



## Knowledge of Pest de Petites Ruminants disease among owners of sheep and goats in Sudan

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### ABSTRACT

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The study was carried out to investigate it knowledge of towners and vetirian of ppn in sudan, the questionnaire was used to collect the data herd it owners. The results of the present study have increased knowledge and perception of PPRV in sheep in Sinnar, Gadarif, Kassala, River Nile and White Nile states of the Sudan. The results of the questionnaire survey showed that sheep owners, herders and veterinarians in states under study have a solid good knowledge of PPR infection, host range, its clinical signs and transmission, incubation period, source of infection, season of occurrence, the effect of animal movements, practicing communal grazing and watering and their practices and attitude to prevent and control the disease spread and its impact on their animals. At the same time there exist considerable reservations of sizeable number of herders against PPR vaccination.

### Introduction:

*Peste des petits ruminants* (PPR) is an acute, highly contagious, infectious, and notifiable transboundary viral disease of domestic and wild small ruminants (FAO, 1999; Bailey *et al.*, 2005; Radostits *et al.*, 2007; Wang *et al.*, 2009; Balamurugan *et al.*, 2010; Khalafalla *et al.*, 2010; Luka *et al.*, 2011).

*Peste des petits ruminant virus* (PPRV), the causative agent, belongs to the genus *Morbillivirus* of the family *Paramyxoviridae*. *Morbilliviruses* are known for their contagious nature and ability to cause some of the most devastating diseases worldwide (FAO, 1999; Murphy *et al.*, 1999; Bailey *et al.*, 2005; Olivier *et al.*, 2011).

PPR is characterized by fever, erosive stomatitis, gastroenteritis, conjunctivitis, pneumonia, and death (Lughano and Dominic, 1996; Radostits *et al.*, 2007; Mulindwa *et al.*, 2011).

PPR is a disease listed in the OIE Terrestrial Animal Health Code, and countries are obligated to report the disease to the OIE (OIE Terrestrial Animal Health Code ([www.oie.int/terrestrialcode](http://www.oie.int/terrestrialcode), Chapter 14.7)).

Infection with PPR virus in the Sudan was observed for the first time in 1972 in Al-Gedarif by Elhag Ali (1973) and by Elhag Ali and Taylor (1984) (cited by Intisar *et al.*, 2009; Khalafalla *et al.*, 2010). Since then continuous outbreaks occur in the country, affecting sheep and goats (Khalafalla *et al.*, 2010).

PPR is well known to be a constraint for animal resources development, horizontal and longitudinal herd growth and small ruminants farming in the Sudan. More importantly, PPR is reducing the export of small ruminants and their products to international markets in North Africa, the Middle East, South East Asia, and Europe (Shuaib, 2011).

In the Sudan, the incidence is also rising in areas where sheep and goats are raised. Moreover, in 2004 the virus did emerge in camels in the Eastern region of the Sudan, with a case-fatality rate reaching up to 50% (Khalafalla *et al.*, 2010). This rise in the prevalence and the emergence in a new species could be probably due to the virus becoming more virulent and having undergone changes in its genetic makeup. Therefore, this situation makes it very important to investigate the knowledge and perception of sheep herders and owners and veterinarians to PPR in Sudan which will enhance control of PPRV.

#### **Material and Methods:**

##### **Study area:**

The aim of this study was to investigate the knowledge and perception of sheep and goats owners and veterinarians on PPR disease in five states: Sinnar, Gadarif, Kassala, River Nile and White Nile.

##### **Study population:**

The study population was all sheep and goats herders and owners in the localities of states. Different breeds of sheep were sampled from different production systems (nomadic, semi-nomadic, sedentary, and semi-sedentary), husbandry systems and ecological conditions.

##### **Sample size:**

A total of 100 owners and 20 veterinarians were questionnaire from each state using the following sample size formula for each state:

$$N = \frac{1.962 P_{\text{exp}} (1 - P_{\text{exp}})}{d^2}$$

N: Required sample size

1.96: z value with confidence level 95%

$P_{\text{exp}}$ : Expected proportions of population knowing about PPR are 50 %

$d^2$ : Desired absolute precision (0.05)

##### **Questionnaire for data collections:**

The questions for owners included herd size, number of animals, animal husbandry, herd origin, where herd kept, measures taken when introducing new animals into the herd,

breed of the animals reared, mixing different species of livestock, mixing herds with each other at pasture or watering points, moving from place to place looking for water and pasture, farming system practiced, the frequency of PPR outbreaks, period(s) of the year when outbreaks occur, the source and actions to control outbreaks of PPR at local level, and general knowledge and perceptions on PPR, its clinical signs, mode of transmission, incubation period, source of infection, season of occurrence, action after infection, action when PPR outbreak occurred and their attitude to vaccination and the effect of animal movements on disease spread and control.

