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AWARENESS CREATION ON THE IMPORTANCE OF LIVESTOCK DEVELOPMENT IN THE ATTAINMENT OF GLOBAL HEALTH AND SUSTAINABLE DEVELOPMENT GOALS

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ABSTRACT

Livestock (farmed domestic animals) play crucial roles in the attainment of several Sustainable Development Goals (SDGs) of the United Nations. There is also an intricate link between one health (human, animal, and environmental) that is advocated by the World Health Organisation and the Sustainable Development Goals which encompasses environmental, economic, and social issues. Many infectious diseases and new or emerging infectious diseases are zoonotic in origin; this includes the current pandemic known as COVID-19. Animal-source foods will increasingly play a huge role in ensuring basic nutrition and health for humans in the coming years, especially in developing countries where the human population will increase rapidly. Three SDGs (Zero hunger, Good health and well-being, and Responsible consumption and production) will thus be addressed by livestock development. Livestock holds the key to sustainable economic growth, addressing two SDGs (Decent work and economic growth and Industry, Innovation, and Infrastructure). The livestock sector contributes 40% of the Agricultural GDP in developing

countries and the percentage is growing (FAO, 2021). Equitable livelihoods can be achieved by livestock development, covering four SDGs (No poverty, Quality education, Gender equality, and Peace, Justice, and Strong Institutions). Lastly, livestock can help ensure sustainable ecosystems. Six SDGs can be covered (Clean water, Affordable and Clean Energy, Sustainable cities and communities, Climate Action, Life below water, and Life on land). Global livestock development should therefore be given a pride of place, especially considering their envisaged importance in developing countries.

Keywords: Livestock, Sustainable Development, One Health, Developing countries.

INTRODUCTION

One Health typically recognises the importance of human health and its inter-relatedness to the health of animals and that of the environment. The broad definition of one health encapsulates it as the collaborative effort of multiple disciplines working locally, nationally, and globally to attain optimal health for people, animals, and the environment. The phrase, 'one health' as presently used traces its origin to a story about Ebola haemmorhagic fever written by a certain Washington Post journalist, Rick Weiss who himself quoted William Karesh on April 7, 2003. The first known formal organ under which 'one health' came is the One Health Commission, a non-profit organization based in the U.S. (Eussen *et al.,* 2017). This was created out of the joint effort of leaders from multiple disciplines. Organisations such as American Medical Association (AMA), American Veterinary Medical Association (AMVA), the UC Davis one health institute, the United States Department for Agriculture (USDA), the Centre for Disease Control and Prevention (CDCP) the National Oceanic and Atmospheric Administration (NOAA), the American Society for Tropical Medicine and Hygiene (ASTMH) and U.S. National Environmental Health Association are actively backing the movement (Eussen *et al*., 2017).

It is pertinent at this juncture to point out the fact that some similarities exist between One Health and sustainable development goals. Firstly, both are global in outlook, secondly, collaboration (galvanization of local actions) is required for their effective achievement. Thirdly, they are geared towards ecosystem balance. Again, they are relatively new phrases but old concepts. For instance, the recognition that environmental factors can impact human health is traceable to Hippocrates (C.460BCE-C.370BCE), the father of modern medicine. Most of the laws bordering on ceremonial cleanliness handed over unto the Israelites by God as recorded in the Bible took 'one health' into cognizance. Some of these had to do with the manner of meat preparation before consumption, the

kinds of meat that could not be eaten, and environmental cleanliness among others (Exodus 19:10; Leviticus 11: 3-4, 27-28). This is one of the reasons Jews do not consume pork as the pig is considered an unclean animal. Likewise, the sustainable development goals are successor goals to the millennium development goals so to speak. Far beyond this, however, the SDGs encompass the three pillars of sustainability (economic, social, and environmental respectively). Sustainability is a compound word comprising 'sustain' and 'ability'; the former means to support something by holding it firmly from below while the latter speaks to the natural tendency to do something successfully or well.

