

## Global nutrition security: the role of Veterinary Services

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### Summary

Disparities in nutrition security and the harmful health effects of malnutrition are pronounced as the world's population continues to rise and nutrition-related development falls short of targets. This paper discusses the importance of animal source foods (ASFs) in global nutrition security and the roles that Veterinary Services play in enhancing availability of and equitable access to ASFs.

The first section of this paper reviews the nutritional value of ASFs and disparities in global consumption patterns. It also presents the biological basis for ASF-derived nutrition, its importance throughout the human lifecycle and the negative effects of both under- and overnutrition. The second section discusses the various roles of Veterinary Services along the pathway from terrestrial livestock production to positive outcomes in nutrition security. It addresses the importance of Veterinary Services in improving production efficiencies in extensive livestock systems as well as the contributions of Veterinary Services to integrated approaches for improved human and livestock health and security. Gaps between ASF availability and nutrition security are then discussed along with the importance of closing these gaps by targeting smallholders and women. The paper concludes with recommendations for incorporating targeted, nutrition-sensitive approaches in Veterinary Services to help populations vulnerable to nutrition insecurity gain more equitable access to ASFs as part of sustainable healthy diets.

### Keywords

Animal source foods – Global nutrition security – Smallholder livestock – Sustainable healthy diets – Veterinary Services.

## Introduction

Disparities in food and nutrition security are becoming increasingly pronounced as the world's population grows toward a projected 9.7 billion by 2050, with most growth occurring in low- and middle-income countries (LMICs) (1). It is estimated that 8.9% of the global population is undernourished, and nearly 750 million suffer severe food insecurity (2). Furthermore, an estimated 21.3% of children under the age of 5 years have stunted growth, while over 250 million of children in this age group experience impaired cognition and development. Over the next five to ten years, reductions in levels of stunting are projected to fall short of targets set by the World Health Assembly (2). Many of those most affected by these nutritional shortcomings reside in LMICs, where populations are particularly vulnerable to the effects of exacerbating external factors including climate change, conflicts and global crises such as the COVID-19 pandemic.

Animal source foods (ASFs) have the potential to substantially reduce global nutrition insecurity and the morbidity and mortality associated with malnutrition. Animal source foods (meat, fish, eggs and milk) supply approximately 15.4% of the global daily calories consumed per capita, with important differences by country income level. In high-income countries, 22.9% of daily calories per capita are from ASFs. In low-income countries, this number falls to 5.7% (2). Animal source foods provide bioavailable micronutrients that are critical for early childhood growth and development, maternal health, and health throughout the lifecycle. However, ASF consumption has been concurrently associated with the global obesity epidemic and such conditions as cardiovascular disease, diabetes and cancer (3).

While global livestock production levels have increased in tandem with a growing population, certain regions, including sub-Saharan Africa and South Asia, have experienced lower per capita livestock production due to rapidly expanding human populations and low production per animal (2, 4). Demand for ASFs is expected to increase in the coming decades, with the greatest growth expected in LMICs (5). Increasing consumption of ASFs is often critiqued as unsustainable and contributing to climate change, yet these critiques tend to focus on large, intensive systems rather than smallholder and mixed systems, which supply over half of the world's food and are vital to feeding undernourished populations (6).

Veterinary Services play a pivotal role in optimising global ASF systems, particularly among smallholders and populations vulnerable to food and nutrition insecurity. Four pillars are recognised as forming the basis of food security: availability, access, stability and utilisation (4). Nutrition security builds on this definition, adding access to high-quality diets and the full range of essential nutrients necessary for optimal growth, development and health in populations. Most

directly, Veterinary Services can help increase the availability of, and potentially access to, ASFs in low-income settings through optimised livestock production efficiencies and improved livelihoods. Veterinary Services also have an important place in integrated One Health approaches aimed at enhancing equitable access to, safety and security of and overall utilisation of ASFs. Ultimately, by targeting vulnerable households, Veterinary Services can positively impact nutrition security along the pathway from livestock to improved, sustainable diets.

This paper will describe the nutritional value of ASFs in the diet and variations in global consumption patterns. It will then present pathways through which Veterinary Services can enhance the availability of and access to ASFs and mitigate risks associated with them. It will conclude with a discussion of the larger role of Veterinary Services in optimising global food and, importantly, nutrition security.

