Chapter

Farm Animals' Health Behaviours: An Essential Communicative Signal for Farmers' Veterinary Care and Sustainable Production

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Abstract

Farm animals constitute valuable source of quality nutrition and economic development across the world, and sustainable farm animal production is greatly being challenged by pests and disease infestation with the resultant poor productivity, death of animals and economic losses to the farmers and nations at large. But before infections reached the threshold of debilitative effects, an infected animal communicates a physiological disturbance by vocalisation and/or visual cues. While a healthy animal communicates its good health status by active display and movement of the body parts in response to its environment, a sick animal manifests its health situation by looking dull, by being self-isolated from the stock, by being sluggish or by refusing to move on when approached or to be fed. Although the communicated cues by a farm animal are determined by the kind of physiological impairment experienced by the animal, farmers' understanding of the specific communication cues by the farm animals would make quick detection of any laden disease in the animals possible and stimulate prompt health care service provision. Consequently, several ways by which farm animals communicate their health situation and the veterinarian actions to be taken in the light of a disease outbreak are highlighted in this article.

Keywords: farm animals, pests and diseases, animal behaviour, animal health communication, farmers' cognition of animal communication, veterinary care

1. Introduction

Farm animals constitute valuable bio-resources that support man's social and nutritional security through provision of quality food resources, specifically in the form of meat, milk, egg, and other food-based by-products, and as well economic development of human society through management and processing of the animals into products and by-products for income generation by individuals and organisations. In this wise, the livestock sector makes valuable contributions to national gross domestic products (GDP) of countries around the world. It contributes about 40% of the global value of agricultural outputs, supports the livelihood and food security of almost 1.3 billion people, and offer opportunities for agricultural development, poverty reduction and food security globally [1]. Animal-based

foods provide a variety of micronutrients that are essentially deficient in plant-based foods [2]. While crop-based foods are deficient in vitamin A, vitamin B-12, riboflavin, calcium, iron and zinc, animal-based foods are particularly rich in these nutrients thereby serving as food resource with which multiple nutrient deficiencies and nutrition challenges that arise from heavy consumption of crop-based foods can be readily addressed [3]. The effects of such animal-based food include good growth, better weight gain and healthy condition, particularly in children [4–6].

In addition to the nutritional values of farm animals is the stock's contribution to economic development around the world. The animals not only serve as means of employment to the farmers but also serve as means of income generation through direct sales of live animals and products such as meat, milk, eggs, wool and hides. Among all other animal products, sales of milk and eggs are essentially a means of continuous cash flow by which farm families move from subsistence to cash-based economies [7] and as well meet other essentialities of life. Similarly, animal husbandry stimulates the development of animal-based food industries through provision of animals and animal products as production resources for processing and conversion into other by-products or animal-source foods. The animal-based food industries not only become a source of income generation owner of the industry, through the distribution and marketing of the produced animal-source foods, but also become a job-creating avenue in the context of production, administration, financial management, marketing and distribution along the production chain to guarantee employment opportunity for individuals seeking to work. The economic values of the livestock sector are however not only limited to the immediate environment (local areas) of production but also have much impact on regional, national and international economies. For instance, the livestock industries contribute a lot to the United States of America's (USA) national economy by providing about 1,851,000 jobs, contributing $346 billion as total economic outputs, $60 billion as household income, $15 billion as income from paid taxes, and $6 billion from property taxes [8]. In the region of South Dakota, where livestock is dominantly managed in the Unites States, the livestock sector provides as much as 29,020 jobs, contributing $7.3 billion in total economic outputs, $1.1 billion in household income, $235 million in income taxes paid, and $149 million in property taxes paid [8].

In Europe. The livestock sector contributes almost 125 billion Euros per year and accounts for 40% of total agricultural production in the area [9]. Also, the contribution of animal production to the gross indigenous production in the region of Europe is about twice as high as the whole agribusiness sector in the area. In the developing countries, livestock contributes about one-third of the total agricultural outputs [10] and 10–45% of GDP in the region. In Ethiopia, the sector contributes an estimate of 19% of the country's total GDP, 45% of the agricultural GDP, and about 20% of the country's export earnings [11]. Based on the social and economic values of livestock a great deal of efforts in terms of research and management has been jeered toward improved and sustainable livestock production around the world.

2. Livestock development to improve productivity

In an attempt to sustain the social and economic values of the farm animals for nutrition and economic benefits of man, research has brought about a great deal of improvement in the livestock sector both in terms of production and management on a global scale. With the USA and Japan's support for livestock development, livestock production technology has developed rapidly worldwide [9]. The development strategies are generally in the form of breeding/cross-breeding, quality feed development,

improved healthcare services, animal husbandry, and marketing system. Also is the development of new or automated technologies to aid the management and well-being of the animals [9]. Impacts of research in breeding include the development of quality breeds of animals with the potential for improved productivity, quick maturing, prolific litter production and resistance or adaptability to changing the environment. In this regard is the emergence of breeds of farm animals with specific production potentials in terms of meat, milk, and eggs. For instance, poultry birds such as broiler—a fast-growing chicken, is specifically developed for meat production while layers are developed for egg production. Pigs are largely developed for pork or beacon (meat) production and given the prolific litters produced at a birth, the animal has been a good source of meat for nutritional security of human society. Alongside the monogastric farm animals is the ruminant comprising sheep, goats, and cattle.

Cattle breeds such as Ayrshire, Brown Swiss, Friesian, etc. are prolific in milk production while the likes of Simmental, Angus, Charolais, Hereford, are good meat (beef) producing breeds. In the same vein are breeds of sheep, such as Dorper, Hampshire, Dorset, Suffolk; and goats—Boer, Spanish, Range Land, Kalhari, etc. with good meat (mutton and chevon, respectively) production. Although milk production is largely from dairy cattle, breeds of sheep—East Friesian, Lacaune, Finnish Landrace Polypay; and goats—Alpines, LaMancha, Saanens, Nubian, and Nigerian Dwarf, etc. are good milk-producing small ruminants [12, 13]. In the same vein are breeds of sheep such as Merino, Leicester Long-wool, Lincoln; developed for wool production alongside the likes of Barbados, Jacob; developed to produce hair for industrial fabric production. The developed prolific breeds of sheep for large litters of birth include Finnsheep, Romanov, and Booroola Merino, etc. [12, 13] thereby providing the sheep keepers the opportunity for quick increase of their flock population within a short time. In the same vein, pig prolificacy brings about 12–14 piglets per litter thereby making the animal the most prolific stock for production by intending livestock farmers.

