

Knowledge and Perceptions of Sheep Owners and Herders on *Peste Des Petits Ruminants* in North Kordofan and Kassala States, the Sudan

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Abstract: A cross-sectional survey was conducted from April to July 2011 to study the knowledge and perceptions of sheep owners and herders and veterinarians on *peste des petits ruminants* in North Kordofan and Kassala States of the Sudan, using semi-structured questionnaires. A total number of 69 questionnaires were administered to and discussed with (39) sheep owners and herders and (30) veterinarians. Sheep pox was ranked as the most economically important disease of sheep by owners and herders but veterinarians indicated that PPR was the most important. Nearly two-thirds of the owners/herders claimed that they know the clinical symptoms of PPR and mentioned lacrimation, stomatitis, coughing and respiratory distress for example. Furthermore, owners/herders incriminated introduction of new animal(s) as the source of PPR outbreaks. Deaths and loss of market value, in addition to treatment burden, abortion and sub-fertility as well as loss of weight and loss of milk were listed as major negative effects of PPR. On the other hand, veterinarians indicated that ignorance of animal owners, not wanting to vaccinate and not being aware of the vaccine benefits as principal problems hinder implementing disease control programs in their localities. Making vaccines available and enforcing routine vaccination, promotion of extension and public education and construction of equipped laboratories were advised given to the MARF/Public/Policy makers by veterinarians concerning the control of PPR in the study area. It can be concluded that sheep owners and herders have little knowledge about the benefits of vaccination but have a good knowledge of patterns of PPR. Extension and communication programs should be started to enable sheep and other livestock owners to understand the importance of vaccination in control and eradication of PPR.

Keywords: PPR; Knowledge and Perceptions; Sheep; Sudan

INTRODUCTION

Livestock and other agricultural products are considered together as one of the main sources of economic growth and livelihood of the majority of the population in the Sudan [1]. Export of livestock and livestock products is the country's most important foreign exchange earner [2]. Export occurs throughout the year, but volumes peak up during the two months prior to the annual Hajj festival and proceeds from livestock, meat, and hides and skins are increasing every year [2]. However, the pattern of demand in the Middle East has been changing in recent years. Increases in incomes and urbanization, combined with a growing immigrant population, have contributed to a rapidly increasing demand for meat. Demands for food quality and safety assurance also have been increasing and the importing countries are increasingly implementing sanitary and phyto-sanitary (SPS) regulations [2]. From 2005 to 2010 the Sudan exported 6,984,015 live animals (US\$ 677,680 million) of which 6,158,252 were sheep (US\$ 567,922 million) and

454,812 were goats (US\$ 15,942 million) [2-8]. Besides to that, livestock are used for a lot of different purposes in the Sudan. Statistical information from the government of the Sudan showed that 80.0% to 90.0% of Sudan's households own livestock, with perhaps one-third to one-half of all households reliant totally upon livestock for their livelihood [9].

Peste des petits ruminants (PPR) is a highly contagious, infectious, and acute notifiable viral disease of domestic and wild small ruminants [10-13]. It is one of the main transboundary animal diseases that constitute a significant threat to small ruminants' production in developing countries [14, 15]. Major PPR epidemics have been reported in many parts of the world [16, 17]. In the Sudan, the disease has been diagnosed in almost all the states of the country and is considered endemic [18, 19]. PPR-infected migratory animals may transmit the disease to susceptible sheep and goat populations while moving from one place to another. Movement of animals, therefore, plays an

important role in the transmission and maintenance of the disease in nature [20, 21]. Trade in small ruminants, at markets where animals from different sources are brought into close contact with one another, affords increased opportunities for PPR virus transmission, as does the aggregation of animals in intensive fattening units [10]. Transmission of the disease can also be through contaminated water, feed troughs and bedding, turning them into additional sources of infection [10, 21, 22]. Its economic impacts are reflected by being able to cause high morbidity, ranging from 50.0% to 90.0%, and by its case-fatality rate that reaches 55.0% to 85.0% in goats, 10.0% in sheep and 50.0% in camels [10, 13, 19].

Livestock owners and herders have an immense and good practical knowledge, experience, and understanding in animals rearing and farming [23]. This knowledge is very helpful when information about susceptibilities of different breeds, age groups and sexes to a certain disease of interest or where information on disease patterns in different production systems, communities and value chains, treatments and local control strategies are needed [23]. Over the last few decades, gathering of existing veterinary knowledge or indigenous ethno-veterinary medicine through surveys has become an important method to identify animal health problems within communities, to design better animal health projects and programs, to improve surveillance, to establish more efficient reporting systems, and to foster control and management strategies [23]. Quantitative research is time-consuming and expensive, and it depends on extensive physical or social sampling at high costs while qualitative research, in comparison, is based on the collection of observations, historical reports and opinions of informants as well as on direct observations of the researchers. Both qualitative and quantitative investigations are required for a full understanding of the ecology of a disease [23]. Therefore, this survey was aiming at investigating the knowledge and perceptions of sheep owners and herders and veterinarians on PPR in North Kordofan and Kassala states, the Sudan.

MATERIALS AND METHODS

Study Area

This study was conducted in North Kordofan and Kassala states of the Sudan. North Kordofan state is located in central Sudan with soil types of about 55% sand or *gouze*, 20% *gerdud*, 15% alluvial land and 10% clay land. The annual rainfall is concentrated in a single relatively short summer season during June to September and ranges from 0 to 500 mm. North Kordofan has abundant fodder and grazing areas during rainy seasons and agriculture and livestock comprise about 70.0% of the economic activity in the state. A mixture of farming systems are practiced in the state including nomadic, sedentary and semi-sedentary animal production systems. Kabashi and

Hamari desert sheep are the main breeds raised in North Kordofan [2]. On the other hand, Kassala state is located in the north-eastern part of the country and has international borders with Eritrea and Ethiopia. It falls within the Sudano-Sahelian climate zone of Africa. Soils are dark, heavy, and deep cracking *vertisol*. Kassala has an annual rainfall is concentrated in a single relatively short summer season during June to September and amounts to around 680 mm per annum. Temperature ranges from a mean minimum of 17°C in January to a mean maximum of 40°C in April and May [24]. During the rainy season, Kassala state has abundant fodder and water in the northern Butanah area and mixed crop–livestock, nomadic, and the semi-nomadic production systems predominate in the region. Dubassy, Gaash, and Watiesh desert sheep breeds are raised and produced in Kassala state for both domestic and export markets [2].