## **Animal source foods and nutrition**

### **Nutritional value of animal source foods**

Animal source foods contain several essential nutrients in bioavailable forms that are important for human growth, development, cognition and maintenance of health throughout the lifecycle. Evidence suggests increases in dietary ASFs occurred at important junctures of hominin evolution and were associated with brain development and other important physiological changes (7). Animal source foods are particularly important among low-income and nutrition-insecure populations where a modest amount of ASF consumption can lead to greater nutritional gains compared to a diet of plant-based foods alone (8).

Eggs and milk are considered ‘first foods’, providing a complete suite of nutrition to young children (9). Eggs are a good source of macronutrients and micronutrients as well as immune and endocrine factors. They are considered a perfect protein source, containing all nine essential amino acids as well as essential omega-3 and omega-6 fatty acids. Choline, an essential nutrient present in high concentrations in eggs, is a phospholipid precursor crucial for cell growth and division and is vital to proper neural development and transmission, gene expression and numerous growth pathways (10). Eggs are also an important source of bioavailable selenium, iron and zinc, as well as vitamins A, B12, D and E and folate (9).

Milk supplies nutritional and bioactive factors known to support childhood growth and development. It contains high-quality protein, including whey and casein, and has a high mineral and micronutrient content (11). There is evidence that milk increases circulating levels of insulin-like growth factor-1, which increases amino acid uptake in bone tissue and promotes

linear growth in children (12). Cow's milk has low iron and zinc content compared to meat and egg products (13) but is rich in A and B vitamins, including B12 (14).

Like eggs, terrestrial animal meats (muscle foods and organ tissue) are high-quality sources of protein that provide all essential amino acids as well varying ratios of monounsaturated, saturated and polyunsaturated fatty acids. Meat is a major source of vitamin B12, which is only naturally found in ASFs. Meat not only supplies iron in the bioavailable heme form, but also enhances the bioavailability of nonheme iron sources in the diet. It is a rich source of potassium, phosphorus, copper, zinc and selenium and also contains fat-soluble vitamins, though in less abundance than plant foods (15).

Aquatic foods (fin fish, crustaceans and molluscs, among others) account for 17% of global animal protein supply. Global fish consumption increased by an average of 3.2% annually between 1961 and 2016. Aquaculture has been the world's fastest-growing food production sector for over four decades (16). Aquatic foods are an especially rich source of omega-3 fatty acids and essential minerals such as zinc, calcium, iron and selenium, as well proteins and other critical vitamins (17). Consumption of the whole bodies of small fish delivers a particularly high concentration of micronutrients (18). Fish consumption has been associated with health benefits including long-term weight loss, reduced mortality from heart disease, and reduced overall morbidity and mortality (19).

### **Nutrition from animal source foods through the lifecycle**

Bioavailable ASF-derived nutrition is important during all stages of the human lifecycle and is particularly critical during childhood and pregnancy/lactation. The complementary feeding period from 6 to 24 months of age is when children are especially vulnerable to malnutrition and subsequent stunting (11). The smaller gastrointestinal capacity of young children combined with a period of rapid growth and development necessitates highly bioavailable nutrients. Starch-based staple diets in many low-resource settings are inefficient at providing critical nutrients such as iron, zinc and vitamin A that are abundantly supplied through relatively small quantities of ASFs (11). Studies examining the effects of terrestrial and aquatic ASFs on stunting and growth have shown mixed results, though interventional trials provide compelling evidence of positive effects on childhood growth and development (20, 21).

Pregnancy and lactation are also nutritionally demanding periods that require digestible and bioavailable ASF-derived nutrients, particularly in low-resource settings where sufficient supplements and/or fortified foods may not be readily available. Deficiencies in micronutrients such as iron, zinc, iodine, vitamin D and calcium can have severe impacts on maternal health and

fetal development (22). Similarly, healthy neural function, bone health and muscle mass throughout adulthood and aging may be difficult to maintain in resource-limited areas without sufficient access to ASFs (23, 24).

### **Global consumption patterns of animal source foods**

Consumption patterns of ASFs vary widely around the world and, consequently, major disparities in food security and nutritional status exist. There has been an overall increase in global per capita ASF consumption over recent decades, a trend that is projected to continue through mid-century, particularly in LMICs (25). Yet some areas of sub-Saharan Africa and South Asia, already characterised by low ASF consumption, have experienced declines in consumption (4). Egg consumption varies by region, with the highest levels in Latin America and the Caribbean and the lowest levels in Africa (9). Per capita milk consumption has experienced a decades-long increase in LMICs except in sub-Saharan Africa (14).