To support the productivity of the developed farm animals is the development of quality feeds that could adequately supply the animals' energy requirement for production and maintenance. Although feed types of the various farm animals differ, the common denominator of them all is the nutritional contents of the feed, characterised by the presence of adequate crude protein, carbohydrates, fatty acids, minerals, and vitamins; that may be available to the animals from the given feeds. In light of this are the development of different feed formulae and automated feed processing technologies for the production of feeds that are adequately rich in nutritional contents. In addition is production of concentrates and other feed additives to enhance feed intake and nutrition of the animals for improve productivity [10] An optimal nutritional program ensures adequate intakes of amino acids (both essential and nonessential), carbohydrates, fatty acids, minerals, and vitamins by animals such that the nutrition contents readily supplement deficiencies in basal diets of the animals for enhanced consumption and conversion [14]. In addition to supporting productivity of farm animals quality feed is of significant value to healthy leaving of the animals as this readily enhance key metabolic functions of the animals to improve fertility and reproductive efficiency, immune function and animals' response to vaccinations, neonatal survival, and growth, feed utilisation efficiency, and meat quality [15]. In line with this is the development of health technologies and human capacities for the detection and effective management of farm animals. Deployment of automated technologies in farm animal management has widely been used, not only to monitor feeding behaviour and intake of animals but for detection ill health in the stock [9]. Consequently, well-fed and healthy animals result in good economic returns for the farmers in terms of profitable production arising from fewer expenses on animal medication, improved productivity and good marketing price.

3. Sustainable livestock production and the challenge of animal pests and diseases

With development efforts in the livestock sector, world animal production has continued growing with increased productivity. Between 1995 and 2002, the world total meat production increased by 19%, the total milk production by 11%, and the egg production by 23% [9]. Notwithstanding the research support for the development and improved productivity of the livestock sector, the sustainability of livestock production is still being challenged by several production and environmental factors; with the degree of impact being influenced by the management system put in place by farmers. While farmers may try as much as possible to give their animals all the necessary care in terms of good housing units—spacious, dry and well ventilated, quality feeds and water, and necessary healthcare, it remains inevitable to completely prevent the incidence of pests and diseases in livestock management basically because of the impossibility of eradicating disease-causing pathogens which could survive in almost all avenue. Reduction of the incidence of pests and diseases in farm animal management has though been achieved by a combination of good hygiene, appropriate use of vaccines and medical therapy, and selection of disease-free breeds of livestock, the result is by no means an eradication of infectious and contagious diseases owing to the fact that a multiplicity of pathogenic agents are inducing emergence of complex diseases that may even be difficult to diagnose [16].

Pathogens, which are groups of organisms that cause diseases in farm animals, exist in form of viruses, bacteria, fungi, protozoa, and parasites, and are so small that they cannot be ordinarily seen by sight except with the aid of electronic magnifiers. These pathogenic micro-organisms or microbes exist in different sizes and shapes and are readily transmitted to animals through various substrates or vectors such as water, soil, waste or faecal matter, humans and animals [17–19]. Viruses are very small micro-organisms and much smaller than all other pathogenic organisms such that it can only be viewed with a strong electronic microscope [16]. However, the micro-organisms can only survive and/or multiply within living cells basically because it lacks cell membranes, cytoplasm, ribosomes, and other cell organelles [20, 21]. This mode of survival and multiplication by viruses make it possible to destroy the cells of the infected host thereby result in certain diseases. About 60% of animal diseases are caused by a virus and unfortunately, such viral diseases have no cure thereby resulting in the death of infected animals [17]. On this note, preventive actions, usually by vaccination, are required to ensure the healthiness of farm animals. Viral diseases of farm animals include foot and mouth disease, rinderpest, bluetongue, vesicular stomatitis, swine fever, fowl pox, avian influencer, etc.

Bacteria, on the other hand, are relatively larger than viruses and also take different shapes and sizes but most are visible under an ordinary microscope. The micro-organisms, unlike viruses, could survive anywhere—within and outside living cells but could sporulate to form a protective coat that makes them survive in any environment for a long period, even years, and later cause infectious disease(s) in farm animals [16]. Bacteria that survive outside living cells could remain inactive until the emergence of favourable conditions to gain entry into the body of the animals, either through the skin or the eyes, breath into the lungs, consumed through food and water, to cause infections [22]. Similarly, some bacteria within the living cells, such as *Bacillus* and *Clostridium* species, envelope themselves with protective spores or endospores, which become dehydrated and highly resistant to an environmental condition such as heath, cold, or chemical compounds. The endospores, within which the bacteria may remain inactive for many years, produce

endotoxin—a deadly substance that causes disease in animals [23, 23]. Bacterial diseases of farm animals include botulism, paratyphoid, anthrax, brucellosis, foot rot, tetanus, etc. Bacterial diseases are however not as deadly as viruses as these could be readily treated with antibiotics, particularly when detected on time. Besides, not all bacteria cause disease as some are of great value in ruminant digestion where they aid fermentation of consumed herbage in the rumen [24].

In similarity to bacteria, fungi are widespread, exist in various shapes and sizes, and could survive in nearly all forms of environment, be it water, soil, air or in the mould on stale food and mushroom for a long period that runs into years. The micro-organisms are though ordinarily harmless, they cause disease in some situations which can be damaging or even devastating in some cases [17, 25, 26]. Some fungal diseases affect the mucous membrane (mucosal) though, most of them affecting the skin (cutaneous) by colonising and destroying their tissues [27]. Skin diseases are though rarely critical or deadly, their resultant irritation discomfort the animals leading to inhibition or disruption of their feed intake and consequently, a drastic drop in productivity [28]. Diseases of fungi could be highly contagious and primarily spread by direct contact between animals; with the clinically infected animals as the greatest source of infections [26]. Examples of fungal diseases include ringworm, aspergillosis, candidosis, mycotic, protothecosis, dermatophytes, etc.

