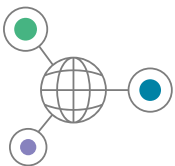





International
Veterinary Vaccinology
Network

Annual Report 2022



International
Veterinary Vaccinology
Network

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Foreword from the IVVN team

The past year has been a positive one for the IVVN. While the previous two years tested the limits of how a Network can bring people together while staying suitably apart, 2022 has brought some of that connectivity back.

Looking internationally, it is remarkable to see the way our members have overcome the challenges of the pandemic, and the work you have achieved despite these difficulties. Do continue to let us know about your achievements and publications and we will share with the community.

We are very proud to have been able to open a new call for laboratory exchange applications this year. This funding will allow members to visit another group to learn a new skill, use specialised equipment or complete a proof-of-concept. The call closed at the beginning of this month and we look forward to funding a new round of projects.

This new call was possible because of the additional funding we were recently awarded (page 7) by UK Research and Innovation from the UK government's Global Challenges Research Fund. As well as this new funding call, we are also planning new activities and opportunities for members, including training for early career researchers and new schools outreach activities. Keep an eye out for news in a future issue of the IVVN newsletter.

Another source of pride for us this year was the fantastic work of our first six IVVN Fellows. Amany, Angela, Laura, Mercy, Sreeja and Tanja all presented at the special dissemination event we held for the programme in July (page 25). All six have achieved tremendous success in a very short amount of time under challenging situations caused by the pandemic. It was a real pleasure to celebrate those achievements with members and the team from Canada's International Development Research Centre, who co-funded the programme.

We have also seen some changes to the Network Management Team (page 8) that administers the day-to-day activities of the IVVN. Professor Christine Maritz-Olivier from the University of Pretoria in

South Africa, and Professor Simon Graham from the Pirbright Institute in the United Kingdom, joined the team in May as co-directors. Our founding co-director, Professor Bryan Charleston stepped down at the same time and joined the Network Management Board. Anne Syrett, our Network Administrator, also left the team earlier this year. We offer our sincere thanks to Bryan and Anne for their years of dedicated support, and a warm welcome to Simon and Christine, who you can read more about on page 9.

Thank you to everyone who has been part of our work over the past 12 months. Whether that has been through a funded project (page 31), attending our online webinars expertly chaired by Professor Brian Perry (page 11), completing our members' survey (page 15) or catching up with our monthly newsletter, we are glad to have you as part of our Network.

As ever, if you have any suggestions on how we can improve the Network, then please get in touch with the IVVN team at IVVN@roslin.ed.ac.uk.

Tim, Simon, Christine, Carly and Mabon

Background

The International Veterinary Vaccinology Network is a global community of scientists and industry partners focusing on developing vaccines against important animal diseases.

Livestock agriculture is crucial for the economies of many low- and middle-income countries (LMICs), with the livelihoods of 1.7 billion people supported by the industry. Nutrient-rich and high-value livestock and fish products also play major roles in sustaining global food security and combatting malnutrition, and demand for these products is increasing as populations grow.

Veterinary diseases have devastating effects on livelihoods, animal welfare, human health and LMIC economies. Vaccines are the most effective means for combatting these diseases – but for many diseases, effective vaccines are either yet to be developed or are not reliably available where and when they are needed.

Developing and deploying a vaccine is a complex process that requires knowledge from a wide range of disciplines from epidemiology to immunology, and from industrial biotechnology to economics. There are often technical and logistical obstacles and bottlenecks, and these require the skills of multiple international specialists to overcome. Opportunities for establishing these important collaborations can be limited for many veterinary diseases, especially those relevant to LMIC settings.

The IVVN seeks to kindle and foster these essential collaborations. With our unique remit, we aim to help researchers, industrial partners and others work together towards developing vaccines specifically for high-consequence livestock (including poultry and aquaculture) diseases in LMICs. We do this through four areas of focus:

- **Facilitating opportunities for networking** to help establish new collaborations and exchange information.
- **Supporting scientific collaboration** by funding pump-priming projects and laboratory exchanges involving international partners.
- **Training early career scientists** to support the development of future international expertise.