Role of Livestock in the attainment of the SDGs

In a broad sense, livestock can be defined as animals kept by humans for a useful or commercial purpose. As put forward by Wright (2017), livestock bears a significant correlation with the 17 SDGs grouped under four clusters. These are Livestock and inclusiveness, sustainable economic growth (Goals 8 and 9 respectively), Livestock and equitable livelihoods (Goals 1, 4, 5, 10, and 16 respectively), Animal-source foods for nutrition and health (Goals 2, 3, and 12), Livestock and sustainable ecosystems (Goals 6, 7, 11, 13, 14, and 15 respectively). Each of these requires the building of partnerships which covers goal 17. The first sustainable development goal states clearly: 'End poverty in all its form everywhere'. If the roles played by livestock in the economies of developing nations, particularly and developed countries generally are undermined, realizing the aforementioned worthwhile objective might be impracticable. In low and middle-income countries, an estimated 750 million people rely on small-scale livestock farming to earn a living. This kind of farming (often referred to as smallholder livestock keeping) contributes a huge 40% to the Agricultural Gross Domestic Product in these countries and that proportion is steadily rising. About 70 % of the animal milk consumed by humans in India and Kenya comes from small-scale livestock farming. The second goal: 'End hunger, achieve food security and improved nutrition and promote sustainable agriculture' will only be realized by putting into proper consideration the role of livestock in sustainable agriculture and food production. It is important to restate the fact that animal agriculture makes small-scale food production viable and renewable on every continent. Over a hundred million people who do not own land keep livestock (Mbow *et al*., 2019). Small-scale mixed crop and livestock farms in developing countries are responsible for putting more than half the grain, milk, and meat on the tables of the poor and better-off alike. Half of the staple cereal food would not have been produced without inputs from animal manure, traction, or sales. There are multiple roles that animal agriculture plays in the hands of small-scale mixed crop and livestock

farmers in ensuring food security and sustaining agricultural production. For instance, they provide 18% of global energy (Kcal) consumption and 25% of global protein consumption. They also provide a source of regular income with which to buy diverse and nutritious foods. From animal manure, one-quarter of the nitrogen used to grow crops in mixed crop-livestock systems worldwide is obtained. The rapid transition that these livestock production enterprises will undergo in the coming decades means they also present the biggest (and perhaps only) opportunity to address the three interlinked high-level recommendations made in the recent livestock report by the UN Committee on World Food Security (Thornton, 2010). These are: improving resource use efficiency, strengthening resilience, and improving social equity/responsibility outcomes.

The third SDG states thus: 'Ensure healthy lives and promote well-being for all at all ages'. Livestock will help to rapidly achieve this noble goal because animal-source foods make a significant lifelong difference to the world's most vulnerable people, including the growth and cognitive development of children (FAO, 2018). Animal-source foods provide humans with vital micronutrients (particularly B12) and make other essential nutrients much more 'bioavailable' than plant foods. A regular glass of milk, a little meat, or an egg can prevent stunting in the 158 million children currently affected by it as well as improve the cognitive development of children, ultimately greatly benefiting the economies of their nations (FAO, 2018). Eminent nutritional scientists studying the roles of animal-source foods in the first 1000 days of life warn that it will be impossible to reach the 1000-day SDG targets without including animal-source foods (Grace *et al*., 2018). As a result of their perishability, milk, meat, and eggs do present particular food safety challenges, especially as up to 90% of these foods are sold in the so-called 'informal' markets of the developing world. This again is an opportunity: novel training and hygiene approaches suited to these traditional markets can make an immense difference to the safety of their products (Grace *et al*., 2018). In East Africa's Kenya and India's state of Assam, over 6 million people have access to safer milk today not because stricter rules and regulations were applied but rather because informal milk processors and sellers were given the training and tools to do so much more safely. Women make up a significant portion of the world's poor livestock keepers and by implication, they (livestock) play unique roles in women's lives (FAO, 2018). This presents a good window of opportunity for achieving gender equality and empowerment for all women and girls (Goal 5). Women who cannot own land, capital, or other major productive resources often can own farm animals, particularly small stock such as goats, chickens, and cavies (ILRI, 2018). The benefits

women in developing countries get from their livestock enterprises tend to be invested back into feeding their families and educating their children. A woman's regular income from dairy or poultry often pays for the education of her daughters. Evidence indicates that women's empowerment is hurt rather than helped if men are left out of the picture (ILRI, 2018). Therefore, gender-sensitive and transformative approaches to livestock development need to focus on men as well as women while supporting women in building their social as well as economic capital.

