European Journal of

Animal Health

(EJAH)

THE IMPACT OF ANIMAL HEALTH ON HUMAN HEALTH IN EAST AFRICA.A CRITICAL LITERATURE REVIEW.

DANSON NGETHE

UNIVERSITYOF NAIROBI, DEPARTMENT OF ANIMAL HEALTH

Corresponding author's email: journals@ajpojournals.org

Abstract

Purpose: Human health is inexplicably connected to animal health and will continue to do so. However, because of the continued effects they have on each other, there is a need to continually find out the adverse effects this comes with. The general objective of the study was to understand impact of animal health on human health in East Africa and possible strategies to mitigate them.

Methodology: The paper used a desk study review methodology where relevant empirical literature was reviewed to identify main themes and to extract knowledge gaps.

Findings: There is need for concerted efforts to build not only on adopted human adaptation strategies but also help them reduce current vulnerability as well as build future resilience.

Unique Contribution to Theory and Practice: There is need to engage communities to understand their levels of vulnerability and design their own sustainable adaptation action plans. The one health paradigm is gaining currency among natural and social scientists, practicing health professionals and, increasingly, wider society. The concept essentially is that the health of humans, animals and also the environment are inextricably interlinked. It follows therefore that research that impacts on one of these components has the potential to influence all.

Keywords: *Animal health, health impact, human health, contamination, microbes, resistance*

1.0 INTRODUCTION

Human health is growingly being attacked with infections unidentifiable or even previously seen in animals. This trend has always warranted a need to find out how and why animal bacteria and infections are increasingly showing up. There is not much research done in East Africa about the impact animal health has on human health given the strong relationship the people have with the animals.

The usage of pesticides has not only provided an important benefit to agricultural production and crop protection but at the same time played a significant role in prevention and control of vector-borne human and animal diseases. However, the occurrence of pesticide residues in several components of the environment and food commodities has raised grim concerns about their use (Gill, 2020).

The spread of resistant pathogens and resistance genes from food animals to humans has serious implications for the treatment of human infections (Lekshmi, 2017). Many of the antimicrobials administered to food animals are either identical to or related to drugs used in human medicine, including penicillins, tetracyclines, cephalosporins, and fluoroquinolones; many of these drugs are also used to treat foodborne disease in humans (McEwen & Collignon,2018). This is problematic because resistance genes frequently encode resistance not just to a particular antibiotic, but to an entire class of antimicrobials, and some genes may cause cross-resistance to compounds that are structurally diverse (Blanco, 2020). In addition, mobile DNA elements often carry several resistance genes; consequently, the acquisition of a single mobile genetic element may confer resistance towards multiple antimicrobials and resistance to several different antimicrobial drugs may emerge when only one antimicrobial drug is used. Indeed, multidrug resistance among foodborne pathogens and other bacteria is becoming more and more common, threatening our ability to successfully treat certain infections (Garvey,2020).

Antibiotics are mainly employed for chemotherapeutic, prophylactic purposes and also used as feed additives to promote growth and improve feed efficiency (Kumar, Patyal & Panda,2018). However, antibiotic residues in animal products may occur, when administration of drug in extra label fashion and not following of withholding period after treatment. Many of the administered drugs are not completely absorbed from gut and excreted through faeces and urine as either parent compound or its toxic metabolites (Jayalakshmi,2017).

Cattle manure harbors microbial constituents that make it a potential source of pollution in the environment and infections in humans. Knowledge of, and microbial assessment of, manure is crucial in a bid to prevent public health and environmental hazards through the development of better management practices and policies that should govern manure handling (Manyi-Loh, 2016)

The application of manure or farm effluents in agricultural land leads to selection of resistant bacteria, development and transmission of antibiotic resistance genes in the microbes. The antibiotic resistance in animal and human leads to poor response to treatment during illness. The antibiotic residues in animal product causes harmful effect on health and also interfere with the processing of milk and milk products. (Berendsen 2015)