- **Promoting gender equality** in veterinary vaccinology to help bridge the opportunity gap for women scientists and create a more diverse and inclusive research environment.

Since launching five years ago, the IVVN has welcomed 1,700 members from 93 countries. Members have benefited from networking opportunities and the exchange of knowledge and ideas at our international conferences in Nairobi and London, our workshops held around the world, and at our online events. We have supported 13 pump-priming grants and 11 laboratory exchanges, and we will be awarding more funding to our members later this month. Our conference grants and training courses have enabled early career researchers to gain new knowledge, make new connections and develop important skills. We are supporting the career advancement of a cohort of women postdoctoral scientists through our fellowship scheme, and we aim to encourage more girls to pursue scientific interests through our outreach programme. And the IVVN's online content serves as a focal point where our global Network can find resources, events, opportunities, publications and news from their fellow members.

The IVVN is always seeking to expand our activities based on our members' needs and feedback. We are proud to play our part in supporting this important and thriving international community.

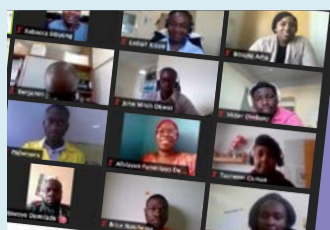
IVVN activities

The IVVN's activities are centred around four key work areas: **facilitation of networking** between members, **supporting scientific collaboration**, **training early career researchers**, and **promoting gender balance** in veterinary vaccinology research.

Facilitation

We seek to bring a large but widely dispersed community together through our international conferences and workshops. Since 2020, these activities have taken place online, and we hope to continue our webinars, virtual symposia and online workshops even as we look to resume in-person events.

Members are kept informed about the Network's activities through our website, a monthly newsletter and our Twitter and LinkedIn pages.



Training for early career researchers

The IVVN is committed to supporting the training and development of early career researchers, especially those working in LMICs. We do this through **conference scholarships** to attend international meetings, running skills-based workshops at our annual conferences, and through our programme of online training courses.

Supporting scientific collaboration

The IVVN's catalyst funding schemes award collaborative research to tackle key bottlenecks in LMIC-relevant vaccine development. Since 2017, we have funded 13 **pump-priming awards** worth up to £100,000 each. We also have a funding programme to facilitate **laboratory exchanges** with £10,000 available for each award; 11 exchanges have already been funded, with more projects due to be awarded soon.



Promoting gender balance

The **IVVN African Schools Outreach Programme** equips a network of women African scientists with the knowledge and tools they need to host interactive workshops in their local schools. The programme launched in 2019 and now has team members based in seven African countries.

The IVVN also runs a **Fellowship Programme** for women postdoctoral researchers, which is co-funded with Canada's International Development Research Centre. The first six projects are now nearing completion, and our fellows recently presented at a special online dissemination event.



IVVN awarded additional funding to support activities

Earlier this year, the IVVN was delighted to be awarded £450,000 of additional funding from the Global Challenges Research Fund (GCRF) of UK Research and Innovation (UKRI).

The GCRF supports cutting-edge research to address challenges faced by developing countries. It is part of the UK's official development assistance (ODA) and is managed by the Department for Business, Energy and Industrial Strategy.

Since 2017, the Network has supported a growing number of veterinary vaccinologists around the world, and we now have more than 1,700 members in 93 countries. The additional funding reflects the strategically important role the Network plays in bringing together this global community.

The additional funds will supplement the original £2.8m grant from GCRF that has funded the Network's activities since its launch.

With this award, the IVVN will be offering members access to new events, training opportunities and funding calls. The award will also provide additional support to the African Schools Outreach Programme, which has continued to grow since its 2019 launch, and help fund our online activities.

