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Effect of Trans boundary Animal Diseases on Livestock Trade and Export in Sudan, a Case Study on Rift Valley Fever

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ABSTRACT

Rift Valley fever (RVF) is a viral zoonosis that primarily affects animals and has the capacity to infect humans. The socio- economic impact of the disease on livelihoods and trade is high due to significant losses in livestock production, closure of livestock markets and bans on livestock trade. This analytical study showed that the export of live sheep in Sudan has decreased by 55% from 1,616,363 in 1999 to 731,242 in 2000 and sharply by 98% from 731,242 **in 2000 to 15,417 in 2001 due to the livestock import ban following the outbreak of RVF in Saudi Arabia in 2000. Following the ban lift, the live sheep export increased rapidly to reach 1,422,209 in 2006. Due to the 2007 RVF outbreak in Sudan, the export volume has decreased by 56% to 615,843 in 2007 and again it increased gradually to reach 3,757,363 in 2013 due to efforts made to overcome the livestock trade restrictions following the 2007 RVF outbreak. Correlation analysis made to measure sheep export in relation to RVF outbreaks; the results gave a coefficient of -0.489 implying a negative correlation. This means that when an RVF outbreak occurs, the model predicts that the sheep export drops by 49%.**

Keywords: TADs, RVF, Livestock trade, correlation analysis
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Abbreviations : AI: Avian Influenza, FAO: Food and Agricultural Organization, **FMD**: Foot &Mouth Disease, **GATT**: General Agreement on Tariffs and Trade, **HPG**: Humanitarian Policy Group , **IMF**: International Monetary Fund,**KSA**: Kingdom of Saudi Arabia, **LMMC**: Livestock and Meat Marketing Corporation, **MoLF&RL**: Ministry of Livestock, Fisheries and Rangelands
ND: New castle disease, **OIE**: Animal Health Organization, **PPR**: Peste des Petits Ruminants, **RVF**: Rift Valley Fever, **SSMO**: Sudanese Standards & Metrology Organization, **SPS**: Sanitary and Phytosanitary Standards,**TADs**: Transboundary Animal Diseases, WHO: World Health Organization, **WTO**: World Trade Organization

INTRODUCTION

Thomson et al. (2004) and Domenech et al. (2006) argued that in an era of globalization, international trade in livestock and livestock products continues to be seriously hindered by epizootic animal diseases, in particular those categorized as 'Transboundary Animal Diseases' (TADs) and that globalization of food and (feed) trade, facilitated by the liberalization of world trade, while offering many benefits and opportunities,

represents new risks. In the same direction Sherman, (2010) claimed that globalization yielded many benefits for society, it has also created many new challenges, particularly with regard to animal, human, and environmental health.

Domenech et al. (2006) elaborated on the fact that TADs pose a serious risk to the world animal, agriculture and food security and jeopardize international trade. Morgan and Prakash, (2006) claimed that escalating and pervasive outbreaks of animal diseases are posing considerable challenges to livestock producers, industries, and policy-makers around the globe in a context of steadily rising demand for locally produced and imported livestock products.

The importance of categorisation and prioritisation of TADs has been recognised earlier by several experts and countries. It is argued that given the ever diminishing resources that are available for animal disease control, it is prudent to create a list of diseases according to priority for efficient resource utilisation. The World Organisation for Animal Health (OIE) had earlier classified animal diseases according to epidemic nature, impact on trade, zoonotic potential and production systems. Diseases of zoonotic importance, trade and of transboundary nature have the overall highest control priorities in the Sudan, namely AI, FMD, RVF, PPR, Sheep and Goat Pox, brucellosis and ND as explained by Abdel Aziz, (2017) who further added that the effect of transboundary animal diseases on livestock trade and export in Sudan can be exemplified by the Rift Valley fever (RVF).

RVF is a zoonotic, viral, vector-borne disease representing a threat to human health, animal health and livestock production in Africa, the Near East and potentially, Europe and the rest of the world. RVF primarily affects sheep, goats, cattle, camels, buffaloes, and antelopes. The majority of human infections result from contact with the blood or organs of infected animals, (FAO, 2015).

As indicated in the 2017 updated WHO RVF fact sheet, RVF virus is a member of the Phlebovirus genus. The virus was first identified in 1931 during an investigation into an epidemic among sheep on a farm in the Rift Valley of Kenya. Since then, outbreaks have been reported in sub-Saharan Africa. In 1977 an explosive outbreak was reported in Egypt, the RVF virus was introduced to Egypt via infected livestock trade along the Nile irrigation system. In 1997–98, a major outbreak occurred in Kenya, Somalia and Tanzania following El Niño event and extensive flooding. Following infected livestock trade from the horn of Africa, RVF spread in September 2000 to Saudi Arabia and Yemen, marking the first reported occurrence of the disease outside the African continent and raising concerns that it could extend to other parts of Asia and Europe (WHO, 2017).