Protozoa are single-cell microbes that survive both inside and outside living cells and could be found in most habitats. Most of the protozoa are though harmless and even play a vital role in controlling bacteria population and biomass; some are however parasitic pathogens of humans and animals [29] and as such significantly cause diseases in farm animals and even as potential drivers of zoonotic transmission [30, 31]. The parasites are a significant cause of abortion and infertility in domestic ruminants [32] and a relatively uncommon group of respiratory ailment [33]. Epidemiological situations of protozoan infection may occur as a single infection or zoonoses and may be sporadic in otherwise healthy hosts [34]. Also, infection of the nervous system is mostly fatal. An epidemiological situation that corresponds to pseudoepidemics occurs in a large host of the animal population due to a common source or poor housing conditions of the animals characterised by poor-quality or badly-stored bedding. Protozoan parasites in poultry are coccidia (species of the *Eimeria* genus), cryptosporidia (*Cryptosporidium baileyi*), and histomonads (*H. melegridis*).

Alongside the pathogenic micro-organisms causing diseases in farm animals are parasites that depend on the animals for growth and/or survival [34, 35]. The parasites may live and survive inside or outside the body of farm animals as internal and external parasites. Common parasites of farm animals exist as worms, flukes, protozoa, and insects such as lice, mites, ticks, flies. Unlike the parasitic protozoa, most parasites are visible to sight but some mites and worms can only be seen under a microscope at their early stages [16, 34]. With the dependence of the parasites on host animal(s) for survival, they may either inhibit the normal physiological functioning of the animals or act as a vector of other diseases thereby resulting in negative impacts on the health and welfare of animals. Such negative impacts, particularly by the internal parasites, may be manifested as anaemia as a result of substantial blood loss, reduction of the animals' appetite resulting in debilitating health and susceptibility of the animals to other diseases, diarrhoea and death of the animals arising from severity of the parasitic impacts [34, 36, 37]. The external parasites, on the other hand, cause open sores on the skin of livestock which becomes irritating and annoying to the animals thereby causing them to reduce grazing and feed consumption.

4. Animal health behaviours: the communication signals for farmers' attention

One of the managerial goals of livestock keepers is the maintenance of good health of their animals as this is crucial to achieving profitable and sustainable animal production. On this note, livestock farmers try as much as possible to keep the animals free of infestation and infections, through hygienic practice and possibly vaccination of the animals against certain disruptive or deadly diseases. However, the ubiquity of pathogenic microbes (protozoa, bacteria, viruses, fungi, parasites) and other external parasites in a production environment of farm animals ultimately prone the animals to infections or infestation of pests and diseases which on gestation may turn out to be chronic or deadly [16]. Consequences of this are poor productivity by animals, increased cost of animal production arising from treatment or veterinary services, economic loss of animals, hindrance of production and/or productivity of animal food source industries, and possibly impairment of human health by infections from the animals [15]. In light of the economic implication of animal diseases, conscious actions need to be taken by farmers to prevent or promptly control any emerging disease of animals in their stock. However, before an infectious disease in farm animals begin to manifest its symptoms or get to the threshold of economic losses, the infected or physiologically disturbed animals ordinarily communicate their health status for the attention of their keepers.

By nature, animals ordinarily communicate with conspecifics or fellow animals in four basic ways, namely pheromones, auditory, visual and tactile cues [38–40]; they however indirectly communicate their social and health statuses to their keepers particularly using the auditory and visual cues. This is based on the fact that both animals and man could make and receive sounds, which are an essential stimulus to effecting responses between the two Animalia. In this wise, farm animals use their vocal sounds to express their health or social conditions to the farmers. For instance, a distressed animal makes distressing vocalisation as a way to call its owner for needed attention. Empirical studies on emotional vocalisations of farm animals [41–45] revealed that environmental stimulus and/or hormone concentrations affecting the mood, thirst, and hunger, and appetitive behaviour of an animal stimulate specific behaviours that may be accompanied vocalisation in the animals [41]. Thus, a dam in parturition distress might make a very high pitch sound to attract an attendant to give needed help for safe delivery; or where its kid is hooked and needed help to have it rescued. In the same vein, ewes or nannies on heat give constant high pitch sound as a way to indicate readiness for a reception which a breeder needs to take advantage of either by the introduction of ram/billy or artificial insemination. Pig is known for screaming when put under stress, particularly when being forcefully pulled in an attempt to move it from one place to the other. This cry may constitute a security call to the owner when the animal is to be forcefully taken out of the herds by an intruder.

The visual cues, on the other hand, are displayed actions that could be visually perceived by the farmers in their animals. Farm animals thus express their social and health situations by visual communication signals which a farm attendant needs to understand for an appropriate response. For instance, healthy farm animals are ordinarily active and ever ready to feed, and will be on the rise when they are approached. Where a farm animal sluggishly or refuses to move, or is reluctant to get up when approached (**Figure 1**) suggests that something is wrong with the animal and as such will need to be attended to for detection a laden health issue. Although, varying diseases have different physiological effects on specific farm animals, infected animals react on whatever kind of disease that might impair their physiological status

Figure 1.
Healthy lambs on their feet with the physiological lamb siting isolated and unable to move. Source: Photo by author.

by the display of signals that serve as health communication[1]. Common communicative signals by a disease-laden animal could thus take the following forms:

a. **Poor appearance of animals:** ordinarily, a healthy animal will generally have a good look with a characteristic good body structure and posture. Related body indicators of animals with good health include robust outlook and/or roundness of the stomach, smooth and well-laid hair or wool with uniform coverage over the body, bright eyes, and dry nose and mouth. On the other hand, a sick animal will put up a poor appearance that may be characterised by leanness, caved-in stomach, falling air or wool, nasal discharge, dripping salivation and/or continuous coughing. The caved-in stomach may have to do with poor feeding or poor feed conversion efficiency by the animal, while the falling hair or wool may be due to ectoparasite infestation of the animal. For instance, piglets severely affected by *coccidia* produce a rough-haired coat, become dehydrated and remain continually dirtied with faeces [46]. In the case of poultry, appearance of a bird with ruffled feathers instead of smooth and glossy ones or the wattle looks dull with lesions instead of being bright suggests impairment of the bird's physiological functions and as such will need veterinary care. A common disease of poultry with these characteristic features is the blackhead disease.

