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PESTE DES PETITS RUMINANTS (PPR) THERMOTOLERANT VACCINE PRODUCTION AND DELIVERY THROUGH A PUBLIC-PRIVATE PARTNERSHIP IN THE SAHEL: THE CASE OF MALI

KEY MESSAGES

The public-private partnership between Mali Laboratoire Central Vétérinaire (LCV), ILRI and Hester Biosciences Ltd of India led to the production of two thermotolerant vaccines for *Peste des Petits Ruminants* (PPR).

Malian livestock farmers are willing to pay for the vaccines because they will prevent infection and greatly reduce the risk of loss of livestock.

Business models to scale up the vaccines in Mali and beyond its borders are needed to vaccinate more livestock. Veterinarians support greater availability of the vaccine to increase coverage of livestock, especially in remote areas.

Each year, PPR causes economic losses worth an estimated USD 1.2 to 1.7 billion, due to animal deaths, reduced production and the cost of fighting the disease. Investing in the control and eradication of PPR will significantly contribute to food security and reducing poverty in the world's most vulnerable pastoral and rural communities.

SUMMARY

Peste des Petits Ruminants (PPR) is caused by a highly contagious, acute virus (similar to rinderpest) that primarily affects domestic small ruminants (SRs) like sheep and goats. It is a widespread, virulent, and devastating disease, with huge economic, food security and livelihood impacts, especially for livestock owners who keep SRs. The animal health and development communities are concerned because the disease is spreading across eco-regions and affecting the livelihoods and nutrition status of hundreds of millions of people.

Given the lack of data on PPR, most endemic countries are unaware of the magnitude of the impact of the disease on their economies. Each year, PPR causes economic losses worth an estimated USD 1.2 to 1.7 billion, due to animal deaths, reduced production and the cost of fighting the disease. Approximately a third of the financial impact occurs in Africa and a quarter in South Asia (OIE and FAO 2015). Investing in the control and eradication of PPR will significantly contribute to food security and reducing poverty in the world's most vulnerable pastoral and rural communities such as women who often hold SRs.

Promisingly, global consensus has been reached on the need to control and eradicate PPR. A Control and Eradication Strategy was endorsed at the International Conference for the Control and Eradication of PPR, organized by the Food and Agriculture Organization of the United Nations (FAO) and the World Organisation for Animal Health (OIE) in 2015. Eradication of the disease by 2030 is its goal (OIE and FAO 2015).

A woman milks a goat in Ségou District, Mali. Sheep and goats are an important source of nutrition and livelihoods for millions of people in the Sahel.

VACCINATING AGAINST PPR: CHALLENGES AND OPPORTUNITIES

The principal method for the control of PPR is vaccination. It is important that all SRs are vaccinated because introduction of unvaccinated animals into a herd is likely to result in the introduction of the virus. There is a homologous live attenuated vaccine that protects SRs against PPR to control losses. The vaccine has shown to be effective for at least three years post-vaccination (equivalent to the average lifespan of a SR). It is produced by private and public laboratories who commercialize it, although laboratories only exist in a few countries, making access difficult for non-producing countries.

This type of vaccine also requires cold storage, and the lack of proper cold chain infrastructure is a major cause of failure in most vaccination programs, especially in countries with very high temperatures. It is often impossible to keep vaccines cold when travelling long distances in rural areas, and lack or failures of electricity, even in urban areas, means use of the current vaccine is constrained.

Sufficient thermostability of the current vaccines for use without a cold chain will greatly facilitate the delivery of vaccination. This will remove the need for heavy cold chain maintenance and will have a significant impact on reducing costs of PPR control programs. It is also expected that vaccination campaigns will be more effective in terms of immunity gains against PPR because failure due to breakdown in cold-chain maintenance would be reduced.



A vaccinator in a herd of sheep in Sikasso, Mali.



A herd of goats in Mopti, Mali.



A teenage girl and one of her family's sheep at an urban farm in Bamako, Mali.

Since 2016, the International Livestock Research Institute (ILRI) has partnered with Hester Biosciences Ltd of India (HBS), a private vaccine production company, to support the Central Veterinary Laboratory (LCV) of Mali in optimizing and producing two thermotolerant PPR vaccines:

1. "ILRI thermotolerant PPR vaccine produced by the Thermovac process" (Mariner et al. 2017) developed by ILRI and referred here as "ILRI protocol".
2. Xerovac an old vaccine whose technology existed already at LCV (Worrall et al. 2000) but has never been marketed by the government because Malian farmers don't like its texture which they perceive as a sign of deterioration.