Study Design

A cross-sectional survey from April to July 2011 was employed with a multistage sampling [25]. Owners and herders of the purposively sampled unvaccinated sheep herds in Shuaib *et al.* [19] were included in this study.

Questionnaire Survey

Semi-structured questionnaires were administered to and discussed with owners and herders of sheep. General subject introductions and clarifications were immediately made after giving out the questionnaires and during discussion. Questions included in the questionnaire were formulated to gather data about herd size, number of young animals, males, and females within the herd, the probable number of animals involved when outbreaks happen (morbidity and mortality), measures taken when introducing new animals into the herd, breed of the reared animals, mixing different species of livestock, mixing herd with other sheep herds at pasture or watering points, moving from place to place looking for water and pasture, practiced farming system, the frequency of PPR outbreaks, period(s) of the year when outbreaks occur, source of outbreaks and actions to control them at local level, and general knowledge and perceptions on PPR, its clinical signs, negative impact, attitude to vaccination and the effect of free animal movements on disease distribution. Answers to questions were recorded by ticking pre-written choices; additional information could be supplied in extra provided spaces.

Other semi-structured questionnaires were administered to veterinarians. These questionnaires addressed the occurrence of PPR outbreaks, perceptions on risk factors and characteristics of outbreaks. Questions were about ranks of the most economically important diseases and conditions of animals, basis of diagnosis and control of these ranked diseases and of PPR outbreaks, the frequency of PPR outbreaks, period(s) of the year when outbreaks occur, the most susceptible species, sex, age group, and breed to PPR, problems faced when implementing a disease control

program and advices to help MARF to control animal diseases more efficiently. Answers to questions were recorded by ticking pre-written choices; additional information could be supplied in extra provided spaces.

Data Management and Statistical Analyses

All collected data were entered, coded, and stored electronically in a Microsoft[®] Excel for Windows[®] 2007 database. The Statistical Package for Social Sciences (SPSS) for Windows[®] version 18.0 (SPSS Inc., Chicago, Illinois) was used for appropriate statistical analyses (Frequencies and percentages).

RESULTS

Outcomes of the Owners and Herders Questionnaire Survey

The questionnaire response rate of sheep owners and herders was 100.0% (39/39). Three-quarters (74.4%; n = 29) of the responders were from North Kordofan state while the remaining quarter (25.6%; n = 10) were from Kassala state.

General Information

All responders were males (100%; n = 39) and 66.7% (n = 26) of them were uneducated, 17.9% (n = 7) had undergone primary school, 2.6% (n = 1) attended high school, 5.1% (n = 2) went to secondary school, 7.7% (n = 3) were graduates, and nobody had taken professional trainings. No any responder (n = 0) was ≤ 20 years old but

17.9% (n = 7) were from 21 to 30 years old, 23.1% (n = 9) were from 31 to 40 years and the majority (59.0%; n = 23) were older than 40 years. Furthermore, 20.5% (n = 8) had ≤10, 17.9% (n = 7) had from 11 to 20, 20.5% (n = 8) had from 21 to 30 and 41.1% (n = 16) had >30 years of experience, respectively.

Ranking of Economically Important Sheep Diseases by Owners and Herders

Owners and herders ranked the economically important diseases of sheep in their areas as in Table 1. Ranks were given points from 1 to 5, each disease ranking-number 1 got 5 points, number 2 got 4 points, number 3 got 3 points, number 4 got 2 points, and number 5 got 1 point. Then the number of points was multiplied by the number of times the disease was rated as rank 1 or rank 2 and so on and the points were added up for the total points indicating the rank of a disease. Sheep Pox (SPP), 144 total points, was perceived to be on the top of the list. On the other hand, internal parasites, brucellosis, and scabby mouth of contagious pustular dermatitis (ORF) (3 total points for each) were perceived to be at the bottom of the list. Some other diseases and conditions were given some intermediate weight.

Opinions and Perceptions of Sheep Owners and Herders on PPR

Responses of sheep owners and herders on the clinical symptoms of PPR and its appearance in their

flocks are presented in Table 2. Less than Two-thirds (66.7%, n = 26) of them indicated that they know the clinical symptoms of PPR, while the remaining (33.3%, n = 13) indicated that they do not know. The major symptoms mentioned by the owners and herders were loss of appetite by 12.2% (n = 14), lacrimation by 2.6% (n = 3), fever, depression, and dullness by 1.7% (n = 2), stomatitis by 8.7% (n = 10), coughing and respiratory distress by 16.5% (n = 19), loss of weight, weakness and emaciation by 8.7% (n = 10), nasal discharge by 7.8% (n = 9), erection of hair and rough coat by 14.0% (n = 16), diarrhoea by 14.8% (n = 17), low milk production by 1.7% (n = 2) and deaths by 11.3% (n = 13). Furthermore, more than half of the owners and herders who know PPR claimed to have seen its clinical symptoms in their flocks in the past while 42.3% (n = 11) of them never had. About half (n = 19) of the owners and herders stated that they had vaccinated their animals against PPR sometime in the past while the rest (51.3%, n = 20) never did. Around two-thirds (68.4%, n = 13) of the respondents who vaccinated in the past, reported that they had vaccinated during the year 2011, 31.6% (n = 6) during the period between 2005 and 2010 and none (n = 0) had vaccinated before 2000 or between 2000 and 2005. Less than one-third (31.6%, n = 6) of the respondents who vaccinated against PPR did vaccinate ≤1000 animals, 15.8% (n = 3) vaccinated >1000 - 2000 animals, 21.0% (n = 4) vaccinated >2000 - 3000 animals, 31.6% (n = 6) vaccinated >3000 - 4000 animals, and nobody (n = 0) vaccinated more than 4000 animals. One-fifth (20.0%, n = 4) of the respondents who did not vaccinate their animals indicated that they did so because of the unavailability of the vaccine, 40.0% (n = 8) because of the high price of the vaccine (expensive), 25.0% (n = 5) because they saw no need to vaccinate their animals, and 15.0% (n = 3) did not give an explanation.