1.2 Statement of the Problem

Livestock industries are growing tremendously along with the human population ensuing in the increase rate of generation of organic residues, which pose problems that warrant strategies for disposal and/or management (Hussein,2021). Agricultural animals, including cattle produce copious quantities of animal manure consisting of animal excreta (feces and urine) along with bedding, microorganisms, process-generated wastewater, secretions (nose, throat, blood, vagina, mammary glands, skin and placenta), undigested and spilled feed, antibiotics, nutrients and fur. In addition, animal manure is known to harbor a wide variety of microorganisms which can be pathogenic or non-pathogenic to both animals and humans (Manyi-Loh, 2016). The levels and types of pathogens occurring in livestock wastes vary with animal species, dietary sources, health status and age of the animals, physical and chemical characteristics of the manure produced as well as the storage facilities of the manure. It is quite unrealistic to enumerate all the microbial pathogens present in cattle manure because of the huge numbers of these pathogens that populate the gastrointestinal tract and the other systems in the animal. Diverse groups of microbial pathogens are involved due to the vast array of physical, chemical and biological constituents contained in cattle manure. (Mamphweli,2016)

There is accumulating evidence that the use of antimicrobials in food-producing animals has adverse human health consequences (Burki, 2018). The use of antibiotics in food animals selects for resistant pathogens and resistance genes that may be transferred to humans through the consumption or handling of foods of animal origin (Sivagami,2020). Recent studies have demonstrated that antimicrobial-resistance among foodborne bacteria may cause excess cases of illness, prolonged duration of illness, and increased rates of bacteremia, hospitalization, and death (Crump, 2015). The continued availability of safe and effective antimicrobials for humans and animals depends upon the responsible use of these products.

Pesticides in freshwater supplies have become a serious and increasingly costly concern with detected levels often exceeding the set limits and also animal feeds are routinely subjected to contamination from diverse sources, including environmental pollution and activities of insects and microbes (Bernardes, 2015). Animal feed may also contain endogenous toxins arising principally from spraying pesticides against pests to strengthen quality competitive aspects of animal products (Anadón, 2018). Feed and fodder offered to animals are often contaminated with pesticide residues] and after feeding, these residues pass through the body systems. The term "feed" is generally used in its widest context to include compound blends of different kind of ingredients as well as forages. With such a broad perspective, it is necessary and more instructive to introduce some focus. The pesticides cover a wide range of compounds including insecticides, fungicides, herbicides, rodenticides, molluscicides, nematicides, plant growth regulators and others (Choudhary, 2018).

Over the past decade, *Clostridium difficile* has emerged as the primary cause of infectious antibiotic-associated diarrhea in hospitalized patients. Unlike other common health care-associated pathogens, *C. difficile* produces resistant spores that facilitate host-to-host transmission and enable long term survival and dispersal in the health care system and the wider environment (Knetsch 2018).

1.3 Objectives of the Study

The general objective of the study was to understand the impact of animal health on human health in East Africa.

1.4 Significance of the Study

This study will help the East African governments and community especially health and environment to better understand how to help the people. It will also help medical practitioners in treatment and advisory services to their clients and in also determining the root cause of some infections.

2.0 LITERATURE REVIEW

2.1 Antimicrobial resistance

The emergence of drug resistance has been observed following the introduction of each new class of antibiotics and repeated exposure to sublethal dose of antibiotics. However, selection of resistant bacteria in the environment could occur, when antibiotic concentration greater than minimum inhibitory concentration. The use of manure for soil fertilization should be considered a main agricultural contributor to environmental contamination and transmission of antibiotic residues, resistant bacteria and resistance genes (Pikkemaat, 2016). Development of antibiotic resistance genes (ARGs) have been commonly reported due to the overuse of antibiotics worldwide. ARGs for tetracyclines and sulphonamides were detected in rice paddy soils fertilized with swine manure in China (Xie, Shen, & Zhao, 2018). The use of antibiotics in food animals selects for bacteria resistant to antibiotics used in humans and these might spread via the food to humans and cause poor response to treatment during illness. Following introduction of fluoroquinolones use in the poultry industry leads to development of fluoroquinolone-resistant strains of Campylobacter jejuni and Salmonella sp, which have isolated from poultry meat (Martins, 2014). Multiresistant Escherichia coli have been evolved by the use of broad-spectrum antimicrobials in both livestock and humans. The development of antimicrobial resistance in E. coli creates problem, because of transmission of antimicrobial resistance genes to next generation. (Berendsen 2015)