Role of Livestock in Achieving One Health

One Health evolved from the recognition that an interdisciplinary approach is required to understand complex health problems and that the health of humans as well as animals is inextricably linked. In addition, we live in a world that is rapidly changing, complex, and progressively more interconnected than ever before (Yitayih, 2017). For instance, the global human population has slightly exceeded 7 billion, with an estimated 30 billion food animals needed to help feed this population and meet its growing demand for protein from animal sources. This convergence of people, animals, and the environment has created a new dynamic concept in which the health of each group is profoundly and inextricably linked and elaborately connected (AVMA, 2008). Inherent in this new dynamic is the changing interface between people and animals, including animal products. Diamond (2002) popularized the argument that close contact with livestock differentially improved human immunity to zoonotic diseases, in turn providing advantages to some cultural groups. Livestock keeping is critical for many of the poor people resident in the developing world, often contributing to multiple livelihood objectives and offering pathways out of poverty. The positive effects of livestock keeping include increased access to nutritious animal-source foods such as milk, meat, and eggs in households owning animals, and higher household cash incomes that increase purchase power for food crops, healthcare, and education. Consumption of animal source foods provides high-quality protein, essential structural fats, and highly bioavailable essential micronutrients (zinc, iron, calcium, vitamin A, vitamin B-12) that are strongly associated with improved growth, health, and cognitive ability of children (Lannotti and Lesorogrol, 2014) and increased resistance to and recovery from infectious diseases (Hughes and Kelly, 2006). All of these have multiplier effects at the community level through better-nourished children becoming more intelligent, healthier, and more productive adults (Randolph *et al*., 2007). It will be out of place though to imply that there are no negative effects of livestock ownership that may worsen human health and nutritional status. The negative effects associated with livestock keeping may include the risk of transmission of zoonotic pathogens from

animals to humans e.g. anthrax, leptospirosis, trypanosomiasis, and rabies, - many of which are neglected (Mableson *et al*., 2014). Also included are food-borne diseases cysticercosis, taeniasis, cryptosporidiosis, brucellosis, development of antimicrobial resistance, and chronic diseases such as cardiovascular disease, cancers, and diabetes associated with excessive consumption of the energy-dense high-level saturated animal source foods (Mableson *et al*., 2014).

In a study by Thumbi *et al*. (2015) to obtain syndromic disease data in animals along with economic and behavioural information for 1500 rural households in Western Kenya, data showed that 93 % of the household owned at least one form of livestock. Digestive disorders, mainly diarrhea episodes, were the most common syndromes observed in cattle, goats**,** and sheep, accounting for 56 % of all livestock syndromes, followed by respiratory illnesses (18 %). In humans, respiratory illnesses accounted for 54 % of all illnesses reported, followed by acute febrile illnesses (40 %) and diarrhea illnesses (5 %). While controlling for household size, the incidence of human illness increased 1.31-fold for every 10 cases of animal illness or death observed (Thumbi *et al*., 2015). Access and utilization of animal-source foods such as milk and eggs were positively associated with the number of cattle and chickens owned by the household. Additionally, health care seeking was correlated with household incomes and wealth, which were in turn correlated with livestock herd size (Thumbi *et al*., 2015). Data obtained from this study helped in gaining an understanding and quantification of the pathways by which human health and welfare are linked to animal health; providing a platform for testing hypotheses related to one-health including scientific inquiries focusing on specific diseases, co-infections**,** and their interactions.

The COVID-19 pandemic further raises questions about the role that interactions between humans and animals play in the context of widespread social distancing and isolation measures. Although the exact source of the current outbreak of COVID-19 is not yet known, it is widely accepted that the spread originally came from an animal, likely a bat (El Sayed and Camel, 2021). Researchers are opening up more information about this virus, and it is now known that it can spread from people to animals in some situations, especially during close contact. People with suspected or confirmed COVID-19 have been advised to avoid contact with animals, including pets, livestock, and wildlife (CDC, 2021). Some of the species that have been noticed to be infected with SARS-CoV-2 are cats and dogs, big cats in zoos or sanctuaries, gorillas in zoos, mink on farms, and a few other mammals. The list is currently inexhaustive, however, pigs can also host coronaviruses. In 2018, researchers described a new bat coronavirus that had killed some 25,000 pigs in southern China.

According to Petrovan *et al.* (2021), the COVID-19 pandemic has alerted the world to risks posed by emerging diseases of zoonotic origin and has prompted widespread concern and interest in acting to prevent future similar pandemics. The rate of zoonotic pathogen emergence reveals that human-induced changes have brought wildlife, livestock**,** and humans into closer and more frequent contact (Morse *et al*., 2012). The proximity of different wild and domestic animal species in a wildlife market setting may enable recombination between more distant coronaviruses and the emergence of recombinants with novel phenotypes (Li *et al*., 2020). This is particularly relevant given that multiple relatives of SARS-CoV-2 and SARS-CoV (the cause of the 2003 SARS epidemic) circulate in wildlife species in Southeast Asia and southern China (Zhou *et al*., 2021). Preventing such situations as well as reducing direct human contact with wild animals appears critical for preventing new coronavirus zoonoses.