In regards to the most susceptible age group, 73.1% (n = 19) of the respondents perceived that sheep ≤1 year were the most susceptible age group to PPR, 26.9% (n = 7) had no idea, but all owners and herders excluded that sheep older than one year were in some way susceptible to PPR. Concerning animal sex and PPR, 3.8% (n = 1) of the respondents considered females were more susceptible to PPR, while 77.0% (n = 20) reported no difference between both sexes, 19.2% (n = 5) were unable to identify a particular sex, and no respondent named males to be more susceptible to PPR than females.

Only one-fifth (21.1%, n = 4) of the respondents perceived the introduction of new animal(s) as the main source of PPR outbreaks, but by far the majority (73.7%, n = 14) named contact at communal points like watering points and pasture as major source of outbreaks. Only 1 owner/herder (5.2%) could not give any opinion on likely outbreak sources, but nobody did perceive contact with wild animals and movement of animal(s) as sources of PPR outbreaks. Regarding

PPR effects on production, several effects were mentioned including deaths (32.7%), loss of market value in addition to treatment burden (23.7%), abortion and sub-fertility as well as loss of weight (each 20.0%) and loss of milk (3.6%), in descending order, as major effects.

A summary of responses of sheep owners and herders on the seasonality of PPR is presented in Table 3. Rainy season was perceived by 15.0% of the respondents as the major outbreak season, 20.0% mentioned cold season, 15.0% indicated both rainy and cold seasons, but 50.0% saw no specific association with any season. Only 5.3% of the respondents claimed to have had PPR outbreak once in the past and 10.5% twice. By far the majority, 84.2%, stated that outbreaks occur annually.

During a PPR outbreak sheep owners and herders take some protective measures like stop moving or move away (22.0%), preventing contact with other animals (34.0%) or reporting to veterinary authorities (24.0%). A considerable number (20.0%) did not take any action at all. Nobody stopped contacts with other people (Table 4).

Nearly half (48.7%) of the respondents had experience with PPR, while 51.3% had not. For 84.2% of owners/herders with experience, this went back \leq 5 years, for 10.5% it was between than 5 and 10 years and for 5.3% more than 10 years. For most herders, experience with PPR was thus relatively recent.

Outcomes of the Veterinarians Questionnaire Survey

A total number of 30 questionnaires were administered to veterinarians in the two surveyed states. These questionnaires were designed to collect detailed and professional data on PPR. The data were also used as a way of triangulation of the data collected from owners and herders. The response rate was 86.7% (26/30).

General Information

A little bit more than half (53.8%, $n = 14$) of the veterinarians answering the questionnaire were from North Kordofan while the rest (46.2%, $n = 12$) were from Kassala. Among them, males were 57.7% ($n = 15$) and females were 42.3% ($n = 11$). Moreover, one-third (34.6%, $n = 9$) had \leq 5 years of experience and the same percentage had >5 -10 years, while 11.5% ($n = 3$) and 15.5% ($n = 4$) had >10 - 15 years and >15 years of experience and 3.80% ($n = 1$) gave no answer.

Ranking of Economically Important Sheep Diseases by Veterinarians

Ranking of the most economically important diseases of sheep and conditions in North Kordofan and Kassala states by vets is presented in Table 5. Diseases were ranked in the same way did for the data provided by owners and herders. PPR

(121 total points) was ranked as the most economically important disease. On the other hand, foreign bodies (2 total points) were ranked as the least important. The remaining 12 diseases and conditions were ranked in between.

Opinions of Vets on Diagnosis and Control Measures of the Ranked Diseases

The majority of the vets (73.1%, $n = 19$) indicated that the ranked diseases were diagnosed routinely by clinical signs and in the laboratory, while the minority (23.1%, $n = 7$) reported that they rely only on clinical diagnosis. No veterinarian saw any value in laboratory diagnosis alone as a routine practice. Treatment was emphasized by 50.0% as primary measure to be taken against the ranked diseases whereas vaccination was emphasized by 48.0%, and isolation and quarantine by 2%. In regards to vaccination schemes in the Sudan, 32.4% were the opinion that vaccinations are practiced against PPR, 33.8% against sheep pox, 18.2% against HS and 7.8% against Anthrax as well as against Botulism.

Opinions of Veterinarians on PPR

Concerning occurrence of PPR, 84.7% ($n = 22$) of the veterinarians answered that the last outbreak was in 2011, 11.5% stated that it occurred between 2005 and 2010, and 3.8% were not sure. All were certain that PPR outbreaks had not occurred before 2000 or from 2000 to 2005. As far as seasonality and pattern of occurrence of PPR are concerned, 61.6% of the veterinarians reported that outbreaks were not specifically associated with seasons, 23.0% placed outbreaks particularly into the cold season, 7.7% into the hot season, and 7.7% had no respective opinion.