2.2 Effect on health

Choudhary (2018) found that influences of pesticide on livestock animals domestic and wild animals may also have adverse effect on the health depending on how and where the compound is used and its persistence after use, but this is usually accidental. Animals can gather these substances from contaminated feed and water. Correspondingly, owing to the lipophilic nature of these pesticides, milk and other fat rich substances are the key items for their accumulation. Koli & Bhardwaj (2018) observed amongst all meat products, greatest contamination was observed in chicken muscle followed by goat and beef collected in Lucknow, India. The cumulative occurrences of pesticide residues in the meat and milk are of a great concern. Higher contents of organo-chlorine pesticide residues have been reported in meat and milk samples collected from different locations of the country. Pests may also develop resistance to pesticides. Pesticides have been associated with serious adverse effects in birds, man and animals like causing carcinogenicity, teratogenicity, immunosuppression embrotoxicity, infertility and birth defects and several others like Hepatotoxicity, Nephropathy, Mutagenicity and Hypersensitivity etc. Pesticides in the environment may play an important role in contributing to underlying causes of fertility problems in dairy livestock. In females the pesticide exposure induced alterations which include poor reproductive behavior, subfecundity, infertility, pregnancy loss, growth retardation, intra-uterine fetal demise and ovarian failure. Certain pesticide residues have the adverse impact of on reproductive system, and such pesticide residues are known as ‘reproductive toxicants’ or ‘endocrine disrupters’. These toxicants modulate or upset reproductive hormone milieu by acting at a variety of sites including hypothalamus, pituitary and reproductive organs. Pesticide residues can be detrimental to male reproductive system by causing toxicity to sperm plasma membrane.

There is ample evidence that human-animal interaction (HAI) is associated with health. In contrast to the distinct animal- and human-associated populations observed for the multidrug-resistant enteric pathogen *Salmonella enterica* serovar Typhimurium strain DT104, Knetsch (2018) demonstrated that *C. difficile* RT078 is a clonal population moving frequently between livestock and human hosts, with no geographical barriers. Although the original reservoir remains unknown, the reciprocal transmission between humans and farm animals emphasizes the importance of a comprehensive One Health perspective in managing and controlling *C.*

difficile RT078. The emergence of *Clostridium difficile* as a significant human diarrheal pathogen is associated with the production of highly transmissible spores and the acquisition of antimicrobial resistance genes (ARGs) and virulence factors. Unlike the hospital-associated *C. difficile* RT027 lineage, the community-associated *C. difficile* RT078 lineage is isolated from both humans and farm animals; however, the geographical population structure and transmission networks remain unknown. (Knetsch 2018)

Most environmental concerns about waste management for farm manure either have focused on the effects of nutrients, especially N and P, on water quality or have emphasized odor problems and air quality. Microbes from manure are often low on the priority list for control and remediation, despite the fact that several out-breaks of gastroenteritis have been traced to livestock operations. The pathogens include protozoans (*Cryptosporidium parvum, Giardia* spp.), bacteria (*Listeria monocytogenes, Escherichia coli* O157:H7, *Salmonella* spp., and *Mycobacterium paratuberculosis*), and some enteric viruses. Clinical symptoms, prospects for zoonotic infection, and control methods other than the use of antimicrobials are considered. Wastewater treatment plant effluent, sludge and manure are the main sources of contamination by antibiotics in the whole environment compartments (soil, sediment, surface and underground water) (Ezzariai, 2018).

Several antibiotic classes are extensively administered to food-producing animals, including tetracyclines, sulfonamides, fluoroquinolones, macrolides, lincosamides, aminoglycosides, beta-lactams, cephalosporins and others. Almost 90% of all antibiotics used in farm animals and poultry are reported to be administered at sub-therapeutic concentrations. About 70% of this is for the purpose of disease prevention and 30% are for growth promotion. The risk of residue from the milk is higher in developing countries compared to develop one. This might be related with lack of facilities for detection and regulatory bodies that control the drug residues level in foods in the form of maximum residue limits (MRLs). The MRL is defined as the maximum concentration of a residue, resulting from the registered use of an agricultural or veterinary chemical that is recommended to be legally permitted or recognized as acceptable in or on a food, agricultural commodity, or animal feed. (Jayalakshmi 2017)

Compounds like Ochratoxin A (OTA) has been shown to be a potent nephrotoxic, hepatotoxic, and teratogenic compound. In farm animals, the intake of feed contaminated with OTA affects animal health and productivity, and may result in the presence of OTA in the animal products. Strategies for the control of OTA in food products require early identification and elimination of contaminated commodities from the food chain (Damiano,2021). However, current analytical protocols may fail to identify contaminated products, especially in animal feed.