Variations in ASF consumption have resulted in global health crises from both under- and overconsumption. There is evidence of associations between low rates of ASF consumption and stunting, cognitive deficits, anaemia and developmental disorders (6). At the same time, ASF overconsumption in high-income countries has been linked to higher rates of cardiovascular disease, colorectal cancer, diabetes, obesity and other health problems. Reasons for these associations are complex and may be linked to higher rates of processed meat consumption (25). From a global health perspective, emphasis should be placed on narrowing the disparities of ASF consumption by ensuring that populations vulnerable to nutrition insecurity have more equitable access to high-quality ASFs during all life stages.

## **From livestock production to nutrition security: the roles of Veterinary Services**

Sustainable livestock production, particularly among smallholder, mixed and other extensive systems, plays a vital role in providing food and nutrition security to those most vulnerable to undernutrition. Extensive livestock production, as opposed to intensive, is characterised by relatively low per-animal productivity and inputs relative to land area used. These systems provide ASFs directly to producer households, communities and local market chains in addition to serving as a source of income and direct farm inputs. Smallholder systems in particular tend to have lower per-animal output and are especially vulnerable to disease and climate extremes.

Veterinary Services can play critical roles along the pathway from livestock production to positive nutrition outcomes by enhancing the availability of and access to ASFs, the stability of these foods through sustainable practices, and the health of communities. **Figure 1** outlines several of these positive impact pathways. This section focuses on the role of Veterinary Services in extensive terrestrial livestock systems with emphasis on the unique needs of smallholder producers. Though aquaculture is not specifically covered, it is crucial to acknowledge the concurrent importance of aquatic systems to global nutrition security and the necessity of Veterinary Services contributions to animal health and welfare in this sector.

### **Optimising livestock production and sustainability**

Animal welfare is ranked as one of the top five priorities of the World Organisation for Animal Health (OIE) Member Countries, but one with a low level of Member preparedness (26). Deficiencies in animal health and welfare at the herd level result in acute to chronic production losses that can be detrimental to the nutrition security and livelihoods of smallholder producers (27). Improving the welfare of livestock mitigates many factors related to morbidity and mortality in young stock and mature animals, lowers herd susceptibility to disease outbreaks, and can reduce waste and downstream losses from condemnation or downgrading during slaughter and processing (4). By filling the gap in preparedness for animal welfare, Veterinary Services can enhance productivity gains in extensive systems, thus improving the quality and quantity of ASFs produced.

Production performance can also be enhanced through strategic improvements in feeding practices of smallholder and mixed-system producers, a strategy that may be overlooked by Veterinary Services in extensive production systems. Proper nutrition and supplementation for animals can help optimise production for a particular setting. Locally available plants and

supplements have been used to enhance the productivity of ruminants and improve the nutritional profile of eggs (28). For example, inclusion of *Moringa oleifera* leaf meal, a drought-tolerant plant grown throughout the tropics, in the diets of lactating goats was found to enhance ruminal fermentation and nutrient digestibility and to increase milk yield (29). Additionally, livestock can contribute positively to total food availability in a community when raised in marginal areas, where they graze off land unsuitable for crop production, or in mixed systems, where they add reciprocal value to the crops grown by consuming post-harvest residues and providing manure and traction (4). These feeding strategies also have planetary health implications, as livestock production is often labelled as unsustainable due to land use and emissions associated with feed production and transportation (8, 30).

Genetic optimisation of extensively farmed livestock is another method of enhancing performance that has received much research interest but may be underutilised by Veterinary Services in settings that could benefit from it (31). Not all breeds of livestock perform equally well in all settings. Native breeds, though often considered less productive than commercial breeds when raised in intensive systems, may perform better in extensive systems due to natural adaptation to the local climate and resistance to endemic diseases, thus requiring fewer veterinary inputs. For example, *Bos taurus* breeds of cattle, such as the indigenous Sheko of Ethiopia, are more resistant to the pathologic effects of African trypanosome parasites. Researchers found that knowledge of trypanosomiasis transmission and tolerance traits among different cattle breeds was lacking among Ethiopian livestock keepers although a majority were positive about wanting to buy more tolerant breeds (32). Veterinary Services' involvement in strategic genetic improvement programmes and education campaigns can facilitate the selection of desired traits in these native breeds to enhance their health and productivity for smallholders (31).

It is essential that Veterinary Services support research and initiatives aimed at improving animal welfare and optimising feed and genetic selection for a particular setting's biogeographical, cultural and nutritional context, with concurrent extension services to educate smallholders about the benefits of these optimisations. Sustainable and efficient extensive production systems can reduce the planetary footprint of livestock and promote positive downstream nutrition outcomes for producers and their communities.

