

CHAPTER ONE

INTRODUCTION

Before oil was discovered in Sudan, export of livestock and livestock products were the country's most important foreign exchange earner. It is currently the second most important source of foreign exchange after oil (Animal Resources Services Company, 2014). Recent animal health emergencies have highlighted the vulnerability of livestock industry to epizootic episodes caused by infectious diseases (Andrés Cartín-Rojas, 2012). Infectious diseases are diseases transmitted from animal to another animal or human by any means or various means of infection, Infectious diseases are caused by pathogenic microorganisms, such as bacteria, viruses, parasites or fungi. More than 300 diseases can be transmitted from animals to humans; only a limited number of zoonotic diseases can be transmitted person-to-person. Animal diseases represent an important threat to human health, since the emergence of human diseases is dominated by zoonotic pathogens, about 75% of recently emerging infectious diseases affecting humans are diseases of animal origin, and approximately 60% of all human pathogens are zoonotic (The National Center for Emerging and zoonotic Infectious Diseases, 2014).

Therefore, an infectious animal disease in agriculture and public health constitutes a serious limitation to export live animals and their products, as well for international trade. Moreover, they seriously compromised food security and caused a high socioeconomic impact on agricultural exporting nations (Rojas, 2012).

According to reports of the General Directorate of Veterinary Quarantine and Meat Hygiene (The Ministry of Livestock, Fisheries and the rangeland, 2014) there are some of the infectious diseases that have an impact on exports of animals in Sudan:

- **Brucellosis:** Brucellosis is one of the most common zoonotic diseases in the present time in both developed and developing countries alike according to the classification of the global organizations (WHO, FAO, OIE (Mohamed Refai, 2011). The importance of this disease is due to the high economic losses as well as the danger to human health and safety (General Administration of livestock - Kassala State, 2012).

- **Camel pox:** Camel pox is an economically important contagious skin disease of camelids. It is a common disease among the camels and human (zoonotic diseases), causes economic impact due to considerable loss in terms of morbidity, mortality, loss of weight and reduction in milk yield (Bhanuprakash et al, 2010).

- Foot and mouth disease (FMD)** is a highly contagious viral disease of cloven hoofed domestic and wild animals. Because FMD is highly contagious it is arguably one of the most important livestock diseases in terms of economic impact throughout the world (Dustin L et al, 2007).

The most prevailing diseases in the Sudan are: brucella, pox, foot and mouth disease and Contagious Bovine Pleuro Pneumonia. They have negative impacts on the Sudanese livestock through affecting the production and reproduction qualities and quantitative wise.

The Ministry of Animal Resources, Fisheries and Range (MARFR) and through its authorized department and referenced institutions for example

Animal Research Corporation, Animal Central Research lab (ACR) and Scientific Research Centre is doing utmost efforts to control and alleviate those diseases for the safety of the Sudanese people and for the sake of animal wealth export.

This research aims to study the impact of infectious diseases on livestock exports in Sudan.

CHAPTER TWO

LITERATURE REVIEW

2-1 The Importance of Animal Diseases:

Losses resulting from the spread of animal diseases: more than half of the world's population suffers hunger today or malnourished diseases, and a few thousand of them dies daily. If we know that the number of the world's population almost seven billion people in 2000, so we realize the need to increase the numbers of livestock to obtain the necessary requirements of animal products most notably meat and dairy products, the most important means by which must be followed to increase these numbers is to eliminate of the animal diseases, which caused heavy losses especially for developing countries. Even with the development of various effective means to control a lot of animal diseases and eliminate them there are still large amounts of meat and dairy lose annually around the world as a result of the spread of these diseases, it should be noted that the losses in some developing countries where control of the disease and eradication are still in the first stages, ranged between 30-40% of the total number of livestock in developing countries. In addition to the above, there are losses resulting from the failure to apply modern methods in animal husbandry and nutrition (Guibati, 2012).

2-2 Infectious Diseases:

The impact of infectious animal diseases seems as great at the start of the 21st century as it was at the start of the 20th. In the developing world, these diseases continue to limit productivity, constrain development and exacerbate poverty (Perry, 2002). In the developed world, infectious animal

diseases still make animals suffer, harm the environment and cause financial loss. In Sudan brucellosis, foot-and-mouth, pox diseases pose a threat to livestock exports as well as human health, this threat results from the nature of these infectious diseases.

2-2-1 Brucellosis:

Brucellosis is one of the world's major zoonosis disease (Boschioli et al,2001). The disease is produced by bacteria of the genus *Brucella* (Bercovich, 2000). The disease poses a barrier to trade of animals and animal products (Ficht, 2003) and has a wide socioeconomic impacts especially in countries where rural income relies to a large extent on livestock breeding and dairy products (Zinsstag et al., 2005). Brucellosis is responsible for economic losses due to abortion, infertility and drop in milk production (Garin –Bastuju, 2003). The Center for Disease Control and Prevention (CDC) lists *Brucella* as a possible bio-terrorist agent, however, it has never been successfully used in this manner .The center also classifies *B. abortus*, *B. melitensis* and *B. suis* as “agents of mass destruction” and as category B-organisms (Elzer, 2002). The control of the disease depends on the system of animal management (Musa, 2004). The approach for control, prevention, or eradication of brucellosis in a country or region depends on many factors, such as the level of infection in the herds or flocks, type of husbandry, economic resources, public health impacts, and potential international trade implications.

2-2-2 Foot and Mouth Disease:

Is an infectious zoonotic and sometimes fatal viral disease that affects cloven-hoofed animals, including domestic and wild bovids (Arzt J

et al, 2011). Foot and mouth disease (FMD) has been eradicated by many wealthy nations but remains endemic in most of the world. When FMD outbreaks occur in disease free countries and zones that produce livestock for export the economic impact is clear to see. Livestock movements and trade play a key role in the spread of FMD. Hence, despite the significant economic losses involved (James and Rushton, 2002), movement and trade restrictions at domestic and international level are fundamental to control (Sutmoller et al., 2003). There is no specific treatment for FMD, other than supportive care, treatment is likely to be allowed only in countries or regions where FMD is endemic. Control measures include quarantine and destruction of infected livestock, and export bans for meat and other animal products to countries not infected with the disease. Report occurrence immediately so as to invoke quarantine after the disease is confirmed by the veterinary authorities. Such quarantines should be lifted only by the authorities, usually 6 weeks after the last recorded case (Force, B, 1999).

2-2-3 Camel Pox:

Camelpox occurs in almost every country in which camel husbandry is practiced, caused by virus of the family Poxviridae, subfamily Chordopoxvirinae and the genus Orthopoxvirus. It causes skin lesions and a generalized infection (Carter G.R., Wise D.J, 2006).

Camel pox diagnosis can be based on symptoms. However, both Camel Contagious Ecthyma and Camel Papillomatosis cause indistinguishable symptoms under similar conditions. Therefore, the best way to diagnose Camel pox is via Transmission Electron Microscopy evaluation of skin samples from infected animals (Khalafalla, A 1998). Camel pox outbreaks have a negative effect on the local economies. Outbreaks often lead to the

loss of young camels, and render older camels useless in terms of milk and meat production, and transportation. As such, attempts are often made to prevent transmission of the disease. An attenuated vaccine is currently available (World Organization for Animal Health, 2012).

