore, animal welfare is also an important component of climate adaptation in livestock systems because it can strengthen the capacity of animals, farmers, and production systems to cope with climate-related stresses and shocks, protecting production and livelihoods<sup>26</sup>. It is important to note that conserving and promoting locally-adapted livestock breeds might represent an important climate strategy adaptation, also contributing to improved animal welfare because livestock diversity is a source of resilience when dealing with increasing climatic variability. Locally-adapted breeds may cope better with heat, disease, and feed scarcity, supporting both welfare and resilience, even if they are sometimes less productive than highly selected breeds<sup>27 28</sup>. In fact, breeds that have evolved under specific environmental conditions often bring traits that enhance their capacity to cope with heat stress, disease challenges, and fluctuations in feed and water availability, helping sustain livestock production and livelihoods under changing climatic conditions<sup>29 30 31</sup>.

<sup>24</sup> Thornton, P.K., Nelson, G., Mayberry, D., & Herrero, M. (2022). *Impacts of heat stress on global cattle production during the 21st century: a modelling study*. The Lancet Planetary Health, 6(3), e192-e201

<sup>25</sup> Sejian, V. et al. (2021). *Impact of Climate Change on Animal Production and Welfare*. In: Sejian, V., Chauhan, S.S., Devaraj, C., Malik, P.K., Bhatta, R. (eds) *Climate Change and Livestock Production: Recent Advances and Future Perspectives*. Springer, Singapore.  
[https://doi.org/10.1007/978-981-16-9836-1\\_1](https://doi.org/10.1007/978-981-16-9836-1_1)

<sup>26</sup> Sejian, V. et al. (2021). *Heat Stress and Goat Welfare: Adaptation and Production Considerations*. Animals, 11, 1021

<sup>27</sup> Nature India (2026) *Genetic evidence confirms native cattle are healthier than crossbred animals*. Nature India, 19 August.

<sup>28</sup> Bilotto, F., Harrison, M.T., Vibart, R., Mackay, A., Christie-Whitehead, K.M., Ferreira, C.S.S., Cottrell, R.S., Forster, D. and Chang, J. (2024) *Towards resilient, inclusive, sustainable livestock farming systems*. Trends in Food Science & Technology, 152, Article 104668.

<sup>29</sup> Hoffmann, I. (2010). Climate change and the characterization, breeding and conservation of animal genetic resources. *Animal Genetics*, 41(Suppl. 1), 32-46.

<sup>30</sup> FAO. 2015. *The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture*. Edited by B.D. Scherf and D. Pilling. Rome: Food and Agriculture Organization of the United Nations

<sup>31</sup> FAO. 2019. *The State of the World's Biodiversity for Food and Agriculture*. Rome, FAO.

Climate-resilient production systems, including agroecological and silvopastoral practices, which enhance biodiversity, soil health, and ecosystem resilience<sup>32</sup>, also tend to be animal welfare-oriented, as they offer more diverse environments, feeds and shelter and better behavioural outcomes for animals. Integrating animal welfare into climate adaptation strategies can therefore generate multiple benefits for animals, people, and the environment, while supporting the long-term sustainability of livestock-based food systems.

Agroecology, backed by a set of Principles from the High Level Panel of Experts to the Committee on World Food Security<sup>33</sup> and the *10 Elements of Agroecology* report by FAO<sup>34</sup> in 2019, promotes the integration of ecological principles into farming, strengthening biodiversity, resilience, animal-environment interactions, and the responsible use of natural resources<sup>35</sup>. Livestock systems which operate within agroecological principles tend to rely on lower stocking densities, greater outdoor access, locally-adapted breeds, and management practices that enable animals to express a wide range of natural behaviours, as highlighted in the Animal Health Principle (“ensure animal health and welfare”) of the HLPE-CFS<sup>36 37</sup>. According to agroecology principles, animals are not merely considered as production units but as integral components of ecosystems, making their wellbeing a meaningful contributor to the system as well.

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<sup>32</sup> FAO (Food and Agriculture Organization of the United Nations). 2026. *Global Plan of Action for Sustainable Livestock Transformation*. Rome: FAO. [FAO Global Plan of Action for Sustainable Livestock Transformation](#) (accessed 15 August 2026)

<sup>33</sup> HLPE. 2019. *Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security*, Rome.