One of the sub-sectors in Nigeria's Agribusiness space that bore the brunt of COVID-19 the most is the Poultry industry. This resulted in a sudden glut, panic sales disrupted business cycles for medium and large-scale poultry farmers among others. It is a well-known fact that as much as 60-70 % of production cost in this industry is attributable to feed and maize as a key component of this constitutes about 40-50 % of the cost (Dei, 2017). The national production of 11.5 million metric tonnes (FAO, 2021) in the year, 2020 was insufficient to meet industry needs; and this was worsened by the Federal Government's ban on maize importation in August 2020. There was the added burden of restricted capacity of farmers to purchase key inputs as the lockdown order was effected to the letter in five of the six south-western states in Nigeria. In Oyo State where movement was permitted in the daytime, there was some ease for farmers but varying levels of difficulties were experienced by different farmers depending on their scale of operation. As a result of these constraints poultry farmers faced, a survey was designed to assess the extent of losses farmers experienced and their attendant coping strategies. This was premised on the fact that should another public health emergency occur in the future, insights gained from this would be used to better plan and effectively tackle it.

A structured questionnaire was designed and shared among residents of various south-western States of Nigeria totaling 2, 011 who are involved in Poultry Farming to varying intensities. Out of this number, only 1, 971 were completed. The consent of respondents was sought before obtaining information and the exercise's purpose was expressly stated. An agreement was reached with each respondent that the identity would not be disclosed during or after the study.

The distribution of this questionnaire was done over six months, November 2020-April 2021. The questions therein were grouped under four different headings viz:

Demography, Level of awareness of respondents about COVID-19 Effects of COVID-19 on respondents and Respondents' strategies for coping with COVID-19. Collated questionnaires were analysed using descriptive statistics.

RESULTS AND DISCUSSION

Table 1 shows that based on demography, males (64.20 %) accounted for a significantly ($P<0.05$) higher number of respondents than females. This might be due to the capital-intensive nature of the poultry sector as it is the most capitalized sector of the livestock sector in Nigeria (Heise *et al*., 2015**).**

Table 1: Gender of Respondents

Gender	Number	Percentage (%)
Male	1, 273	64.6
Female	698	35.4

Source: Field Survey conducted by Jimoh and Oyeniyi (2021)

Table 2 shows that the most practiced value chain enterprise in the poultry sector was production, with more than half (69.8 %) of respondents engaged in it. Other value chains that respondents engaged in were poultry feed production (11.9 %), poultry product processing (5.6 %), poultry production, marketing and sales (9.5 %), poultry input suppliers (1.6 %), and poultry extension agents (1.1 %). The high number of respondents involved in production might be because this has traditionally been the most well-known value chain and its seemingly low entry point compared to feed production or product processing **(**NEA, 2020).

Table 2: Respondents Involved in Poultry Value Chains Enterprises

Poultry Value Chain	Number of respondents	Percentage (%)
Poultry production	1, 375	69.8
Poultry feed production	235	11.9
Poultry product processing	110	5.6
Poultry production, marketing and sales	188	9.5
Poultry input suppliers	32	1.6
Poultry extension agents	22	1.1

Source: Field Survey conducted by Jimoh and Oyeniyi (2021)

Table 3 shows that 1, 971 respondents were involved; 41.8 % were subsistent poultry farmers, while 58.2 % practiced commercially. Since several respondents were exclusively or partly engaged in poultry production, a flock size of less than 100 was classified as subsistent. It is instructive to note that up to 80 % of those involved in poultry production in Nigeria and many sub-Saharan African countries reside in rural households under extensive or semi-extensive systems, contributing substantially to egg and meat production.