Fourth round of laboratory exchanges announced

The first new opportunity we can run using this additional funding is a new round of laboratory exchange funding.

This new call, announced in September, is the fourth round of this funding scheme, with 11 projects awarded in previous cycles.

Successful applicants will receive an award of up to £10,000 to facilitate the transfer of skills or experience between laboratories, and/or to allow specialised proof-of-concept work to take place. These funds can be spent on travel, accommodation and laboratory consumables for a visiting researcher to spend time in a hosting researcher's laboratory.

IVVN laboratory exchanges are awarded competitively, with submitted applications reviewed by members of the IVVN Network Management Board. Applications closed on 5 October, and the successful projects will be announced later this year.

IVVN structure

The IVVN is directed by **Dr Timothy Connelley**, **Professor Simon Graham** and **Professor Christine Maritz-Olivier**. The Network is governed by a Network Management Board and advised by an External Advisory Group, both of which comprise international experts from across the fields of human and veterinary vaccinology.

The Network is managed by **Dr Carly Hamilton**, with communications support by **Dr Mabon Elis**. Please do not hesitate to contact the team at IVVN@roslin.ed.ac.uk if you have any questions or comments.

Network Management Team

- Network Director: Dr Timothy Connelley, Roslin Institute, UK.
- Network Co-Director: Professor Simon Graham, The Pirbright Institute, UK.
- Network Co-Director: Professor Christine Maritz-Olivier, University of Pretoria, South Africa.
- Network Manager: Dr Carly Hamilton, Roslin Institute, UK.
- Network Communications Officer: Dr Mabon Elis, Roslin Institute, UK.

Network Management Board

- Professor Bryan Charleston, The Pirbright Institute, UK.
- Dr Baptiste Dungu, Afrivet, South Africa.
- Dr Michael Francis, BioVacc Consulting Ltd, UK.
- Dr Crystal Loving, USDA ARS, United States.
- Dr Michèle Mboo-Tchouawou, AWARD, Kenya.
- Dr Vish Nene, International Livestock Research Institute, Kenya.
- Dr Thảo Ngô, Biotechnology Center of Ho Chi Minh City, Vietnam.
- Professor Brian Perry, Universities of Oxford and Edinburgh, UK.
- Dr Carolin Schumacher, GALVmed, UK.
- Professor Fiona Tomley, Royal Veterinary College, UK.
- Professor George Warimwe, KEMRI-Wellcome Trust Research Programme, Kenya.

External Advisory Group

- Professor Adrian Hill, Jenner Institute, University of Oxford, UK.
- Dr Valeria Mariano, World Organisation for Animal Health.
- Dr Keith Sumption, Food and Agriculture Organisation of the United Nations.

Two new co-directors join IVVN team



We were delighted to announce earlier this year that **Professor Christine Maritz-Olivier** and **Professor Simon Graham** have become co-directors of the Network.

Along with founding director Dr Tim Connelley, Simon and Christine will lead the Network Management Team that runs the IVVN's activities.

Christine Maritz-Olivier is a professor in the Department of Biochemistry, Genetics and Microbiology at the University of Pretoria, South Africa, where she leads the Ticks and Tick-Borne Diseases programme. Her research looks at how the cattle immune system responds to ticks and the diseases they transmit, helping to improve vaccine formulations. To ensure translation of this research to field conditions, the team's vaccinology studies are conducted in parallel with phylogeography of tick species and animal models.

Before starting her current role, Christine carried out postdoctoral research as a Wellcome Trust-funded fellow in South Africa and the Netherlands. Christine is also co-initiator of a Bill and Melinda Gates Foundation-funded cattle tick vaccine project and is a past president of the International Society of Tropical Veterinary Medicine. She has received several international awards, serves on a number of journal editorial boards, and has been a member of the team delivering the IVVN African Schools Outreach Programme in South Africa since 2019.

Professor Maritz-Olivier said: "I am excited to be joining the Network Management Team of the IVVN, and be part of an enthusiastic team focused on bringing together current researchers in the field while also creating an enabling environment for the next generation of veterinary vaccinologists."