<sup>34</sup> FAO. 2018. *The 10 Elements of Agroecology: Guiding the Transition to Sustainable Food and Agricultural Systems*. Rome, FAO. <https://openknowledge.fao.org/items/74156cdc-0000-4150-8b60-e06162a095c8>

<sup>35</sup> Idem

<sup>36</sup> HLPE. 2019. *Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security*, Rome

<sup>37</sup> Villaverde MS et al. 2025. *Interconnection between pastures, grazing ecosystem, animal welfare, meat quality, and human health*. Animal Frontiers.

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Pastoral systems also reflect One Health principles in practice. Well-managed rangelands provide essential ecosystem services, including biodiversity conservation, soil fertility, water regulation, and carbon sequestration<sup>38</sup>. Pastoralists play a crucial role as stewards of ecosystems, using traditional knowledge and adaptive grazing practices<sup>39</sup>. The mobility of herds and the sustainable use of rangelands often enable animals to express natural behaviours, access diverse grazing resources, and live in environments more closely aligned with their behavioural and physiological needs<sup>40</sup>. Protecting and supporting pastoralism therefore contributes not only to the welfare of animals and the livelihoods of pastoral communities, but also to the conservation of natural resources and the long-term health of people, animals and ecosystems<sup>41</sup>. This close relationship between animal welfare and environmental integrity demonstrates why pastoralism can be a valuable pathway for advancing One Health outcomes.

As outlined in the **Animal health and animal welfare interconnections** section earlier, antibiotic misuse and overuse, which can be driven by poor welfare, contribute to AMR and to the related effects of AMR on the environment<sup>42</sup>.

<sup>38</sup> Briske, D.D., Cromsigt, J.P.G.M., Davies, J., Fernández-Giménez, M.E., Luizza, M.W., Manzano, P. & Singh, R. (2026). *Pastoralism Can Mitigate Biodiversity Loss on Global Rangelands*. *BioScience*, 76(1), 78–89

<sup>39</sup> UNCCD (2024). *Global Land Outlook Thematic Report on Rangelands and Pastoralists*.

<sup>40</sup> FAO (2026). Everything you ever wanted to know about rangelands and pastoralists. Everything you ever wanted to know about rangelands and pastoralists (accessed 23/07/2026)

<sup>41</sup> FAO. (2021). *Pastoralism: Making Variability Work*. FAO Animal Production and Health Paper No. 185.

<sup>42</sup> United Nations Environment Programme. (2023). *Bracing for Superbugs: Strengthening Environmental Action in the One Health Response to Antimicrobial Resistance*. UNEP.  
<https://wedocs.unep.org/items/e06380a1-453c-4a77-811f-9bfcced60018>

According to UNEP's report, *Bracing for Superbugs: Strengthening Environmental Action in the One Health Response to Antimicrobial Resistance*, AMR is not only a human and animal health challenge but also a critical environmental health issue. Abuse and misuse of antimicrobials in livestock and aquaculture production, poor sanitation systems and untreated wastewater can create conditions that favour the emergence and persistence of resistance in the environment. Antimicrobial residues can put selective pressure on microbial communities, enabling the survival and proliferation of resistant organisms. Water, soil, air, sediments, and wildlife can then act as reservoirs and pathways through which antimicrobial-resistant bacteria, resistance genes and antimicrobial residues can circulate and spread between humans, animals, and ecosystems. Where good standards of animal welfare are implemented and occur in the context of more sustainable agricultural practices, with reduced and responsible use of antibiotics, the threat to ecosystems health is reduced. Evidence also suggests that communities making inappropriate antimicrobial use for human health may exhibit similar tendencies in antimicrobial use for animals in ways that can increase the risk of AMR<sup>43 44</sup>, reiterating the connection to the human dimension of One Health.

These examples also show that animal welfare policies under One Health should be context specific and adapted to specific farming systems. In agroecological contexts, welfare improvements can be developed in close connection with biodiversity and landscape consideration, while in pastoral systems they may depend on mobility, rangeland access, water availability, animal health services and the protection of pastoral livelihoods. Animal welfare measures should therefore reinforce local sustainability characteristics of production systems.

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<sup>43</sup> Hicks, J.P., Latham, S.M., Huque, R., Das, M., Newell, J., Abdullah, S.M., Al Azdi, Z., Jahan, I., Rassi, C., Hamade, P., Shafique, M., Islam, M.S. and King, R., 2021. *Antibiotic practices among household members and their domestic animals within rural communities in Cumilla district, Bangladesh: a cross-sectional survey*. BMC Public Health, 21, p.406.