2-3 Transboundray diseases:

Transboundray diseases are a permanent threat for livestock keepers. They have major economic implications – both through the private and public costs of the outbreak. Transboundray animal diseases are defined as “those that are of significant economic, trade and/or food security importance for a considerable number of countries; which can easily spread to other countries and reach epidemic proportions; and where control/management, including exclusion, requires cooperation between several countries, within this definition there are many diseases that cause damage or destruction to farmers, property may threaten food security, injure rural economics and potentially disrupt trade relations (Ifpri, 1999).

2-3-1 Significant Transboundray Animal Diseases:

- Foot and mouth diseas (FMD): substantial progress has been made towards control and eradication of FMD in several regions of the world.
- Rindrpest (RP): rinderpest was eradicated from Southern Africa during the first half of this century by strict enforcement of cattle movement controls, quarantining of infected areas and selective ‘stamping out ’of infected herds and vaccination in risk areas, it is also eradicated in Sudan .
- Contagious bovine pleuropneumonia (CBPP): CBPP is often regarded as an insidious, low mortality disease of cattle, but this is based on experiences

in endemic areas. In susceptible cattle populations the disease can spread surprisingly rapidly and cause high mortality.

- Rift Valley Fever: is mosquito-borne viral zoonotic disease. The first recorded outbreak in Egypt 1977 caused an estimated 200, 000 human cases of the disease with some 600 deaths as well as large numbers of deaths and abortion in sheep, cattle and other livestock species. Outbreak of the disease in East Africa in 1997-8 and 2000 not only caused livestock losses and human deaths but also seriously disrupted the valuable livestock export trade to the Middle East.

There are other diseases considered as Transboundary Animal Diseases such as Avian Influenza, Newcastle disease and Peste des petits ruminants (PPR) and others.

Introduction of animal diseases occurs in many ways, the most common includes live diseased animals and contaminated animal products either as imports or as food waste from international aircraft or ships. Other introductions are from importation of contaminated biological products (e.g. vaccines) or germplasm (semen or ova), migrating animals and birds, or even by natural spread of insect vectors or by wind currents (McLeod.A and Leslie, 2000).

2-3-2 Economic Impact of Transboundary Animal Diseases:

The economic impacts of transboundary animal diseases can be complex and go beyond the immediate impact on the directly affected agricultural producers. In specific cases, the actual economic impact will vary depending on factors such as the type of transboundary animal diseases, but the

complexity of the effects often make the precise measuring of the economic impact very difficult.

Production The most direct economic impact of transboundary animal diseases is the loss of or reduced efficiency of production, which reduces farm income. The severity of the economic effect will depend on the specific circumstances. If the farm economy is relatively diversified, and other income opportunities exist, the burden will be reduced. Conversely, if the local economy is heavily dependent on one or few vulnerable commodities, the burden may be severe and local food security impaired. The impacts of reduced productivity of animals can be long-lasting and diseases can have lasting effects on livestock output in a number of “hidden” ways (such as delays in reproduction leading to fewer offspring and the consequences of a reduced population) which often exceed the losses associated with clearly visible illness (Mumford et al, 2000).

Although the loss of output from transboundary animal diseases may appear easy to identify, it can nevertheless be difficult to measure in precise economic terms. Indeed, such an economic evaluation should not simply measure the value of lost output multiplying estimated physical loss by the market price. This may indeed exaggerate the likely economic impacts of damage. Actual economic impacts will also depend on adaptation by farmers as well as possible market adjustment. Among the ways in which farm communities can respond are releasing stocks or selling assets, engaging in non-farm income earning activities etc. For these reasons, the welfare loss may be less than the value of lost output. Only if the farmer livelihood responses are very restricted, or the community economy is heavily dependent on the commodity affected by the disease are the welfare losses

likely to exceed the value of lost output. Further, the difficulty of distinguishing the production impacts of diseases from other impacts, such as climate, has not been effectively overcome. Often disease epidemics coincide with changes in climatic conditions, such as drought, early rains and other output-reducing events. Lack of record-keeping by farmers in developing countries adds to the uncertainty about how much given change in production is attributable to diseases, how much to weather, how much to farm management and other variables (Tambi et al, 1999).

Price and market effects along with production impacts can cause variations in prices, determined by the supply and demand effects induced by transboundary animal diseases. Market effects can similarly induced variations in wages for farm and processing employment and can otherwise spread through to upstream and downstream activities. The relative effects on producers and consumers of the production shortfall will depend on the relative elasticities of demand and supply (that is the responsiveness of demand and supply to price changes). Negative price effects can also occur where consumer health concerns leads to reduction in demand.

Trade through the demand channel introduced diseases can have major implications for farmers and countries producing for export or wishing to export. Countries which are free from major diseases will tend to protect their local agriculture by totally excluding the importation of livestock products from areas affected by specific animal diseases or by making importation conditional upon a series of precautionary measures. These trade implications of transboundary animal diseases can cause a greater economic impact than the direct production losses themselves. Conversely benefits of elimination of transboundary animal diseases can be very large. The desire

to gain access to high-value export markets is indeed, the driving force behind many animal disease eradication efforts (McLeod et al, 2003).

Food security and nutrition transboundary animal diseases can often have significant negative impacts on food security and nutrition in developing countries. The growth of international trade in agricultural produce buffers the potential impacts of transboundary animal diseases on food availability, but there can still be major impacts on poorer communities that do not have access to substitute supplies. The food security impact is the paramount concern of many national policy-makers in developing countries and provides one of the main arguments in favour of international assistance for control programs.

Health and environment the main threat to human health arises from zoonotic diseases, such transmission of diseases from animals to humans appears to have increased in recent years, perhaps due to increasingly intensive livestock production in areas of proximity to human populations. Increasing concern is arising over threats to the environment, either from diseases themselves, which might move into domestic wildlife, or from the control measures used to combat diseases.

Financial costs there are also budgetary implications of transboundary animal diseases. Control measures generally involve budgetary outlays. These include costs for inspection, monitoring, prevention and response. Also, demands are often put on government to extend financial assistance to the affected producers. The costs of some of these measures are proportional to the size of the agriculture sector being protected, while others are less closely related. As for the benefits of control measures, generally the

benefits of prevention and emergency preparedness are not directly apparent and depend on assumptions about avoided costs of infections and disease outbreak (FAO, 1992).

2-4 The Economic Importance of The livestock Sector:

Livestock is the single most important component of the agricultural sector in Sudan, consistently accounting for nearly half of the gross domestic product (GDP) of the sector (47%), almost equal to that of all crops combined. The livestock sector makes an important contribution to the food security of the country, employment, export earnings, means of transport of goods and individuals, draught power, manure for soil fertilization and a means of accumulation of capital assets. It is considered an important element in poverty alleviation programmes in the country. Table (1) demonstrates the Estimation of Livestock Population in Sudan. The prevailing livestock production system in Sudan is the traditional nomadic and transhumant herding. In addition there are sedentary and semi-sedentary livestock production systems, small intra-urban backyard production, and integrated livestock/crop production operations. Livestock population is concentrated in the Western States, comprising 36% of cattle, 40% of sheep, 36% of goats and 33% of camels (These figures are Ministry of Animal Resources and Fisheries estimates based on data of the last animal census carried out in 1975/76). Considerable ecological changes have taken place since then which might have affected the present livestock population and distribution. It is of paramount importance to conduct a new census) (Konandreas, 2009).

