Workshop Report:
Assessment of Peste Des Petits Ruminants (PPR) in the MENA Region

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Abstract*:*
A regional workshop, sponsored by UN Development Programme, to address the problem of peste des petits ruminants (PPR) in the Middle East (Jordan and Palestine) and North African (Algeria and Egypt), (MENA) region, was held at the Jordan University of Science and Technology in February 2017. Thirty-two key scientists from universities and governments in 4 countries (Jordan, Palestine, Egypt, and Algeria) gathered to present and discuss various aspects of PPR. Additionally, several farmers from the Mafraq area of Jordan, participated to learn and inform. Using an interactive framework, attendees shared perspectives and gained valuable information on control of this transboundary animal disease problem. The group created a list of key issues for addressing this serious problem, including: education of farmers about clinicopathologic signs of disease for immediate reporting (passive surveillance); increasing emphasis on disease reporting (passive surveillance) as opposed to active surveillance (serologic testing); importance of sequencing isolates for variation and lineage testing; establishment of OIE reference laboratory within or close to MENA region.

Introduction:

The last few years have seen transboundary diseases move through the MENA region, creating considerable hardships for herders and disrupting the economic base of animal agriculture. Foot-and-mouth disease, lumpy skin disease, sheep pox, and peste des petits ruminants, have all emerged into new areas, often as a result of civil strife, refugee movement, and inability of fragile governments to enact effective control (Brito et al, 2015; Abutarbush et al, 2013).

Peste des petits ruminants is a notifiable and highly contagious acute viral disease of rsmall ruminants. It is also classified as a Transboundary Animal Disease (TAD), due to its proclivity of spreading rapidly and creating considerable socioeconomic havoc. The disease has gained particular attention globally, with its steady march to new areas (Libeau et al, 2014), notably the Middle and Far East. There are 2 billion small ruminants globally, and approximately 80% reside within countries affected by PPR. Of the 70 countries of the world reporting the presence of PPR, most are classified as developing, and it is in these countries where those citizens in the economic margins rely on their animals for livelihoods. Consequently, PPR has the potential to greatly increase global poverty (Baron et al, 2016). In a rough tally, more than 300 million families who depend on these small ruminants are threatened with economic hardship due to illness and death of their animals. The successful eradication of rinderpest has led global authorities to suggest a similar program for the related PPR, with a global control and eradication program announced by World Organisation for Animal Health (OIE) and the UN Food and Agriculture Organization (FAO) in March 2015 (OIE, 2015). A recent economic analysis confirmed the utility of a global eradication, citing a net benefit of US$74.2B, corresponding to a benefit-cost ratio of 33.8 (Jones et al, 2016). In the MENA region, sheep and goats often form the cornerstone of the local economy, and so PPR has been especially devastating there. Furthermore, many countries in this region export live sheep and goats, for valuable foreign exchange. There is also reported to be large numbers of animals that are part of the informal (or illegal) trade across borders, but it is not possible to calculate exact figures. Control and prophylaxis of PPR disease is paramount in order for the agricultural economies to stabilize, and to provide economic opportunities.

For discussion among various countries in the MENA region, a PPR workshop was held in February 2017 at the Jordan University of Science and Technology, funded by the UN Development Porgramme. The workshop, with participants from Jordan, Egypt, Palestine, and Algeria, had three main themes: testimony from farmers affected; national policies for testing and surveillance; and country control programs. This paper describes highlighted discussion points and presents consensus summary statements regarding preferred paths forward.

Reports from the field:

Several herders attending the workshop hailed from the Mafraq region of Jordan, which is the semi-desert area in the north of Jordan, sharing a long border with Syria to the north and a shorter border with Iraq to the east. This area contains approximately 40% of the sheep and goat population of the country. Several herders related how rearing sheep is a centuries-old practice, now in danger of disappearing. They stated that, historically, a flock of 200 sheep could support 20 people, a large extended family, providing a way of life and also a livelihood, with the off

take enabling the family to "build a house, marry our sons, and send our children to university." But now, with increasing loss to new diseases, and the rising cost of feed, herding sheep is no longer a profitable business. One herder relayed how he had 500 sheep, and he had to sell 250 of them in order to purchase enough feed for the remainder. Additionally, the presence of PPR, as well as some other transboundary animal diseases, hinders their ability to export sheep and goats to the Gulf countries, which had always been a mainstay of income. They expressed disappointment that the national and international communities have not done more to help them, as they absorb animals and their diseases from surrounding countries experiencing serious civil strife.