WHO, (2017) elaborated on RVF transmission to humans indicating that the majority of human infections result from direct or indirect contact with the blood or organs of infected animals. The virus can be transmitted to humans through the handling of animal tissue during slaughtering or butchering, assisting with animal births, conducting veterinary procedures, or from the disposal of carcasses or fetuses. Certain occupational groups such as herders, farmers, slaughterhouse workers, and veterinarians are therefore at higher risk of infection.

The RVF virus infects humans through inoculation, for example via a wound from an infected knife or through contact with broken skin, or through inhalation of aerosols produced during the slaughter of infected animals. There is some evidence that humans may become infected with RVF by ingesting the unpasteurized or uncooked milk of infected animals (WHO, 2017).

The socio- economic impact of the disease on people's livelihoods and on trade can be high due to significant losses in livestock production (meat and milk), closure of livestock markets and bans on livestock movement and slaughtering. (FAO, 2015). The total livestock population in Sudan was estimated in (2012) to be: Cattle: 29.840 million head, Sheep: 39.483 million head, Goats: 30.837 million head and Camel: 4.751 million head (MoLF&RL) 1995-2013. Most of these animals are kept under transhumance and pastoral management systems in the savannah belt, where the nomads and semi- nomads roam with their herds over vast areas in search of grazing and water. Sudan is geographically well situated to meet the demand for livestock and meat to 190 million consumers in the Middle East region but the main marketing constraints in addition to animal health, are inconsistent seasonal supply from the production areas, poor animal transportation system from the production areas to central Sudan, inefficient shipping arrangements, lack of capital to fund fattening and trading needs and excessive and complex fees and taxes (Abdel Aziz, 2017).

The total livestock production in Sudan increased rapidly during the 1990s and the off-take of sheep quadrupled between 1989/1990 and 1999/2000 in response to strong export market in the Gulf countries, especially Saudi Arabia. Traditionally, Sudanese sheep has comparative advantage in the Middle East market and particularly preferred by Saudi Arabia, which are the traditional export destination for sheep where the export occurs throughout the year. In terms of seasonality and volumes, the peak always during the two months prior to the annual Hajj festival. (Abdel Aziz, 2017).

In 1973, RVF disease was reported for the first time in Sudan in the White Nile State and the Sudanese authorities considered White Nile as the permanent focus for the disease. (Eisa et al .,1977). Hassan *et al.* (2011) indicated that, in 2007 the disease was again reported from the same area where the reports followed to include areas of White Nile, El Gezira, and Sennar state near to the White Nile and the Blue Nile Rivers. The RVF outbreaks resulted in human disease, but also large

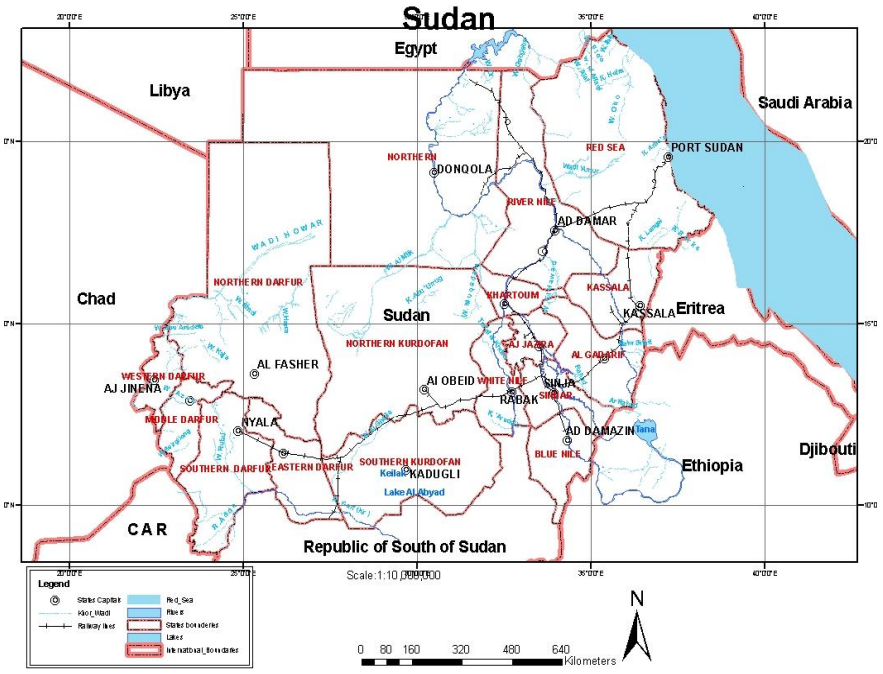

Figure 1. Map of Sudan.

economic loss with an impact beyond the immediate influence on the directly affected agricultural producers (Hassan et al., 2011) (Figure 1).