Table (1) Estimation of Livestock Population by states in 2012:

States	Cattle	Sheep	Goats	Camels	Total
North Kordofan	954880	7282303	3651171	1246187	13134542
South Kordofan	7498792	3123987	3409226	533537	14565543
North Darfour	695272	3790788	2925336	594350	8005746
South Darfour	2346916	2132082	1668898	88060	6235956
West Darfour	1920204	1741200	1365462	72049	5098916
Senter Darfour	1844112	1776735	1998238	193366	5812450
West Darfour	2255904	2163668	2445374	236125	7101071
Elgedarif	1050368	2152664	1068957	343972	4615961
Kassala	853424	2037155	1689217	693171	5272966
Red sea	137264	420032	725835	287911	1571042
Blue Nile	2038072	3937799	457496	14253	6447620
Sennar	1599424	1386105	1654025	117350	4756904
Elgezira	2509544	2493939	2164309	124001	7291793
White Nile	3536040	2572695	2582214	35633	8726582
Northern	253640	987075	1161336	49410	2451462
River Nile	101456	1039579	1218523	114974	2474533
Khartoum	244688	446284	651052	6651	1348676
Total	29840000	39484092	30836670	4751000	104911762

Source: Ministry of Livestock, Fisheries and the rangeland- Information center 2012.

2-5 The Livestock Marketing Chain in Sudan:

(Animal Resources Services Company, 2002) Major livestock production areas are scattered in the range of some 600-1,200 kms from the terminal markets. The efficiency of the marketing system is co-related to the distance of production areas and the seasonality of supplies (due to migrations), which in turn have led to the development of a unique internal livestock market system in Sudan. The livestock markets of Sudan are highly broker-dominated and without any parallel in the region (there are 550 licensed livestock traders/brokers operating in the secondary market of Kosti alone in the small White Nile State). Statistics provided on market prices are approximate guesses and should therefore be treated with caution. The only exception is Kosti market where transaction takes place through an open auction, though scales are not used. This may appear as anomaly but the practice has been in use since the colonial days when the first meat processing plant in Sudan was built in Kosti in 1954. The main livestock supply areas for both the terminal and the export markets are Northern Darfur, Northern Kordofan and Butana area (camels), Southern Darfur and Southern Kordofan (cattle), Northern Kordofan, Western Kordofan and Gedarif state (sheep). Figure (1) illustrates the livestock marketing chain in Sudan.

2-5-1 Market Actors:

(Animal Resources Services Company, 2001) In general, the market chains are dominated by livestock traders and exporters who operate through a network of agents (wakil), subagents, small traders and brokers. The supply chain is characterized by many intermediate stages, with transaction costs being taken up mostly by intermediary traders and brokers. Most trading is done by private treaty, with the exception of large numbers of animals intended for export which are sold by private auction at primary, secondary or terminal markets. Resale in the same market on the same day is common, and animals may be fattened or reconditioned before resale.

Bush traders (Ghelaja): These agents purchase animals directly from producers at grazing areas, villages or primary markets and sell them to local brokers (sebbaba) at primary markets.

Local brokers (Sabbaba): There are three categories of animal sabbaba in Sudanese livestock markets, according to the roles they play in the transaction. The first category of sebbaba purchases animals either from ghelaja or directly from producers at the primary market. They then sell the animals either at another primary market or at a secondary market. Although they are called 'local brokers', they are also traders in the sense that they purchase animals from one market and sell in another market or in the same primary market. However, at the primary markets they are called *sebbaba* because they mostly act as brokers and act as a link between buyers and sellers. The second category of sebbaba operates at primary, secondary or terminal markets. They are classical brokers or typical middlemen involved in all transactions between sellers and buyers along the market chain. The

majority does not have working capital and are paid a commission based on the number of animals or herds handled.

The third category of sebbaba is also called kaggir. These brokers buy animals at a nominal fee or acquire the animals without paying a fee. Transactions by this category of brokers are relatively fewer and account mostly for domestic demand.

Suppliers (Jellaba): They purchase animals from remote production areas and bring them to the terminal markets for live animals export. They may work in partnership with animals' exporters and wholesalers. They are speculative traders who buy and sell livestock with the main aim of profiting from price fluctuations.

Guarantor (Damin): The damin provides a guarantee to the buyer that animals offered for sale are not stolen and that the seller is known by tribe. Each tribe has a guarantor. They are present in all livestock markets in the Sudan with high concentration in production areas. They also provide services for livestock owners, providing credit for managing and accommodating animals, and sometimes advice producers as to whom they can sell on credit basis. To operate in the market, they must have a valid license from local authority.

Agent (Wakil): Agents act only as representatives of their clients; they do not own the animals they handle. They receive their income in the form of fees and commissions and provide services to buyers and sellers. Often, the main service they provide is market information and the linking of buyers and sellers.

Auctioneers (Dallallein): They arrange for terms of sale of the animals, receive the payments, deduct their fees and transfer the balance to the owners. They influence the supply of sheep to Omdurman terminal market

and the price determination. At secondary markets, they have the same function, but with relatively less influence. The role of the different actors in the livestock market chain is summarized in the Table (2).

Table (2) The role of market actors:

Type of market	Market actors	Function
Primary	Producers <i>Ghelaja</i> (bush traders) Local butchers <i>Wakil</i> (agent/subagent) <i>Jellaba</i> (suppliers) <i>Sebbaba</i> (local broker) Brokers (<i>semsar</i>)	Produce Sell, purchase and resell Purchase for local slaughter Purchase for export Purchase and assemble Purchase, sell or mediate Commissioned middlemen
Secondary	Local butchers <i>Wakil</i> (agent/subagent) <i>Jellaba</i> (suppliers) <i>Sebbaba</i> (local broker) Brokers (<i>semsar</i>)	Purchase for local slaughter Purchase for local slaughter and/or export Sell/or purchase and assemble Purchase, sell or mediate Commissioned middlemen
Terminal	Local butchers <i>Wakil</i> (agent/subagent) <i>Jellaba</i> (suppliers) Brokers (<i>semsar</i>) <i>Sebbaba</i> (local broker) Small traders Big traders Big auctioneers	Purchase for local slaughter Purchase for sheep export Sell for domestic consumption export Commissioned middlemen Purchase, sell or mediate Purchase and sell to big traders/consumers Purchase and sell to live sheep exporters Sell to live sheep exporters

Source: Adapted and modified from Solomon and Nigussie by El Dirani (2007).

2-6 Type of Livestock Markets:

There are three types of livestock markets in the Sudan:

2-6-1 Primary markets:

Usually located within a village market or near a livestock-producing village, have no physical infrastructures (such as fencing, water and feed for animals) or market information. Animals are not kept in the market overnight. Market days are variable with some markets open once or twice a week and others operating daily. Some primary markets operate only during the wet or dry season. Trading may be by direct negotiation between sellers and buyers or sometimes through a broker. Except in el Showak (Gedarif State) and el Khowei (West Kordofan State) where vaccination and inspection centers are present, veterinary certificates are not issued for movement of purchased animals.