<https://doi.org/10.1186/s12889-021-10457-w>

<sup>44</sup> Hicks, J.P., Huque, R., Fieroze, F., Saify, M.B., Ensor, T., Islam, K., Latham, S., Mitchell, J., Rahman, A., Islam, M.N. and King, R., 2025. *Associations between sociodemographic characteristics and knowledge about antibiotics and antibiotic resistance and usage of antibiotics from a One Health perspective in rural Bangladesh: a descriptive cross-sectional study*. BMJ Open, 15(12), e104131. [BMJ Open article](#) [Accessed 21 August 2026]

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## Animal welfare's linkages with human health

Recognising the connections between animal welfare and human health can help when translating One Health principles into practical action. Examples of the connections related to AMR and zoonotic disease are already covered in previous sections. This section highlights where animal welfare can contribute to food safety and psychological and social health outcomes, demonstrating its relevance as a cross-cutting component of One Health implementation.

### Food safety

According to the World Health Organization (WHO), unsafe food causes around 600 million cases of foodborne illness and 420,000 deaths every year worldwide<sup>45</sup>, imposing a substantial burden on public health and economic development. Foodborne diseases generate significant healthcare costs, productivity losses, trade restrictions, and food industry expenses associated with product recalls<sup>46</sup>. Foodborne pathogens such as *Campylobacter* and *Salmonella* are commonly associated with animal-sourced foods, which contribute to over one-third of the foodborne disease burden<sup>47</sup>. Evidence across pig, cattle and poultry food systems indicates that welfare factors such as stocking density, choice of more robust breeds, the ability to perform species-specific behaviours, housing conditions, transport, and the stress levels and other mental states associated with these factors, influence pathogen prevalence and transmission within livestock populations, with poorer animal welfare leading to a higher risk of pathogen contamination of carcasses within slaughterhouses and, consequently, of animal products<sup>48 49 50</sup>. For instance, high stocking density alone can lead to higher faecal contamination of the housing environment and increased prevalence of pathogens taken into processing, especially if combined with poor management practices and the inability to perform motivated behaviours<sup>51 52</sup>.

<sup>45</sup> World Health Organization. (2021). *WHO global strategy for food safety*. Geneva: WHO

<sup>46</sup> World Health Organization. (2026). *Foodborne Disease Estimates*.

<sup>47</sup> Li, M., Havelaar, A. H., Hoffmann, S., Hald, T., Kirk, M. D., Torgerson, P. R., & Devleeschauwer, B. (2019). Global disease burden of pathogens in animal source foods, 2010. *PloS one*, 14(6), e0216545.

<sup>48</sup> De Passillé, A. M., & Rushen, J. (2005). *Food safety and environmental issues in animal welfare*. *Revue Scientifique et Technique (OIE)*, 24(2), 757-766. <https://doi.org/10.20506/rst.24.2.1599>

<sup>49</sup> Iannetti, L., et al. (2020). *Animal welfare and microbiological safety of poultry meat: impact of different at-farm animal welfare levels on at-slaughterhouse Campylobacter and Salmonella contamination*.

<sup>50</sup> Rostagno, M. H. (2009). Can stress in farm animals increase food safety risk?. *Foodborne pathogens and disease*, 6(7), 767-776.

<sup>51</sup> Gast, R. K., Guraya, R., Jones, D. R., Anderson, K. E., & Karcher, D. M. (2017). Frequency and duration of fecal shedding of *Salmonella enteritidis* by experimentally infected laying hens housed in enriched colony cages at different stocking densities. *Frontiers in veterinary science*, 4, 47.

<sup>52</sup> Iannetti, L., Neri, D., Santarelli, G. A., Cotturone, G., Vulpiani, M. P., Salini, R., ... & Messori, S. (2020). Animal welfare and microbiological safety of poultry meat: Impact of different at-farm animal welfare levels on at-slaughterhouse *Campylobacter* and *Salmonella* contamination. *Food Control*, 109, 106921.

Further, lesions such as foot dermatitis, induced by the use of fast growing and more inactive breeds and by poor litter quality, are associated with higher prevalence of pathogens and severity of infection at slaughter<sup>53</sup>. Also, poor management practices at the end of the production cycle (such as excessive feed withdrawal and inadequate transport conditions) induce stress, immunosuppression and depletion of muscle reserves, which in turn increase the proliferation of pathogens and the incidence of meat quality issues such as pale, soft and exudative (PSE) meat or dark, firm and dry (DFD) meat<sup>54 55</sup>.