An outbreak of RVF in southern Saudi Arabia and Yemen (the first reported outside Africa) in September and October 2000 has left dozens of people dead and hundreds infected. As a consequence six Gulf States - Saudi Arabia, Bahrain, Oman, Qatar, Yemen and the United Arab Emirates - have banned livestock imports from nine African countries, principally in the Horn of Africa FAO, (2001). Although RVF is endemic in the affected countries none has reported a recent RVF epidemic. Although they are therefore not experiencing the direct impacts of the disease, the livestock trade embargo will undermine a precarious regional food security situation (FAO, 2001). Exports of sheep rebounded significantly in 2002 following the resolution of the veterinary problem in Saudi Arabia, but potential risk to Sudan's live sheep export remains (Elbashir et al., 2004).

As described by Ramcharan, (2002), the export ban placed on Sudanese livestock in 2000 has had a multitude of consequences most of them unexpected. On the short run, meat and food prices were lowered in Sudan, even leading to a dramatic all over drop in inflation. On the long run however, loss of income and wealth is the result. The mid-2000 witnessed an unusual and significant decline in livestock prices and this sudden decline would lower household wealth and, thus, overall aggregate demand and he added that prices on other agricultural products also start dropping, as is inflation. The economic effects of the 2007 outbreak have not been investigated, but there is a huge economic impact on both the domestic and international animal market of the country and the Sudan live sheep export volume has considerably decreased. Unfortunately no economic studies have been undertaken in Sudan to explore that (Abdel Aziz, 2017).

In the current analytical study, correlation analysis was done to measure how sheep are export in Sudan in relation to the two outbreaks of RVF. The analysis clearly indicates a strong correlation between RVF outbreaks and live sheep export and it is clearly observed that the sheep export figures in Sudan is negatively correlated to the two RVF outbreaks of 2000 and 2007.

MATERIALS AND METHODS

Data collection

The current study is an analytical research based on secondary data collected and compiled during the progress of efforts exerted and programs implemented for animal health and epizootic diseases control in Sudan. Information were compiled from the Animal Health Reports of the Department of Animal Health and Epizootic Diseases Control of the MoLF&RL 1995-2013 and the Animal Health Status Report 2013. The study data included livestock export figures 2002-2013, live Sheep exports 1995-2013, live Sheep exports against RVF outbreaks 1995-2013 and animal health and epizootic diseases control reports 2002-2013,

Table 1. Compiled livestock exports figures in Sudan 2002-2013*

Year	Cattle	Sheep	Goats	Camels
2002	2,655	1,602,638	53,164	155,710
2003	184	1,315,399	57,639	88,423
2004	750	1,703,562	101,899	132,602
2005	501	1,271,787	109,650	131,156
2006	0	1,422,209	102,378	116,184
2007	3,658	615,843	30,290	85,862
2008	1,198	610,832	14,337	140,757
2009	19,265	1,510,996	104,630	154,477
2010	5,130	1,813,926	121,493	117,**971**
2011	21,056	2,729,134	162,149	151,208
2012	26,145	3,415,739	162,116	166,240
2013	11,202	3,757,363	197,958	129,647
TOTAL	91,744	21,769,428	1,217,703	1,570,237

*Data source MoLF&RL.

Figure 2. Livestock exports in Sudan, extrapolated from MoLF&RL 2002-2013 reports.

live Sheep exports 1995-2013, live Sheep exports against RVF outbreaks 1995-2013 and animal health and epizootic diseases control reports 2002-2013

Study data analysis

Both quantitative and qualitative analyses were combined. The quantitative analysis tool used is the Microsoft Excel Spread Sheet 2010.

RESULTS

Table 1 shows Sudan live animals exports for the period 2002-2013, the live animals export have significantly increased by almost (515%) in terms of live sheep animal export in 2013 compared to that of 2008. This is could be attributed to many factors including improvement in the quarantine facilities, decentralization of quarantine measures and issuing of standard operating procedures for imports and exports. On the other hand, there is no significant increase of export of live goats, cattle and camel observed for the same period where the export is maintained at a Plateau level as shown in (Figure 2). In response to strong export market in the Gulf countries, especially Saudi Arabia the Sudanese live sheep exports increased from 617,004 in 1995 to reach 1001705, 1074576, 1584858 and 1616363 in 1996, 1997, 1998 and 1999 respectively (Table 2).