4.1 Inactive socialisation

A healthy animal is socially active and ever alert to its environment by having its head raised in an attempt to keep watch of its surroundings, and usually in close groups with one another. In ruminants, the animals are constantly chewing due to regurgitation of consumed pasture. *Babesiosis* disease, which is common to cattle, is known to cause cessation of rumination or constipation in the animal [47, 48]. Poultry birds in cages, deep litters, and free-range will equally have their heads up clucking or gobbling (respectively to chicken and turkeys) which increases on sighting someone or something strange in their environment. Where an animal is in isolation of the other animals or has its head lowered or drooped down and becomes dulled, unable to stand up or move sluggishly when being approached imply that the animal is physiologically disturbed and as such will need an examination to detect what is wrong with it.

[1] There abound diseases of farm animals with specific causative agents, symptoms, treatment, methods of control and prevention which is beyond the scope of this chapter. This chapter has only highlighted possible signs that an animal might display as an indicator of ill health which could be readily perceived by livestock farmers for prompt veterinarian actions.

4.2 Wobbled movement or gait

Whenever there is a need for farm animals to move, they will move steadily and easily; and where there is the need to flee from threats in their environment, they move very fast and run. Where an animal moves sluggishly or could not move would imply ill health. Abnormal gait can include unusual walking patterns or uneven weight-bearing, as seen when a cow is suffering from lameness [49]. Lameness may be an indication of rot in the foot characterised by swelling and moistened skin between the claws and foul-smelling discharge. Consequently, the animal remains lying down for long periods and may not bear weight on the affected leg, and where both front legs are affected, sheep, for example, walk on their knees and severe cases and chronic infection leads to grossly misshapen and overgrown hooves [50]. In the same vein is an abnormal stance indicating pain and this may be reflected as tucked abdomen and tail, hunched back or standing still for extended periods [49].

4.3 Drop or refusal of food consumption

Animals are ever ready to feed when nothing is wrong with them and as such a drop in the rate of feed consumption or outright refusal of feed by an animal or non-excitation at being fed would imply that something is wrong with the animal. Most diseases though cause an animal to refuse feed, nutritional factors equally accounted for feed refusal. For instance, diseases such as bloating, grass tetany, ketosis, hypocalcaemia, and mineral deficiencies are caused by nutrient deficiencies, excesses or imbalances, or by metabolic disturbances [51]. As a result of poor feeding or feed conversion efficiency, the animals lose weight with characteristic caved-in stomach and general weakness.

4.4 Abnormal droppings/dungs

Excreta of farm animals should be firm or looks 'bolus' and black or darkish green, particularly in cattle and pigs, and like small balls in sheep and goats. Droppings in poultry are usually greyish with urinary liquid. Where the dung of an animal looks watery, and sometimes have the faeces stained with blood would imply that something is wrong with the animal. Such signs usually have to with diarrhoea or other gastrointestinal diseases. Coccidia in piglets, for instance, is characterised by diarrhoea and scour in early stage, and late-stage, faeces become yellow or creamy-grey diarrhoea causing loss of condition and reduced growth rates at age 7–10 days [45]. Mortality rates may reach 20% [52]. Concurrent infections with other bacteria, viruses or parasites can increase mortality further.

4.5 Abortion in animals

One of the production goals in livestock management is a production of litters either for multiplication of animal population or marketing for income generation. A farmer could readily achieve this with healthy animals but where a pregnant animal is infected with the abortion-related disease the resultant effect is loss of foetus. Diseases such as leptospirosis, vibriosis, pestivirus, and trichomoniasis cause abortion which may be early-term abortion or embryonic loss in ruminant farm animals [51]. Also, there may be stillbirth, weak, stunted or deformed calves, and low calving and lambing rate. Observation of these traits in the animals calls for veterinary care of the animal(s).

4.6 Drop-in productivity

A careful look at production records of the animals could help determine the health status of the animals. An animal that has been prolific in production certainly loses production potential when its normal healthy condition is hindered by a disease or pest infestation. In a lactating dam with impaired physiological functions, there may be a drop in the quantity of produced per day or drop in egg production by sick birds [53]. Dressing of diseased animals also produces poor quality meat that is unfit for consumption thereby leading to loss of revenue or profitable income to the farmer.

4.7 Sudden death of animal(s)

The end of physiologically disturbed animal(s) is death, especially where the signs of ill health are not quickly detected for prompt veterinary action. In some cases, however, death may be sudden without a physical sign of ill health. Several diseases are so virulent that it leads to the death of farm animals within a short time. For instance, anthrax could cause sudden death within 2–3 days in ruminant and pigs. In the vein, PPR (Peste des petits ruminants) in small ruminants is associated with high morbidity and mortality [54, 55].

5. Economic implications of animal diseases

Diseases of farm animals generally cause a lot of losses either directly or indirectly in livestock production. Direct economic implications include decreased productivity of the animals, cost of disease control of animals, death of farm animals and loss of means of livelihood or economies of farmers. A diseased animal generally has its physiological functions impaired and as such will not be able to perform maximally or optimally. In the light, production outputs of farm animals in terms of egg, milk, meat, and wool production gradually decline [56] thereby resulting in inefficient production of the farmers. In other words, what farmers get as returns from production is far less than what is invested in the production of the animals. This is usually due to decreased food intake and/or inability of the animals to efficiently convert consumed feed into metabolic energy required for productivity. Alongside this is loss of quality products—milk and meat that might come from infected animals thereby losing market acceptability or value [53]. In severe cases and depending on the virulence of the disease, animals might lose weight appreciatively and die. This incur great loss to farmers as opportunity for production of kids is lost due to disease-related abortions by dams, revenue that could have accrued from sales of animals and animal products, and ultimate loss of means of livelihood in case of high mortality or death of herds and flocks which may be difficult to replace in most cases. An attempt to save the stock and sustain production result in increased cost of production arising from the cost of drug acquisition for treatment of the animals and of veterinary services. Economic losses to the world poultry industry are believed to be more than US$3 billion annually [57]. Back in the year 2000 in rural communities in the northern part of Cameroon, an estimated value of sheep and goats losses to PPR was put at US$53, 902 over five years, while in Bangladesh, the estimated value of goats mortality from PPR was put at US$34.8million in the year 2001 [56]. Also is a devastating effect on cash flow and equity at the farm or industry level arising from sharp fall in consumers' demand for primary products of livestock out of concern of zoonosis, and severe limitation or elimination of animal marketing options [18, 55]. In the same vein, access to

the premium export market is affected as animal-source food from a region with disease outbreak will not be accepted in the international markets thereby distorting the development of the livestock sector both within the country(ies) in question and globally [56].