The proposed vaccines have proved considerably stable at ambient temperatures up to seven days for the ILRI protocol and fourteen days at 40°C for the Xerovac protocol, which has tremendous advantage in hot countries and in remote areas. The project has gone beyond technology development to identify and test components of new institutional model for delivering effective PPR control services to SRs producers in Mali.

APPROACHES AND RESULTS

Process optimization, vaccine production and field testing

The two vaccines (ILRI protocol and *Xerovac*) targeted for thermostability are made of the live attenuated Nigeria 75/1 vaccine strain, and their processes mainly differ in the inputs used and lyophilization (freeze-drying) techniques. A lactalbumin hydrolysate and sucrose stabilizer were used in the case of the ILRI protocol; while a stabilizer based on trehalose was used for the *Xerovac*.

ILRI and LCV researchers tested the vaccines in 2018 and 2019 for thermostability which was measured at different temperatures and time, and the shelf-life of the vaccines was determined as the time a vial retained the minimum dose required titer as $10^{2.50}$ DITC₅₀ at the specified temperature. The vaccines have passed the Pan African Veterinary Vaccine

Centre of the African union (AU-PANVAC) external quality control.

Both vaccines meet FAO and OIE thermostability recommended standards (which is at least 25°C for 10 days or 40°C for 2 days) which is an advantage for hot climate countries in remote areas. Some of the advantages of thermotolerance include less cold chain maintenance costs leading to less financial cost of PPR control programs, thus improved effectiveness of vaccination campaigns in terms of immunity gains against PPR. Vaccines were then deployed for field validation in the Sikasso region of Mali. Results from field testing of *Xerovac* showed 99% effectiveness in protecting the small ruminants. Field tests for the ILRI vaccine will be completed in 2022.

Ex-ante assessment of PPR vaccine delivery

Prior to deployment of vaccines to the field, ex-ante assessment studies were carried out to collect feedback from stakeholders, such as farmers and veterinarians who are the main vaccinators, on how to improve vaccination coverage of small ruminants.

Willingness to vaccinate livestock and to pay for it

A study on farmers willingness to vaccinate and pay for it was carried out with 304 livestock producers in Mopti and Sikasso regions. Both distance effects and vaccine quality-tracker effects were associated with farmer willingness to pay more than the current vaccine prices. Farmers practicing semi-intensive production systems were willing to pay 20 percent more than the current vaccine prices, as were users who believe in the beneficial effects of vaccination, consider the prices of vaccines as fair, and those who believe that some vaccines are more important than others. Targeted information dissemination campaigns by the Malian authorities are needed to address the factors that discourage farmers from vaccinating. Greater price transparency throughout the vaccine production and deployment chain is critical, while timely availability of vaccine tested for viability would

increase the willingness to vaccinate while improving access (Wane et al. 2019).

Perception of vaccinators of the thermostable PPR vaccine and recommendations to improve vaccination coverage

A survey on the perception of PPR thermostable vaccines was conducted with 35 veterinarians who provide health services to livestock producers in the Sikasso region. Two thirds of the vaccinators welcomed the introduction of a new thermotolerant vaccine. Others showed concerns that farmers might start self-medicating as they can now store the vaccines given there are no cold-chain requirements. Most vaccinators (86%) believe that the thermotolerance of the vaccines will have a great socio-economic advantage and they expect a high acceptance rate by end users.

Recommendations provided by veterinarians to improve immunization coverage include raising awareness and educating farmers on the benefits of vaccination; ensuring vaccines are available in large numbers; reducing the price of the vaccine at the farmer's level and improving programming and monitoring of vaccination programs.



A banner announcing the vaccination campaign for sheep and goats.

IMPLICATIONS AND RECOMMENDATIONS

- Business models should be developed to make the case for the commercialization of the vaccines in Mali and beyond its borders.
- Governments, partners, veterinarians, and livestock farmers need to develop a sustainable vaccination strategy that looks at consolidating the successful stakeholder platform model and make a call for investments in the control of PPR and other livestock diseases through public-private-partnership.

CONCLUSION

ILRI and HBS usefully built-in house local capacity at LCV laboratories in Mali to enable production of the two thermotolerant PPR vaccines. The added advantage of these vaccines is that they will reduce use of cold chain, hence lowering investment and reducing the logistical burden for vaccinators. If used, these vaccines have a huge potential in preventing further losses due to PPR outbreaks. These emerging results from initial field tests and the encouraging insights from the ex-ante assessments, act as the basis for pursuing next steps.

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