The IMF study done in 2002 following the ban on livestock export from Sudan indicated that the export ban placed on Sudanese livestock in 2000 has had a multitude of consequences most of them unexpected. The descriptive export statistics of live sheep in Sudan

Table 2. Compiled Sheep exports in Sudan against RVF outbreaks 1995-2013.

Year	Sheep exports	RVF Outbreak
1995	617,004	
1996	1,001,705	
1997	1,074,576	
1998	1,584,858	
1999	1,616,363	
2000	731,242	RVF reported in the Kingdom of Saudi Arabia KSA
2001	15,417	
2002	1,602,638	
2003	1,315,399	
2004	1,703,562	
2005	1,271,787	
2006	1,422,209	
2007	615,843	RVF reported in Sudan
2008	610,832	
2009	1,510,996	
2010	1,813,926	
2011	2,729,134	
2012	3,415,739	
2013	3,757,363	

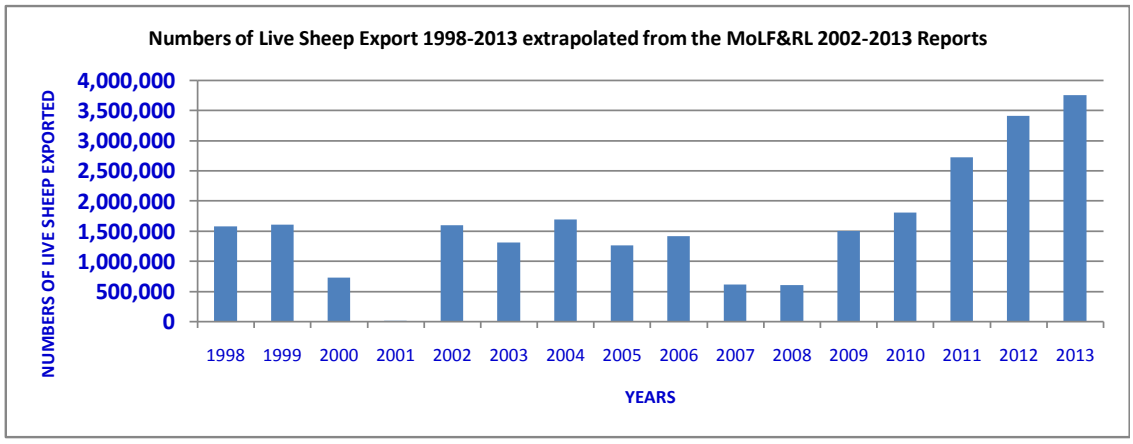

Figure 3. Live sheep exports in Sudan, extrapolated from MoLF&RL 1998-2013 reports.

Table 3. Correlation of sheep export and RVF occurrence
Summary output.

	Sheep	RVF Code
Sheep	1	
RVF Code	-0.4895001	1

has decreased by almost 55% during 2000 from 1,616,363 in 1999 to 731,242 and sharply by almost 98% from 731,242 in 2000 to 15,417 in 2001. Following the ban lift, the live sheep export increased rapidly to reach 1,703,562 in 2004 and 1,422,209 in 2006. Due to the 2007 RVF outbreak in Sudan, the export volume has decreased by 57% from 1,422,209 to 615,843 in 2007 and again it increased gradually to reach 3,757,363 in 2013 as it is shown in (Table 2 and Figure 3**)** above due the efforts made to overcome livestock trade restrictions following the 2007 RVF outbreak in the country.

Regression analysis for sheep trade and RVF occurrence

Correlation analysis was done to measure how sheep export is related to outbreaks of RVF and results are shown in (Table 3**)**. The results in (Table 3) gave a coefficient of -0.489 implying a negative correlation. This means that when an RVF outbreak occurs, the model predicts that the sheep export drops by 49%. This clearly indicated a strong correlation between RVF outbreaks and live sheep export and was shown in (Tables 4, 5 and

Table 4. Summary output of regression statistics.

Multiple R	0.635616491
R Square	0.404008324
Adjusted R Square	0.36894999
Standard Error	751664.4593
Observations	19

Table 5. Statistical analysis using ANOVA.