"I believe the IVVN has a vital part to play in scientific training and leadership. Nowhere is this more evident than in Africa, where skills development will be key for the realisation of the sustainable development goals on the continent. As stated by Marie Curie: 'You cannot hope to build a better world without improving the individuals.'"

Professor Simon Graham leads the Porcine Reproductive and Respiratory Syndrome (PRRS) Immunology group at The Pirbright Institute in the

United Kingdom, and is also a visiting professor at the University of Surrey. Simon's research seeks to understand how PRRS viruses interact with the immune system, and to exploit this knowledge to develop improved vaccines. He also leads research aimed at developing a vaccine for use in pigs to protect against the zoonotic Nipah virus.

Before joining Pirbright, Simon led the Animal and Plant Health Agency's immunological and vaccine-related research on a number of viral diseases of livestock. He has also worked on theilerioses vaccine development at the University of Edinburgh and the International Livestock Research Institute, Kenya.

Professor Graham said: "I am honoured and excited to take on this role. I look forward to working with the IVVN team and members to continue connecting and catalysing veterinary vaccinology for the benefit of both livestock and human health."

After serving as co-director since the Network launched, and previously serving as director of the UK Veterinary Vaccinology Network, Professor Bryan Charleston stepped down from the Network Management Team this year. The team will continue to benefit from his experience and advice as he joins the Network's governing body.

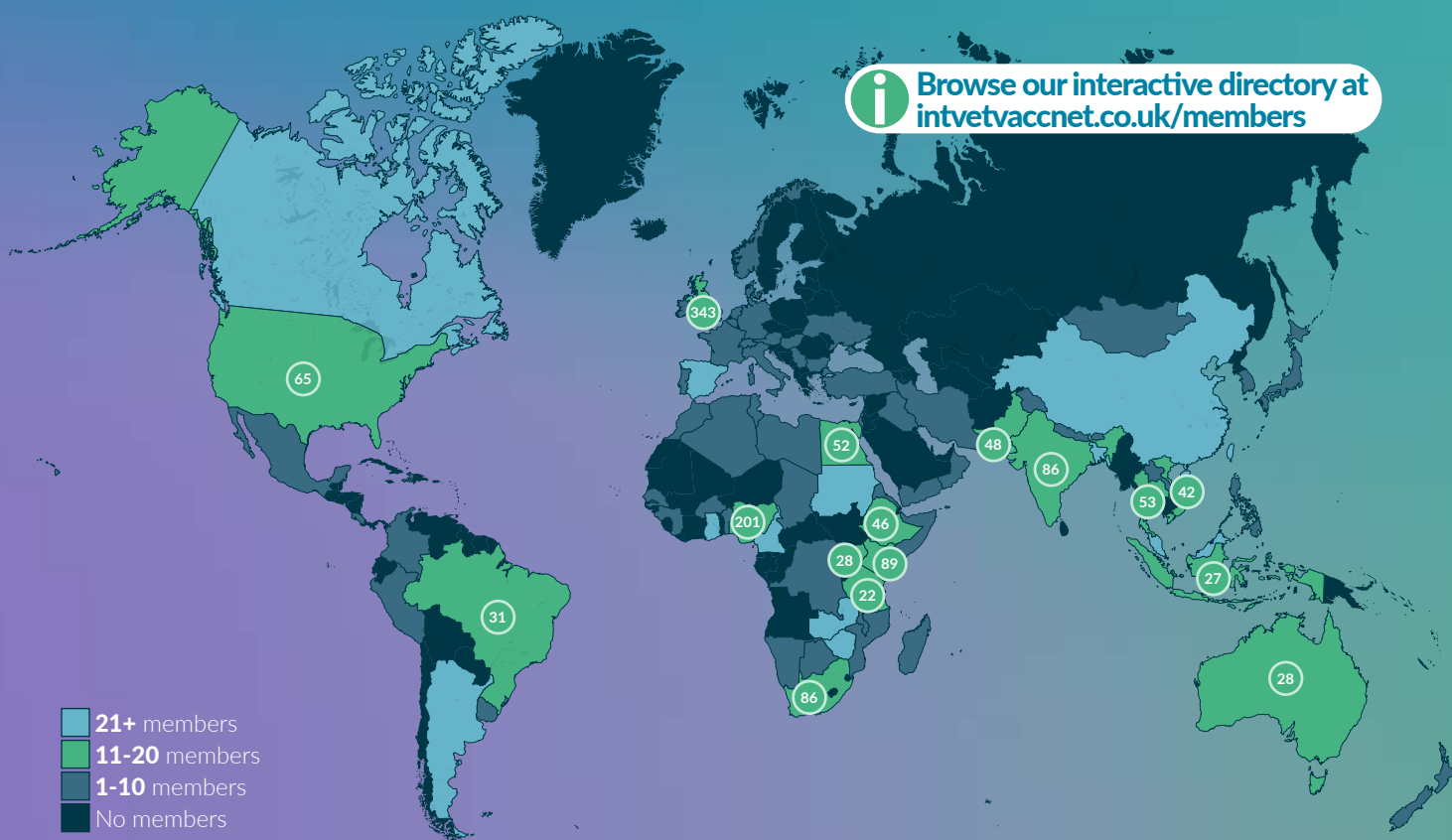
Dr Tim Connelley, Network Director, said:

"I am thrilled that Christine and Simon have agreed to join the Network Management Team. This is an exciting time for the IVVN, as we come to the end of the original grant that funded the Network and move towards a new funding model. Christine and Simon's experience and expertise will bring new perspectives and help drive new activities over the coming years."

"I also want to thank Bryan for the invaluable support and expertise he has provided over the past five years, and for the solid framework he built for the IVVN through the work of the UK Veterinary Vaccinology Network. I am grateful that he will continue to support and advise the IVVN in his role on the Network Management Board."

Membership

Since welcoming our first IVVN members in August 2017, our membership has grown steadily month by month. The Network now has more than 1,700 members in 93 countries around the world, and we would like to thank all of you for your continued contribution to the community we are building.



i Browse our interactive directory at intvetvacnet.co.uk/members

21+ members
 11-20 members
 1-10 members
 No members

Not yet a member of the IVVN?

Membership is free, and registering is quick and simple. Visit intvetvacnet.co.uk/user/register to sign up. Benefits of being an IVVN member include:

- Being part of an international community of researchers working to develop improved vaccines for major livestock and zoonotic diseases.
- Access to potential collaborators from across the fields of veterinary and human vaccinology through our members directory.
- Networking opportunities through attendance at our conferences, workshops and online events. Members can also apply for scholarships to attend meetings.
- Members can apply for IVVN catalyst funding to accelerate their vaccine research.
- Opportunities to host and attend workshops on specific vaccine-related topics.
- Notification of news, events, training, funding and publications in our monthly newsletters.

Webinar series

The IVVN hosts a regular series of online seminars, which have seen internationally renowned speakers presenting on a wide range of topics and engaging in discussion with IVVN members.

New developments in vaccines against African swine fever

30 November 2021 [Watch this webinar](#)

This webinar on African swine fever virus vaccine development was presented by **Dr Lucilla Steinaa** from the International Livestock Research Institute (ILRI) in Kenya. This virus causes devastating hemorrhagic disease in pigs and wild boars and has spread from Africa to Eastern Europe, Asia and more recently the Americas. Dr Steinaa's research has established reverse genetics and CRISPR/Cas 9 gene editing platforms to make attenuated versions of the virus for use as a live vaccine. She discussed the process of making and testing these attenuated viruses, as well as work to screen for antigens to be used in subunit vaccines.