A semi-structured questionnaire was designed for veterinarians. Questions included: farming system, ranks of the most economically important diseases, season of PPR occurrence, 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, the source of PPR infection, major PPR symptoms, actions to control outbreaks of PPR at local level, vaccination and quarantine measures.

#### Data management and analysis:

All collected data of individual animals and locations were entered, coded, and stored electronically in a Microsoft® Excel for Windows® 2007 data base. The Statistical Package for Social Sciences (SPSS) for Windows® version 18.0 (SPSS Inc., Chicago, Illinois) was used for all appropriate statistical analyses.

Descriptive statistics of the variables were obtained. For each variable, frequencies (number of observations within variable) were also obtained, and multiple responses were calculated.

#### Results:

##### Owners' Questionnaire outcomes:

About (17.8 %, n = 89) of the owners and herders indicated that the sedentary system is their animal husbandry, while (14.6 %, n = 73) of them indicated that the semi-sedentary system is their animal husbandry and the majority (67.6 %, n = 338) of them indicated that nomadic is their animal husbandry. About 14.6 % (n = 73) of owners and herders kept their herds in the yard, 17.8 % (n = 89) kept their herds in farms, but the majority (67.6 %) were nomadic.

One hundred thirty eight (27.6 %) of the owners and herders who introduced new animals into the herd indicated that they do quarantine and vaccination first, while 72.4 % (n = 362) mixing them with the old ones. About 74.4 % (n = 372) of the owners and herders did mix different species, while 25.6 % (n = 128) did not mix.

Table (1) Frequencies of responses (n = 500) on management and knowledge of PPR and host range

Variable with Levels	NO	%
Animal Husbandry		
Sedentary	89	17.8
Semi-sedentary	73	14.6
Nomadic	338	67.6
Herd kept		
Yard	73	14.6
Farm	89	17.8
Nomadic	338	67.6

Action when introducing new animals into the herd		
Quarantine and vaccination	138	27.6
Mixing them with the old ones	362	72.4
Do you mix different species?		
Yes	372	74.4
No	128	25.6

Concerning occurrence of PPR outbreak, 52.8 % (n = 264) of the owners and herders answered that the last outbreak of PPRV in their flocks was in 2019, 29.6 % reported it to have occurred between 2016 and 2018, 17.6 % reported it to have occurred between 2013 and 2015, but had not occurred before 2013.

When an outbreak of PPR occurs, 15.6 % of them blame it on contact with infected animals as likely sources, 12.2% of them blame contaminated water, and 10 % of them blame contaminated feeds, 20.0 % of them due to vaccination of animals, but the majority (42.2 %) stated that mix of those sources are the source of PPR outbreaks. Contaminated trough were given no role at all. In regards to seasonality and frequency of occurrence to PPR, 15 % (n = 75) of the owners and herders perceived the rainy season as major outbreak season, 20 % (n = 100) of them in the cold season, while 15% (n = 75) of responders saw it occurred in both the rainy and cold seasons of a year, but 50.0 % (n = 250) saw no specific association with any season.

Table (2) Frequencies of responses (n = 500) on knowledge of PPR, source of infection and seasonality

Variable with Levels	NO	%
Last PPR outbreak		
Before 2013	0	0
2013 to 2015	88	17.6
2016 to 2018	148	29.6
2019	264	52.8
Source of infection		
Contact with infected animals	78	15.6
Contaminated water	61	12.2
Contaminated feeds	50	10.0
Contaminated troughs	100	20.0
Vaccination	211	42.2
Season of occurrence		
Rainy season	75	15.0
Cold season	100	20.0
Rainy and Cold	75	15.0
Not associated	250	50.0

About 9% (n = 45) of the owners and herders perceived that sheep are the most affected species, 14% (n = 70) of them said it is goats, 9% (n = 45) of them perceived that it is camels, while the majority 68% (n = 340) of them perceived that both sheep and goats are the most affected species.