Table 3: Demography on scale of operation of respondents' enterprise

Scale of Operation	Number	Percentage (%)
Subsistent	823	41.8
Commercial	1148	58.2

Source: Field Survey conducted by Jimoh and Oyeniyi (2021)

Table 4 below shows that nearly half (45.6 %) of respondents made direct sales to customers while 16.5 % sold to canteens and quick-service restaurants. Another 17.5 % sold to retailers while 20.4 % sold to wholesalers. The convention is for most poultry farmers to be linked with ready markets or off-takers who are often processors (NEA, 2020)

Table 4: Demography on Marketing/Sales Channels of Respondents

Marketing/Sales Channel	Number	Percentage (%)
Direct sales to consumers	899	45.6
Sales to canteen/restaurants	325	16.5
Sales to retailers	344	17.5
Sales to wholesalers	403	20.4

Source: Field Survey conducted by Jimoh and Oyeniyi (2021)

The level of awareness about the pandemic among respondents was generally high as nearly all respondents (96.7 %) were aware that COVID-19 was declared as a pandemic by the World Health Organisation (WHO) early in 2020, while just 3.3 % were unaware of the development. In addition, 94.9 % of respondents knew that COVID-19 is a viral disease while 5.1 % did not know about this. Also, 92.8 % of the respondents believed that COVID-19 spread through respiratory droplets in the air from coughing and sneezing while just 7.2 believed otherwise. The majority of the respondents believed that COVID-19 can be contacted through physical contact such as shaking hands and hugging infected persons; 88.9 % of them believed that COVID-19 can be contacted through these means while just 11.1 % believed that COVID-19 cannot be contacted through physical contact. Again, 89.6 % reported that the use of face masks, observing personal hygiene**,** and social/physical distancing was effective in preventing COVID-19 while 10.4 % claimed that the use of face masks, observing personal hygiene**,** and social/physical distancing was not effective in preventing COVID-19.

More than half of the respondents (67.75 %) had been observing biosecurity measures before the coronavirus while 32.3 % did not adhere fully to biosecurity measures before coronavirus disease emergence. Quite surprisingly, about 56.6 % of respondents reported that there was no disease outbreak on the farm before the onset of the pandemic while 43.4 % experienced one disease outbreak or the other on their farms before COVID-19. Of the proportion involved in livestock production, 57.2 % of respondents reported improvement in their livestock production over the past 3 months, while 21.4 % did not experience any change in livestock production, 15.7 % experienced retrogression in their livestock production**,** and 5.7 % did not observe any significant difference or simply did not know.

Respondents reported a high loss of animals through shortage of feed (36.4 %), while 26.6 % indicated that lack of access to veterinary service accounted for losses; another 20.6 % of respondents claimed that disease incidence was responsible for loss of animals while 13.1 % affirmed that losses were due to theft. Thus, during COVID-19, animal loss was mostly caused by feed shortages. This is quite understandable because of the restricted vehicular and human movements. Feed shortage topped the three critical factors responsible for poor animal welfare in a similar study conducted in Central Punjab, Pakistan (Hussain *et al*., 2020).

As seen in Table 5, a large proportion of the respondents involved in one value chain or the other in the poultry sector experienced some form of downturn or the other. For instance, 40.4 % of respondents reported a decrease in income while 31.1 % reported severe feed shortage, 2.1% were displaced, 5.5 % experienced social isolation**,** and another 2.9 %, ill-health. Also**,** 4.3 % reported having been in a state of constant fear while 9.5 % reported severe animal loss, 2.2 % reported a rise in criminal activities around their farms**,** and 2 % were said to have been affected in other ways.

Table 5: Effect of COVID-19 on the livelihood of different categories of poultry farmers in S/West Nigeria

Effect on Poultry Farmers	**Number of Farmers Affected**	**Percentage (%)**
Decrease in income	796	40.4
Food shortage	612	31.1
Displacement	42	2.1
Social isolation	109	5.5
Ill health	57	2.9
Constant fear	85	4.3
Livestock loss	187	9.5
Increased crime	44	2.2
Others	39	2.0
Decrease in income	796	40.4

Source: Field Survey conducted by Jimoh and Oyeniyi (2021)

About 70.2 % of respondents noticed a change in their enterprise's operation before COVID-19, while 29.8 % did not notice a change in their enterprise's operation before COVID-19. During COVID-19, 75.7 % of the respondents noticed a change in their enterprise's operation, while 24.3 % did not notice a change. Most of these changes were said to be negative such as high feed cost, low sales, reduced access to physical cash, etc. The main positive change some respondents reported was increased attention paid to the birds. Furthermore, the pandemic-induced lockdown adversely restricted access of respondents to feed, vaccines, and other materials as a large number (78.1 %) experienced one or more of these while 21.9% reported that the lockdown did not adversely restrict their access to feed, vaccines, and other materials. Several researchers (Hussain *et al.*, 2020; Uyanga *et al*., 2021) reported that farmers generally had restricted access to essential supplies such as feed and veterinary services, among other inputs. Respondents devised various means of coping with the pandemic, and this took on various forms, such as self-protection from contracting the viral disease, as seen in Table 6 below. They resorted to isolation (14.8 %), social distancing (30.9 %), spiritual reinforcement (3.1 %), use of nose masks and hand sanitizers (50 %) and others (1.1 %).