New sights on PPR pathogenesis and development of PPR live attenuated DIVA vaccines using reverse genetics approach

14 December 2021 [Watch this webinar](#)

This webinar on *peste des petits ruminants* (PPR) virus vaccine development was presented by **Dr Satya Parida**, Laboratory and Vaccine Specialist at the Food and Agriculture Organisation of the United Nations, and Visiting Professor at the Royal Veterinary College, University of London. PPR places a huge disease burden on agriculture across large parts of the world. Vaccines are available but current tests cannot differentiate between infected and vaccinated animals (DIVA). Dr Parida spoke about efforts to develop DIVA-compliant vaccines.



The development of African horse sickness virus-like particle vaccines produced in plants

25 January 2022 [Watch this webinar](#)

This webinar on African horse sickness (AHS) virus vaccine development was presented by **Dr Ann Meyers** from the Biopharming Research Unit at the University of Cape Town, South Africa. AHS is a devastating and economically important disease spread by midges in sub-Saharan Africa. Current live vaccines lack DIVA compliance and there is a risk of reversion to virulence. Dr Meyers spoke about the development of a virus-like particle vaccine candidate made in plants which lacks viral genetic material.



The role of vaccination in the future control of high pathogenicity avian influenza: challenges and perspectives

21 February 2022 [Watch this webinar](#)

This webinar on high pathogenicity avian influenza (HPAI) vaccine development was presented by **Dr Ian Brown** from the Animal and Plant Health Agency, United Kingdom. HPAI has spread transcontinentally over the last 20 years, affecting all types of poultry production systems. Dr Brown discussed the logistical and practical considerations for next generation vaccines against HPAI, and how the constantly changing nature of the virus presents challenges for efficacious vaccine development.



AgResults foot-and-mouth disease vaccine challenge initiative for Eastern Africa

21 April 2022 [Watch this webinar](#)

The topic of this webinar was the GALVmed-led AgResults Foot and Mouth Disease (FMD) Vaccine Challenge Project. It was presented by **Nina Henning** and **Dr Jef Hammond** from GALVmed, who discussed the unique approach of the project – an eight-year, US\$17.68 million prize competition that supports the development and uptake of high-quality quadrivalent FMD vaccines tailored to meet the needs of Eastern Africa. They discussed current progress and challenges, and the public-private partnership framework involved.



Vaccines against babesiosis: where we are now and possible roads ahead

18 May 2022 [Watch this webinar](#)

This webinar on bovine babesiosis was presented by **Dr Monica Florin-Christensen** from the National Institute of Agricultural Technology (INTA), Argentina. Babesiosis commonly results in substantial cattle morbidity and mortality, and is caused by tick-transmitted haemoprotezoans in the genus *Babesia*. There are live vaccines available against babesiosis but these have considerable disadvantages, and better strategies are required. Dr Florin-Christensen presented a history of vaccine development work as well as research approaches towards the generation of improved formulations.



Ensuring vaccine quality in Africa: the role of the African Union Pan African Veterinary Vaccine Centre (AU-PANVAC)

28 September 2022 [Watch this webinar](#)

This webinar discussed the work of the African Union Pan African Veterinary Vaccine Centre (AU-PANVAC), and was presented by **Dr Nick Nwankpa**, the centre's director. The centre was established following concerns that some vaccines used in the Joint Project 15 rinderpest campaign in the 1980s did not meet international quality standards. Its mandate was expanded to include quality control of all vaccines used in Africa, and today it continues to play a major role in ensuring the quality of vaccines and reagents.



The IVVN has also co-hosted webinars with other organisations. You can read more about these on the following pages.



Joint webinar with US vaccine network sheds light on bovine *Mycoplasma* vaccines

23 March 2022

The International Veterinary Vaccinology Network teamed up with our sister network in the United States to host a joint webinar on bovine *Mycoplasma* vaccines and immune responses.

In March this year, we joined forces with the US Animal Vaccine Research Coordination Network (USAVRCN) to host a webinar on immune responses and vaccination efforts for bovine disease caused by *Mycoplasma* species.