2-6-2 Secondary markets:

May or may not have facilities and infrastructure, such as fencing, water and feed for animals. For example, these facilities are present in Gedarif and el Nihood markets but absent in el Damazeen market, animals are inspected by a veterinary officer and veterinary health certificates are issued, animals may be kept overnight in the market in holding facilities (mannama) or fenced areas, more secure and better managed than the primary markets (Dirani. 2007).

2-6-3 The Terminal Markets:

Infrastructure facilities (e.g. fencing, water and feed, veterinary clinic and pharmacy, loading ramps) are in place. Officials from the federal veterinary authority and market management are present at the market. Some primary markets, (e.g. el Khowei in West Kordofan State and el Showak in Gedarif)

also serve as terminal markets, due to the recent setting up of veterinary quarantines for export. Some terminal markets for meat are located next to export abattoirs that receive live animals directly from production areas; where live animals are supplied directly from production areas (Dirani, 2007).

Sudan is expanding the number of its terminal markets. Currently, livestock are exported directly from El Muwelih in Omdurman and el Khwei, el Rahad in North Kordofan and el Showak through Port Sudan. Soon Kosti and El Gedarif will be upgraded as terminal markets for export when the quarantine stations under construction in these areas begin operations. Elobeid, Kosti and El Gedarif also double as secondary markets since they supply the El Muwelih market in Omdurman. In Sudan, animals delivered to the terminal markets need to be accompanied with vaccination certificates for anthrax, BQ, CBPP, CCPP and sheep pox. Livestock without vaccination certificates are vaccinated before entering the terminal markets (Livestock and Red Meat Export Marketing Study Vol II, 1997).

El Muwelih is the largest terminal market in Khartoum (located in Omdurman) operating on Wednesdays and Saturdays serving both the domestic and the export markets (The Ministry of Foreign Trade is planning a separate market for export at the moment). A number of other smaller sheep markets also operate in Omdurman. The Animal Resources Services Company (ARSC) has also put up recently a new sheep market in the Dar Es Salam area of Omdurman in agreement with the Khartoum State, where market fees will be shared at a proportion of 75 and 25% respectively. Wholesale butchers buy cattle and sheep in bulk and take them for slaughter either to the Ganawa slaughterhouse (privately owned) or to one of the nine Government owned slaughterhouses (2 big slaughterhouses and 7 slabs) and

managed by Khartoum Animal Resources Services Export Co Ltd they Sell the meat to retail butchers either directly or through intermediary wholesalers. The retail butchers pay one-third of the price upon collecting the meat and pay the rest after selling the meat (an extension of the trust system), some of the wholesalers also run their own butcheries on the side. Small butcheries lack the necessary capital to run their own feedlots and have to rely for their supplies on wholesalers (Livestock and Red Meat Export Marketing Study, 1997).

Livestock have to undergo a 21 days quarantine period for export certification. At times, the quarantine may take place simultaneously with fattening. In any case, the quarantine takes place in stages allowing the transportation of livestock in the meantime. For example, livestock bought in Omdurman are kept at the quarantine station there for 10 days while being fattened. Then they are moved to Kadero quarantine station (which is linked to the railway) for 5 days where further observations and Brucellosis tests takes place. Livestock are then transported for two days to Port Sudan where veterinary staff check them for a further 4-5 days before shipment. The exporter pays all quarantine vaccination, feed and shipping costs. Exporters are keen to help in the inspection of their animals as early detection prior to reaching Port Sudan permits the disposal of rejected animals in the local markets (Arab Organization for Agricultural Development, 2000).

2-7 Inspection Points:

Different levels and actors are involved at various points in the export chain from primary market up to export. At each level, there are inspection and selection criteria, for meat export, Khartoum airport and any other export ports for meat (e.g. Nayala), export slaughterhouses, inspection and vaccination centers are involved in addition to inspection at livestock

markets. There are two major bodies through which inspection and selection for quality assurance and certification of export animal are: The export enterprises or companies provide quality assurance through a number of steps and actions. First, they screen animals at the time of purchase on the basis of a number of criteria. The purchase team observe and inspect animals individually by visual assessment, to avoid the following: enlarged lymph nodes and abscesses, mange on nostrils or anywhere, infected wounds, scratches, diarrhea, or any disease which cannot respond to fast treatment, or will leave a scar on the body. Second, further screening on the basis of health specifications and indicators of good quality. The most important instruction guide here from exporter is to avoid purchases from infected areas or markets with diseases that affect the export flow. After the first visual assessment if inflamed lymph nodes exceed 5%, there should be individual checking of all animals in the flock.

In inspecting inflamed lymph nodes, certain locations on the body should be considered, e.g. on the head, in front of the four legs (supra scapular), genital organs, or any abnormal apparent swelling on the body.

The Ministry of Animal Resources and Fisheries (MARF) performs several functions through the General Directorate of Veterinary Quarantine and Meat Hygiene, Inspection and Vaccination Centers and Veterinary Quarantines. Their role at the entry point of secondary quarantine facilities is the inspection for presence of notifiable or non-notifiable diseases, non-castrated males, emaciated and poor quality animals, and then vaccination.

Finally Brucella testing is done, unfit animals for export are rejected, and then they issue certification. Animals are then ear tagged to identify state of origin to ensure good quality animal ready for export. General Directorate of Veterinary Quarantine and Meat Hygiene includes the following sections:

- ✓ Administration of veterinary quarantines includes (Port Sudan quarantine station, Kadero quarantine station, Wadi Halfa quarantine, Airport, Alshouak(Stopped working), Dongola, Kassala, Nyala and others), these quarantines spread over different parts of the country and exits to the implementation of operations and provide services to exporters special Operations of export live animals through the ports and ensure safety and free of diseases and health certification also oversees the export and import of wild animals.
- ✓ Administration of Slaughterhouses and meat: This department oversees export of carcass in Sudan and contains six slaughterhouses distributed across the country (Kadero Slaughterhouse, Sbaloga, Gnawa, Nyala, Gemco and Radwan. Currently all slaughterhouses stopped working except Kadero and Sbaloga. These slaughterhouses operate on meat and validated by the international standard specifications and conditions agreed between the countries, after the meat processing are entering refrigerators for cooling until degree (-1C°) Degrees C and then be shipped to ports and airports across the moving refrigerators.
- ✓ Inspection centers.
- ✓ Center of regional training to examine the health and grades of meat (General Directorate of Veterinary Quarantine and meat hygiene, 2014).

2-8 The Main Constraints along the Market Chains for Live Animals and Meat and the Key Activities that Relate to Quality and Safety Assurance:

There are many obstacles that facing traders and exporters on the length of the marketing chain from production areas to the terminal markets, these constraints impede livestock marketing process in Sudan.

2-8-1 Primary Markets:

- Lack of veterinary service provision.
- Absence of formal quality assurance system: Few actors benefiting from the informal grading system in use because of monopoly of relevant knowledge and information.
- Limited provision of services and infrastructure by local authorities (water and troughs, treatment/vaccination crushes and fencing) and lack of an accurate and comprehensive record keeping system.
- Absence of regulation of brokerage services.
- Absence of formal traceability system.
- Insecurity during transport of animals from Greater Darfur states leading to increased transaction costs ('rent seeking' and unofficial taxes).