ANOVA								
	Df	***SS***	***MS***	***F***	***Significance F***			
Regression	1	6.51099E+12	6.51099E+12	11.52389	0.0034472			
Residual	17	9.60499E+12	5.64999E+11					
Total	18	1.6116E+13						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	(212,687,127.74)	63093689.99	-3.370973036	0.003629	-345803176.5	-8E+07	-3.5E+08	-8E+07
X Variable 1	106877.4561	31483.75965	3.394685302	0.003447	40452.53019	173302.4	40452.53	173302.4

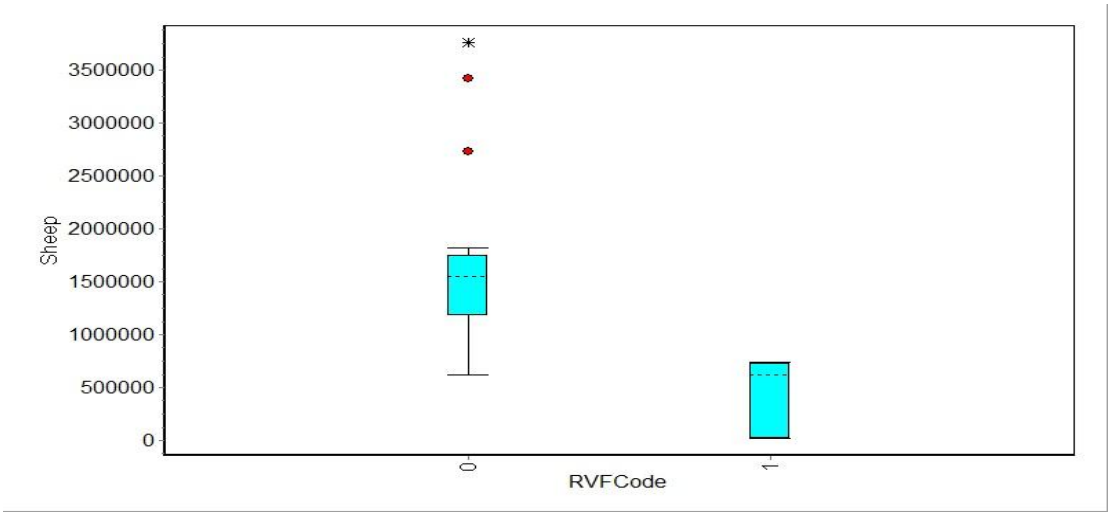

Figure 4. Correlation of sheep export VS RVF occurrence.

Figures 4, 5**)** on the regression analysis for sheep trade and RVF occurrence. It is clearly observed that the sheep export figures in Sudan is negatively correlated to the two RVF outbreaks of 2000 and 2007. The result gave a coefficient of -0.489. The results indicated that there is an association between RVF and sheep exports. When RVF occurs or increases, there is a decrease in sheep exports. Furthermore the results were graphed and shown in (Figure 5).

Figure 4 showed the visual display of the mean distribution of sheep data grouped by RVF status. The box plot indicated Code 0 representing the mean number of sheep exported when there was no RVF outbreak. Box plot Code 1 represented the mean number of sheep exported when there is RVF outbreak. The data reflected that when there is an RVF outbreak, the average number of sheep exported tremendously droped.

Regression to predict sheep export per year

Regression analysis was done to predict the number of sheep exported for a particular year. The results are shown in (Tables 4, 5 and Figure 5). The results in (Table 4) indicated an R square of 0.40 implying that the variation of sheep export was 40%. On the other hand the model in (Table 5) predicted that sheep export for any particular year was 106,877. This implied that from 1995, the sheep export grew by 106,877 every following year. The results in (Figure 5) indicated a strong relationship between population and time but the relationship is nonlinear or polynomial. It is evident that there is strong correlation between RVF outbreaks and export of livestock in Sudan. This is clearly shows the sheep export figures in Sudan is negatively correlated to the two RVF outbreaks of 2000 and 2007.