Surveillance for infection:

Representatives from each of the countries at the workshop described their surveillance and control plans. Only Algeria does not conduct serosurveillance, but instead, when there is an outbreak, with recognition of clinical disease, they do a stamping out program, with payment of indemnities and vaccination in surrounding zones. None of the other countries present at the workshop (Jordan, Palestine, Egypt) offers indemnities for stamping out. For these 3 countries, serosurveillance is done as a national program, with regular serosurveys, but all agreed that this does not provide an accurate picture of where the disease is occurring, because of the long-term serologic positivity subsequent to either vaccination or infection. In Palestine, control is especially problematic because some of the areas in Palestine are under control of Israel, and the Palestinian authorities cannot test animals in that zone. Another big problem in Palestine is the lack of ability to get to the farms. There are 100 veterinarians and veterinary inspectors working for the government, but they have only 13 cars. Fattening farms within the country, in Ramallah, Jenin, and Hebron, have the highest incidence of disease, and some disease there is believed due to smuggling of Israeli animals into Palestine. Egypt described a program of "emergency vaccination", whereby when a herd is infected, the ill animals are segregated from the rest of the herd which is then given the PPR vaccine. Jordan described the government's free-of-charge annual vaccination program of PPR (conducted since 1997 until now) along with the vaccination programs for other animal diseases, including FMD, sheep and goat pox, brucellosis and anthrax.

The clinical syndrome and characteristic postmortem findings were reviewed and shared with the farmers. The propensity of the virus to attack certain body tissues and create typical lesions makes this disease an excellent candidate for participatory disease surveillance, i.e., one in which producers are actively involved in recognizing and alerting authorities. As the virus is known to attack epithelium in the oral cavity and intestine, typical mouth lesions are present (Figure 1) and the diarrhea is due to intestinal ulcerations instigated by the virus (Figure 2). As animals survive the alimentary phase of the infection, the virus will attack the bronchiolo-alveolar junction cells in the lung, creating the typical broncho-interstitial pattern seen grossly (Figure 3). All agreed that earlier notification of authorities regarding the possible presence of the disease would be instrumental in decreasing outbreak spread.

Morbidity and mortality rates for PPR are variable, but can reach up to 100% and 80–90%, respectively, illustrating how dangerous and costly the disease can be for small ruminant populations. In the MENA region, perhaps due to vaccination programs, the morbidity and mortality rates do not reach these levels. There are, however, often problems with co-

morbidities, perhaps due to the immune compromise by the PPR virus (Toplu et al, 2012; Maan et al, 2017).

Four lineages of PPR have been described. Lineage III is believed to be the ancient lineage, from which all the others developed. Lineage IV is currently the lineage predominant in the world, and it has moved through the Middle East, across North Africa, and down through East Africa, replacing previous lineages. Lineage IV is proving to be very diverse, with distinct clades and subclusters. There is, however, only one serotype, and testing for either antigen or antibody can be accomplished using the structural proteins that are present on all lineages. Concern arises because of the possibility of mutations in Lineage IV continuing to accumulate, perhaps allowing the virus to successfully infect and cause disease in another species, for instance, cattle.

Control programs

With the exception of Algeria, all the countries present promote a national vaccination program, and are in varying stages of the Progressive Control Pathway recommended by the OIE.

The vaccine for PPR in greatest use globally is a modified live vaccine made from the Nigeria 75 strain, which is Lineage III. JOVAC, a vaccine company located in Jordan, currently produces this vaccine and will create, under OIE's direction, a large vaccine bank for PPR. The PPR vaccine produces a strong humoral response that lasts for at least three years. One problem with the vaccine is that, because it is a modified live vaccine, once reconstituted, must be administered to the animal within two hours, or it loses potency. Given the extensive management system of the pastoralist herds and flocks, maintaining the cold chain is problematic.