### Psychological and social health

Animal welfare should be understood not only as an outcome of good management but also as a reflection of the wellbeing of the people who care for animals. Farmers with higher occupational wellbeing and lower levels of stress achieved better animal welfare outcomes, while poor mental health, loneliness, and work-related stress were associated with poorer animal welfare indicators<sup>56</sup>. In addition, poor animal welfare can impose substantial economic burdens through reduced productivity, increased disease, mortality and veterinary costs, while also causing emotional distress to farmers who depend on healthy animals for their livelihoods. Promoting good animal welfare can generate benefits beyond the animals themselves, contributing to healthier livestock, more sustainable livelihoods, reduced occupational stress, and improved quality of life for farming communities. These findings suggest that the welfare of animals and farmers are closely interconnected, with each influencing the other. Good animal welfare and good farmer welfare should therefore be considered mutually reinforcing components of resilient and sustainable livestock systems<sup>57</sup>. This also underlines the need for animal welfare policies to be socially and economically context-sensitive. Measures that improve welfare should be designed with farmers, pastoralists and animal keepers, taking into account their working conditions, resources, knowledge systems, market constraints and livelihood needs. When welfare policies are co-designed and adapted to local realities, they are more likely to be feasible, equitable and effective in supporting both animal and human wellbeing.

<sup>53</sup> Bull, S. A., Thomas, A., Humphrey, T., Ellis-Iversen, J., Cook, A. J., Lovell, R., & Jorgensen, F. (2008). Flock health indicators and *Campylobacter* spp. in commercial housed broilers reared in Great Britain. *Applied and environmental microbiology*, 74(17), 5408-5413.

<sup>54</sup> Saucier, L. (2016). Microbial spoilage, quality and safety within the context of meat sustainability. *Meat science*, 120, 78-84.

<sup>55</sup> Rostagno, M. H. (2009). Can stress in farm animals increase food safety risk?. *Foodborne pathogens and disease*, 6(7), 767-776.

<sup>56</sup> Hemsworth, P.H., & Coleman, G.J. (2011). *Human-Livestock Interactions: The Stockperson and the Productivity and Welfare of Intensively Farmed Animals*.

<sup>57</sup> Hansen BG, Østerås O. Farmer welfare and animal welfare- Exploring the relationship between farmer's occupational well-being and stress, farm expansion and animal welfare. *Prev Vet Med*. 2019 Oct 1;170:104741. doi:10.1016/j.prevetmed.2019.104741 PubMed PMID: 31421504

Proudfoot K, Habing G. Social stress as a cause of diseases in farm animals: Current knowledge and future directions. *The Veterinary Journal*. 2015 Oct 1;206(1):15-21. doi:10.1016/j.tvjl.2015.05.024 PubMed PMID: 26160470.

## Animal welfare as a strategic investment in One Health

International finance is increasingly interested in integrated and systemic approaches that recognise the interconnections between human, animal, and environmental health, and this represents an opportunity to further incorporate animal welfare into sustainable development and One Health investment frameworks. During the 2026 One Health Summit in Lyon, governments, international organisations, development banks, philanthropists, and other stakeholders recognised finance as a key enabler of One Health implementation and called for stronger investment in preventive, integrated approaches that address interconnected human, animal, and environmental challenges<sup>58</sup>.

Animal welfare is recognised as a material consideration in livestock investment and commercial operations<sup>59</sup>, with investments in higher-welfare livestock systems that may generate wider public benefits including improved animal health, reduced disease risks and antimicrobial use, enhanced resilience, and positive environmental outcomes as highlighted in this document.

International policy discussions have begun to call for the redirection of public and private financial flows towards production systems that deliver benefits for animals, people and the environment, and reduce trade-offs<sup>60</sup>. Analyses of development finance have highlighted the potential for banks and donors to further align investments with sustainability, One Health, and Sustainable Development Goal commitments<sup>61</sup>.

Furthermore, a recent systematic review of the economic value of One Health interventions found that initiatives generating benefits across human, animal, and environmental health, and through the inclusion of animal welfare, can produce substantial economic returns, highlighting the importance of adopting integrated approaches when guiding resource allocation and investment decisions<sup>62</sup>.

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<sup>58</sup> One Planet Summit (2020) *One Health Summit*.

<https://oneplanetsummit.fr/en/events-16/one-health-summit-305> (Accessed: 14 September 2026).

<sup>59</sup> International Finance Corporation (IFC) (2014) *Improving animal welfare in livestock operations: Good practice note*. Washington, DC: International Finance Corporation, World Bank Group.

[IFC Good Practice Note](#)

<sup>60</sup> UNEP & ILRI. (2020). *Preventing the Next Pandemic: Zoonotic Diseases and How to Break the Chain of Transmission*.

<sup>61</sup> Committee on World Food Security (CFS). (2014). *Principles for Responsible Investment in Agriculture and Food Systems*.