Susceptible age group, 97% (n = 485) of the owners and herders perceived that sheep  $\leq$  1 year are the most susceptible age group to PPRV, 1.6 % (n = 8) of them perceived that

sheep 1 - 2 year are the most susceptible age group to PPRV and 1.4% (n = 7) had no idea concerning the most susceptible age group, but all owners and herders excluded that sheep older than one year were in some way particularly susceptible to PPRV infection. In regards to sex and PPR, 4.4 % (n = 22) of the owners and herders considered females most susceptible to PPRV, 92.6 % (n = 463) reported no difference between both sexes, 3 % (n = 15) were unable to identify a particular sex, but no owner and herder named males to be the most susceptible sex for PPRV infection.

Table (3) Frequencies of responses (n = 500) on affected species and the susceptibility of different age groups and sexes of sheep to PPRV infection

Variable with Levels	Number	%
Susceptible Species		
Sheep	45	9.0
Goat	70	14.0
Camel	45	9.0
Sheep, Goat	340	68.0
Susceptible age		
≤ 1 year	485	97.0
1-2 year	8	1.6
Do not Know	7	1.4
Susceptible sex		
Females	22	4.4
Both equally	463	92.6
Don't know	15	3.0

Importantly, three quarters (75.4 %, n = 377) of the owners and herders indicated that PPR disease transmit from animal to animal while the rest quarter (24.60 %, n = 123) of them indicated it doesn't. Forty six (9%) of the owners and herders perceived the indirect contact is the mode of PPRV transmission, but the majority 59% (n = 295) named direct contact as the common mode of PPRV transmission, while 13.6 % (n= 68) perceived it is both direct and indirect contact, but 18.2% (n= 91) of owners/herders could not give any opinion on likely PPRV transmission mode. Loose feces, droplet from cough or sneeze, saliva, discharge from eyes, nose and mouth were perceived to be the mode of direct transmission by 15 % (n = 75) of the owners and herders, but 15.2 % (n = 76) of them saw it is contact with infected animals, while the majority 42.2 % (n = 211) agrees its mix of both route. In regards to indirect contact 27.6 % (n = 138) of the owners and herders considered contaminated materials is the mode of PPRV indirect contact transmission.

Importantly, majority 78.2% (n = 391) indicated that the PPR is fatal disease, while 20.0% (n = 100) of them indicated that it is not fatal disease and 1.8% (n = 9) of them indicated that they did not know. The clinical signs, loss of appetite were perceived by 3.5 % (n = 152), lacrimation by 10.6 % (n = 459), fever, depression and dullness by 1.8 % (n = 77), stomatitis by 7.4 % (n = 321), respiratory distress by 7.3 % (n = 316), Dyspnea and coughing by 6.4 % (n = 280), loss of weight, weakness and emaciation by 6.4 % (n = 280), serous or mucopurulent oculonasal discharges by 7.5 % (n = 326), erection of hair and rough coat by 5.1 % (n = 220), mucoid or blood tinged diarrhoea by 3.7 % (n = 162), low milk production by 2.7 % (n = 118), erosions in the vulva or prepuce and mucous membranes by 4.2 % (n = 181), high mortality in youngs by 4% (n = 174), high mortality in adults by 2.3 % (n = 101), high morbidity by 4 % (n = 176),

abortions by 8.7 % (n = 378), breath putrid odor by 9 % (n = 391) and conjunctivitis by 5.4 % (n = 236) . About 91.8 % (n = 459) of the owners and herders stated that the incubation period of PPRV infection is 3 to 4 days, 2.2 % (n = 11) stated that the incubation period of PPRV infection is 8 to 13 days, while 6 % (n = 30) of them did not know.

Table (4) Frequencies of responses (n = 500) on the mode of transmission, symptoms and incubation period of PPRV infection

Variable with Levels	Number	%
Transmit from animal to animal		
Yes	377	75.4
No	123	24.6
Mode of transmission		
Direct contact	295	59.0
In Direct contact	46	9.2
All	68	13.6
Don't know	91	18.2
Mode of direct transmission		
Saliva, discharge from eyes, nose and mouth		
Contact with infected animals	75	15.0
All	76	15.2
	211	42.2
Mode of indirect transmission		
Contaminated materials	138	27.6
Is PPR disease fatal?		
Yes	391	78.2
No	100	20.0
Don't know	9	1.8
Signs and symptoms		
Respiratory distress	316	7.3
Dyspnea and coughing	280	6.4
Serous or mucopurulentoculonasal discharges	326	7.5
Stomatitis	321	7.4
Mucoid or blood tinged diarrhoea	162	3.7
Erosions in the vulva or prepuce and mucous membranes	181	4.2
Abortions	378	8.7
High mortality in youngs	174	4.0
High mortality in adults	101	2.3
High morbidity	176	4.0
Loss of weight, weakness and emaciation	280	6.4
Low milk production	118	2.7
Loss of appetite	152	3.5
Fever, restless and Depression	77	1.8
Erection of hair and rough coat	220	5.1