Clinical diagnosis alone was perceived to be the routine practice of the diagnosis of PPR by 34.60% ($n = 9$) of the veterinarians, while both clinical and laboratory diagnoses were perceived to be the routine practice by 57.80% ($n = 15$), laboratory diagnosis alone was perceived as a routine practice by 3.80% ($n = 1$), and 3.80% ($n = 1$) veterinarian did not give an answer. While for its control, treatment was perceived by 28.10% ($n = 18$), vaccination by 37.50% ($n = 24$), isolation and quarantine by 9.40% ($n = 6$), and public education by 25.0% ($n = 16$). More than half (57.8%) of the vets reported that in case of PPR outbreaks, no quarantine was practiced in their localities, only 1 vet reported a possible quarantine from 2 to 8 months. Almost one-third could not develop an opinion on quarantine.

The majority (88.5%) saw sheep as most susceptible species, 11% gave goats this role. Regarding breeds, nearly two-thirds of vets (65.5%) saw all sheep breeds as equally susceptible to PPR, the Hamari breed was mentioned by 11.5% as most susceptible and 3.8% mentioned crosses of local breeds.

Nearly one-fifth (19.2%) had no opinion on sheep breed susceptibility.

Animals within the age group ≤ 1 year were perceived by 57.7% as most susceptible to PPR whereas 15.4% thought this role was taken by animals between 1 and 2 years old. No difference between age groups in regards to susceptibility to PPR, was perceived by 19.2% of the vets and 7.7% were not sure. By far the majority of the veterinarians (73.1) saw males and females as equally susceptible and 7.7% saw females as the most susceptible. Surprisingly, 19.2% were unsure regarding their answer to this question, but none of the veterinarians mentioned males as the most susceptible sex to PPR.

Major clinical signs of PPR seen frequently by the vets in North Kordofan and Kassala States are listed in Table 6. In a descending order, the major clinical signs reported were mucoid or bloody tinged diarrhoea (20.7% of the answers), mucopurulent oculonasal discharges (18.1%), respiratory distress (13.8%), stomatitis (13.8%), high morbidity (9.5%), high mortality in young animals (7.8%), loss of milk production (4.3%), loss of weight, weakness and emaciation (3.4%), dyspnea and coughing (2.6%), abortion (2.6%), lacrimation (1.7%), and erosions in the vulva or prepuce (0.9%).

The vast majority (92.4%) of the vets stated that the last vaccination against PPR was in 2011; 7.7% failed to give an answer. Few vets (3.8%) thought to recall that the number of animals vaccinated was less than 1000 animals and 15.5% remembered more than 4000 animals but 69.2% were unsure whilst 11.5% of veterinarians preferred not to give an answer.

The most practiced farming system in the study areas was nomadic as such identified by 69.2% of the vets whilst 3.8% mentioned semi-sedentary, 7.7% semi-nomadic system, 3.8% reported that more than one farming systems is practiced, and 11.5% failed to give an answer. Only 5.6% of the veterinarian could indicate the migratory route for the nomads while 94.4% could not. When an outbreak of PPR occurs, 52.5% blame it on contact at communal points like watering points and pasture as possible sources, 35.0% on movement of animals and 12.5% on the introduction of new animal(s) into flocks. Wild animals were given no role at all.

Opinions of Veterinarians on Problems Facing Disease Control Programs

A summary of responses of veterinarians on principal problems they face when implementing a disease control programme and specifically when controlling PPR in North Kordofan and Kassala States is presented in Table 7. Ignorance of animal owners, not wanting to vaccinate and not being aware of the vaccine benefits were seen as the major problems (16.7% of answers). Uncontrolled use of drugs by the owners/herders of animals and boycotting organized control programs (12.1%) as did continuous uncontrolled movement of sheep and other animals from and into the study areas (12.1%). Logistical and regulatory issues like problems of insufficient vaccine supplies (10.6%) or the fact that vaccination certificates were not issued sometimes and usually owners do not keep them (9.1%) were further added to the problems hindering the implementation of meaningful control programmes. Owners/herders too often do report outbreaks to the veterinary authorities too late (7.6%). Difficulty of diagnosis was perceived as a problem by 7.6% of the vets. Compared to these major problems, improper vaccine preparation and dosage (4.5%), the large number of animals to be vaccinated (4.5%) and the inefficient recording system (4.5%) each were seen as relatively minor problems. No problems basically arise from insufficient cold chains and vaccine storage problems (1.5%) and 6.1% of veterinarians did prefer not to answer these questions.

Comments and Advises given by Veterinarians

A summary of veterinarians' comments, advises, and additional information they want to give to the Ministry of Animal Resources and Fisheries (MARF)/Public/Policy makers concerning PPR control are presented in Table 8. Making vaccines available and enforcing routine vaccination by law were given the highest priority (21.0%), followed by promotion of extension and public education (16.0%) and construction of well-equipped laboratories (11.0%). Training, including that of para-vets was recommended by 9.0%. The need to establish check points, intensive follow up and proper reporting systems and to provide more logistics was considered by 8.0%, respectively. The need to reduce contact of animals and regulate their movements from and to different areas by law was well thought-out by 7.0% and 7.0% each recommended to make cold chains available and to improve pastures and water supply. The quality of vaccines was given good marks; only 1.0% of vets saw need to improve the preparation of vaccines and 5.0% of veterinarians had no advice.