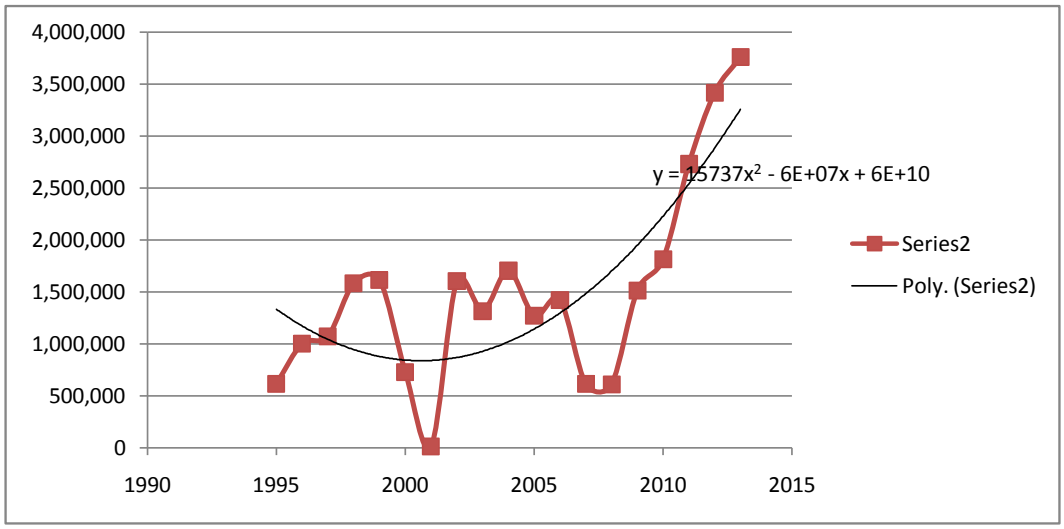

Figure 5. Model prediction of sheep export using the regression line in red below the data.

DISCUSSION

In 1973 RVF disease was reported for the first time in Sudan, from the White Nile State. From that incidence, Sudanese authorities considered White Nile as the permanent focus for the disease till recently in 2007 the disease was again reported from the same area where the reports followed to include areas of Sennar, Gezira and Southern Sudan.

In September 2000 the veterinary authorities in Saudi Arabia banned the import of sheep from eight East African countries (Kenya, Somalia, Djibouti, Uganda, Tanzania, Eritrea, Ethiopia and Sudan) due to the outbreak of RVF in the southern part of the Kingdom and brought a temporary halt to the boom during 2000-2001. In March 2007, RVF disease was reported in Sudan from the White Nile State where the reports followed to include areas of Sennar, Gezira and Southern Sudan.

Thomson et al. (2004) and Domenech *et al.* (2006) argued that in an era of globalization, international trade in livestock and livestock products continues to be seriously hindered by epizootic animal diseases, in particular those categorized as TADs. Hence Dagg *et al.* (2006) indicated that countries that export food commodities derived from livestock must meet both the requirements of importing country and domestic standards. Domenech et al. (2006) elaborated on the fact that TADs pose a serious risk to the world animal agriculture and food security and jeopardize international trade. Morgan and Prakash, (2006) claimed that escalating and pervasive outbreaks of animal diseases are posing considerable challenges to livestock producers, industries, and policy-makers around the globe in a context of steadily rising demand for locally produced and imported livestock products. Africa has been constrained in world markets by low productivity, animal diseases and high global standards for animal health and food safety that have precluded large-scale exports (Scoones and Wolmer, 2006; Rich, 2009). In the same direction Food and Agriculture Organisation (FAO, 2010) sees animal health and food safety standards and regulations may act as barriers to trade in livestock and animal source foods. The 1995 WTO Agreement on SPS Measures acknowledged a country's right to protect itself from risks to human, animal and plant life and health, but requires that sanitary and phytosanitary (SPS) measures be based on scientific grounds to avoid countries using them as trade barriers.

The development of capacities for implementation and compliance with international standards was clearly indicated by Evans and MacInnes, (2012). Hence, market requirements that were mentioned at the Food Safety Situation in Sudan (2013) indicated the need for establishing a National Task Force to address compliance with export market requirement, compliance with export market standards for packaging and labeling and code of hygienic practice. The bulk of work of food safety in Sudan now is carried by the Sudanese Standards and Metrology Organization(SSMO) and the standards issued cover all types of commodities, code of practices, guidelines, sanitary requirements and measures for food establishments and transportation vehicles (Abdel Aziz, 2017).

Brückner, (2011) described and discussed some of the challenges for facilitation of safe trade and suggested how international organizations could evolve to confront such issues. The Humanitarian Policy Group (HPG) Synthesis Paper, (2009) elaborated on the issue of trade restrictions with regards to prevalence of transboundary diseases and the envisaged stringent livestock trade standards as a major constraint to international trade. The Paper further stated that the OIE has made a

commitment to review regulations related to livestock commodities and to assist in the development of new commodity-specific standards to facilitate international trade. Evans and MacInnes, (2012) added that another significant challenge for many national Veterinary Services in developing meaningful disease prevention policies is whether the level of resources is sufficient for the surveillance, inspection, investigation and enforcement necessary to effectively achieve the policy intent. However, it was earlier claimed by Brückner, (2004) that it would also be wrong and probably naive to expect developing countries to comply fully with international disease control standards before even considering trade negotiations. Standards based on the very latest advances in scientific and technological knowledge may be well beyond the capacity of many developing countries and thus may act to their detriment.