Most of the currently used antibacterials are relatively nontoxic, even at higher concentration but, few antibiotics pose a serious public health issue. Antibiotic residues in milk are of great public health concern since milk is being widely consumed by infants, youngster and adults throughout the globe (Bhoomika,2019). The long-term exposure to antibiotic residues in milk may result in alteration of the drug resistance of intestinal microflora (Ngangom,2019). Several antibiotics are potent antigens or act as a haptens and occupational exposure on a daily basis can lead to allergic reactions (Wollenberg,2016). The most of the allergic reactions have been reported against ß-lactam antibiotic residues in milk or meat. It is a one of the hypersensitivity reactions. It may be either IgE-mediated or non IgE-mediated. The IgE-mediated response occurs shortly after exposure to drug. These include urticaria, anaphylaxis, bronchospasm and angioedema. Non IgE-mediated reactions include hemolytic anemia, thrombocytopenia, acute interstitial nephritis, serum sickness, vasculitis, erythema multiforme, Stevens-Johnson syndrome and toxic epidermal necrolysis. Antibacterial agents like tetracyclines, nitrofurans and sulfonamides are widely used as feed additives in cattle feed, which may excrete in milk and sometimes associated with toxicological effects in human (Jayalakshmi 2017). The nitrofurans at higher concentrations cause carcinogenic and mutagenic effects (Mund,2017). Recently Etminan and coworkers reported the risk of retinal detachment in individuals upon continued exposure to fluoroquinolones (Chaudhry,2015). Chloramphenicol is also associated with optic neuropathy and brain abscess with varied intensities and clinical manifestations (Bhoomika,2019). There are two major concerns in the presence of antibiotic residues in milk, meat and egg. One is allergic reaction even at smaller dose, another development of antibiotic resistance and disruption of soil microbial community. Monitoring of antibiotic residues in milk and milk products, meat and meat products, egg, faeces and urine is necessary to safeguard the health of the consumers as well as minimise environmental contamination. (Jayalakshmi 2017)

2.3 Empirical review

Pesticides residue poses serious concerns to human health. Gill 2020, carried out a study to determine the pesticide residues of peri-urban bovine milk (n = 1183) from five different sites (Bangalore, Bhubaneswar, Guwahati, Ludhiana and Udaipur) in India and dietary exposure risk assessment to adults and children. Pesticide residues were estimated using gas chromatography with flame thermionic and electron capture detectors followed by confirmation on gas chromatography-mass spectrometer. The results noticed the contamination of milk with hexachlorocyclohexane (HCH), dichloro-diphenyl trichloroethane (DDT), endosulfan, cypermethrin, cyhalothrin, permethrin, chlorpyrifos, ethion and profenophos pesticides. The residue levels in some of the milk samples were observed to be higher than the respective maximum residue limits (MRLs) for pesticide. Milk samples contamination was found highest in Bhubaneswar (11.2%) followed by Bangalore (9.3%), Ludhiana (6.9%), Udaipur (6.4%) and Guwahati (6.3%). The dietary risk assessment of pesticides under two scenarios i.e, lower-bound scenario (LB) and upper-bound (UB) revealed that daily intake of pesticides was substantially below the prescribed acceptable daily intake except for fipronil in children at UB. The non-cancer risk by estimation of hazard index (HI) was found to be below the target value of one in adults at all five sites in India. However, for children at the UB level, the HI for lindane, DDT and ethion exceeded the value of one in Ludhiana and Udaipur. Cancer risk for adults was found to be in the recommended range of United States environment protection agency (USEPA), while it exceeded the USEPA values for children.

Sultan et al. reported that enrofloxacin residues in liver sample of poultry, sheep and cattle collected from slaughter house of Mousl city, Iraq. Out 30 samples from each species 17 poultry sample, 8 cattle sample and 5 sheep sample exceeded the maximum residue limits (Permitted MRL by European agency 100-300 µg/kg). The concentration of enrofloxacin in liver sample of poultry, cattle and sheep were 10-10690, 30-3610 and 20-1320 µg/kg respectively. This may be heavy use of enrofloxacin in poultry industry to control diseases.