Table 1: Mentioning and ranking of economically important sheep diseases by owners and herders in North Kordofan and Kassala States (survey from April to July 2011)

Disease		Rank 1 × 5	Rank 2 × 4	Rank 3 × 3	Rank 4 × 2	Rank 5 × 1	Total Points
SPP	Times ranked	12	12	12	0	0	144
	Points	60	48	36	0	0	
Botulism	Times ranked	10	6	4	1	0	88
	Points	50	14	12	2	0	
PPR	Times ranked	8	4	4	5	0	78
	Points	40	16	12	10	0	
Blood parasites	Times ranked	3	5	5	4	1	59
	Points	15	20	15	8	1	
Pneumonia	Times ranked	0	4	2	3	1	29
	Points	0	16	6	6	1	
HS	Times ranked	2	2	1	3	0	27
	Points	10	8	3	6	0	
CCPP	Times ranked	2	1	0	1	0	16
	Points	10	4	0	2	0	
Diarrhea	Times ranked	0	0	1	4	1	12
	Points	0	0	3	8	1	
Abortion	Times ranked	0	1	1	0	1	8
	Points	0	4	3	0	1	
Anthrax	Times ranked	0	1	0	0	1	5
	Points	0	4	0	0	1	
Arthritis	Times ranked	1	0	0	0	0	5
	Points	5	0	0	0	0	
Internal Parasites	Times ranked	0	0	1	2	2	3
	Points	0	0	3	6	6	
Brucellosis	Times ranked	0	0	1	0	0	3
	Points	0	0	3	0	0	
ORF	Times ranked	0	0	1	0	0	3
	Points	0	0	3	0	0	

SPP = sheep pox, PPR = peste des petits ruminants, HS = hemorrhagic septicemia, CCPP = contagious caprine pleuropneumonia, and ORF = scabby mouth of contagious pustular dermatitis

Table 2: Frequencies of responses of sheep owners and herders on clinical symptoms of PPR in their flocks in North Kordofan and Kassala States (survey from April to July 2011)

Variable with Levels	Number	%
Knowledge on PPR		
Know	26	66.7
Do not Know	13	33.3
Symptoms of PPR		
Loss of appetite	14	12.2
Lacrimation	3	2.6
Fever and Depression	2	1.7
Stomatitis	10	8.7
Respiratory Distress	19	16.5
Weakness and Emaciation	10	8.7
Nasal Discharge	9	7.8
Rough Skin	16	14.0
Diarrhoea	17	14.8
Low Milk Production	2	1.70
Deaths	13	11.3

Table 3: Frequencies of responses of sheep owners and herders on seasonality and frequency of occurrence of PPR in North Kordofan and Kassala States (survey from April to July 2011)

Risk Factors with Levels	Number	%
Season of Occurrence		
Dry	0	0
Rainy	3	15.0
Hot	0	0
Cold	4	20.0
Rainy and Cold	3	15.0
Not Associated	10	50.0

Table 4: Frequencies of responses of sheep owners and herders on protective measures during a PPR outbreak in North Kordofan and Kassala States, (survey from April to July 2011)

Risk Factors with Levels	Number	%
Measure for PPR Outbreaks		
Stop Moving or Move Away	11	22.0
Prevent Contact with Animals	17	34.0
Prevent Contact with Humans	0	0
Report to Vet authorities	12	24.0
Do not Take Action	10	20.0

Table 5: Ranking of economically important sheep diseases by veterinarians in North Kordofan and Kassala States (interviews from April to July 2011)

Disease		Rank 1 × 6	Rank 2 × 5	Rank 3 × 4	Rank 4 × 3	Rank 5 × 2	Rank 6 × 1	Total Points
PPR	Times ranked	15	2	0	7	0	0	121
	Points	90	10	0	21	0	0	
SPP	Times ranked	6	8	6	2	1	3	111
	Points	36	40	24	6	2	3	
Blood parasites	Times ranked	1	3	8	6	2	1	76
	Points	9	15	32	18	4	1	
Botulism	Times ranked	0	5	3	1	1	0	42
	Points	0	25	12	3	2	0	
HS	Times ranked	2	3	2	1	1	0	40
	Points	12	15	8	3	2	0	
Pneumonia	Times ranked	0	1	2	0	5	0	23
	Points	0	5	8	0	10	0	
Internal parasites	Times ranked	1	0	1	2	2	0	20
	Points	6	0	4	6	4	0	
Intoxication	Times ranked	0	2	2	0	0	0	18
	Points	0	10	8	0	0	0	
Brucellosis	Times ranked	0	1	1	0	0	0	9
	Points	0	5	4	0	0	0	
CCPP	Times ranked	1	0	0	0	0	1	7
	Points	6	0	0	0	0	1	
Mastitis	Times ranked	0	0	1	0	0	3	7
	Points	0	0	4	0	0	3	
Anthrax	Times ranked	0	0	0	2	0	0	6
	Points	0	0	0	6	0	0	
Diarrhoea	Times ranked	0	1	0	0	0	0	5
	Points	0	5	0	0	0	0	
Foreign Body	Times ranked	0	0	0	0	1	0	2
	Points	0	0	0	0	2	0	

PPR = peste des petits ruminants, SPP = sheep pox, HS = hemorrhagic septicemia, and CCPP = contagious caprine pleuropneumonia

Table 6: Frequencies of responses of veterinarians on the major clinical signs of PPR seen frequently in North Kordofan and Kassala States (survey: April to July 2011)

Clinical Signs of PPR	Number answers	%
Respiratory distress	16	13.8
Dyspnea and coughing	3	2.60
Occulonasal discharges	21	18.1
Stomatitis	16	13.8
Mucoid or bloody diarrhoea	24	20.7
Erosions in the vulva/prepuce	1	0.90
High morbidity	11	9.50
High mortality in young	9	7.80
High mortality in adults	0	0.00
Abortion	3	2.60
Weakness and emaciation	4	3.40
Loss of milk production	5	4.30
Lacrimation	2	1.70
No answer	1	0.90

Table 7: Responses of veterinarians on problems they face when implementing disease control programs in North Kordofan and Kassala States (survey: April to July 2011)