Beyond the farm, level is indirect consequences of disease in animals which include zoonotic and cost of human treatment, loss of employment to farm labours and employment in other livestock values chains or industries, alteration of nutritional balance of the populace, change in consumer behaviours and marketing shocks. Humans become infected with animal diseases either from consumed products of infected animals or the circulation of zoonotic agents between animals, humans, and the environment with hindrances of their wellbeing and economic activities. The direct cost of zoonotic diseases over the last decade is estimated to be more than $20 billion with over $200 billion indirect losses to affected economies as a whole [58]. With marketing shocks, characterised by either short supplies of animals and animal products and/or an increase in prices of the available ones, consumers to make rational decisions to opt for alternative safe and cheap food sources. For instance, short supply of livestock products such milk, eggs and poultry meat, which tend to be cheapest, may lead to increase in prices thereby forcing consumers, particularly the poor people, to substitute with vegetable proteins or consume more of carbohydrate food sources with consequential less balanced diet [56]. In addition to related diseases of farm animals' disruption of nutrition security of the human populace is the transmission of such disease(s) to human populace either directly from the animal or on consummation of food products from the diseased animals. Farmworkers are most affected directly due to contacts with animals they care for and indirectly with the general populace through the consumption of disease-laden animal products. As expressed by the world society for the protection of animals, as much or more than 500 different pathogens, be it viruses, bacteria or parasites, are be transmitted from animals to humans through contact with live animals and dust inhalation, and consumption of disease-laden meat and animal by-products [59]. With numerous cases of animal diseases, particularly Avian Flu, Swine Flu, infecting people as well as the workers and veterinarians, the spread of animal viruses to humans is thus a serious public health concern and as such, they need for control and prevention of diseases in farm animals.

6. Farmers' cognition of farm animal-health behavioural communication and the veterinary responses

Given the social and economic implications of diseases of farm animals, it is essential that veterinary actions are taken to prevent, control and treat animals of any emerging disease. It is however of great value to have earlier detection of emerging or laden diseases where it is invariably impossible to prevent disease outbreak as this will save a great deal of the cost of treatment and prevent possible loss of animal to death. To achieve this, it becomes essential that livestock farmers have good cognition of their animal communication. The concept of animal communicate is generally grounded in animal behaviours whereby animals' social actions are interpreted with meaning either by fellow animals or humans. Consequently, by behavioural actions, animal communication is described as the process by which an animal transmits information to other animals (**Figure 2**) for incorporate into their decision making [60] or cause some kind of change in the animals that gets the information [61]. The transmitted information by animals in the communication process is however in form signals often reflected in sounds, colour patterns, postures, movements, electrical discharges, touches, the release of odorants, or

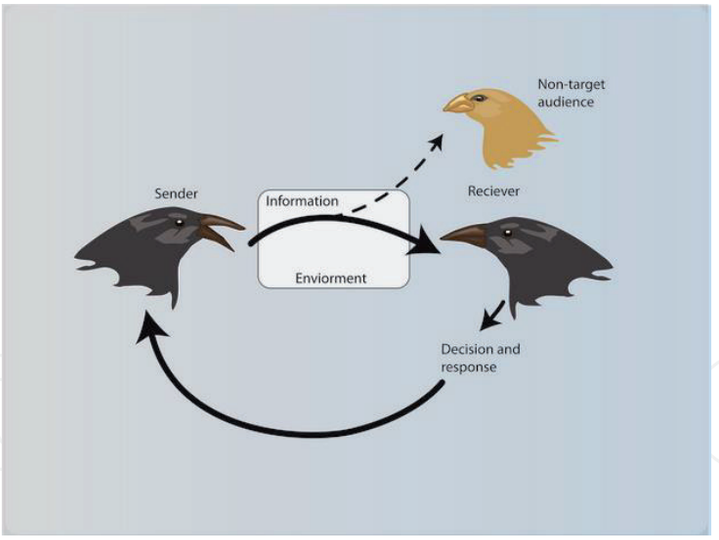

Figure 2.
A model of communication flow between animals. Source: Gillam [62].

Figure 3.
Vocalisation by a bird to its environment for a specific purpose. Source: Khan Academy [63].

some combination of these mediums [60]. These series of signals of animal communication are thus classified into four basic categories, namely visual, auditory, tactile and pheromone cues [60].

The auditory communication cue entails the use of the vocal cord (**Figure 3**) for sending sounds or cries by an animal to fellow animals or other species of animals to stimulate action(s) in the receiving animals [61, 62]. In other words, an animal vocalises to effect behavioural action(s) in the targeted receivers with the expectation that the receiving animals will appropriately use the acquired message from the vocalisation to take a responsive action [60, 63, 64]. For instance, the cries of an animal might be a message of attraction toward it or detraction away from it; and whatever action is to be taken by the animal(s) receiving the cries depends on the strength of pitches or frequencies of the vocalised sounds or cries [65] and in turn, the strength of the pitches or frequencies depend on the emerging stimulus in the environment of the animal(s) at a particular point in time. Consequently, vocalised sounds by animals at any point in time have distinct sound characteristics that denote the intent of the vocalising animal(s) and expected responses by the receiving animals. For instance, the croaking of male frogs described as 'whine' and 'chuck', maybe for attraction female frogs or keep other males away from the territory [63, 66]. Similarly, the barking or gnawing of a dog may imply a warning

of a possible attack against and intruder. In the light of this, cries and sounds are essential tools by which animals communicate, not only with their surroundings [67] but also to convey a great deal of information over long distances for a specific purpose. Thus, most animals rely on sound communication for social relations, protection of themselves, survival and understanding of their environment [68].