Table 6: Respondents' means of self-protection from contracting COVID-19

Health Protective measures	Number of Respondents	Percentage (%)
Isolation	292	14.8
Social distancing	610	30.9
Spiritual reinforcement	61	3.1
Use of nose masks and hand sanitizers	986	50
Others	22	1.1

Source: Field Survey conducted by Jimoh and Oyeniyi (2021)

An aggregate of 83.9 % of respondents sometimes used their vehicles as mobile markets for the sale of farm produce during the lockdown while 16.1 % never adopted mobile marketing for their products. In like manner, 83.6 % of respondents sometimes employed social media for marketing

purposes during the lockdown while 16.3 %, did not resort to such a marketing form. Also, 70.3 % of respondents reported sometimes reducing the price (s) of farm produce to make quick sales while 21.5 % always reduced prices and 8.2 % did not reduce the price at all. About 51.5 % of respondents sometimes preserved farm products for the post-lock-down period, 31.0 % always preserved their farm products while 17.2 % did not preserve farm products. Uyanga *et al*. (2021) reported in another study that poultry product supply chains were disrupted during the lockdown and it is therefore unsurprising that respondents had to find unconventional means of marketing their products. Another 54.3 % of the respondents sometimes provided incentives in the form of palliatives for farmworkers to encourage them during the lockdown, while 28.9 % always provided such incentives and 16.8 % did not provide any incentive. In a bid to further cope, 74.1 % of respondents acquired a livestock insurance policy to cushion the negative effect(s) of the pandemic while 25.8 %, did not acquire a livestock insurance policy.

Promoting Public Understanding

It is perhaps surprising that One Health has gained so little mainstream traction among biomedical professions. This is despite a succession of global disease problems such as highly pathogenic avian influenza, severe acute respiratory syndrome, Ebola haemorrhagic viral disease, and Bovine spongiform encephalopathy which all had their origins in animal populations and are linked with agro-ecological change (Rahman *et al.*, 2020). A possible explanation is that separate animal and human health agencies responsible for disease prediction, prevention, and control have been embedded in many developed countries since the 19th century with institutional barriers impeding horizontal collaboration. The resulting gulf between human and animal health, caused by disciplinary conventions and cultures rather than scientific rationale has divided medicine in two (Kamani *et al.*, 2015). In Africa however, where people's lives are intimately related to the health and productivity of livestock and the natural environment, the situation is different. National medical and veterinary institutions are still maturing, which presents African health professionals with an opportunity to build on an instinctive understanding of the connectivity between people, animals, and their environments, and to 'leapfrog' barriers imposed by more well-established and rigid institutional systems. If this succeeds, African scientists and African institutions have the opportunity to become world leaders in One Health (Kamani *et al*., 2015).

In the agricultural sector, information is one of the major resources to increase food production, and effective information delivery service greatly enhances agricultural development. However, in

a situation where information about new methods of production rarely reaches peasant farmers, the majority of whom have very little or no formal education, it becomes necessary to adopt alternative methods to adequately meet these demands. Such an approach should provide the information needed to solve their problems, and also motivate them to accept changes and adopt improved practices (Sam, 2011). Peasants are largely involved in the bulk production of food (crops and livestock) in developing countries. Their inability to sustain increased food production levels over the years can be attributed to factors such as the lack of reliable information that will help them adjust their farm management practices. To overcome this problem, they have to be provided with the requisite knowledge to enable them to increase their output, and thereby increase their earnings from farming activities. A blend of indigenous communication tools such as village debates, town criers, traditional musicians, and exchange visits as well as information communication technologies such as computers, internet and mobile phones, newspapers, radio, television, and landline telephony will help address this gap. Furthermore, efforts should be made to ensure wild-life farming is safe and legal, whilst also putting in place measures to reduce wildlife–livestock–human interfaces in and around farms and wild places. Also, animal hygiene and health standards for livestock and farmed wild animal production should be significantly increased. This is in addition to enforcing biosecurity on livestock farms through routine surveillance.