2-8-2 Secondary Markets:

- Meager veterinary service provision: Only animal health inspection and vaccination, priority for transboundary diseases and screening of export trade animals. Weak enforcement of animal welfare standards. No isolation for sick and suspected animals.
- Absence of formal quality assurance system. Few actors benefit from the informal grading system in use.

- Limited provision of services and infrastructure by local authorities (water and troughs, treatment/vaccination crushes, isolation facilities, loading and fencing) and lack of accurate record keeping system.
- Unregulated tax collection system.
- Absence of regulation of brokerage services.
- Absence of formal traceability system.

2-8-3 Terminal Markets:

Omdurman livestock markets and export slaughterhouse, Gezira International Meat Company and Nyala slaughterhouses.

- Absence of regulation of brokerage services at livestock markets or slaughterhouses.
- Absence of a formal quality assurance system; few actors benefiting from the informal grading system.
- Absence of a formal traceability system:
 - Lack of specialized vessels for sea transport of live sheep.
 - Lack of refrigeration facilities (specialized containers and airplanes with chilling facilities) at Khartoum airport.

2-8-4 During Purchases or Extra-Market Purchases:

- ❖ Risk of loss or theft of animals bought at producing areas (watering points, grazing areas, villages).
- ❖ Brokers and agents: Reliance on subjective visual inspection to screen animals for clinical symptoms of disease or assess quality attributes during purchase (e.g. breed, sex, age or nutritional status).

- ❖ Brokers: high brokerage costs and weak enforcement of informal contracts and property rights.
- ❖ Exporters: high cost of labor, trekking and trucking during peak seasons (Ibrahim A, 2004).

CHAPTER THREE

Methodology

3-1 The Collection of Data:

Structured questionnaire was designed to complete the necessary information needed for this study. Four visited were carried to the General Directorate of Veterinary Quarantine and Meat Hygiene (The Ministry of Livestock, Fisheries and the rangeland) to collect the data needed for this work .It include the following:

- Sudan's exports of meat (sheep, goats, cows and camels) in 2010, 2011, 2012, and 2013.
- Live animal exports (head) in 2010, 2011, 2012, and 2013.
- Rejection of vessels and the reasons of the reject in 2010, 2011, 2012, and 2013.
- Rejection of animals and the reasons of the rejection in 2010, 2011, 2012, and 2013.
- Check of brucellosis per head in 2010, 2011, 2012, and 2013.

Another visited to the Animal Resources Services Company in Omdurman to find out information about the livestock markets in Sudan.

Unfortunately the response to the structured questionnaire did not find any response from the departments and the companies of concern without justification for that.

Such alitual created constraints in finding real factual data from field, the matter which forced the researcher to find other means for collecting the

necessary needed data to complement the initial data obtained from the Ministry of Livestock and its affiliated centers.

3-2 Analysis:

The data was organized in a well set up tables and a proper statistical analysis applied (correlations- Pearson).

CHAPTER FOUR

Results

The present study showed the following facts:

Results in table (3) figure (2) illustrated that in the year (2010) 13% of the rejected vessels were because of Brucella, 67% was due to Pox and 3% was because of suspicion cases of foot and mouth disease. But in (2011) 43% of the rejected vessels were due to pox, 14% Brucella and 43% suspicion of foot and mouth disease. In (2012) 64% rejected due to Brucella, 18% pox and 18% external parasites. Also in (2013) 60% rejected because of Brucella, 20% pox and 20% was due to external parasites.

Also the result showed that the correlation between diseases (brucell, pox and external parasites) and years (2010, 2011, 2012, and 2013) is weak positive correlation but in suspicion cases of foot and mouth disease is moderate positive correlation.

Results in figure (3) demonstrate that about 16% of the animals tested were infected with brucella in (2010), 10% in (2011), 7% in (2012), 4% in (2013) and 4% in (2014) taking into account the incomplete information about the examination of Brucella in 2014.

Results in table (4) figure (4) showed that the percentage of Brucella in camel higher than sheep, goats and cattle with the knowledge of the lack of information about the examination of Brucella in cattle in (2012), (2013) and 2014.

Sheep constitutes about 86% of livestock exports in Sudan in (2010), 89% in (2011), 91% in (2012) and 92% in (2013) (Table3), this means that the

Sudan one of the countries that depends heavily on sheep in livestock exports (Figure5).

Results in figure (6) illustrated the percentage of animals excluded in 2010 was 5%, 3% in (2011), 2% in (2012) and 1% in (2013),The reasons for exclusions: Brucella, mange, suspicion of foot and mouth disease, inflammation of lymph nodes, pox, pneumonia, diarrhea, suspicion pox, abscess, lameness and others.

Table (3) The Reasons of Returned Shipment in 2010, 2011, 2012 and 2013:

Diseases	2010	2011	2012	2013
Brucella	13%	14%	64%	60%
Pox	67%	43%	18%	20%
Suspicion of foot and mouth	3%	43%	-	-
Lack of health certificates	17%	-	-	-
External parasites	-	-	18%	20%

Table (4) The Check of Brucella in 2010, 2011, 2012, 2013 and 2014:

Animals	2010	2011	2012	2013	2014
Goat	7.55%	0.26%	0.05%	0.40%	0.30%
Sheep	0.51%	0.26%	0.20%	0.10%	0.20%
Camel	7.93%	8.98%	6.90%	3.60%	3.20%
Cattle	0.20%	0.34%	-	-	-

Table (5) The Percentage of exports (sheep, goat, camel and cattle) in 2010, 2011, 2012 and 2013:

Years	%Sheep	%Goat	%Cattle	%Camel	Percentage
2010	86	6	0.2	8	100
2011	89	5	1	5	100
2012	91	4	1	4	100
2013	92	4	1	3	100

Table (6) live livestock exports (head) of 2010 to 2013:

Years	Sheep	Goat	Cattle	Camel	Total
2010	1,813,926	120,693	5,130	172,196	2,111,945
2011	2,729,134	162,149	21,056	151,208	3,063,547
2012	3,415,739	162,116	26,145	166,240	3,770,240
2013	3,757,363	197,958	11,202	129,647	4,096,170

Table (7) The exports of meat (Weight (Tons)) in 2010, 2011, 2012 and 2013:

Years	Sheep	Goat	Cattle	Camel	Total
2010	٤١٢٦.٥٣	٤.37١	٩٩١.٢٩	٠.٤٩٨	5122.689
2011	5425.831	42.7785	3552.989	٠.٢٦٥	9021.864
2012	٣,٨٩٩.٣٨٩	٥٥٥.٦١٤	٢,٤٦٣.٨٣٨	0.082	6,918.92
2013	2,131.809	232.758	195.608	0.191	2,560.37

Table (8) The percentage of animals excluded in 2010, 2011, 2012 and 2013:

Years	The total number of animals exported	Number of rejected animals	Percentage of rejected
2010	٢,١١١,٩٤٥	106884	5%
2011	3,063,547	103920	3%
2012	٣,٧٧٠,٢٤٠	77530	2%
2013	4,096,170	51269	1%

Fig (2) The Reasons of Returned Shipment in 2010, 2011, 2012 and 2013:

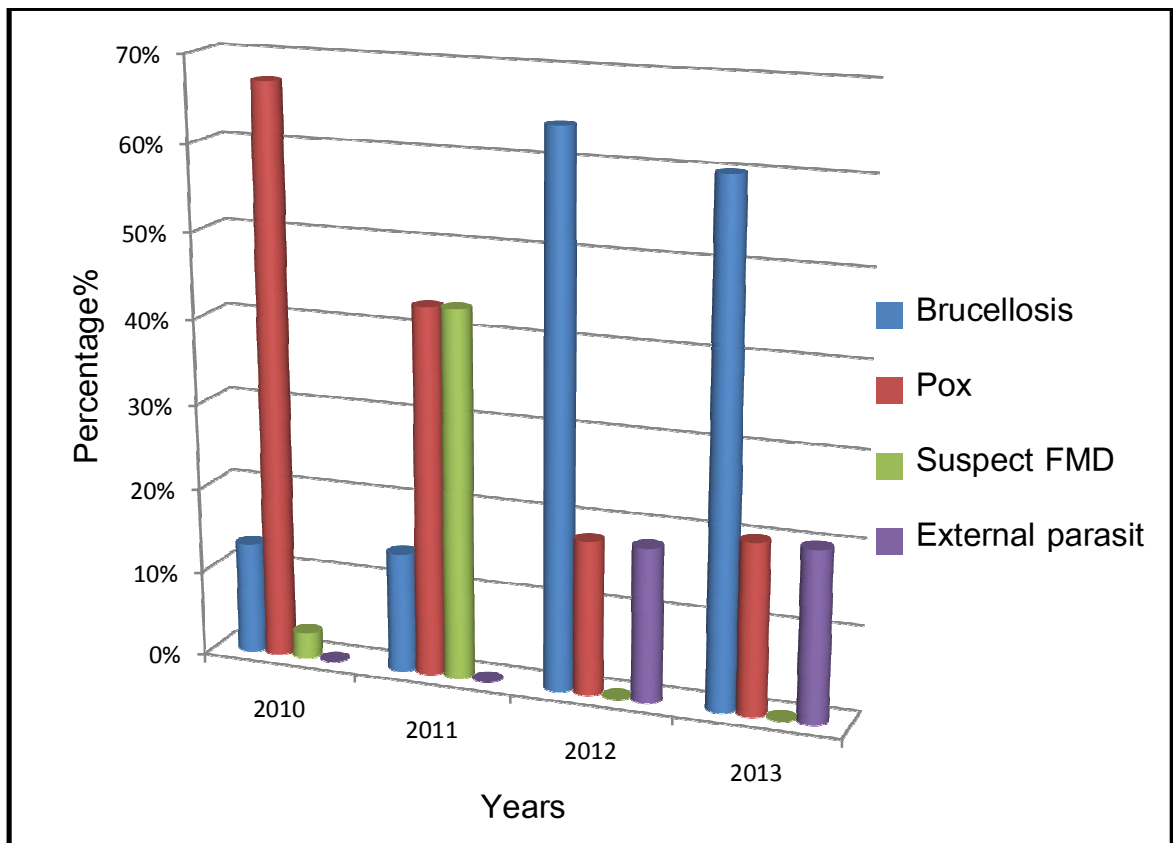


Fig (3) The percentage of brucella in different species through the years (2010, 2011, 2012, 2013, and 2014):

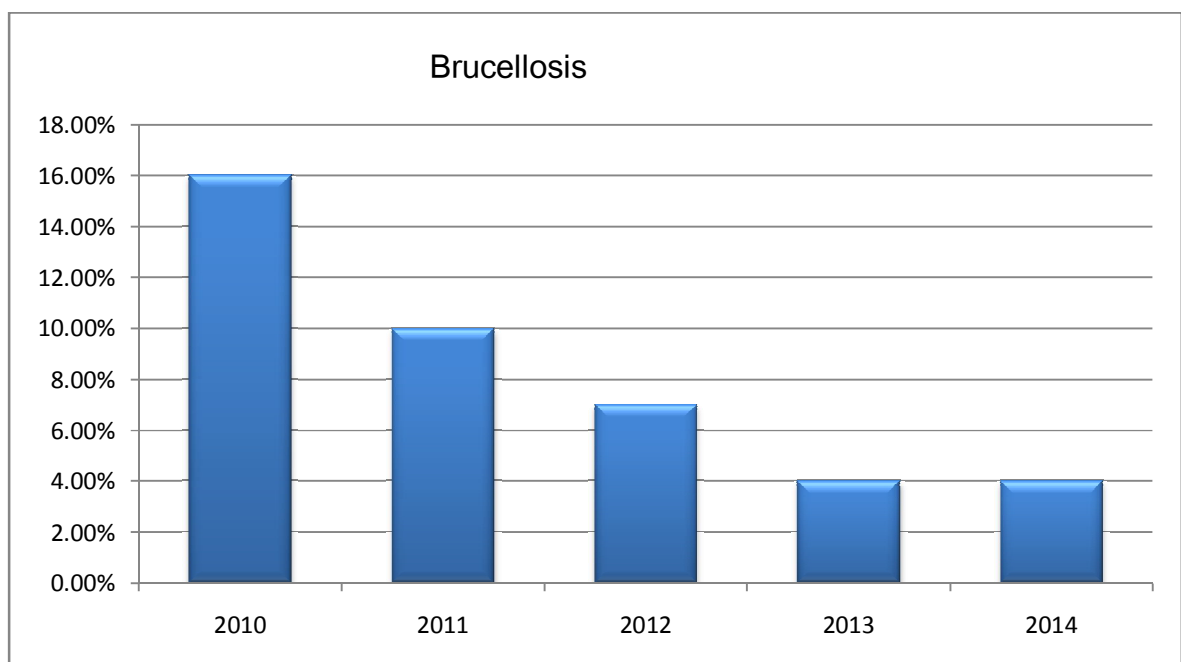


Fig (4) The percentage of brucella in each (cattle, camel, cheep and goat) in (2010, 2011, 2012 and 2013, 2014):