Lacrimation	459	10.6
Breath putrid odor	391	9.0
Conjunctivitis	236	5.4
Incubation period		
Immediately	0	0
3-4 days	459	91.8
8-13 days	11	2.2
I don't know	30	6.0

About 47.2 % (n = 236) of the owners and herders stated that they had positive attitude to vaccination their animals against diseases while 52.8 % (n = 264) of owners and herders did not. All positive attitude to vaccination (n = 236) of the owners and herders who did vaccinate their animals reported that they had vaccinated in the year 2019, where as 203 of them (86 %) were vaccinated animals in the period between 2016 and 2018 but not had vaccinated before 2013 or between 2013 and 2015. Sixty eight (28.8 %) of the owners and herders vaccinated  $\leq$  1000 animals, 30.1 % (n = 77) vaccinated  $>1000$  \_ 2000 animals, 18.6 % (n = 44) vaccinated  $> 2000$  \_ 3000 animals, 22.5 % (n = 53) vaccinated  $> 3000$  \_ 4000 animals, and nobody (n = 0) vaccinated more than 4000 animals.

Table (5) Frequencies of responses (n = 500) on vaccination against PPRV and number of vaccinated animals

Variable with Levels	NO	%
Attitude to vaccine		
Positive	236	47.2
Negative	264	52.8
Vaccinations born in herd/ brought in		
Yes	236	47.2
No	264	52.8
Last Vaccination		
2016 to 2018	203	86
2019	236	100
Vaccinated animals		
$\leq$ 1000	68	28.8
$>1000$ - 2000	71	30.1
$>2000$ - 3000	44	18.6
$>3000$ - 4000	53	22.5

Eighty eight (17.6%) of the owners and herders perceived the treatment as the best action after PPRV outbreaks, 4 % (n = 20) perceived vaccination is the best action after infection, but the majority (55 %, n = 275) named isolation of infected animals as the best action after infection , while 5.6% (n = 28) of owners/herders could not give any opinion on the best action after infection, but (17.8 %, n = 89) perceive all this measures were the best actions after PPRV outbreaks.

Regarding action taking to dead animal by owners and herders, 55.8 % (n = 279) left the dead animal behind, 9.6 % (n = 48) burn the dead animal, 13.2 % (n = 66) burial the dead animal and 21.4 % (n = 107) burn and burial the dead animal.

During a PPRV outbreak the owners and herders were taken some protective measures like stop moving or move away (18.4 %), preventing contact with animals and other herds (57 %) or reporting to veterinary authorities (19 %). A considerable number (5.6 %) did not take any action at all. Nobody stopped contacts with other people.

Table (6) Frequencies (n = 500) on the control and prevention measures against PPRV infection

Variable with Levels	NO	%
Action taking after infection		
Isolation of infected animals	275	55.0
Treatment	88	17.6
Vaccination in time	20	4.0
All	89	17.8
Don't know	28	5.6
Action taking to dead animals		
Left behind	279	55.8
Burn	48	9.6
Burial	66	13.2
Burn and Burial	107	21.4
Action when an outbreak of PPR or any other disease occurs in the next herd		
Stop movement	92	18.4
Prevent contact with other herd or animals	285	57.0
Report to the authorities	95	19.0
Do not Take Action	28	5.6

#### Veterinarians Questionnaire Outcomes:

The most practiced farming system in the study areas was nomadic and as such identified by 71.9 % of the veterinarians; 3.1 % of them mentioned a sedentary, 15.6% of them recorded a semi-nomadic system and 9.4 % reported semi-Sedentary/ nomadic farming systems was practiced. About 36.5 % of the veterinarian could indicate the migratory route for the nomads while 63.5 % could not. Veterinarians were mentioned the most economically important diseases of animals in their areas in decreasing order. PPR (36.5 %) was ordered first of the list, sheep pox (24%) ordered second, blood parasites (22.9%) ordered third and botulism (16.6 %) ordered fourth. The remaining diseases and conditions took low ranks.