<sup>62</sup> Baum, S. E., Machalaba, C., Daszak, P., Salerno, R. H., Karesh, W. B., et al. (2024). *Current evidence of the economic value of One Health initiatives: A systematic literature review*. *One Health*, 19, 100881.

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This momentum was reinforced in a recent brief by FAO, WHO, and WOA<sup>63</sup> highlighting that One Health investments can generate significant economic returns by delivering benefits across multiple sectors simultaneously, including health, agriculture, food systems, and the environment. The document emphasises that preventive and integrated approaches are often more cost-effective than reactive responses to crises, but remain underfunded due to fragmented financing and sector-specific budgeting. It therefore calls for investment frameworks that recognise cross-sectoral benefits and support coordinated, long-term action.

Scaling up dedicated financing for animal welfare could therefore accelerate the transition towards more resilient and sustainable agrifood systems while ensuring that animal welfare objectives are supported by adequate resources rather than remaining unfunded policy aspirations.



<sup>63</sup> FAO and WOA<sup>H</sup> (2026) *Financial and economic returns to investing in One Health: Evidence and future directions*. Rome: Food and Agriculture Organization of the United Nations (FAO) and World Organisation for Animal Health (WOAH).

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## Recommendations

Animal welfare is a measurable, science-based lens through which One Health outcomes can be accelerated. To effectively design, implement, and evaluate One Health interventions in livestock and agrifood systems, we recommend that animal welfare indicators are integrated into One Health frameworks, finance and programmes. Welfare can provide measurable, evidence-based indicators that can be part of an informed cross-sector decision-making process under a One Health approach.

### 1. Recognise the importance and incorporate key features of animal welfare into One Health policies

Integrate animal welfare considerations into the FAO One Health in Agrifood Systems Framework, as well as in subsequent guidelines, or technical documents derived from it, and in other One Health policies at global and national level where livestock is concerned. This would help ensure that the interconnected health of animals, humans, and the environment is addressed through a more comprehensive and preventive approach, strengthening the effectiveness and sustainability of One Health interventions. Such guidance should also support Member States in adapting animal welfare policies to national and local contexts, including differences in livestock species, production systems, ecosystems, socio-economic conditions, cultural settings and institutional capacities, drawing on existing international frameworks such as the WOAHA Global Animal Welfare Strategy and WOAHA Animal Welfare Standards to support implementation and capacity development.

### 2. Include animal welfare in financing mechanisms

Financing and funding mechanisms should recognise animal welfare as a strategic investment for delivering One Health outcomes, including improved animal health, reduced disease risks, lower antimicrobial use, greater resilience, and positive environmental and livelihood benefits. Animal welfare criteria should therefore be integrated into public and private investment frameworks, development finance, and sustainable agrifood system funding, ensuring that resources support preventive, integrated approaches that benefit animals, people, and ecosystems. This would help align financial flows with One Health objectives and ensure that animal welfare commitments are backed by adequate implementation support.

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### 3. Strengthen the science-policy interface on animal welfare and One Health

Support interdisciplinary research, data collection, and economic evaluation studies to quantify the public, environmental and economic benefits of animal welfare interventions. Develop common indicators and assessment frameworks that enable animal welfare outcomes to be incorporated into One Health policies, monitoring systems and investment decisions, helping governments and funders recognise animal welfare as a cost-effective component of sustainable agrifood system transformation.

### 4. Integrate animal welfare into One Health actions in livestock systems

- **Encourage the use of welfare indicators as an early signal for intervention in animal health monitoring**

Animal welfare indicators including behavioural changes, mortality patterns and stress-related health problems can act as practical, on-the-ground early warning signs, often before formal surveillance or diagnostic systems detect a problem. These indicators can be observed directly by farmers, herders, and animal handlers, so offer a low-cost, immediate way to flag deteriorating conditions, emerging disease risk, or increased vulnerability to pathogen transmission. Welfare indicators can therefore support timely intervention and more effective monitoring of zoonotic risks ahead of formal surveillance approaches.

- **Improve animal husbandry to reduce disease pressure, antimicrobial use, and AMR**

Poor welfare conditions can increase stress, weaken immune function, and heighten susceptibility to infectious diseases, often leading to greater reliance on antimicrobials. We therefore recommend the inclusion of animal welfare considerations, strategies and measures into National Action Plans to Reduce Antimicrobial Resistance under a One Health approach.