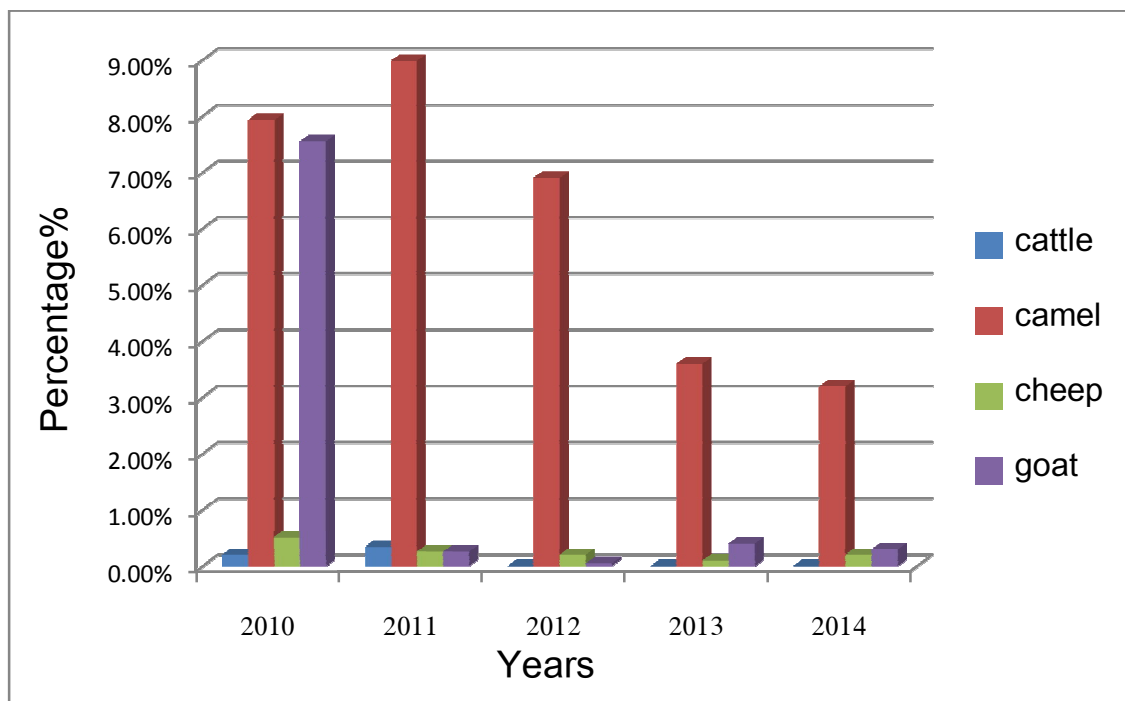


Fig (5) The proportion of exports (sheep, goat, camel and cattle) in 2010, 2011, 2012 and 2013:

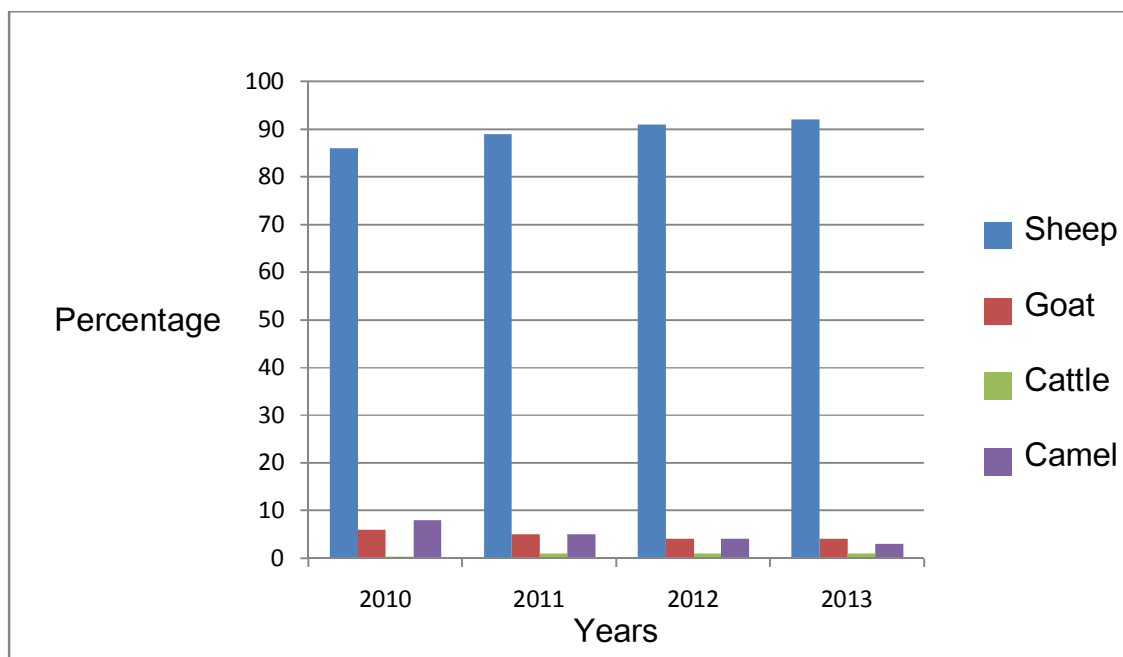
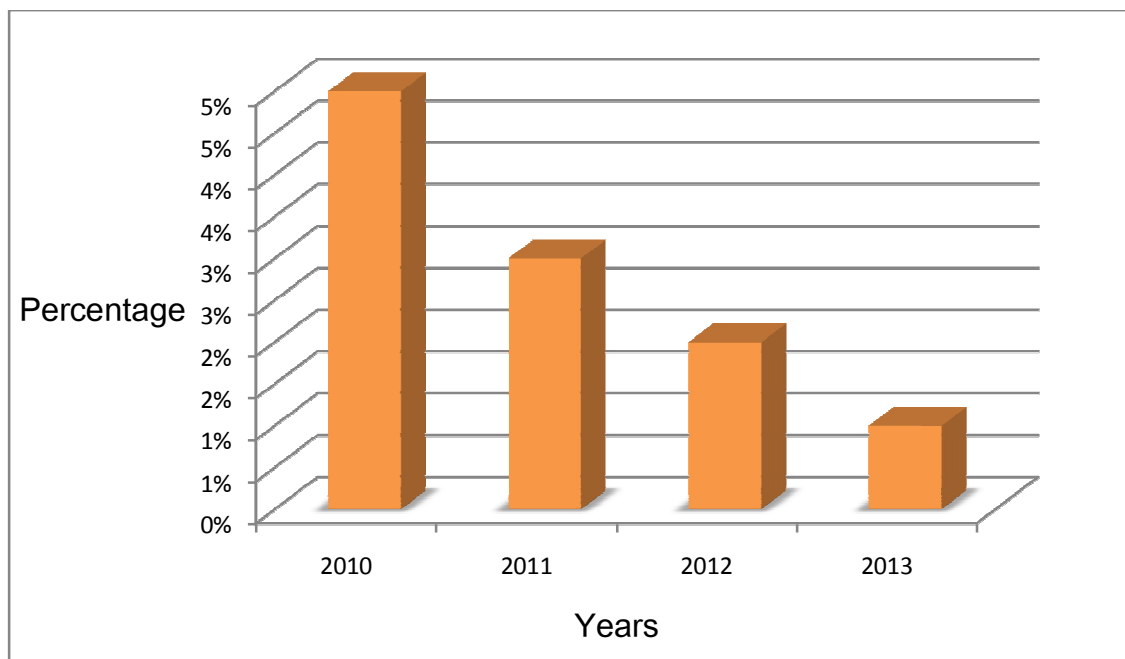


Fig (6) The percentage of animals excluded in 2010, 2011, 2012 and 2013:



CHAPTER FIVE

DISCUSSION

The small market share for the Sudanese livestock and fresh and frozen sheep meat reflects the lack of expertise in meat processing, handling and packing (Ibrahim, 2004). Other factors for the Sudan's relatively lower market share of fresh and frozen sheep meat is considered primarily due to differences in product characteristics, namely, shelf life, taste and average carcass weight (El Dirani et al., 2009). The noncompliance with the SPS measures and international agreements followed by the Gulf market is another major reason for this lower market share. Sudan's market share and absolute exports to the Saudi market have declined in some years (2000–01) giving way to other countries (Australia and New Zealand) increasing their share to the Middle East market. This decline in the country's share might be attributed to the outbreak of Rift Valley fever in the Horn of Africa.