Table (7) Frequencies (n = 96) on farming systems, migratory routes of nomads and the economically important animal diseases

Variable with Levels	NO	%
Farming system	3	3.1
Sedentary	69	71.9
Nomadic	15	15.6
Semi-Nomadic	9	9.4
Semi-Sedentary/ Nomadic		
Migratory route	35	36.5
Indicated	61	63.5
Not indicated		



Economically important animal		
diseases	35	36.5
PPR	23	24
Sheep pox	22	22.9
Blood parasites	16	16.6
Botulism		

Concerning occurrence of PPRV, 55.2 % (n = 53) of the veterinarians mentioned that the last outbreak of PPRV in their localities was in 2019, 14.6 % reported it to have occurred between 2016 and 2018, 14.6 % reported it to have occurred between 2013 and 2015, 10.4 % reported it to have occurred before 2013 and 5.2 % were not sure. As far as seasonality and pattern of occurrence of PPR is concerned, 68.8 % of the veterinarians reported that outbreaks were not specifically associated with seasons, 21.9 % of them placed outbreaks particularly into the cold season, but 6.2 % of them showed that the disease occurred in hot season. Only 3.1 % of veterinarians had no respective opinion. When an outbreak of PPR occurs, 54.2 % of them blame it on contact at communal points like watering points and pasture as likely sources, 31.2% of them contact moving animals and 14.6 % of them due to the introduction of new animal(s) into flocks. Wild animals were given no role at all.

Table (8) Frequencies (n = 96) on the last occurrence of PPR and its pattern, seasonality and sources of outbreaks

Variable with Levels	NO	%
Last Outbreak of PPR		
Before 2013	10	10.4
From 2013 to 2015	14	14.6
From 2016 to 2018	14	14.6
2019	53	55.2
Not Sure	5	5.2
Season of Outbreaks		
Cold season	21	21.9
Hot season	6	6.2
Not associated	66	68.8
No Answer	3	3.1
Source of PPR outbreaks		
Introduction of new animal(s)	14	14.6
Contact at communal points	52	54.2
Movement of animal(s)	30	31.2

The majority of veterinarians (81.2 %) saw sheep as most susceptible species, but 18.8% of them gave goats this role. Regarding breeds, most of veterinarians (54.2%) saw Kawahla breed is the most susceptible breed to PPRV, the Baladi breed was mentioned by 24% of them, the Hamari breed was mentioned by 10.4 % of them as most susceptible, and 15.6% mentioned crosses of local breeds, all sheep breeds equally susceptible to PPRV mentioned by 7.3 and 2.1% had no opinion on sheep breed susceptibility.

Animals within the age group  $\leq 1$  year were perceived by 60.4 % of veterinarians as most susceptible to PPRV, 14.6 % of them saw this role taken by animals between 1 and 2 years age. About 24 % of the veterinarians perceived there was no difference between age groups in regards to susceptibility to PPRV, and 1 % were not sure. By far the

majority of veterinarians (78.1 %) saw males and females as equally susceptible to PPR, but 15.6 % of them saw females as most susceptible, 6.3 % of them were unsure, but none of the veterinarians mentioned males as the most susceptible sex to PPRV.

Table (9) Frequencies (n = 96) on susceptible species, susceptible breed, susceptible age group and sex to PPRV infection

Variable with Levels	NO	%
Susceptible Species		
Sheep	78	81.2
Goats	18	18.8
Susceptible Breed		
Kawahla	39	40.6
Baladi	23	24.0
Hamari	10	10.4
Crosses of local breeds	15	15.6
No difference	7	7.3
No Answer	2	2.10
Susceptible Age		
≤1	58	60.4
>1 - 2	14	14.6
No difference	23	24.0
No Answer	1	1.0
Susceptible Sex		
Females	15	15.6
Equally Susceptible	75	78.1
Not Sure	6	6.3

In descending order, the major clinical signs reported for the study states were: mucoid or bloody tinged diarrhoea (19.8 % of answers), mucopurulent oculonasal discharges (16.7 %), respiratory distress (14.6 %), stomatitis (13.5%), high morbidity (10.4 %), high mortality in young animals (8.3 %), loss of milk production (4.1%), loss of weight, weakness and emaciation perceived (3.1 %), dyspnea and coughing (3.1 %), abortion (2.1 %), erosions in the vulva or prepuce (2.1%) and lacrimation (1.1 %).