- **Include animal welfare in One Health actions on environment**

We recommend that governments integrate animal welfare considerations into climate and environmental policies and investments, including through targeted financial support, extension services, research and capacity-building initiatives. At both global and national levels, the implementation of One Health, Climate and

Biodiversity agendas should systematically incorporate animal welfare considerations, in a manner that is consistent with the objectives of the Rio Conventions and tailored to local ecosystems, climatic conditions, species needs, production systems and community priorities.

- **Ensure that welfare is considered in One Health approaches aiming at improving productivity, livelihoods and food security**

Embedding animal welfare metrics within One Health initiatives that aim to improve productivity, livelihoods and food security is essential because welfare is not only an outcome of sustainable development but also a key determinant of its success. At the same time, the human dimension of One Health underscores the close links between animal welfare and human wellbeing, including farmer health, working conditions, livelihoods, social cohesion, and food security.

## Conclusions

The growing recognition of the interconnectedness between human, animal, and environmental health has made the One Health approach an essential framework for addressing the most pressing challenges facing agrifood systems today. As this brief has shown, animal welfare is not a peripheral concern within this agenda but a foundational element that directly influences the effectiveness of One Health interventions. Scientific evidence increasingly shows that animal welfare is closely linked to animal health, zoonotic disease prevention, antimicrobial stewardship, environmental sustainability, climate resilience, and human wellbeing. Improving welfare conditions can therefore generate benefits that extend far beyond individual animals, creating positive outcomes across the entire food system.

As governments, international organisations, researchers, farmers, pastoralists, youth, civil society, and other stakeholders work to implement the One Health agenda, animal welfare should be recognised as not only an outcome, but also as a driver for achieving healthier and more sustainable societies. By placing animal welfare at the centre of livestock transformation efforts, policymakers can unlock synergies across all dimensions of One Health and accelerate progress towards resilient agrifood systems that support the wellbeing of people, animals and the environment.

## Case studies

### The carbon cost of impaired welfare on sheep farms in the UK<sup>64</sup>

This study provides compelling evidence that poor animal welfare can increase the environmental footprint in sheep farming. By demonstrating that common welfare problems can lead to higher greenhouse gas (GHG) emissions per kilogram of meat produced, it highlights how animal welfare can contribute directly to climate mitigation showing a relevance for the environmental dimension of One Health.

While animal welfare is increasingly acknowledged as an important component of sustainable livestock systems, evidence linking welfare outcomes to environmental performance has been limited. To address this gap, Lanzoni *et al.* (2025) quantified the “carbon cost” of impaired welfare on sheep farms in the United Kingdom. The study examined how common welfare challenges affect GHG emissions and production efficiency.

The researchers used two Scottish sheep farms representing typical lowland and hill production systems. High-welfare conditions served as the baseline, defined as systems where animals had adequate nutrition, shelter, health, and opportunities to express natural behaviours. They then modelled the effects of several common welfare challenges using data from published literature. These included lameness, gastrointestinal parasites, liver fluke infection, blowfly strike, inadequate shelter, inadequate feeding during pregnancy and lamb growth, and high lamb mortality. GHG emissions were calculated using Agrecalc®, a life-cycle assessment tool that estimates emissions from cradle to farm gate.

The study found that impaired welfare consistently increased the emissions intensity of sheep production. Although some poor-welfare scenarios slightly reduced total farm emissions because fewer animals survived or grew to market weight, they reduced productivity even more substantially. As a result, the amount of GHG emissions associated with each kilogram of meat produced increased.

Key findings included:

- **meat production declined by 1.3% to 16.6%** under poor-welfare scenarios, reducing resource-use efficiency
- **lameness** had the greatest impact, **increasing emissions intensity by 18% in hill systems and 10% in lowland systems**, largely because of higher lamb mortality

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<sup>64</sup> Lanzoni, L., Reeves, M.C., Waxenberg, K., Ramsey, R., Atzori, A.S., Bell, J., Rees, R.M., Vignola, G. and Dwyer, C.M. (2025) ‘The carbon cost of impaired welfare on sheep farms’, *Animal*, 19(2), Article 101390. <https://doi.org/10.1016/j.animal.2024.101390> (Accessed: 2 September 2026).

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- **inadequate shelter provision increased emissions intensity by 8 to 15%**
- **parasite** burdens such as gastrointestinal nematodes and liver fluke **increased emissions intensity by 1 to 13%**
- **inadequate feeding management increased emissions intensity by 3 to 4%.**

The findings show that welfare problems undermine production efficiency by reducing growth rates, increasing mortality, impairing health, and lowering overall output. Since animals consume resources and generate emissions throughout their lives, losses in productivity translate directly into a larger carbon footprint per unit of food produced.