### **Integrated One Health approaches**

Food safety is a major concern for global Veterinary Services and has considerable relevance to nutrition outcomes, particularly among low-income populations. A survey of OIE Member Countries revealed foodborne disease to be an issue of high importance with low preparedness,

highlighting a critical gap that Veterinary Services must address (26). Animal source foods are estimated to cause 35% of the global burden of all foodborne disease (33). Diarrhoeal and other gastrointestinal illnesses resulting from ASF consumption can cause acute to chronic nutrient loss and reduced nutrient absorption, thus impeding nutrition gains (34). In addition, illness caused by ASFs often leads to fear and reluctance to consume these foods, meaning their nutritional benefits are sacrificed (35).

At the national level, public funding is essential for the functioning of Veterinary Services operations and infrastructure necessary to provide adequate disease and food safety surveillance, yet only 15 of 84 OIE-Member LMICs report adequate funding for operations and capital investment. Based on estimates of disability-adjusted life years (DALYs) resulting from ASF-related foodborne disease among countries in sub-Saharan Africa, nations with adequate operational funding for Veterinary Services had an average of 361 fewer lost DALYs than nations with inadequate Veterinary Services funding (36), revealing a clear association between adequate Veterinary Services funding and improved food safety.

While involvement of Veterinary Services in national food safety policy and operations is essential, this may largely exclude smallholders and other small-scale producers who rely heavily on informal market chains (37). Therefore, ensuring preparedness for ASF-derived foodborne disease outbreaks by strengthening Veterinary Services funding and capacity for prevention, surveillance and response among smallholders and the markets they serve is essential to improving downstream nutrition outcomes.

International- and national-level Veterinary Services can also have an important local effect on smallholders by improving resilience against shocks and stresses such as large-scale disease outbreaks or droughts. Enhanced resilience increases ASF stability in communities and along market chains (26). Deficits in national Veterinary Services organisation, particularly in LMICs, may include inadequacies in biosecurity protocols, vaccination and drug distribution campaigns, animal disease surveillance, animal disease reporting and traceability systems, laboratory capacity and transboundary disease contingency plans (36, 38).

It is also imperative that Veterinary Services be on the frontlines of integrated efforts to uncover and mitigate the drivers of emerging and endemic zoonoses, which may disproportionately affect smallholders with limited access to Veterinary Services and public health systems. A strong association exists between zoonoses, livestock keeping, poverty and hunger. Countries such as India, Nigeria, Ethiopia, Bangladesh and the Democratic Republic of Congo have particularly high densities of poor livestock keepers as well as zoonoses burden (39). A major barrier to

controlling zoonoses is substantial under-reporting of these disease in LMICs, a gap that Veterinary Services must help fill.

Inadequacies in these integrated approaches have significant downstream effects on food chains, with negative consequences for populations that depend on ASFs for their nutritional needs (27). Strengthening of Veterinary Services operations as part of multidisciplinary approaches to livestock and public health helps build short- and long-term resilience to shocks among smallholders, therefore promoting more secure ASF availability to those most at risk for undernourishment.

### **Closing the gaps in nutrition security**

Improving production and availability of ASFs does not necessarily translate into equitable access for those most in need of ASF-based nutrition. It is estimated that the overall global availability of ASFs is sufficient to feed the current human population; however, disparities in access are the underlying driver of food insecurity (4). Access to high-quality ASFs involves a complex web of economic and sociocultural factors, and ASFs tend to be considered luxury goods in low-income countries (40). In these settings, relatively high prices of ASFs compared to other foods are likely linked to supply constraints due to poor productivity (41). Poor smallholders may thus sell off ASFs in order to feed their households with lower-cost starchy staples. The decision of smallholders over which animal products they will either consume or sell is highly household dependent. It is essential that Veterinary Services help optimise smallholders' abilities to make these choices by enhancing the productivity and sustainability of their livestock systems.

In order to ensure that populations at risk for nutrition insecurity benefit from Veterinary Services, access to these services needs to be improved and strategically targeted. Particular emphasis should be placed on smallholders and women in low-resource settings. Smallholders are particularly vulnerable in situations where increasing privatisation of Veterinary Services has resulted in gaps in extension services (4). These gaps make smallholders more vulnerable to devastating disease outbreaks, famine, welfare and food safety concerns, and poor productivity due to insufficient or inefficient inputs.