With regards to investment on livestock in Sudan it was shown while examining the livestock policies to overcome constraints affecting livestock disease control during the current study, that there is limited access to finance. Improving animal health and food safety in Sudan need to be considered as a global public good and the government should invest in Veterinary Services to prevent exotic disease outbreaks and to control important endemic diseases. There is also a need that policies must address increased access to credit and capitals as shown by El Dirani et al. (2009) and Elbashir et al. (2004). Policies must address the potential for overcoming the hindrance posed by TADS as indicated by Thomson, (2004). Also policies must include means to attempts to have access to new markets and on the other hand policies must also consider the development and improvement of the disease free zones as clearly recommended by Thomson, (2004). In addition, there is a need for strong policies on imports control, as clearly indicated by Abdel Aziz and Abdel Razig, (2008)

On barriers to trade in livestock and livestock products Leslie and Upton, (1999) indicated that the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) established the World Trade Organization (WTO) to supervise the reduction of barriers to, and liberalization of, world trade. The application of SPS measures should be standardized to avoid use for protectionist purposes by countries or regional trade blocks. Furthermore Kitching, (2000) argued that WTO agreements have swept aside many of the previous constraints to international trade in animals and animal products and have looked critically at those that still survive.

Kellar, (1993) described the application of risk analysis to international trade in animals and animal products in an era when arduous land and sea journeys separated exporting and recipient nations, whereas Fidler, (1996) added that the global nature of the threat posed by new and re-emerging infectious diseases will require international cooperation in identifying, controlling, and preventing these diseases. Thomson et al. (2004) reported that the international animal health standards designed to facilitate safe trade in livestock and livestock products are set by the World Organization for Animal Health (OIE) under the SPS Agreement of the WTO and documented in the OIE's Terrestrial Animal Health Code.

The situation in Sudan was addressed by many authors and collaborators. Livestock marketing in Sudan was described by Nur, (2003) as mainly organized and financed by the private sector after the dissolving of the Livestock and Meat Marketing Corporation (LMMC) in 1992 in the advent of liberalization of the economy and privatization of all activities connected to commerce and production. Sudan is solely exporting live sheep as reported by many authors. Abdel Aziz, (2004) and Abdel Aziz and Abdel Razig, (2008) elaborated on the potentials of livestock exports in Sudan and indicated that live sheep is the major export animal. In Sudan there is some preference for Sudanese breeds of sheep in the Middle East markets as indicated by El Dirani et al. (2009)

Almost all live sheep are exported from Port Sudan. This was described by Abdel Aziz and Abdel Razig, (2008) that most of the sheep are first collected and fattened on the flats at Muweilih Terminal Market at Omdurman and then passes through Al Kadaro quarantine station before being transported by truck to Port Sudan quarantine station. However, small numbers of sheep are trekked directly to Port Sudan. It is also possible that for sheep can be transported from Al Kadaro to Port Sudan by rail but apparently this is rarely done at present and this emphasized the need for an elaborate strict system of inspection and certification for live animals and meat involving quarantine, testing and screening for specific transboundary or trade-related diseases as indicated by El Dirani et al. (2009).

The export opportunities for Sudan are considerable, but several problems and issues need to be addressed if the potential is to be maximized. Some of these factors are beyond the control of livestock sector, but issues like development of livestock markets need to be considered as a priority as was supported by Thomson, (2004) in addition to compliance with international standards due to the fact that TADs affected seriously the Sudan economy as it was clearly explained by Konandreas, (2009).

The potential for overcoming the hindrance posed by TADs to exports of live sheep in Sudan was studied by Thomson, (2004), he mentioned that attempts to have access to new markets in the Middle East are being hampered by demands for health guarantees with respect to Foot and Mouth Disease (FMD), RVF, Congo haemorrhagic fever and West Nile Virus. However, it appears that recent changes to the chapters dealing with FMD and RVF diseases in the OIE's Terrestrial Animal Health Code are favourable to the situation in Sudan and can be turned to Sudan's advantage.

El Dirani *et al.* (2009) showed that the market chain comprises several intermediaries along the supply chains

and multiple local government taxes; this results in high marketing and transactions costs while the competitiveness of Sudanese sheep is low. El Dirani *et al.* (2009) reported on the strict screening at the port of arrival in Saudi Arabia, where a whole vessel is usually rejected if only one or two animals with unacceptable symptoms are detected.

In Sudan, the disease priorities and ranking process showed that the diseases of zoonotic importance, trade and of trans-boundary nature have the overall highest priorities, namely AI, FMD, RVF, brucellosis and Newcastle Disease (ND) (Abdel Aziz, 2017).