This research is a practical example where animal welfare is not only an ethical concern but also an important environmental and sustainability issue. The study illustrates several pathways through which improved welfare supports One Health objectives.

### **Environmental health.**

Better welfare reduces emissions intensity by improving animal performance and resource-use efficiency. Welfare interventions therefore can complement climate mitigation efforts.

### **Animal health.**

Many welfare challenges examined in the study, including lameness and parasitism, are also important animal health problems. Preventing these conditions improves welfare and productivity simultaneously.

### **Sustainable food systems.**

Improving welfare can increase outputs without increasing animal numbers or resource inputs, supporting more sustainable livestock production.

The findings are particularly significant because they challenge the perception that welfare improvements necessarily create trade-offs with environmental goals. Instead, the study shows that enhancing welfare can be a practical strategy for reducing the environmental impact of livestock systems.

## Operationalising One Health to strengthen food security and health in pastoral communities in northern Kenya<sup>65</sup>

Pastoral communities in the drylands of northern Kenya depend heavily on shared natural resources, particularly water, for the health and productivity of people, livestock and ecosystems. A research initiative in Samburu, Marsabit and Turkana counties has applied a One Health approach to better understand the links between water, zoonotic disease and food security. Water access, disease risk and the impacts of prolonged drought are examples of risks to livestock welfare in pastoral settings; by contrast, the social structures of herds, freedom of movement, and dynamic environments provide welfare opportunities for livestock.

The project combines GPS tracking of livestock movements, mapping of water points, network analysis of disease transmission pathways, participatory research methods and stakeholder engagement; all acting as activities that can benefit the wellbeing of people, their animals and the local environment. The initiative seeks to understand - through the integration of quantitative and qualitative data - how interactions between people, livestock, wildlife and shared water resources influence disease risks and food security. Particular attention is given to zoonotic diarrhoeal diseases, which are often overlooked despite their close relationship with malnutrition and human wellbeing.

A central feature of the project is its emphasis on systems thinking. In fact, the approach recognises the multiple interlinkages between environmental conditions, animal health, human health and livelihoods. Stakeholder workshops have brought together government agencies, NGOs and local communities to improve the understanding of these complex relationships and support coordinated action. The project also aims to improve data-driven decision-making by governments and development organisations while increasing the role of local communities in shaping development programmes. Results of the initiative will demonstrate how One Health approaches can contribute to both animal welfare and sustainable development. Better understanding of livestock movements, water resource use and disease transmission can support interventions that improve animal health, reduce disease burdens and strengthen the resilience of pastoral livelihoods. This work illustrates how integrated approaches can help address interconnected challenges affecting animals, people and ecosystems in pastoral systems.

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<sup>65</sup> Thomas, S. International Livestock Research Institute (ILRI). GAAFS & Jameel Observatory Graduate Fellow. [CGSpace Repository Presentation](#)

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## Pasture-based livestock systems and One Health: evidence from Italy<sup>66</sup>

Pasture-based livestock systems offer a valuable example of how a One Health approach can generate benefits across multiple dimensions of agrifood systems. In Italy, growing attention is being paid to livestock production models that can reconcile food production with environmental outcomes, animal welfare, and human wellbeing. Through a literature review and a study on the field, this abstract focuses on four aspects: **animal welfare, food quality, production methods** and **ecosystem maintenance**. Well-managed rotational grazing systems enable animals to express natural behaviours such as grazing, walking and social interactions, while making productive use of grassland resources in the rural and underdeveloped areas. At the same time, these systems contribute to maintaining ecosystem functions, including nutrient cycling, soil conservation, and biodiversity, while ensuring an income for farmers, producing good quality food. Adopting pasture-based systems can help to address animal welfare, environmental sustainability, and food production simultaneously through integrated management approaches.

This multidisciplinary study conducted in the Emilia-Romagna Apennines evaluated a herd of 25 Rossa Reggiana dairy cows managed under a rotational grazing system over a 90-day summer period, on an area of 25 hectares. As a background, in 2024 Italy invested in Eco-scheme Level 1 - Level 2 in CAP 2023-27 approximately 18% of total national CAP expenditure (about €69 million). In Italy, permanent pastures and grassland cover about 3.5 million hectares accounting for 20.97% of the national utilised agricultural area (UAA).

The research assessed indicators related to animal welfare, environmental sustainability, and food quality. Welfare monitoring showed low levels of gastrointestinal parasites, stable body condition and the absence of lameness throughout the study period, indicating that animals maintained good health and welfare under the grazing regime.