Table (10) Frequencies (n = 96) on the major clinical signs of PPRV infection seen frequently

Clinical Signs of PPR	Number answers	%
Respiratory distress	14	14.60
Dyspnea and coughing	3	3.10
Oculonasal discharges	16	16.70
Stomatitis	13	13.50
Mucoid or bloody diarrhoea	19	19.80
Erosions in the vulva/prepuce	2	2.10
High morbidity	10	10.40
High mortality in young	8	8.30
High mortality in adults	0	0.00
Abortion	2	2.10
Weakness and emaciation	3	3.10
Loss of milk production	4	4.10

Lacrimation	1	1.10
No answer	1	1.10

Both clinical and laboratory diagnoses were perceived to be the routine practices of diagnosis for the ranked diseases by 63.5 % (n = 61) of the veterinarians, while just clinical diagnosis was seen sufficient by 34.4% of them and 2.1 % did not give an answer. No veterinarian saw any value in laboratory diagnosis alone as a routine practice. Treatment was emphasized by 29.2 % of them as primary measure to be taken against the ranked diseases when diagnosed, vaccination used by 21.9 %; but only 5.2 % saw isolation and quarantine as useful routine practice, while the majority (43.7 %) saw all this choices is the routine protocol for PPR control. In regards to vaccination schemes in the states, their opinion of vaccination of animals was practiced for PPR (36.5 %), sheep pox (39.6 %), HS (12.5 %), anthrax (8.3%) and botulism (3.1 %).

Table (11) Frequencies (n = 96) on routine diagnosis, control practices and control measures taken and vaccination for the ranked diseases

Variable with Levels	NO	%
Diagnosis of ranked diseases		
Clinical	33	34.4
Laboratory	0	0
Both	61	63.5
No Answer	2	2.1
Control of ranked diseases		
Treatment	28	29.2
Vaccination	21	21.9
Quarantine/ Isolation	5	5.2
All	42	43.7
Vaccination against ranked diseases		
PPR		
SPP	35	36.5
HS	38	39.6
Anthrax	12	12.5
Botulism	8	8.3
	3	3.1

For the diagnosis of PPRV, clinical diagnosis was perceived to be the routine practice of diagnosis for PPRV by 27.1 % (n = 26) of the veterinarians, while both clinical and laboratory diagnoses were perceived to be the routine practices of diagnosis for PPRV by 64.6 % (n = 62) of the veterinarians, laboratory diagnosis alone was perceived as a routine practice by 7.3 % (n = 7) of them, and 1 % (n = 1) veterinarian did not give an answer. But for its control, treatment was perceived 30.2 % (n = 29) of them against PPRV, vaccination against PPRV was perceived 50 % (n = 48) of them, isolation and quarantine was perceived by 6.3 % (n = 6) of them against PPRV; public education was perceived 13.5 % (n = 13) of them as needed against PPRV. About 78.1 % of veterinarians reported that in case of PPR no quarantine was practiced in their localities, only 4 veterinarians reported a possible quarantine for 3 weeks and 2 veterinarians reported a possible quarantine for 1 month. And 15.6 % of the veterinarians could not develop an opinion on quarantine; they failed to give any answer.

Table (12) Frequencies (n = 96) on diagnosis, control measures taken against PPRV and quarantine period

Variable with Levels	NO	%
Diagnosis of PPR		
Clinical	26	27.1
Laboratory	7	7.3
Both	62	64.6
No Answer	1	1.0
Control measures for PPR		
Treatment	29	30.2
Isolation/Quarantine	6	6.3
Vaccination	48	50.0
Public Education	13	13.5
Quarantine period		
3 weeks	4	4.2
1month	2	2.1
Not practiced	75	78.1
No Answer	15	15.6

In regards to vaccination period, 53.1% (n = 51) of veterinarians stated that they had PPR vaccination in their flocks every year, while 46.9%, of them stated that they vaccinated their flocks only in response to outbreaks.

About 65.6 % of veterinarians stated that the last vaccination against PPRV in different localities had occurred in 2019, about 15.6 % of veterinarians stated that the last vaccination against PPRV in different localities had occurred between 2016 to 2018; 11.5% of veterinarians stated that the last vaccination against PPRV in different localities had occurred between 2013 to 2015, but 7.3 % of them failed to give an answer. About 9.4 % of the of veterinarians thought that the number of vaccinated animals was  $\leq 1000$  animals, 17.7 % of them thought that the number of vaccinated animals was  $>1000$  – 2000 animals, 8.3 % of them thought that the number of vaccinated animals was  $> 4000$ , while 50% of them were not sure about the number of vaccinated animals and 14.6% of them have no answer to give. Half of veterinarians (50 %) found that the PPR vaccine is protective, while 29.2 % of them were not saw this protectivity, although 17.7% of them found the PPR vaccine is protective to some extend and 3.1% of them did not know.