El Dirani et al. (2009) further elaborated that studies were made to characterize the nature of some problems related to livestock export by using a market chain framework and collecting data on several components of the framework. Data analysis focused on how producers are linked with the terminal domestic or export markets through various actors and institutions along the market chains, and the constraints at different stages of the market chain. El Dirani et al*.* (2009) summarized the main marketing constraints as the form of poor quality linking the supply hinterlands, particularly those in the western part of Sudan, to the main seaports of Port Sudan and Sawakin and trekking takes a long time, with negative consequences for the health and quality of the animals. In Sudan the possibility of importing RVF into countries of the Middle East remains a constraining issue for live export from Sudan, however Thomson, (2004) indicated that the new Terrestrial Animal Health Code chapter on RVF adopted by the International Committee of the OIE in May 2003 provides a possible way for overcoming the problem because vaccination of exported animals is now possible in terms of the new chapter as long as the animals are not slaughtered less than 2 weeks after vaccination.

Chibeu, (2012) developed an action plan for the control of RVF in Sudan using a combination of techniques and tools including the use of Smithburn neutrophic strain (SNS) vaccine of RVF used extensively in East and South Africa since the 1950's., however, there is no vaccination against RVF conducted in Sudan due to the fact that the recommended live virus vaccine against RVF causes abortions and the vaccines is expensive and the campaign will not be practicable. Instead, every year during the rainy season, there are limited campaigns for vector control in cooperation and collaboration with the public health authorities at Gazira and White Nile states. Hence Sudan is vulnerable to a serious RVF outbreak unless there are regular vaccination campaigns together with vector control and continuous surveillance (Abdel Aziz, 2017).

The current analytical study showed the need to address the ultimate aim to protect food safety and human health, which is the responsibility of the veterinary services as described by Petitclerc, (2012) in addition to the use of the food chain approach as indicated at the Food Safety Situation in Sudan (2013). Export procedures examined in Sudan proofed that there is a lack of standardization in the process of livestock export and there is a need to improve and standardize the Sudan live animals export along the value chain. This was supported by El Dirani *et al.,* (2009) while addressing the challenges of export animals rejected. Sudan should follow the procedures enumerated by Brückner, (2004) that the requirements for entering the pathway is the acceptance of disease control standards which are primarily determined by the international acceptance of the disease control guarantees and how effectively the level of protection for animal and human health and this is in agreement with (FAO, 2011).

This current analytical study showed that the descriptive export statistics of live sheep clearly shows the sheep export figures in Sudan is negatively correlated to the two RVF outbreaks of 2000 and 2007. Hence the RVF disease prevalence is among the key factors that either contribute or hamper export of live animals. The study of Ramcharan in 2002 showed that the, as result of the export ban, pastoralists have flooded the local market with livestock, leading to the observed sharp decline in food prices. The increase of local supply of meat and lowering income played a large role in the observed decline in both food and non-food inflation and there was no doubt that the economic impact had been significant, even on the Sudanese exchange rate. However, the economic effects of the 2007 outbreak have not been investigated, but one could suspect a huge economic impact on both the domestic and international animal market of the country. Unfortunately no studies have been undertaken in Sudan to explore that.

Therefore, in Sudan there is a need for livestock value chain analysis to be used as a tool to identify key constraints and opportunities within a livestock value chain including possible risk for disease transmission within a livestock sector and the people involved at these points. This is in agreement with El Dirani et al. (2009) who stated that there are specific qualities, health and safety requirements, the value chain should be utilized to include risk management procedures and value addition to livestock production process and marketing as described by FAO (2011) and indicated by Food Safety Situation in Sudan (2013). The current analytical study indicated the need to provide methodologies to combine value chain analysis with risk analysis. In Sudan there is also a need to explore more markets and this is in line with Konandreas, (2009) who stated that there is a need for not only exporting live sheep to only the traditional markets, diversification of exports need to be promoted.

CONCLUSION AND RECOMMENDATIONS

Exports of sheep from Sudan has recovered significantly in 2002 and 2008 following the resolution of the

veterinary problem in importing countries, but the potential risk of RVF to Sudan's live sheep export still remains a major risk to livestock export. In Sudan, risk analysis with regards to TADs, should be in place to deal with diseases which pose a potential danger, managed according to certain standard procedures and more attention should be in place to address zoonotic haemorrhagic fever diseases like RVF and Congo Crimean Fever which include hazard identification, risk assessment, risk management and risk communication together with risk-based management procedures. The strategic approach with regards to RVF in Sudan developed by Chibeu, (2012) is not practiced and no vaccination against RVF is conducted, instead, every year during the rainy season there are limited campaigns for vector control. Hence Sudan is vulnerable to a serious RVF outbreak unless there are regular vaccination campaigns together with vector control and continuous surveillance.

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