M. mycoides is a widespread bacterial pathogen that causes contagious bovine pleuropneumonia in cattle and other bovids, with severe outbreaks occurring in sub-Saharan Africa. A related species, *M. bovis*, causes mastitis and respiratory disease in cattle and bison, especially in North America.

The webinar convened three experts in the fields of mycoplasmaology, vaccinology and immunology to discuss these two important pathogens, the challenges of developing vaccines against them, and the immune responses to *M. mycoides* and *M. bovis* in cattle.

The session was chaired by **Professor Brian Perry**, IVVN board member and coordinator of our webinar series, and **Professor Steve Geary**, director of USAVRCN.

Our first speaker of the day was **Professor Jörg Jores** from the University of Bern, Switzerland. Professor Jores gave a presentation titled 'Contagious bovine pleuropneumonia: current vaccines and future perspectives'.

The second speaker was **Dr Jose Perez-Casal** from the Vaccine and Infectious Disease Organization (VIDO), Canada. Dr Perez-Casal's presentation was titled 'Current challenges for the development of a vaccine for control of *Mycoplasma bovis* disease in cattle'.

The session's final speaker was **Professor Cynthia Baldwin** from the University of Massachusetts Amherst, United States. Professor Baldwin presented 'Evaluation of the immune response for protective immunity'.

After the presentations, we held a panel discussion, with the speakers answering questions from the audience. We are grateful to all the speakers and participants for their time, and to the USAVRCN team for their collaboration on this exciting topic.





Webinar with IDRC focuses on efforts to develop multivalent Rift Valley fever vaccines

6 July 2022

Rift Valley fever virus causes devastating disease in unpredictable cycles, hindering vaccination. Could a combined vaccine that protects against other pathogens help make vaccination more practical?

In July, we co-hosted a webinar on the zoonotic viral disease Rift Valley fever (RVF) with Canada's International Development Research Centre (IDRC). Two early career researchers from the Moroccan animal health company MCI Santé Animale presented their work and answered questions from the online audience.

RVF is a vector-borne disease of sheep, cattle and goats that causes abortion of foetuses and mortality in young animals. It can also spread to humans where it usually presents as a mild flu-like illness, but can lead to life-threatening complications.

Solid herd immunity through livestock vaccination could control RVF epizootics, but the disease occurs as severe episodes separated by long periods without visible disease, making it difficult to achieve enough vaccine uptake.

A project at MCI Santé Animale funded through IDRC's Livestock Vaccine Innovation Fund (LVIF) seeks to develop combined vaccines for RVF and other pathogens that occur in the same regions: peste des petits ruminants (PPR) virus, and the capripoxviruses that cause sheeppox and lumpy skin disease. Combining vaccines could make RVF vaccination more practical during periods between epizootics.

At the webinar, **Youness Es-Sadeqy** presented the sheep and goat pox and lumpy skin disease aspects of the project. The work he described revealed a viral interference between capripoxviruses and the RVF virus, which has made the development of a combined vaccine difficult.

Dr Zahra Bamouh described the second aspect, which involved evaluation of a safe and efficient combined live vaccine against RVF and PPR.

The speakers were introduced by **Dr Victor Mbao**, Senior Program Specialist at IDRC, and the question-and-answer session was moderated by IVVN board member **Professor Brian Perry**.

We are grateful to the speakers for their time, to everyone who attended and asked questions, and to the IDRC team. We hope to feature more LVIF projects in future webinars.



Results of the 2022 IVVN members' survey

For the third time, we conducted a survey of the International Veterinary Vaccinology Network's members. Here, we share the results and the themes highlighted.

Since 2018, the IVVN has held biannual surveys of its members. The third and latest of these members' surveys was held earlier this year.

The survey comprised a series of multiple choice, ranked choice, and free text questions, and was hosted on an online questionnaire platform (Online Surveys by Jisc) licensed by the University of Edinburgh. Members were sent a link to complete the survey with the IVVN newsletter in February, March and April 2022, and twice in a direct email.