Knetsch (2018) applied whole-genome phylogenetic analysis of 248 *C. difficile* RT078 strains from 22 countries. The results demonstrated limited geographical clustering for *C. difficile* RT078 and extensive coclustering of human and animal strains, thereby revealing a highly linked intercontinental transmission network between humans and animals. Comparative whole-genome analysis reveals indistinguishable accessory genomes between human and animal strains and a variety of antimicrobial resistance genes in the pangenome of *C. difficile* RT078. Thus, bidirectional spread of *C. difficile* RT078 between farm animals and humans may represent an unappreciated route disseminating antimicrobial resistance genes between humans and animals. These results highlight the importance of the "One Health" concept to monitor infectious disease emergence and the dissemination of antimicrobial resistance genes. (Knetsch 2018)

Kimari, (2016) did a pilot study therefore aimed at demonstrating the presence of the bacteria in rodent carriers in Tana River and Garissa counties of Kenya, areas that are characterized by irrigation and pastoral activities respectively. Leptospirosis is a neglected zoonotic disease that disproportionately affects poor populations in the world. Prevalence data in human populations in pastoral communities has been shown to be high. The disease is therefore contributing to an unknown toll on livestock productivity as well as human health in these areas. Rodent populations in irrigated areas of Kenya have also seen a rise and this could lead to an increase transmission of rodent-borne diseases. Kidney and blood samples from 67 rodents previously collected from these areas (mainly mice and multimammate rats) were analyzed using PCR. Prevalence of leptospires in rodent carriers was found to be 41.8% (28/67). Prevalence in the towns was: 16% (4/25) in Bura; 42% (8/19) in Hola; 82% (9/11) in Ijara and 58% (7/12) in Sangailu. Prevalence was found to be influenced with the area of sampling, with rodents from the pastoral areas being more likely to have the bacteria than those from the irrigated areas (Odds Ratio = 6.095). Prevalence showed no association with the species and age of rodents. Sequencing data revealed the species in circulation among rodents is Leptospira interrogans. This pilot study is one of the few to demonstrate the bacteria in rodent carriers in North-Eastern Kenya, which illustrates the underplayed public health importance of the disease in this part of Kenya. The high rodent prevalence of these bacteria poses risk of transmission of the disease in animal and human populations. These results demonstrated the need for policy makers to consider disease emergence and transmission in these marginalized parts of Kenya. More epidemiological knowledge of the disease like circulating serotypes and role of animal hosts in the area will greatly aid in forming public health policy aimed at controlling the disease.

2.4 Research Gaps

A knowledge gap occurs when desired research findings provide a different perspective on the issue discussed. For example Gill 2020, carried out a study to determine the pesticide residues of peri-urban bovine milk (n = 1183) from five different sites (Bangalore, Bhubaneswar, Guwahati, Ludhiana and Udaipur) in India and dietary exposure risk assessment to adults and children. Pesticide residues were estimated using gas chromatography with flame thermionic and electron capture detectors followed by confirmation on gas chromatography-mass spectrometer. The results noticed the contamination of milk with hexachlorocyclohexane (HCH), dichloro-diphenyl trichloroethane (DDT), endosulfan, cypermethrin, cyhalothrin, permethrin, chlorpyrifos, ethion and profenophos pesticides. The residue levels in some of the milk samples were observed to be higher than the respective maximum residue limits (MRLs) for pesticide. Milk samples contamination was found highest in Bhubaneswar (11.2%) followed by Bangalore (9.3%), Ludhiana (6.9%), Udaipur (6.4%) and Guwahati (6.3%). The dietary risk assessment of pesticides under two scenarios i.e, lower-bound scenario (LB) and upper-bound (UB) revealed that daily intake of pesticides was substantially below the prescribed acceptable daily intake except for fipronil in children at UB. The non-cancer risk by estimation of hazard index (HI) was found to be below the target value of one in adults at all five sites in India. However, for children at the UB level, the HI for lindane, DDT and ethion exceeded the value of one in Ludhiana and Udaipur. Cancer risk for adults was found to be in the recommended range of United States environment protection agency (USEPA), while it exceeded the USEPA values for children. This presents a geographical gap as it specifically targets India and our research is targeting East Africa.