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<sup>66</sup> Long abstract: *Pasture-Based Livestock Systems as Leverage Points for Food System Sustainability: A Multi-disciplinary Perspective from Italy*

Mia Scotti (CREA-PB), Tiziana Amoriello (CREA-AN), Marika Ferrari (CREA-AN), Giulia Pastorelli (CREA -PB), Sujen Santini (CREA-ZA), Daniele Valcavi (CREA-ZA), Elena Zanelli (CREA-ZA), Davide Bochicchio (CREA-ZA)

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At the same time, pasture-fed cows produced milk with a more favourable nutritional profile, particularly in terms of carotenoids and omega-3 fatty acids. During the grazing season, milk from pasture-fed cows contained 1.53% of  $\alpha$ -linolenic acid (18:3n3, % of total fatty acids), compared with 0.86% in milk produced under barn-feeding conditions with hay by the same animals, **corresponding to a 78% increase**. Milk colour, which is influenced by carotenoids, riboflavin, and folates, was assessed using the  $b^*$  colorimetric index (Graulet & L. Girard, 2017), which was markedly higher in pasture milk (8.36) than in barn milk (4.88), **corresponding to a 71% increase compared with milk produced under barn-feeding conditions with hay by the same animals**.

The system was also less reliant on feed (1.5kg of concentrate per day). Taken together, the findings highlight the interconnected nature of animal, human, and environmental health and demonstrate how practices that promote animal welfare can also contribute to healthier ecosystems and more nutritious food. This case study illustrates how animal welfare can serve as a practical entry point for implementing One Health in livestock production systems. While animal welfare is often treated as a stand-alone ethical consideration, this study shows that it can also support wider societal objectives by contributing to environmental sustainability, food quality, and the resilience of farming systems. The findings suggest that well-managed, pasture-based systems can create synergies between healthy animals, functioning ecosystems and human nutrition, helping to address multiple sustainability challenges simultaneously. As countries explore pathways towards more sustainable agrifood systems, integrating animal welfare considerations into livestock management may offer an effective strategy for delivering One Health outcomes while supporting long-term food system resilience.



## Integrating animal welfare, animal health and environmental sustainability through crop-livestock-forestry systems in Brazil<sup>67</sup>

As climate change increases the frequency and intensity of heat stress events, providing cattle with access to shade is becoming an important animal welfare consideration. Trees in silvopastoral and agroforestry systems can improve welfare by offering protection from solar radiation and adverse weather conditions, allowing animals to express natural behaviours while reducing thermal stress. However, pasture-based systems may also face challenges, including exposure to parasites such as cattle ticks (*Rhipicephalus microplus*) which can affect animal health and increase reliance on chemical control measures.

Tick infestations represent a significant concern because they can impair health and productivity while increasing the use of acaricides, with potential environmental consequences. Finding strategies that maintain the welfare advantages of tree-based grazing systems while limiting parasite burdens is therefore highly relevant from a One Health perspective.

A three-year study in southern Brazil evaluated different integrated production systems, including livestock-only, livestock-forestry, crop-livestock, and crop-livestock-forestry systems. The research found that systems incorporating crop rotations alongside grazing reduced tick infestations and lowered the need for acaricide treatments compared with systems based solely on livestock production. The authors attributed these effects to the interruption of the tick life cycle during the crop phase, when cattle were absent from the pasture.

This approach illustrates how integrated land-use planning can deliver multiple benefits across One Health dimensions. The inclusion of trees can contribute to animal welfare through shade and shelter, helping animals cope with heat stress and increasingly variable climatic conditions. At the same time, the crop rotation component can reduce parasite pressure, improving animal health and reducing dependence on chemical treatments. Lower acaricide use may also benefit the environment by decreasing chemical inputs and supporting more sustainable pasture management. Together, these features demonstrate how integrated crop-livestock-forestry systems can help align animal welfare, animal health, and environmental objectives.

The study offers an important example of how management innovations can help overcome trade-offs that may arise in higher-welfare grazing systems. By combining trees, pasture and crop rotations, producers may be able to retain the welfare advantages associated with shaded grazing environments while addressing parasite-related health challenges. This highlights the value of integrated approaches that consider animal welfare, animal health and environmental sustainability together, rather than as separate objectives.

<sup>67</sup> Martin, D.M., Moraes, R.F., Portugal, T.B., Molento, M.B., Oliveira, L.B. de and Moraes, A. de (2026) 'Can integrated crop-livestock systems reduce tick infestation in cattle?', *Research in Veterinary Science*



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