Alongside the auditory communication is the visual dimension of the animals' communication whereby animals display signals that are visible to fellow animals. Such signals may be gestures, body postures, and colouration, movement or positioning of the body by the communicating animals [63]. Consequently, animals communicate non-verbally by expression of signals that could be described as acts or structures, to convey information to recipients to elicits a response in the recipients [69]. For instance, claw raising by hermit crab which implies an intention to attack is a warning communication signal to recipients and processing of such a signal would make the recipient respond by fleeing the environment of moving away from the crab. Similarly, a chimpanzee communicates threats by raising its arms, slapping the ground or staring directly at another chimpanzee [63]. Given the need for mating, some animals communicate to one another by a display of colouration change to attract the opposite sex. For instance, a display of bright yellow feathers by a male American goldfinch is a communicative signal to a prospective mate for mating. Animals thus communicate by behaviours to help them recognise and care for the young ones, find mates, coordinate group behaviour, defend territory and establish dominance.

Given the concept of animal communication, the same principle applies to farm animal communication to farmers whereby farm owners rely on behavioural actions of their animals as an element of information communication with them [66, 70–74]. In essence, farm animals communicate their current status to their owners by both vocalisation and behavioural signals. Given that environmental stimulus and/or hormone concentrations affecting the mood, thirst, hunger and appetitive behaviour of an animal stimulate specific behaviours and vocalisations in the animals, livestock farmers would need, not just to perceive the displayed actions by their animals, but to appropriately interpret such vocalisations and behaviours for necessary action to be taken. Although animals' vocalisations have been categorised into five 'main syllables' based on the mouth, tongue and nasal placement and the speed of air leaving the throat, no specific meaning has been attributed to different calls [75]. Consequently, a particular farmer will have to use his judgement, particularly based on experience and familiarity with his sets of animals, to determine the state of his animals' welfare and/or needs. Understanding the varying pitches or frequencies of sounds by animals is thus crucial to ensure an appropriate response to the animals' needs by a livestock attendant. For instance, a livestock attendant with a good understanding of the varying vocalisation pitches may get to know that a high and consistent pitch of sounds by a dam is an indication of out of contact with its kids [76–78] or that of difficult parturition. Frequency and pitch of coughing by farm animals equally serve as a good auditory cue to attract the attention of a farmer for the healthcare of the animal. Thus as an animal becomes more excited or distressed, the duration, volume, and pitch of the calls increase.

The auditory communicative signal may though be a narrow lead to early detection of illnesses in farm animals, the visual communication cue is more elaborate and much obvious to attract the attention of farm attendants or farmers for prompt veterinary actions. Ordinarily, a healthy animal is active and mostly in group association, but becomes dull or isolated when its normal healthy condition is impaired which becomes a communicative signal of ill health. As highlighted in **Table 1**, the displayed signals can be readily seen and obvious to stimulate veterinary actions.

Farm animals	General signs of illness	Respiratory signs	Gastrointestinal signs	Skin signs	Neurological signs
Cattle	Fever, lethargy (lack of energy) Excessive salivation Lameness	Multiple coughing animals Difficult laboured or rapid breathing Nasal discharge	Appetite loss Diarrhoea Abdominal pain Weight loss Dehydration (sunken eyes, prolonged skin tent)	Blisters or ulcers around muzzle, mouth, lips, gums, tongue, teats and/or feet Severe itching Circular areas of hair loss Warts	Behavioural changes or easily startled Restlessness or agitation Lack of coordination or high stepping Head rubbing, tossing or pressing Exaggerated blinking and chewing movements Trembling or convulsions
Sheep and goats	Depression Fever Lethargy (lack of energy) Dull coat Watery eyes Lameness, arthritis, or hot and painful feet	Coughing Nasal discharge Difficulty breathing	Weight loss Decreased appetite Diarrhoea and abdominal pain Food coming out of nose or mouth	Itchy, dry brittle fleece Red mouth and nose Blisters or ulcers around muzzle, mouth, lips, gums, tongue, teats and/or feet	Behavioural changes Excessive scratching and rubbing Loss of coordination Abnormal gaits (high stepping) Biting feet and limbs Head tilt or head pressing Inability to rise or convulsions
Pigs	Lethargy (lack of energy) Fever Lameness, painful movement and stiffness Swollen joints	Coughing Difficult laboured or rapid breathing	Lack of appetite Weight loss Diarrhoea	Blisters or ulcer around nose and feet Pustules Blotchy Skin	Behavioural changes Lack of coordination Excessive salivation or drooling Seizures or tremors Paddling while lying on their side
Poultry	Lethargy (lack of energy) Depression Drop in egg production Eye discharge Thin-shelled eggs Ruffled feathers Off feed or water	Open mouth breathing Nasal discharge Sneezing Coughing or gasping	Diarrhoea Weight loss Swollen crop or abdomen	Swollen and/or discoloured comb, wattles, legs and head Dark or crusty spots on comb Mites or Lice (near vent) Scaly legs	Difficulty walking Torticollis (twisted neck) Lack of coordination or inability to rise Tremors or paralysis of limbs or neck Paralysis and dilation of the crop Blindness Head pressing

Source: Developed from Department of Agriculture and Rural Development, State of Michigan Bulletin (Retrieved from online, July 1, 2019).

Table 1.
Signals for early detection of ill-health in farm animals.