Summary and Consensus Recommendations:

The path forward discussion at the end of the workshop highlighted four main points for countries to support:

- PPR is a contagious viral disease which has a great national and international economic and social impact because it affects mainly poor small ruminant herders, and thus deserves the attention of politicians and decision makers for promoting and supporting its prevention and control.
- The discussions around serosurveillance, and the costly and inaccurate nature of pinpointing disease based on serologic results, led many to conclude that passive surveillance, i.e., enlisting farmer-reporting of disease occurrence would be more efficient and cost effective than serosurveys. All agreed that a more robust field-laboratory connection could greatly improve confirming where the disease is occurring in the country. To that end, training of field veterinarians in sample collection and submission, and, importantly, training of farmers and herders on recognition of key clinical signs and the importance of alerting veterinarians would be critical.
- Networking among the countries, to continually discuss the occurrence of disease, problems associated with diagnosis or epidemiologic aspects, could improve the situation for all.

- Sending all strains isolated for lineage testing will be important to allow molecular epidemiologists to more closely examine spread and any potential changes that might presage a change in the disease.
- Currently the OIE Reference Laboratory for PPR is in Pirbright, England. It would be very advantageous for a reference lab to be located in the MENA region, for improved access by countries most affected.

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208 **Figure Legends**
209
210 Figure 1. Typical oral lesions seen in a sheep infected with PPR. There is widespread destruction
211 of epithelium, creating extensive ulceration
212
213 Figure 2. Opened cecum of a goat infected with PPR. The virus destroys parts of the intestinal
214 lining, causing ulceration and hemorrhage.
215
216 Figure 3. Lungs of a sheep infected with PPR. The virus grows in cells deep within the bronchial
217 tree, creating multiple areas of necrosis scattered throughout the whole lung.
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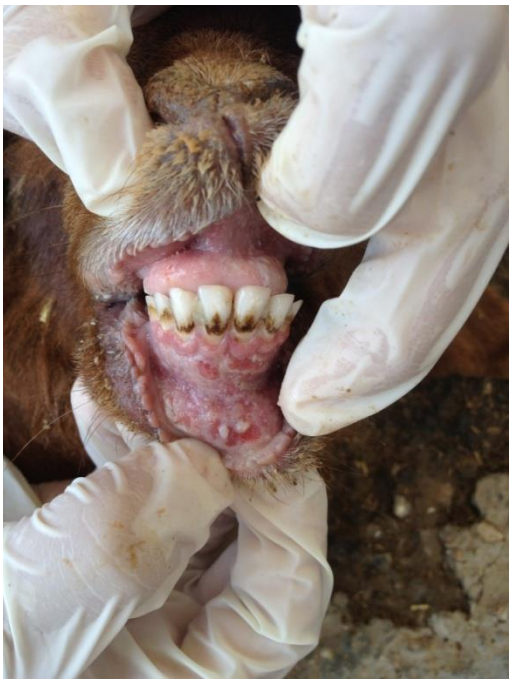

Figure 1

Figure 2

Figure 3

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Improving the Diagnostic Capacities of *Peste Des Petits Ruminants* (PPR), Enhancing the Vaccination And Control Strategies with Special Emphasis on Farmers Education and Awareness in Egypt, Algeria, the State of Palestine and Jordan.

Jordan University of Science and Technology Jordan, February 19-21th, 2017

Report from the field:

Several herders attending the regional workshop on PPR which we organized on February 17-19th, 2017, hailed from the Mafraq region of Jordan, which is the semi-desert area in the north of Jordan, sharing a long border with Syria to the north and a shorter border with Iraq to the east. This area contains approximately 40% of the sheep and goat population of the country. Several herders related how rearing sheep is a centuries-old practice, now in danger of disappearing. They stated that, historically, a flock of 200 sheep could support 20 people, a large extended family, providing a way of life and also a livelihood, with the off take enabling the family to "build a house, marry our sons, and send our children to university." But now, with increasing loss to new diseases such as *Tahoun Almochtarat Alsagerah*/PPR and abortions, and the rising cost of feed, herding sheep is no longer a profitable business. One herder relayed how he had 500 sheep, and he had to sell 250 of them in order to purchase enough feed for the remainder. Additionally, the presence of PPR, as well as some other transboundary animal diseases, hinders their ability to export sheep and goats to the Gulf countries, which had always been a mainstay of income. They expressed disappointment that the national and international communities have not done more to help them, as they absorb animals and their diseases from surrounding countries experiencing serious civil strife.