Table (13) Frequencies (n = 96) on vaccination period, last vaccination against PPRV, number of vaccinated animals and vaccine

Variable with Levels	NO	%
Vaccination period		
Every year	51	53.1
Only in response to outbreaks	45	46.9
Last Vaccination		
From 2013 to 2015	11	11.5
From 2016 to 2018	15	15.6
2019	63	65.6
No Answer	7	7.30
Number Vaccinated		
$\leq 1000$	9	9.40

>1000 - 2000	17	17.7
>4000	8	8.30
Not Sure	48	50.0
No Answer	14	14.6
Vaccine protectivity		
Yes	48	50.0
No	28	29.2
To some extend	17	17.7
Don't know	3	3.10

### Discussion:

The results of owners and herders showed that all responders were males and majority of them were uneducated. Therefore, avoiding vaccination, taking no actions when diseases of animals, including PPR, break out and practicing communal grazing and watering could be related to their poor educational status.

The majority did perceive contact with infected animals, contact of animals at communal points like watering points and pastures as the essential source of PPR outbreaks. This observation could be related to the fact that substantial amounts of PPRV are found in the secretions and excretion of infected animals (Chauhan *et al.*, 2009; Abu bakar *et al.*, 2011) and hence pastures and water sources are heavily contaminated. A considerable number of the owners and herders did perceive vaccination is the essential source of PPR outbreaks that explain their unwillingness to vaccinate their animals and their avoiding communicating with the veterinary authorities. On the other hand the majority of them saw mix of these reasons as likely source of PPR outbreaks.

The owners and herders were well known that PPR is a fatal disease affected sheep and goats. The majority perceived that outbreaks were not specifically associated with seasons. This is in disagreement with the reports of Abubakar *et al.* (2011), and Sarker and Hemayeatul (2011) and agrees with Shuaib (2011). On the other hand, the majority reported that last PPR outbreaks occur in 2019 and it occurred annually.

The majority of owners and herders perceived animals  $\leq 1$  year to be the most susceptible age group to PPRV. This result would confirm findings of most studies carried out on PPRV, like that of El-Rasih (1992), Saliki *et al.* (1993), Srinivas and Gopal (1996), Abubakar *et al.* (2011) and Shuaib (2011), who all did confirm a distinction in the susceptibility and the level of antibodies to PPRV in different age groups.

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, this agrees with Shuaib (2011) although Sarker and Hemayeatul (2011) came to a different conclusion.

The majority perceived the frequent animal-to-animal transmission. Direct contact happening on pastures and at watering points with secretions and excretions of infected animals was scored highest. Indirect transmission was perceived by considerable number of owners and herders,

The majority indicated that they were known the clinical symptoms of PPRV infection. Wifag (2009) found that only about 50% of owners and herders knew some clinical symptoms of PPRV infection.

More than half of the owners and herders who have had experience of PPR outbreaks in their flocks stated that the incubation period is 3 to 4 days, this is agrees with finding of (Roeder and Obi, 1999; Diallo, 2000; DEFRA, 2001; Diallo, 2004).

More than half of them answered that they had not vaccinated their animals against PPRV. The majority have negative attitude to vaccination and do reject vaccination and this rejection extend to not vaccinate the born in herd/ brought in animals. It also is possible that a considerable number of owners and herders does not vaccinate because they have to pay vaccination fees sometimes. Wifag (2009) and Shuaib (2011) also reported only one-third of owners and herders vaccinating against PPRV.

More than half of the owners and herders who vaccinated their animals did so in the year 2019, rather than in previous years. The number of vaccinated animals is very small.

During a PPR outbreak, owners and herders take some protective measures like stop moving, preventing contact with other herd or animals, reporting to veterinary authorities. Others though do not take any action. Some control measures such like isolation of infected animals, treatment, vaccination and burn and burial the dead animals after infection. Other owners/herders are less serious: they have very little knowledge of PPR and neglect its devastating effects, in consequence, do not take any action when PPR breaks out. Those who do not take positive action may do so because the disease had never occurred in their herd.

The majority of veterinarians confirm that they are confronted with a traditional nomadic system. Scarce feed and water are the determining factors of this system. This system did also prevail in the investigations of Wifag (2009) and Shuaib (2011). Surprisingly then is 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, Shuaib (2011) agrees with this.

The majority of the veterinarians reported that the last outbreak of PPR in their locality was in 2019.

The majority of veterinarians did not associate PPR outbreaks with any particular season. Abubakar *et al.* (2011) and Sarker and Hemayeatul (2011) and Shuaib (2011) in principle come to the same conclusion of a non-seasonality of PPR.