Problems Faced	Number answers	%
Difficulty of Diagnosis	5	7.6
Insufficient Logistics	2	3.0
Lack of Desire to Vaccinate	11	16.7
Vaccine Storage Problems	1	1.5
Insufficient Vaccine Supply	7	10.6
Improper Preparation and Dosage of Vaccines	3	4.5
Uncontrolled Movement	8	12.1
Uncontrolled use of Drugs	8	12.1
Huge Number of Animals Issuing Vaccination Certificates	3	4.5
Late Reporting of Outbreaks	6	9.1
Inefficient Recording System	5	7.6
No Answer	3	4.5
	4	6.1

Table 8: Comments, advises, and additional information of veterinarians they want to give to the MARF/public/policy makers on PPR control and management of PPR in North Kordofan and Kassala States (survey: April to July 2011)

Advices	Number answers	%
Construct equipped labs	11	11
Availability of Vaccines and Enforce Vaccination by Law	21	21
Promote Extension	16	16
Regulate Movements by Law	7	7
Proper Reporting Systems	8	8
Make Logistic Available	8	8
Make Cold Chain Available	7	7
Training including Para-Vets	9	9
Improve on Pastures and Water	7	7
Good Preparation of Vaccines	1	1
Nothing to say	5	5

DISCUSSION

The results of the questionnaires administered to owners and herders showed that all responders were males and the majority of them were uneducated. The poor education or ignorance could probably explain why they were avoiding vaccination,

taking no actions when diseases of animals, including PPR, and practicing communal grazing and watering.

Sheep owners and herders did rank PPR (78 total score points) to be the third most economically important disease among the diseases and conditions of animals prevailing in the study areas, after SPP (144

total score) and botulism (88 total score). Ranking diseases as being most economically important, in all likelihood is related to the economic losses they cause in terms of morbidity, mortality, and reducing the market value of the animals in addition to the cost of treatments. Ranking of SPP and PPR as important diseases is in agreement with what has been found by ILRI [2]. In contrast, botulism was given a lower importance in the study carried out by ILRI [2]. Furthermore, our findings are dissimilar to a study carried out in the White Nile state of the Sudan by Wifag [26], where 48.8% of owners and herders did select PPR as most important disease, 46.5% (n = 40) selected other diseases, and 4.70% (n = 4) had no idea about which disease is the most important. Whether this dissimilarity is related to differences in the epidemiology of PPR in different regions, it deserves more investigation. On the other hand, veterinarians ranked PPR (121 score points) as most economically important disease, followed by SPP (111 score) and blood parasites (76 score). This is in agreement with the findings of ILRI [2], where PPR was ranked as number 1 important sheep disease in the Eastern region, while information about its ranking in Kordofan region was not available. For SPP rank, it also is in agreement with the findings of ILRI [2], where SPP was ranked number 1 important sheep disease in Kordofan region, while information about its ranking in the Eastern region was not available. PPR and SPP being ranked as most important sheep diseases without doubt reflects their alarming picture in the Sudan and their coverage of vast areas across the country.

The majority of the owners and herders indicated that they know the clinical symptoms of PPR virus infection. Wifag [26] disagreed and found that only about 50% of owners and herders knew some clinical symptoms of PPR, while the other half were unaware of the major clinical symptoms. This disagreement could be related to the dissimilarity of the number of questionnaires admitted to the owners and herders or number of owners and herders interviewed in each study. In this study, owners and herders indicated they know the following clinical symptoms of PPR: loss of appetite, lacrimation, fever, depression, and dullness, stomatitis, coughing and respiratory distress, loss of weight, weakness and emaciation, nasal discharge, erection of hair and rough coat, diarrhoea, low milk production, and deaths. From this finding it can be concluded that the owners and herders have a good knowledge on the clinical symptoms of PPR. Moreover, more than half of the owners and herders answering the questionnaires claimed to have seen the clinical symptoms of PPR in the past in their flocks. Wifag [26] also reported, that a little less than half the owners and herders confirmed to themselves having seen the clinical symptoms of PPR in their herds, while a little bit more than the other half had not. Wifag [26] also reported that 20.9% of owners and herders stated that morbidity did exceed mortality, while 18.6% saw

mortality being higher than morbidity. However, 60.0% were unable to address this issue. It remains to question whether owners and herders really have seen all mentioned clinical symptoms of PPR or whether they recalled from what they know from hearsay. Without doubt, many owners and herders were unable to relate whatever signs and symptoms with PPR disease.

Less than half of the owners and herders answering the questionnaire had vaccinated their animals against PPR virus. The majority of owners and herders do reject vaccination because they think that vaccination causes the disease rather than protecting their animals against it. It also is possible that a considerable number of owners and herders does not vaccinate because they have to pay vaccination fees sometimes. Wifag [26] also reported only one-third of owners and herders vaccinating against PRR.

In this study, more than half of the owners and herders who vaccinated their animals did so in the year 2011, rather than in previous years. Whether these 2011-vaccinations are related to the increasing number of outbreaks as well as to the economic impact of these outbreaks, remain unanswered.

The study showed that the number of vaccinated animals is very small. It is obvious that this low number of vaccinated animals against PPR in the Sudan will not lead to effective containment and control of PPR due to the fact that the Sudan has millions of susceptible host animals. Vaccination campaigns further on were not well organized since they have been established in 2002 [18]. The educational status of the owners and herders, their unawareness of the benefits of vaccination and the fees of vaccination could all be probable explanations why only very small numbers of animals are vaccinated. Also, vaccine availability plays an essential role. More than half of the owners and herders who had never vaccinated their animals in the past indicated that vaccine was unavailable.

Concerning sheep age groups, the majority of owners and herders perceived animals ≤ 1 year to be the most susceptible age group to PPR. It is possible that this reflects the experience most owners and herders claimed to have had with PPR outbreaks. In the investigation of Wifag [26] on herders' perceptions about the disease, 7.0%, 20.9% and 11.6% selected adults, young and younglings as well as adults as most susceptible age groups, respectively. More than 60.0% of owners/herders though had no opinion on this issue at all.