Body movement of the animals is also essential cues to understanding the health communication behaviours of the animals. For instance, cattle will normally have their tails raised and positioned horizontally when defecating or urinating bur observation such positioning of tail aside the need for excretion is an indication of the health issue to be given attention. Also, kicking and tail swishing may be performed in response to acute pain with these signals directed toward the painful stimulus [49]. The ability of farmers to understand the communicative signals, however, depends on their good knowledge of different animal diseases and the signs that may be shown before the emergence of a particular disease. Based on experience, some farmers have developed the skills and intuition to rightly interpret behavioural signals of an animal about a specific kind of illness that is most likely to emerge or already discomforting the animals[2]. A field experience by which a set of goats' communicate their owner that their pen is heavily infested by lice was by their reluctance to enter the pen each day they return from free-range, and when forced into the pen, they began an unusual and constant stamping of their feet. But a curious examination of the sudden reluctance of entry into the pen revealed that the dusty floor of the pen was highly infested by lice which always walk into the goats' underneath hair thereby causing skin irritation to the animals. This was discovered when a multitude of lice flung onto the farmer's legs on entering pen thereby necessitating thorough cleaning of the pen and thereafter, no constant stamping of feet was observed among the goat. In essence, every behavioural actions farm animals might mean a lot and as such, livestock farmers need to understand and be able to distinguish between normal and abnormal behaviours of their farm animals to ensure good management of the animals' welfare. But farmers who do not have the experience or skill to accurately interpret the observed health communication behaviour of a farm animal would have to consult the service of a veterinarian. Thus farmers would have to consciously monitor the social actions of their animals for quick detection of laden diseases in their stock.

7. Essential healthcare services to attaining cost-effective health management of farm animals

Prevention and control of pests and diseases of farm animals are essential to achieving profitable and sustainable farm animal production. This involves putting up all necessary actions to ensure that animals in stock are free of infections or debilitating effects of pests and diseases. Such actions are not only to save the animals but also give an added opportunity of eliminating or reducing the cost of treatment, which is usually expensive where animals were to be treated. However, an important step to preventing and controlling disease outbreak in farm animals by farmers is cognition of health communication behaviours of the farm animals, nature and virulence pathogenic organisms that may induce ailment, and signs that are disease-laden and symptoms of emerging diseases in the animals. Because of this, farmers may have to promptly and diligently take the following actions for good health management[3] of farm animals and as well ensure profitable and sustainable livestock production.

[2] Not all diseases in farm animals could be determined by physical examination. It may require clinical examination, immune system function, nociceptor response and behavioural assessment for accurate diagnosis of a particular disease which of course could not be done a farmer but by a veterinarian.

[3] This section and of course this chapter did not provide information on treatment, prevention, and control of specific diseases but on basic actions that could be taken in health management bused on animal attendants' cognition of the animals' vocalisation and the observed visual cue for health management of the animals.

7.1 Surveillance

Effective care of farm animals begins with a vigil on the posture and environment of the animals. This entails regular checks on kept animals in stalls and fields and intermittent physical examination of the animals' bodies for early detection of impairment of their normal behaviours and any possible ill-health. Given this, farmers must be on the lookout for signs and conditions that may engender disease outbreak or infestation of pests in their animals. Hence, the understanding that a healthy animal will normally be on the stand on sighting their attendants and/or move excitedly when being approached to be fed makes it possible for a farmer to know that failure or refusal of an animal to stand up or move is a sign of impairment of the normal health of the animals and as such would need to be attended to, at least for examination and determination of what the health issue might be. Field experience in this regard with a livestock attendant 0n small ruminant farms shows that regular checks on the animals daily made it possible for quick detection of impairment of the animals' normal health condition. Observed cases of health issues in the stock as a result of regular checks on the animals include lameness (**Figure 4**) and refusal of one or two of the animals to move on being an approach. With these signs, cases of foot rot or scald, pneumonia, infestation by sheep fleas and worms in the animals. Physical examination of bodies of the animals for insects or pests is equally of great value in early detection of flies' infestation in ruminant skin and lice in poultry birds. Surveillance though begins with individual farmers and their farms, collective efforts become crucial to curtailing the spread of infectious diseases from farm to farm. Surveillance is about disease identification and reporting cases of infections by livestock keepers to animals' health agencies and veterinarians to enable disease patterns to be monitored [79]. On this note, the World Organisation of Animal Health—OIE, emphasises that effective surveillance system entails identification and/or observation of emerging disease and reporting such for sample and data collection, epidemiological and laboratory investigations, and management and communication of the resulting information to provide guidance on priorities and targets for the application of interventions to effectively control of the disease [80].

7.2 Hygiene practice

Hygiene practice is an important aspect of animals' health management and this entails keeping the farm environment free of any anything or condition that could induce pest infestation and disease infections in the animals. This includes

Figure 4.
A lamb with lame foot as result of infection. Source: Photo by author.

ensuring that farmhouses and animal beddings are dry and regularly cleaned, and as well as the equipment and all facilities used for movement and care of farm animals. Cleaning may include scraping, sweeping, washing, possibly with the use of disinfectants. This action is underscored by the understanding that pathogenic micro-organisms and eggs of external and internal parasites could survive under any condition, particularly in a wet and filthy environment. With hygiene practices, no favourable condition is created for the micro-organisms to be active or survive to cause infections in the animals. Disinfection may though be essential, most disinfectants are not particularly effective in combating viruses *thereby* emphasising the need for physical cleaning and burning of bedding [81]. Droppings or faeces by animals, feathers and dead animals need to be promptly removed pens and ranches as these are sources of pathogens [82]. Also, too many animals on-site and over-crowding within building and cages should be avoided to prevent the rapid spread of emerging diseases of stock [16].

7.3 Biosecurity checks

This is an aspect of farm hygiene but goes beyond the physical cleaning of farm facilities and equipment. The focus is basically on the cleanness of the animals concerning freedom from diseases of any kind. Scrutiny of animals to be introduced into farm sites is essential to maintaining farm hygiene and preventing the introduction of diseases into the farmyard. In the same vein, non-farm workers or visitors should be prevented from gaining access to the stock, be it in stalls or farm sites; and where necessary, all should have their feet and booths washed when going into the farm. Quarantining of new animals is essential to allow time for the manifestation of hidden disease in the animal(s) and such restriction may be for at least 3 weeks and/or possibly conduct a clinical test on the animal for the potential disease of concern. Other biosecurity measures to be taken include culturing milk from individual animals for contagious organisms, selection of healthy animals and use of semen, embryos or bulls from suppliers with control programs for the infectious disease [83].