Sustainable livestock production will require the long-term application of a One Health approach with its focus on mitigating health risks at the interfaces between animals and humans in different ecosystems. It will stimulate the joint working of multiple interests in pursuit of most of the sustainable development goals.

REFERENCE

AVMA (2008). American Veterinary Medical Association. One health: a new professional imperative. One health initiative taskforce final report pg 3; published July 15, 2008. https://www.avma.org/sites/default/files/resources/onehealth_final.pdf.

CDC (2021). Animals and COVID-19. Article by Centre for Disease Control and Prevention, 1600 Clifton Road, Atlanta, GA 30329 USA, Accessed via https://www.cdc.gov/coronavirus/2019-ncov/daily-life-coping/animals.html.

Dei, H. K. (2017). Assessment of maize (*Zea mays*) as feed resource for poultry. *Intech Open. Poultry Science* 3 http://dx.doi.org/10.5772/65363.

Diamond, J. (2002). Evolution, consequences and future of plant and animal domestication. *Nature* 418: l-707 In: Randolph, T. F., Schelling, E., Grace, D., Nicholson, C. F., Lerry, J. Cole, D. C., Demment, M. W., Omore, A., Zinstang, J. and Ruel, M. (2007). Invited review: role of livestock in human nutrition and health for poverty reduction in developing countries. *Journal of American Science*, 85 (11) 2788-2800.

El Sayed, A., Camel, M. (2021). Coronaviruses in humans and animals: the role of bats in viral evolution. *Environmental Science Pollution Research Intenational*. 28(16): 19589–19600.

Eussen, G.M., Schaveling, J., Dragt, M. J., Blomme, R. J. (2017). Stimulating collaboration between human and veterinary health care professionals. *BMC Veterinary Research*. **13** (1): 174. doi:10.1186/s12917-017-1072 x.ISSN17466148. PMC 5470326. PMID 28610617

FAO (2018). World Livestock: Transforming the livestock sector through the Sustainable Development Goals. Rome. Pg 158. Licence: CC BY-NC-SA 3.0 IGO.

FAO (2021). Food and Agricultural Organisation. GIEWS - Global Information and Early Warning System for Nigeria, Reference Date January 04, 2021. http://www.fao.org/giews/countrybrief/country.jsp?code=NGA

Grace, D., Dominguez-Salas, P., Alonso, S., Lannerstad, M., Muunda, E., Ngwili, N., Omar, A., Khan, M. and Otobo E. (2018). *The influence of livestock-derived foods on nutrition during the first 1,000 days of life*. ILRI Research Report 44. Nairobi, Kenya: International Livestock Research Institute (ILRI).

Kamani, T. M., Kazwala, R., Mfinanga, S., Haydon, D., Keyyu, J., Lankester, F. and Buza, J. (2015). One health: a concept led by Africa, with global benefits. *Veterinary Record*, 496.

Heise, H., Crisan, A., and Theuvsen, L. (2015). The Poultry Market in Nigeria: Market Structures and Potential for investment in the Market. *International Food and Agribusiness Management Review* 18:1.

Hussain S., Hussain A, Ho J., Sparagano O.A.E., and Zia U-u-R (2020). Economic and Social Impacts of COVID-19 on Animal Welfare and Dairy Husbandry in Central Punjab, Pakistan. *Front. Vetenary Science 7:589971.doi: 10.3389/fvets.2020.589971*

ILRI (2018). International Livestock Research Institute Bulletin, *Livestock and Gender*. March 2018.https://cgspace.cgiar.org/bitstream/handle/10568/92869/gender_PP.pdf?sequence=3 &isAllowed=y.

Lannotti, L and Lesogrol, C. (**2014**). Animal milk sustains micronutrient nutrition and child anthropometry among pastoralists in Samburu, Kenya. *American Journal of Physiology and Anthropology, 155 (1):66.* doi:10.1002/ajpa.22547.

Kamani, T. M., Kazwala, R., Mfinanga, S., Haydon, D., Keyyu, J., Lankester, F., Buza, J. (2019). One Health: a concept led by Africa, with global benefits *Vet. Research.* 176(19): 496–497.