Kimari, (2016) did a pilot study therefore aimed at demonstrating the presence of the bacteria in rodent carriers in Tana River and Garissa counties of Kenya, areas that are characterized by irrigation and pastoral activities respectively. Leptospirosis is a neglected zoonotic disease that disproportionately affects poor populations in the world. Prevalence data in human populations

in pastoral communities has been shown to be high. The disease is therefore contributing to an unknown toll on livestock productivity as well as human health in these areas. Rodent populations in irrigated areas of Kenya have also seen a rise and this could lead to an increase transmission of rodent-borne diseases. Kidney and blood samples from 67 rodents previously collected from these areas (mainly mice and multimammate rats) were analyzed using PCR. Prevalence of leptospires in rodent carriers was found to be 41.8% (28/67). Prevalence in the towns was: 16% (4/25) in Bura; 42% (8/19) in Hola; 82% (9/11) in Ijara and 58% (7/12) in Sangailu. Prevalence was found to be influenced with the area of sampling, with rodents from the pastoral areas being more likely to have the bacteria than those from the irrigated areas (Odds Ratio = 6.095). Prevalence showed no association with the species and age of rodents. Sequencing data revealed the species in circulation among rodents is Leptospira interrogans. This pilot study is one of the few to demonstrate the bacteria in rodent carriers in North-Eastern Kenya, which illustrates the underplayed public health importance of the disease in this part of Kenya. The high rodent prevalence of these bacteria poses risk of transmission of the disease in animal and human populations. These results demonstrated the need for policy makers to consider disease emergence and transmission in these marginalized parts of Kenya. More epidemiological knowledge of the disease like circulating serotypes and role of animal hosts in the area will greatly aid in forming public health policy aimed at controlling the disease. This however presents a critical research gap as it concentrated on rodents specifically while the greater threat is from farm animals that humans are mostly in contact with.

3.0 METHODOLOGY

The study adopted a desktop literature review method (desk study). This involved an in-depth review of studies related to impact of animal health on human health in East Africa. Three sorting stages were implemented on the subject under study in order to determine the viability of the subject for research. This is the first stage that comprised the initial identification of all articles that were based on impact of animal health on human health in East Africa. The search was done generally by searching the articles in the article title, abstract, keywords. A second search involved fully available publications on the subject on impact of animal health on human health in East Africa. The third step involved the selection of fully accessible publications. Reduction of the literature to only fully accessible publications yielded specificity and allowed the researcher to focus on the articles that relay the impact of animal health on human health in East Africa which was split into top key words. After an in- depth search into the top key words (Animal health impacts, human health, contamination, microbes), the researcher arrived at 3 articles that were suitable for analysis. These are the findings from the research.

4.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The One Health concept proposes that there is a connection between human, animal and environmental health. Plants and their health are not explicitly included. The "One Health" concept, which connects the health of humans to the health of animals and their shared environments, represents a relevant framework for understanding the emergence and spread of pathogens. *C. difficile* RT078 is commonly isolated from both humans and farm animals and is increasingly recognized as a causative agent of both health care- and community-associated *C. difficile* infection (CDI). This lineage typically affects a younger population and results in higher mortality than infection by *C. difficile* RT027. Standard genotyping tools have highlighted genetic similarities between human and animal *C. difficile* RT078 strains, raising the possibility of zoonotic transmission. Nevertheless, the exact evolutionary and epidemiological relationships between human and animal *C. difficile* RT078 strains remain unknown due to the lack of discriminatory power of these typing methods and the clonal nature of *C. difficile* lineages. Recently, using whole-genome phylogeny, we reported that asymptomatic farmers and their pigs can be colonized with clonal *C. difficile* RT078 isolates, demonstrating evidence for spread between animals and human. (Knetsch 2018)

Consequently, anaerobic digestion of animal manure is currently one of the most widely used treatment method that can help to salvage the above-mentioned adverse effects and in addition, produces biogas that can serve as an alternative/complementary source of energy. However, this method has to be monitored closely as it could be fraught with challenges during operation, caused by the inherent characteristics of the manure. In addition, to further reduce bacterial pathogens to a significant level, anaerobic digestion can be combined with other methods such as thermal, aerobic and physical methods (Manyi-Loh, 2016)**.**

While this study provides insights to how animal health can impact human health, households have to adjust their crops farming and animal husbandry practices in response to what doing nothing leads to. Use of antibiotics as feed additives at sub therapeutic dose should be strictly prohibited. For therapeutic purpose, it must be used in proper dose for proper time (Jayalakshmi 2017).