7.4 Exploration of animals' behavioural communication cues

With a cognition of communication cues of farm animals, a keen observation of postures of the animals is crucial to ensuring quick response to the health needs of the animals. Farmers should know that a healthy animal is alert and aware of its surroundings by standing and actively holding its head up watching what is happening around it, be in close groups, moves easily and steadily with regular steps. Deviation from these postures implies impairments. Also, the eyes of the animals must be bright, ears must be erect and move swiftly in the direction of sounds and to get rid of flies, mouth, and nose must be free of dripping saliva and nasal discharge. Where discharges are observed in these body parts, it would imply health issues that need to be attended to. Examination of bodies of the animals should reflect smooth and shiny hair or coat if healthy, breathing should be normal, urine must be clear and faeces must not be watery [84]. Vigil on these cues is essential to initiate a quick response to the health needs of farm animals.

7.5 Disease diagnosis

While it may be possible to see visual communication cues of farm animals means of monitoring or detecting health issues in the animals, internally developed diseases may not be so easy until the animal reaches a critical stage of illness.

However, intermittent collection of animals' faeces for an examination of worm-eggs and examination of urine for blood and yellow colouration that could signify jaundice in the animals. The use of faecal egg counts has proven to be a valuable tool for detecting worm infestation in animals and the basis for designing appropriate deworming routine and determination of the right deworming medication. For instance, faecal analysis of cattle in Malawi reveals infestation of bacteria—coliforms and *Clostridium perfringens* spores; pathogenic protozoa—*Cryptosporidium* and *Giardia;* and enteric viruses—adenovirus, enterovirus, and reovirus in the farm animals. Examination of watery stool suggests diarrhoea in the animals and as such, necessary medication could be administered for treatment of the animals before their health situation result in economic losses [85]. Other diagnostic tests for detection of animals diseases include parasitological tests for detection of parasites in animals, microbiological and virological test for identification of the presence of micro-organisms and viruses in the animals, and serological or blood test for anlysis of blood serum of sampled farm animals. Other tests may include necropsies, abortions and stillborn, and milk tests.

7.6 Vaccination

This is an essential way to prevent or strengthen the immunity of farm animals to infectious diseases[4]. With the understanding that viral diseases cannot be treated vaccination becomes the means to prevent the outbreak of the diseases in farm animals. Vaccination protects the welfare of farm animals by preventing or reducing disease, which in turn reduces the pain and suffering often associated with illness [86]. Further insight into the value of vaccination shows that the drug mimics infections to provide immunity such that the animals could not be overreached by the disease but healthier [87]. However, the vaccine must be disease-specific and appropriately administered as recommended by the veterinarian and by checking the recommended dosage, dilution rate, route of administration and all precautions. Animals must be injected on the recommended parts of the animal's body and ensure that the injected sites are clean and dry.

7.7 Treatment of diseases

Treatment becomes essential and inevitable where farm animals have become infected by pests and diseases[5]. Unlike vaccination that is meant to prevent disease or infections by boosting the immunity of kept animals, treatment is meant to eradicate or halt the debilitating effects of diseases in farm animals (**Figure 5**). Treatment, however, takes different forms, depending on the nature of the ill-health affecting an animal(s). It could be by prophylaxis, intravenous injection, dipping, isolation or culling [88, 89]. For instance, treatment of bacterial diseases such as Salmonellosis could be by the use of antibiotics such as ampicillin, chemotherapeutics and fluid therapy, isolation and general nursing [89] while worm such as liver-fluke is treated with medication such as oxyclozanide, nitroxynil,

[4] Vaccination, especially when it involves an injection, is delicate medical care and as such could not be undertaken by just anybody but by well-trained animal health attendants or veterinary doctors. Vaccination is most cases are based on the pre-knowledge of certain diseases in certain farm animals and as such consultation of well-trained animal health officers for an appropriate recommendation of vaccines and dosage is crucial good health management of farm animals.

[5] Treatment of animal diseases is generalised in this section and as such, farm animal attendants will need to know that specific disease condition requires specific treatment and will be subject to appropriate diagnosis by well-trained animal health officers or veterinary doctors.

Figure 5.
A lamb being treated of infection by an experienced animal health attendant. Source: Photo by author.

albendazole [88], etc. In addition, treatment of bloat disease—gas build up in rumen, requires the service of a veterinary surgeon who might need to insert stomach tube into the rumen to have the built-up gas released and in extreme cases, the rumen will have to be punctured on the left flank with surgical apparatus such as trocar and cannula [16]. This suggests that a farmer cannot handle all treatment of emerging diseases in their farm animals.

8. Social and economic implications of health management of farm animals

The goal of livestock management is to ensure the efficient production of animals and animal products for social and economic gains at all strata of the human social system. Achieving this goal implies that farm animals must be kept healthy at all times for enhanced productivity. An important way to maintaining good health of farm animals is by eradication of epidemiological diseases or reduce their debilitating effects to barest level through combination of hygiene practices, biosecurity and vaccination of animals as failure in this regard may lead to immediate loss of livelihood to those in the livestock sector, disruption of domestic trade or the cessation of access to international markets, and threats to public health [1, 8, 10, 83]. Hence, the need for mitigation of the impact of diseases of farm animals. Prevention and control of animal diseases not only prevent the loss of animals to death but largely reduce the burden of the debilitating effects of disease and associated suffering of the animals such that they can enjoy better health and welfare. In addition, consumers could then have a supply of safe and affordable food [85]. In the same vein, vaccination of farm animals greatly protect animal and public health, reduce animal suffering, enable efficient production of food of animal source to feed the burgeoning human population, and greatly reduce the need for antibiotics to treat food and companion animals [90]. This, however, requires responsible use of vaccines and antibiotics to prevent, not just to control a disease outbreak in the farm animals but to ensure the safety of products from vaccinated or treated animals for safe consumption by humans. Control and prevention of diseases are however with cost implications whereby vaccination and treatment of animals add to cost the cost of livestock production and to the national veterinary budget [85]. This notwithstanding, advantages of boosting farm animals' immunity through vaccination and recovery of animals from ill-health by treatment worth the efforts and cost than losing the entire stock by death as the regained productivity of the farm animals could help recover the expended cost on vaccination and treatment in the long run.

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