Additionally, evidence indicates that nutrition outcomes are more likely to be improved when livestock interventions target women (35). In many regions, women are the primary caretakers of small livestock but have more limited access to animal production and health trainings, information about animal disease control measures, and other veterinary extension services (42). Small livestock such as poultry and small ruminants provide a continuous source of eggs or milk

and reproduce quickly, increasing household ASF availability. They also require lower capital investment, survive in harsher conditions and can be sold quickly, generating income and providing added security against acute crises (43). Providing women and other smallholders with access to the appropriate animal health resources as well as public- and private-sector extension services can therefore help increase household and community access to high-quality ASFs.

## **Conclusions**

Animal source foods are essential sources of high-quality nutrition for much of the world's population, particularly those most vulnerable to food insecurity and undernutrition. Veterinary Services are a key contributor on this pathway from livestock production to positive nutrition outcomes. It is critical that the design of Veterinary Services take into consideration a nutrition-sensitive lens and the global movement toward more sustainable diets and food systems (27, 44).

Efforts to strategically close gaps in Veterinary Services in LMICs are integral to improving human and animal health as well as mitigating environmental impacts at a global level. These gaps are largely context specific and may extend to animal welfare, production efficiencies for mixed and extensive livestock systems, public funding of Veterinary Services, food safety, resilience against shocks and stresses, zoonotic disease preparedness and more. Smallholders and women should be targeted as they are most vulnerable to poverty and malnutrition and also provide much of the ASFs to the world's poor.

National and local Veterinary Services programming with defined nutrition objectives should be implemented using an integrated approach that is sensitive to the local context. Such an approach may include interdisciplinary training and response at the national level, incorporation of nutrition education into animal health services, and improvement in access to public and private extension services targeted at women, smallholders and populations vulnerable to malnutrition.

Finally, investigators in the Veterinary Services field should be actively involved in multidisciplinary research efforts to continue building evidence for the role of ASFs in sustainable healthy diets. Further insights into the constraints facing livestock-based food production systems are critical to informing optimal policies and evidence-based solutions. One Health approaches are vital to an understanding of how Veterinary Services can enhance global nutrition security at all points along the farm-to-fork pathway.

As threats to planetary health such as climate change, pandemics and poverty grow, Veterinary Services are increasingly recognised for the role they play in building a sustainable future. Strengthening Veterinary Services as part of integrated public and One Health efforts will

support enhanced availability of and equitable access to ASF-based nutrition, thus achieving more sustainable healthy diets around the globe.

## Sécurité nutritionnelle mondiale : le rôle des Services vétérinaires

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### Résumé

À mesure que la population mondiale s'accroît, les disparités d'accès à la sécurité nutritionnelle et les effets nocifs pour la santé de la malnutrition s'accroissent, tandis que les évolutions en lien avec la nutrition demeurent en deçà des objectifs. Les auteurs examinent l'importance des denrées alimentaires d'origine animale pour la sécurité nutritionnelle mondiale ainsi que le rôle joué par les Services vétérinaires pour garantir une meilleure disponibilité et un accès équitable à ces denrées.

Dans la première partie de leur article, les auteurs soulignent la valeur nutritionnelle des denrées alimentaires d'origine animale et font le point sur les disparités des structures de consommation dans le monde. Ils expliquent également la base biologique de l'apport nutritionnel des denrées alimentaires d'origine animale ainsi que l'importance de ces dernières à chaque étape de la vie humaine, en analysant les effets négatifs induits tant par la sous-nutrition que par la surnutrition. Dans la deuxième partie, ils examinent les divers rôles des Services vétérinaires le long du processus allant de la production d'animaux d'élevage terrestres à l'obtention de résultats favorables en termes de sécurité nutritionnelle. Leur analyse souligne l'importance des Services vétérinaires dans l'amélioration des performances des systèmes d'élevage extensifs ainsi que leur contribution à la mise en œuvre de méthodes intégrées visant à améliorer la santé et la sécurité des populations humaines et des cheptels. Les auteurs examinent ensuite les écarts entre la disponibilité des denrées alimentaires d'origine animale et la sécurité nutritionnelle, ainsi que l'importance de résorber ces écarts au moyen d'interventions ciblées visant spécifiquement les petits exploitants et les femmes. Les auteurs concluent en recommandant que les Services vétérinaires intègrent des méthodes ciblées et axées sur les priorités nutritionnelles afin que les populations exposées à l'insécurité nutritionnelle puissent accéder de manière plus équitable aux denrées alimentaires d'origine animale, dans le cadre d'une alimentation saine et durable.