Veterinarians saw the likely sources were contact at communal points like watering points and pasture, movement of animal(s) and introduction of new animal(s).

Also they confirm that sheep are more susceptible to PPRV than goats.

Kawahla breed was perceived by the majority of the veterinarians in regards to susceptibility to PPRV. This finding is in disagreement with Shuaib (2011) who found that no difference between animal breeds. While Abu bakar *et al.* (2011) emphasize that PPR is significantly associated with breeds.

Most veterinarians consider the age group  $\leq 1$  year as most susceptible to PPRV This agrees with reports of Saliki *et al.* (1993), Srinivas and Gopal (1996), Ozkul *et al.* (2002), Singh *et al.* (2004), Waret-Szkuta *et al.* (2008) and Abd El-Rahim *et al.* (2010).

Most veterinarians consider both males and females equally susceptible to PPRV, which seen to be subjected to the same risk and source of PPRV, contradicting reports of Waret-Szkuta *et al.* (2008), Abubakar *et al.* (2011) and Sarker and Hemayeatul (2011) and Shuaib (2011).

The major clinical signs of PPRV infection have been seen frequently by veterinarians in the study states.

The minority of veterinarians saw clinical diagnosis as sufficient for routine practice, this agrees with Shuaib (2011).

Treatment, isolation and quarantine, public education and vaccination were perceived by many of the veterinarians as necessary measures against the ranked diseases.

Veterinarians ranked PPR as most economically important disease, followed by sheep pox and blood parasites. This is in agreement with the findings of ILRI (2009).

The majority of the veterinarians reported that quarantine is not practiced in 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.

Majority of veterinarians stated that they had PPR vaccination in their flocks every year as routine vaccination, while the rest of them vaccinated their flocks only in response to outbreaks and the last vaccination against PPR conducted in 2019.

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, owners' unwillingness to vaccinate animals due to their unawareness of vaccination benefits, insufficient cold chains and vaccine storage problems, insufficient vaccine supply, improper vaccine preparation and dosage, 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, 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 states 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, intensive follow ups and proper reporting systems, making logistics available, making cold chains available, training, including the para\_vets, improvements of pastures and water supply and better preparation of vaccines.

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, Shuaib (2011) agrees with this.

### **Conclusion:**

The results of the present study have increased knowledge on the epidemiology of PPRV in sheep in Sinnar, Gadarif, Kassala, River Nile and White Nile states of the Sudan, by using questionnaires and personal interview. It showed that the knowledge and perceptions of PPRV was considerably high in the five studied states. In total, knowledge on these aspects of PPR in the Sudan is still fragmentary and far from being complete; it might be entirely lacking in most parts of the country.

Traditional owners and herders are said to have an immense and good practical knowledge, experience, and understanding in their farming fields and businesses. This knowledge is very helpful when information about susceptibilities of 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 is needed (Tun 2007; Shuaib, 2011). The amount of peoples' knowledge on a particular farming sector is usually related to the kind of their economic activity. Community knowledge related to animal health has been termed existing veterinary knowledge or indigenous ethno-veterinary medicine (Tun 2007; Shuaib, 2011). Over the last few decades, the gathering of existing veterinary knowledge or indigenous ethno-veterinary medicine through surveys has become an important method to identify animal health problems within communities (Tun, 2007, Shuaib, 2011).

However, existing veterinary knowledge or indigenous ethno-veterinary medicine can be further used to design better animal health projects and programs, to improve surveillance, to establish more efficient reporting systems, and to foster control and management strategies (Tun 2007: Shuaib, 2011).

An obstacle to PPR control by vaccination is the fact that sheep owners and herders have little knowledge about the benefits of vaccination and consider it as source of infection and risk factor. This is seen by the regional veterinarians as one of the major problems interfering with the implementation of any PPRV control program.

Other than being highly sceptical against vaccination, sheep owners and herders have a good knowledge of patterns of PPRV infection, its clinical signs, season of occurrence, sources of infections, economic impact and the disease picture in different age groups, breeds, and sexes.

PPR, Sheep pox, blood parasites and botulism in this order are diseases of economic importance for the sheep owners and herders in Sinnar, Gadarif, Kassala, River Nile and White Nile states.

Vaccination and treatment are major control measures taken against PPR and many other diseases in the Sudan. In contrast, movement control and quarantine, very important strategies in controlling PPRV as recommended by OIE, are not practiced.

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