4.2 Recommendations

Recommendations to avoid disease transmission from manure include taking steps to ensure the provision of clean, unstressful environments to reduce disease susceptibility and the careful handling and spreading of manure from animals at high risk for infection, especially young calves. Composting and drying of manure decrease the number of viable pathogens. Environmental controls, such as filter strips, also reduce the risk of water contamination.

Organic farming is the better and fruitful option to combat the problems related to pesticide residue. Establishing regulatory standard and management practices of using the pesticides are the alternative ways to prevent the adverse effect of pesticide residue on the environment.

REFERENCES

. Masse DI, Cata Saady NM, Gilbert Y. Potential of biological processes to eliminate antibiotics in livestock manure: an overview. Animals. 2014; 4:146-163.

. Sultan IA. Detection of Enrofloxacin in livers of livestock animals obtained from a slaughterhouse in Mosul City. Journal of Veterinary Science and Technology. 2014; 5(2):1-3.

. Zeina K, Pamela AK, Fawwak S. Quantification of antibiotic residues and determination of antimicrobial resistance profiles of microorganisms isolated from bovine milk in Lebanon. Food and Nutrition Sciences. 2013; 4:1-9.

Anadón, A., Martínez-Larrañaga, M. R., Ares, I., & Martínez, M. A. (2018). Regulatory aspects for the drugs and chemicals used in food-producing animals in the European Union. In *Veterinary toxicology* (pp. 103-131). Academic Press.

Berendsen BJA, Wegh RS, Memelink J, Zuidema T, Stolker AAM. The analysis of animal faeces as a tool to monitor antibiotic usage. Talanta. 2015; 132:258-268.

Bernardes, M. F. F., Pazin, M., Pereira, L. C., & Dorta, D. J. (2015). Impact of pesticides on environmental and human health. *Toxicology studies-cells, drugs and environment*, 195-233.

Bhoomika, P. T., Kadwalia, A., Jaiswal, S., Rani, B., & Patel, P. K. (2019). Antibiotic residues in animal products and its effect on human health. *The Pharma Innovation Journal*, *8*(4), 03-06.

Blanco, P., Hjort, K., Martínez, J. L., & Andersson, D. I. (2020). Antimicrobial peptide exposure selects for resistant and fit Stenotrophomonas maltophilia mutants that show cross-resistance to antibiotics. *Msphere*, *5*(5), e00717-20.

Burki, T. K. (2018). Tackling antimicrobial resistance in food-producing animals. *The Lancet Respiratory Medicine*, *6*(2), 93-94.

Chaudhry, S. B. (2015). Miscellaneous Antibacterial Drugs. In *Side Effects of Drugs Annual* (Vol. 37, pp. 293-305). Elsevier.

Choudhary, S., Yamini, N. R., Yadav, S. K., Kamboj, M., & Sharma, A. (2018). A review: Pesticide residue: Cause of many animal health problems. *Journal of Entomology and Zoology Studies*, *6*(3), 330-333.

Crump, J. A., Sjölund-Karlsson, M., Gordon, M. A., & Parry, C. M. (2015). Epidemiology, clinical presentation, laboratory diagnosis, antimicrobial resistance, and antimicrobial management of invasive Salmonella infections. *Clinical microbiology reviews*, *28*(4), 901-937.

Damiano, S., Longobardi, C., Andretta, E., Prisco, F., Piegari, G., Squillacioti, C., ... & Ciarcia, R. (2021). Antioxidative effects of curcumin on the hepatotoxicity induced by ochratoxin a in rats. *Antioxidants*, *10*(1), 125.

Ezzariai, A., Hafidi, M., Khadra, A., Aemig, Q., El Fels, L., Barret, M., ... & Pinelli, E. (2018). Human and veterinary antibiotics during composting of sludge or manure: Global perspectives on persistence, degradation, and resistance genes. *Journal of hazardous materials*, *359*, 465-481.

Garvey, M. (2020). Bacteriophages and the one health approach to combat multidrug resistance: Is this the way?. *Antibiotics*, *9*(7), 414.

Gill, J. P. S., Bedi, J. S., Singh, R., Fairoze, M. N., Hazarika, R. A., Gaurav, A., ... & Kakkar, M. (2020). Pesticide residues in peri-urban bovine milk from India and risk assessment: a multicenter study. *Scientific reports*, *10*(1), 1-11.