Li, X., Giorgi, E. E., Marichannegowda, M. H., Foley, B., Xiao, C., Kong, X. P., Chen, Y., Gnanakaran, S., Korber, B. and Gao, F. (2020). Emergence of SARS-CoV-2 through recombination and strong purifying selection. *Science Advances,* 6:153

Mableson, H. E., Okello, A., Picozzi, K., Wellburn, S. C., (2014). Neglected zoonotic diseases – the long and winding road to advocacy. PLoS. Neglected Tropical Diseases. 8 (6): 2800. https://doi.org/10.1371/journal.pntd.0002800

Mbow, C., Rosenzweig, C., Barioni, L.G., Benton, T.G. , Herrero, M. Krishnapillai, E. Liwenga, P. Pradhan, M.G. Rivera-Ferre, T. Sapkota, F.N. Tubiello, Y. Xu, (2019). Food Security. In: *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems* [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D.C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley (eds.).

Morse, S. S., Mazet, J. A., Woolhouse, M., Parrish, C. R., Caroll, D., Karesh, W. B., Zambrana-Torrelio, C., Lipkin, W. I. and Daszak, P. (2012). Prediction and prevention of the next pandemic zoonosis. *The Lancet* 380, 1956– 1965.

NEA (2020). Netherlands Enterprise Agency; Poultry Sector Study in Nigeria, pgs. 13 & 36. Publication number: *RVO 153-2020/RP-INT.*

Petrovan, S. O., Aldridge, D. C. Bartlett, H., Bladon, A. J., Booth, H., Broad, H., Broom, D. M., Burgess, M. D. Cleaveland, S., Cunningham, A. A. Ferri, M., Hinsley, A., Hua,F., Hughes, A. C., Jones, K., Kelly, M., Mayes, G., Radakovic, M., Ugwu, C. A., Uddin, N., Veríssimo, D., Walzer, C., White, T. B., Wood, J. L., Sutherland, W. J. (2021). Post COVID-19: a solution scan of options for preventing future zoonotic epidemics. *Biological Reviews* 2021. doi: 10.1111/brv.12774.

Rahman, T., Sobur, A., Islam, S., Levy, S., Hossain, J., El Zowalaty, M., Rahman, A. T., Ashour, H. M. (2020**).** Zoonotic Diseases: Etiology, Impact, and Control. *Microorganisms* 8(9): 1405.

Randolph, T. F. Schelling, E., Grace, D., Nicholson, C. F., Lerry, J. Cole, D. C., Demment, M. W., Omore, A., Zinstang, J. and Ruel, M. (2007). Invited review: role of livestock in human nutrition and health for poverty reduction in developing countries. *Journal of American Science*, 85 (11): 2788-2800.

Sam, J. (2011). Delivery of information through rural advisory services of Ghana. *Report to the Technical Centre for Agricultural and Rural Co-operation (CTA) of the Netherlands in connection with the external evaluation of the question and answer service.* Pg 29.

Thumbi, S. M., Njenga, M. K., Marsh, T. L., Noh, S., Otiang, E., Munyua, P., Ochieng, L., Ogola, E., Yoder, J., Audi, A., Montgomery, J. M., Bigogo, G., Breiman, R. F., Palmer, G. Y., McElwain, T. F. (2015). Linking Human Health and Livestock Health: A "One-Health" Platform for Integrated Analysis of Human Health, Livestock Health, and Economic Welfare in Livestock Dependent Communities. *PLoS One*, 10(3): e0120761. doi: 10.1371/journal.pone.0120761.

Uyanga, A. V., Okanlawon M. Onagbesan, Onwuka, C. F. I., Emmanuel, B. and Lin, H. (2021) Coronavirus Disease 2019 (COVID-19) and Poultry Production: Emerging issues in African Countries, *World's Poultry Science Journal*, 77(1):153-174.

Wright, I. A. (2017). The role of livestock in achieving the Sustainable Development Goals. *25th Anniversary Ethiopian Society for Animal Production.* Haramaya University; 24-26 August; 2017, Pg 7-8.

Yitayih, T. T. (2017). Application and challenges of one health approach in relation to Ethiopian

context. *Journal of Medicine, Physiology and Biophysics,* 31:26-27.

Zhou, H., Ji, J., Chen, X., Bi, Y., Li, J., Wang, O., Tao Hu, T., Song, H., Zhao, R., Chen, Y., Cui, M., Zhang, Y., Hughes, A. C., Holmes, E. C. and Shi, W. (2021). Identification of novel bat coronaviruses sheds light on the evolutionary origins of SARS-CoV-2 and related viruses. *Cell* 184 (17): pg. 4383 DOI: 10.1016/j.cell.2021.06.008