### Mots-clés

Alimentation saine et durable – Denrées alimentaires d'origine animale – Petits élevages – Sécurité nutritionnelle mondiale – Services vétérinaires.

## Función de los Servicios Veterinarios de cara a la seguridad nutricional del mundo

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### Resumen

Hoy, a la vez que la población mundial sigue creciendo y que aún quedan lejos las metas de desarrollo vinculadas a la nutrición, se acentúan las disparidades de seguridad nutricional y las negativas consecuencias sanitarias de la malnutrición. Los autores exponen la importancia que revisten los alimentos de origen animal para la seguridad nutricional mundial y las funciones que cumplen los Servicios Veterinarios a la hora de mejorar la disponibilidad de alimentos de origen animal y potenciar un acceso equitativo a ellos.

En la primera sección, los autores exponen el valor nutricional de los alimentos de origen animal y la disparidad existente en el mundo en cuanto a regímenes alimentarios. También presentan la base biológica de una nutrición derivada de alimentos de origen animal, su importancia a lo largo del ciclo vital de las personas y los efectos perjudiciales que tienen tanto la desnutrición como la sobrealimentación. En la segunda sección presentan las diversas funciones que incumben a los Servicios Veterinarios en el proceso que va de la producción de ganado terrestre a la obtención de resultados positivos de seguridad nutricional. Así, destacan la importancia de los Servicios Veterinarios para mejorar la eficiencia productiva de los sistemas de ganadería extensiva, así como su contribución a planteamientos integrados de trabajo que aporten un mayor grado de salud y seguridad a personas y animales. Después exponen el desfase existente entre la disponibilidad de alimentos de origen animal y la seguridad nutricional, así como la importancia de corregir estas deficiencias, apuntando selectivamente a los pequeños productores y las mujeres. A modo de conclusión, formulan recomendaciones para que los Servicios Veterinarios incorporen lógicas de trabajo por objetivos que tengan en cuenta las cuestiones de nutrición, a fin de ayudar a las poblaciones expuestas a la inseguridad nutricional a lograr un acceso más equitativo a alimentos de origen animal como parte de una alimentación sana sostenible.

### Palabras clave

Alimentación sana sostenible – Alimentos de origen animal – Ganado de minifundio – Seguridad nutricional mundial – Servicios veterinarios.

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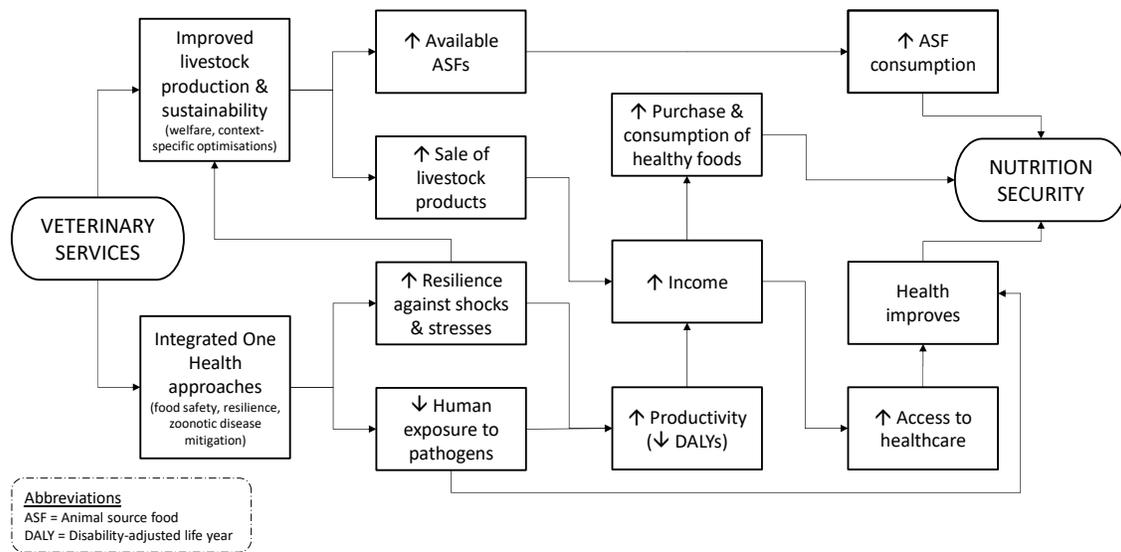
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**Fig. 1**

**Positive impact pathways of Veterinary Services on nutrition security**