The majority of the owners and herders perceived both sexes (males and females) to be equally susceptible to PPR. Obviously both sexes are seen as subject to the same risk and source of virus at e.g. communal points, although Sarker and Hemayeatul [27] came to a different conclusion.

The majority of the owners and herders did perceive contact of animals at communal points like watering points and pasture as essential source of PPR outbreaks. This observation could be related to the fact that substantial amounts of PPR virus were found in the secretions and excretion of infected animals [20, 21] and hence pasture and water sources would heavily be contaminated. Susceptible animals pick up the virus there and become infected.

Equally, as divergent as answers of owners and herders are on the epidemiology of PPR, were their assessments of the economic impacts of PPR on production. Abortion and sub-fertility, loss of weight, emaciation and weakness, loss of milk, loss of market value in addition to treatment burden, and deaths all were stated to affect production. Again, Wifag in 2009 came to a different result, with deaths ranking as most important economic factor of PPR disease. As with important individual animal and herd factors, a surprising 60% of owners and herders had no opinion on this important issue in Wifag's [26] investigation.

The majority of the owners and herders perceived that outbreaks were not specifically associated with seasons. This was in disagreement with the reports of Abubakar *et al.* [21], and Sarker and Hemayeatul [27]. On the other hand, the majority of the owners and herders reported that PPR outbreaks occur annually. If so, this annual occurrence of PPR in most of the flocks would suggest that PPR has taken an endemic pattern of occurrence or has reached the endemic stability state. Observations of Banyard *et al.* [17] also point in this direction; they state that PPR is endemic across the majority of countries of East Africa.

During a PPR outbreak, owners and herders take some protective measures like stop moving or moving away, preventing contact with animals, reporting to veterinary authorities. Others though do not take any action. Local disease control measures, if implemented, could be a valuable result of the long experience owners and herders have with many infectious animal diseases. FAO [28], Saliki [29], Abubakar *et al.* [21] and Baron *et al.* [15] confirm the existence of such local measures. Moreover, Al-Majali [30] reported that visiting the live animal market was seen as a risk factor for PPR transmission. The same might be true for visiting flocks at pasture. As some of the owners and herders know this fact, they do prevent people from visiting their herds. Other owners/herders are less serious: they have very little knowledge of PPR and neglect its devastating effects. They, in consequence, do not take any action when PPR breaks out in their area and are not impacted by positive actions of owners and herders who have had negative experience with PPR. Those who do not take positive action may do so because the disease had never occurred in their herd. The majority of the owners and

herders who had experience with PPR though stated that it had occurred during the last 5 years, indicating that the disease has been circulating recently.

For the diagnosis of ranked diseases, particularly PPR, the minority of veterinarians saw clinical diagnosis as sufficient for routine practice, whereas the majority underlined the necessity of both clinical and laboratory diagnoses. In absence of a functioning laboratory within reach, most of the outbreaks or cases of the ranked diseases and PPR were consequently not diagnosed in the correct way. Still, samples have to be sent to the Veterinary Research Institute in Soba, Khartoum, for confirmation of the tentative diagnosis. However, Wifag [26] reported that the available vehicles and other facilities identified in her study were principally suitable for an ongoing control program against epidemic diseases in the White Nile state. However, running budgets are insufficient to maintain this infrastructure [26].

Treatment, isolation and quarantine, and vaccination were perceived by many of the veterinarians as necessary measures against the ranked diseases as well as public education. However, chemotherapy and vaccination are the easiest measures to be taken against animal diseases in the investigated areas and the Sudan and most of the ranked diseases are seen as being most effectively addressed by using drugs (chemotherapy). Even for those diseases which cannot be treated by drugs, drugs can be used prophylactically or curatively for secondary infections; overall, the severity of diseases and resultant economic losses can be reduced. Most needed vaccines are produced locally for many of the ranked diseases like PPR, sheep pox, HS, and Anthrax, with the exception of vaccine against Botulism which has to be imported.

The majority of the veterinarians answering the questionnaire reported that quarantine is not practiced in the study areas and the Sudan. This finding can be related to lack of laws and legislations, the vast areas of the Sudan, and having no specific routes for animal movements. Shortage of technical staff is another problem even if check points are established. FAO [28], Abubakar *et al.* [21] and Baron *et al.* [15] nevertheless pointed out to the fact that control of PPR outbreaks can at least be essentially supported by movement control and quarantine.

For occurrence of PPR, the majority of the interviewed veterinarians reported that the last outbreak of PPR in their locality was in 2011. This confirmation of outbreaks in 2011 supports the idea that PPR has recently been circulating in the surveyed localities [19]. The widely practiced communal grazing and watering by almost all owners and herders, resulting in healthy animals coming in contact with infected ones, supports this hypothesis. Free movement of animals from one place to another also plays a significant role in disseminating the disease, in addition to the huge number of susceptible animals existing in North Kordofan and Kassala and the whole Sudan.

Moreover, lack of knowledge by owners and herders how PPR is being transmitted could be another reason, in addition to the very small number of vaccinated animals [31]. Al-Majali [30] and Wifag [26] support these underlying facilitating factors from their investigations. Furthermore, the same explanations can apply to the seasonality or the pattern of occurrence of PPR, again supported by the expertise of the majority of veterinarians who did not associate PPR outbreaks with any particular season. Abubakar *et al.* [21] and Sarker and Hemayeatul [27] in principle come to the same conclusion of a non-seasonality of PPR.

The majority of veterinarians also did confirm that sheep are more susceptible to PPR than goats. Further to a particular effect of the species itself, variation in husbandry and production systems of sheep and goats in the Sudan make differences in disease occurrence in both species likely. Sheep flocks are, in most parts of the Sudan, kept away from home for grazing and watering, while goats are raised at home and do graze not very far from home. In addition, goat flocks always consist of a smaller number of animals in comparison to sheep herds. Abubakar *et al.* [21] did not support the effects of husbandry and herd size. They emphasized the species variation in the susceptibility to PPR virus infection and indicated that PPR is more severe in goats than sheep, based on serological investigations and clinical observations.