Han RW, Zheng N, Yu ZN, Wang J, Xu XM, Qu XY et al. Simultaneous determination of 38 veterinary antibiotic residues in raw milk by UPLC-MS/MS. Food Chemistry. 2015; 181:119-126.

Hussein, L., Uren, C., Rekik, F., & Hammami, Z. (2021). A review on waste management and compost production in the Middle East–North Africa region. *Waste Management & Research*, 0734242X211068236.

Jayalakshmi, K., Paramasivam, M., Sasikala, M., Tamilam, T. V., & Sumithra, A. (2017). Review on antibiotic residues in animal products and its impact on environments and human health. *J Entomol Zool Stud*, *5*(3), 1446-1451.

Kimari, M. W. (2016). *A pilot study of Leptospira in rodents in North-Eastern Kenya* (Doctoral dissertation, University of Edinburgh).

Knetsch, C. W., Kumar, N., Forster, S. C., Connor, T. R., Browne, H. P., Harmanus, C., ... & Lawley, T. D. (2018). Zoonotic transfer of Clostridium difficile harboring antimicrobial resistance between farm animals and humans. *Journal of clinical microbiology*, *56*(3), e01384-17.

Koli, P., & Bhardwaj, N. R. (2018). Status and use of pesticides in forage crops in India. *Journal of pesticide science*, *43*(4), 225-232.

Kumar, A., Patyal, A., & Panda, A. K. (2018). Sub-therapeutic use of antibiotics in animal feed and their potential impact on environmental and human health: a comprehensive review. *Journal of Animal Feed Science and Technology*, *6*(15), 25.

Layada S, Benouareth DE, Coucke, Andjelkovic M. Assessment of antibiotic residues in commercial and farm milk collected in the region of Guelma (Algeria). International Journal of Food Contamination. 2016; 19(3):1-16.

Lekshmi, M., Ammini, P., Kumar, S., & Varela, M. F. (2017). The food production environment and the development of antimicrobial resistance in human pathogens of animal origin. *Microorganisms*, *5*(1), 11.

Manyi-Loh, C. E., Mamphweli, S. N., Meyer, E. L., Makaka, G., Simon, M., & Okoh, A. I. (2016). An overview of the control of bacterial pathogens in cattle manure. *International journal of environmental research and public health*, *13*(9), 843.

Martins MT, Melo J, Barreto F, Hoff RB, Jank L, Bittencourt MS et al. A simple, fast and cheap non-SPE screening method for antibacterial residue analysis in milk and liver using liquid chromatography–tandem mass spectrometry. Talanta. 2014; 129:374-383.

McEwen, S. A., & Collignon, P. J. (2018). Antimicrobial resistance: a one health perspective. *Microbiology spectrum*, *6*(2), 6-2.

Mund, M. D., Khan, U. H., Tahir, U., Mustafa, B. E., & Fayyaz, A. (2017). Antimicrobial drug residues in poultry products and implications on public health: A review. *International Journal of Food Properties*, *20*(7), 1433-1446.

Ngangom, B. L., Tamunjoh, S. S. A., & Boyom, F. F. (2019). Antibiotic residues in food animals: Public health concern. *Acta Ecologica Sinica*, *39*(5), 411-415.

Pan X, Qiang Z, Ben W, Chen M. Residual veterinary antibiotics in swine manure from concentrated animal feeding operations in Shandong Province, China

Pikkemaat, M. G., Yassin, H., Fels-Klerx, H. J., & Berendsen, B. J. A. (2016). *Antibiotic residues and resistance in the environment* (No. 2016.009). RIKILT Wageningen UR.

Sivagami, K., Vignesh, V. J., Srinivasan, R., Divyapriya, G., & Nambi, I. M. (2020). Antibiotic usage, residues and resistance genes from food animals to human and environment: An Indian scenario. *Journal of Environmental Chemical Engineering*, *8*(1), 102221.

Wollenberg, A., Oranje, A., Deleuran, M., Simon, D., Szalai, Z., Kunz, B., ... & Torrelo, A. (2016). ETFAD/EADV Eczema task force 2015 position paper on diagnosis and treatment of atopic dermatitis in adult and paediatric patients. *Journal of the European Academy of Dermatology and Venereology*, *30*(5), 729-747.

Xie, W. Y., Shen, Q., & Zhao, F. J. (2018). Antibiotics and antibiotic resistance from animal manures to soil: a review. *European journal of soil science*, *69*(1), 181-195.