The results of this study show that Brucellosis was the main cause of rejection of livestock vessels from Saudi port and that the percent of vessels' rejection increased from 13% in 2010 to 14% in 2011 and then a sharp increase (64%) occurred in 2012 and then 60% in 2013. These figures were also in agreement with (El Dirani et al., 2009) who reported that the records from primary, secondary and port quarantines and port authorities during 1997–2005 show that, 30.7% of the animals offered for export were rejected at various points in the domestic portion of the export chain starting from the first quarantine' and another 2.1% were rejected at the Jeddah port once the shipment was made. Because of the strict quarantine measures at the Jeddah port, a whole vessel is rejected even when only one or two animals with

unacceptable disease symptoms are detected. Similar results were also reported by Aklilu et al. (2002) who stated that about 6% of the sheep may be rejected at Kadero quarantine due to nasal discharge, emaciation, broken legs and Brucellosis (the latter accounts for 2% of the sheep) and again a rejection of 5-10% of the sheep and 3-5% of the cattle at Port Sudan. Saudi Arabia also invariably rejects more animals (13- 25% of sheep in 1994-1996). The reason for these strict quarantine measures is attributed to the fact that the disease represents a public health hazard (WHO, 2006). It is also reported that freedom from this disease is a pre- requisite for exportation of live animals, especially the camels, because of the zoonotic nature of this disease (Ahmed et al., 2013). Ahmed et al. (2013) also stressed the economical impact of brucellosis on the country's trade during the last few years. The authors reported that brucellosis emerged as one of the most important disease barriers to Sudan's international camel trade and that whole camel shipments were returned to Sudan from Saudi Arabia due to few animals being found sero-positive for brucellosis - despite all animals were tested negative before being shipped. The fact that brucellosis poses a barrier to trade of animals and animal products has also been reported by Fitch (2003).

The present study shows that abscess and inflammation of lymph nodes were among reasons for animal exclusion during the years 2010, 2011, 2012 and 2013. This result is in line with that reported by Aklilu et al (2002) who stated that out of the 936,415 sheep returned from Saudi Arabia between 1990-1998, 77% were rejected on the grounds of sheep abscess or Morel's disease and that at times, the Saudis may reject the whole shipment because of 1 or 2 abscess cases. The economic impact due to the rejection of

shipments destined to Saudi Arabia because of Morel's disease amounted to several millions of US dollars (Aklilu et al., 2002). Similar results were reported by Musa et al. (2012 a, b) who stated that the economic losses due to rejection of animals affected by Morel's disease (sheep abscess disease) and caseous lymphadenitis at veterinary quarantines and condemnation of carcasses of sheep in abattoirs were significant. The prevalence of abscess diseases in sheep at Alkadaro quarantine was reported by Rodwan et al (2013) who found a percent of 3.4% (n= 4167). Since abscesses involved mostly the lymph nodes in the head, the neck and the shoulder regions, such a mode of infection suggests small abrasions and self inflicted injuries or wounds caused by sharp ends of metallic feeding troughs as port of entry and the infection is also aided by the obvious overcrowding during feedlotting and transportation (Alhendi et al., 1993).

This study has also revealed that 43% of the rejected vessels in 2011 are due to suspicion of foot and mouth disease. Small percent of the vessels were also rejected in 2010, 2012 and 20113. Earlier studies indicated that the Sudan is highly endemic for FMD (Abu Elzein, 1983, Abu Elzein et al,1987) and four of the seven FMD virus serotypes (O, A, SAT-1 and SAT- 2) have been reported (Abu Elzein et al., 1987). James and Rushton (2002) reported that if regular FMD outbreaks occur, the trade of livestock and livestock products will be restricted. The major reason behind vessels rejection may be attributed the fact that Foot and Mouth Disease is the most contagious of animal diseases with a great potential for causing heavy economic losses in susceptible livestock (El-Hussein and A Daboura, 2012). This statement is also similar to that reported by Le Gall and Leboucq (2004) who mentioned

that in Africa it has been estimated that more is spent controlling FMD than any other veterinary disease.

As shown in the present study, Sheep and goat pox percent of the excluded vessels in 2010 accounted for 65% and it declined to slightly above 40% in 2011 and to slightly above 15% in 2012 and increased again to slightly below 20%. The reason for exclusion might be attributed to the fact that the disease is considered as a major obstacle in the intensive rearing of sheep and goats and also greatly hampers international trade (AU-IBAR, 2015). Sudan is not free from the disease since it has reported 29 outbreaks of sheep pox and goat pox in 2011 (AU-IBAR, 2015).

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6-1 Conclusion:

Based on the results obtained, livestock exports in Sudan Constitutes a great importance in the country's economy as a second source after oil in bring hard currency, but there are a lot of obstacles that have affected economically on this sector and reduce competition and raise prices. The most serious transboundary animal diseases that threaten human health and Export seriously, the lack of studies and research on this subject is a big obstacle in identifying problems, diagnosis and therefore find appropriate solutions.

6-2 Recommendations

- In order to increase Sudan's share in livestock and meat export market, strict welfare, hygiene, and disease control regulations in livestock sector must be considered.
- In view of the high rejection rates of livestock along the chain and at importing ports, the capacity to screen and test animals at the primary inspection stage must be improved and the systems of inspection and certification for live animals and meat should be applied more rigorously and adequately to meet the importing countries requirements.
- A reliable system for disease diagnosis, reporting and control should be built by regular complementary serological studies and examination of clinical records for validation.

- Strategies for veterinary health services, staff capacity building in addition to well equipped laboratories need to be set and implemented.

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Appendix

Correlations (Pearson)

Brucella	0.8790
pox	-0.9321
External parasites	0.9154

Lack of health	-0.7746
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suspicion of food	-0.3190
-------------------	---------

Cases Included 4 Missing Cases 0

Correlations (Pearson)

	yea
Brucella	0.8790
P-VALUE	0.1210
pox	-0.9321
P-VALUE	0.0679
Lack	-0.7746
P-VALUE	0.2254
Suspicion	-0.3190
P-VALUE	0.6810
External	0.9154
P-VALUE	0.0846

	yea	External	Brucella	Lack	pox
External	0.9154				
P-VALUE	0.0846				
Brucella	0.8790	0.9911			
P-VALUE	0.1210	0.0089			
Lack	-0.7746	-0.5758	-0.5882		
P-VALUE	0.2254	0.4242	0.4118		
pox	-0.9321	-0.8988	-0.9106	0.8698	
P-VALUE	0.0679	0.1012	0.0894	0.1302	
suspicion	-0.3190	-0.6292	-0.6185	-0.2692	0.2397
P-VALUE	0.6810	0.3708	0.3815	0.7308	0.7603

Cases Included 4 Missing Cases 0

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Sudan University of Science & Technology

Faculty of Graduate Studies

Master of Animal Production

Questionnaire

The market Name.....

Veterinarian Name.....

The name of exporting company.....

1/ What are the diseases that infect goats and sheep and their impact on the marketing / export process?

.....

2/ What are the diseases that infect cattle and their impact on the marketing / export process?

.....

3/ How estimated the financial losses (exporters)?

.....

.....

4/ Are you thinking of continuing to export in the field of animal production (exporters)?

a) Yes

b) No

c) Maybe

5/ In your opinion, what are the solutions proposed to avoid the impact of these diseases?

.....



Initial examination of sheep prepared to export



Transportation of sheep



Port Sudan port