Surprisingly, no difference between breeds in regards to susceptibility to PPR was perceived by the majority of the veterinarians. If, as suggested, PPR has taken an endemic course of occurrence in the Sudan, as probably this would only result in a very little difference in the susceptibility of different breeds. Abubakar *et al.* [21], nevertheless, still emphasized that PPR was significantly associated with breeds, whereby the prevalence in indigenous breeds of Bengali goats was higher than in exotic breeds of goats; also, the Guinean breeds were recognized as being highly susceptible [21].

Most veterinarians consider the age group ≤ 1 year as most susceptible to PPR, which was not confirmed by Shuaib *et al.* [19]. An explanation can be sought in the immunity of different age groups. Older animals are probably been exposed to PPR virus many times and as result they develop immunity against severe infection. The reverse may be true for younger animals after losing their maternal immunity. This agreed with reports of Saliki *et al.* [32], Saliki *et al.* [29], Srinivas and Gopal [33], Ozkul *et al.* [34], Singh *et al.* [35], Waret-Szkuta *et al.* [36], and Abd El-Rahim *et al.* [37].

Most veterinarians consider both males and females equally susceptible to PPR. Males and females were seen to be subjected to the same risk and source of PPR virus, contradicting reports of Waret-Szkuta *et al.* [36], Abubakar *et al.* [21] and Sarker and Hemayeatul [27], where a significant association of

PPR virus infection with sex in goats was identified, with he-goats apparently being more prone to PPR virus infection than she-goats.

The major clinical signs of PPR virus infection seen frequently by veterinarians in the study regions were respiratory distress, dyspnea and coughing, serous or mucopurulent oculonasal discharges, stomatitis, mucoid or bloody tinged diarrhoea, erosions in the vulva or prepuce, high morbidity, high mortality in young animals, high mortality in adults, abortion, loss of weight, weakness and emaciation, loss of milk production, lacrimation. This wide spectrum of clinical signs almost copies compiled lists of signs in veterinary textbooks [10].

The last vaccination against PPR in the surveyed localities was perceived by almost all veterinarians to have been in 2011. Larger scale frank outbreaks of PPR in all likelihood occurred just a short time ago. On the other hand, the number of vaccinated animals (648.900 animals from the questionnaire survey) is very small. MARF [31] also reported only a small number of vaccinated animals. Ignorance of owners and herders to vaccinate their animals, vaccination fees, and also vaccine shortage all will have contributed to this unsatisfactory vaccination coverage, reported also for another state in the Sudan in a previous year [26].

The majority of veterinarians confirmed that they are confronted with a traditional nomadic system. Scarce feed and water are the determining factors of this system. The majority of owners and herders move freely from one place to another looking for pasture and water for their animals. This system did also prevail in the investigations of Wifag [26]. Surprisingly then was the fact that almost all veterinarians were unable to identify the migratory route(s) of the nomads. In absence of movement regulations and laws, this area is of no concern to the veterinary services.

When outbreaks of PPR occur, the likely sources were introduction of new animal(s), contact with wild animals, and movement of animal(s). Direct contact happening on pastures and at watering points was scored highest by veterinarians. The survival period of the virus is an issue in this context, as PPR virus might live longer in drinking water, considering its survival at 60°C for 60 seconds and its stability between pH 4.0 and pH 10.0, as reported by OIE [38].

Veterinarians face a multitude of frustrating problems and drawbacks when they attempt to apply a disease control program. Questionnaire results list these drawbacks as ranging from difficulty of diagnosis, insufficient logistics, distance of animals from veterinary services, and vast area to be covered, owners' unwillingness to vaccinate, their unawareness of vaccination benefits, insufficient cold chains and

vaccine storage problems, insufficient vaccine supply, improper vaccine preparation and dosage, continuous uncontrolled movement of sheep and other animals from and into areas, uncontrolled use of drugs, huge number of animals to be vaccinated, vaccination certificates not being issued sometimes and owners not keeping them, to late reporting of outbreaks to veterinary authorities and the inefficient recording system.

Some solutions to the problems were suggested by the veterinarians to improve the quality of veterinary services in the study areas and in the Sudan. Suggestions range from constructing well equipped laboratories, making vaccines available and enforcing routine vaccination by law, promotion of extension and public education, reduction of contact of animals and regulation of movements to and from areas by law, establishment of check points, intensive follow ups and proper reporting systems, making logistics available, making cold chains available, training, including that of paravets, improvements of pastures and water supply to a better preparation of vaccines. Whether investments are justified or whether more 'policing' actions by the veterinary services are the panacea has to be seen with great reservations. The biggest problem seems to be that the veterinary services are not well connected with the animal keeping communities and that communication between them is only fragmentary.

CONCLUSIONS AND RECOMMENDATIONS

From the results of the study it can be concluded that one of the important obstacles to PPR control by vaccination is the fact that sheep owners and herders have little knowledge about the benefits of vaccination. This is seen by the regional veterinarians as one of the major problems interfering with the implementation of any PPR virus control program. Other than being highly sceptical against vaccination, sheep owners and herders have a good knowledge of patterns of PPR virus infection, its clinical signs, seasonality of occurrence, sources of infections, economic impact and the disease picture in different age groups, breeds, and sexes.

The study showed need for that the socio-economic impact of PPR virus infection and vaccination cost-benefit ratio to be understood. As many of sheep owners and herders are not convinced of benefits of vaccination, extension and communication programs should be started to enable sheep and other livestock owners to understand the importance of vaccination in control and eradication of PPR virus and other infectious diseases and also comprehend the risks to their animals by practicing communal grazing and watering and free movement from one place to another.

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