A total of 124 members – around 8% of the membership – filled out the questionnaire over the nine-week open period of the survey. Fewer members completed this survey than the last survey in 2020, when 241 members took part.

Figure 1 shows some demographic information on the survey's respondents. Just over three fifths of these respondents were male and two fifths female, which is similar to the gender ratio of the IVVN membership as a whole. The respondents were distributed across 38 countries, with the highest representation from the United Kingdom, Nigeria, Brazil and South Africa. More than seven in 10 of the respondents were from a low- or middle-income country (LMIC), which is slightly higher than the overall LMIC representation of the network membership (64%). The majority of members worked in academia (63) or in a publicly owned organisation (38), while a small number worked in industry (14) or at a non-governmental organisation (8).

Challenges and barriers

We asked survey respondents about the challenges and barriers that had affected their work. Respondents were presented with a series of common

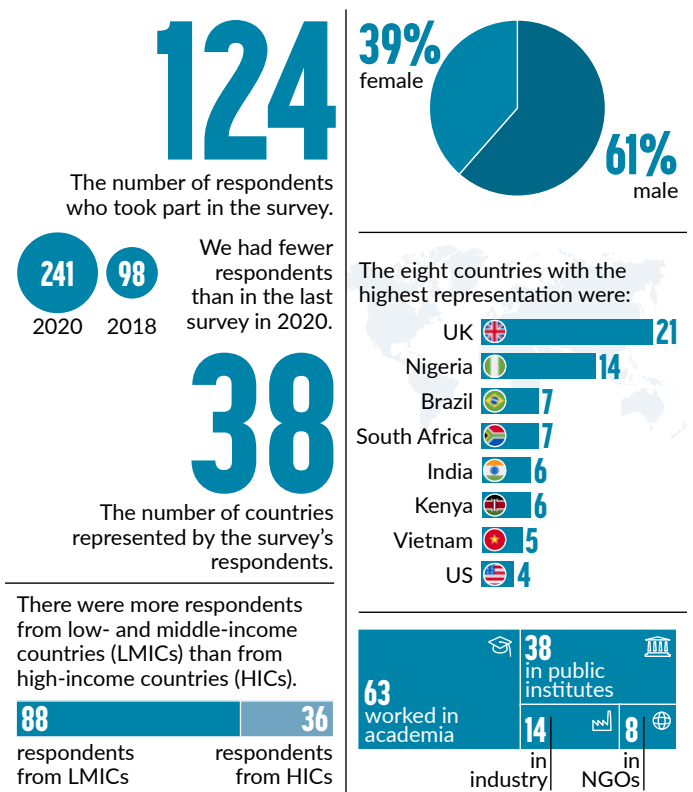


Figure 1 Demographic statistics on the survey's respondents.

challenges highlighted by previous IVVN surveys and asked to rank them from the most to least challenging. Many of the options reflect areas the IVVN is currently working to address, while others relate to possible future activities. Respondents were also given the opportunity to write in other challenges/barriers they had faced.

What are the greatest professional challenges and barriers that have negatively affected your scientific research? Please rank the options according to how much of a challenge they have presented, from most to least challenging.

To analyse the results, respondents' choices were assigned a score from 8 (most challenging) to 1 (least challenging). The average score for each of the options is shown in **table 1**. We also looked at the number of respondents that selected each option as their top challenge (**figure 2**).

Table 1 Average scores for each of the answer options for the question 'What are the greatest professional challenges and barriers that have negatively affected your scientific research?' Respondents ranked the options from most challenging, which was given a score of 8, to least challenging, given a score of 1.

Challenge	Average score
Lack of funding opportunities	6.7
Lack of collaborative opportunities	5.5
Lack of access to scientific equipment	5.3
Lack of career progression opportunities	4.9
Lack of mentoring opportunities	4.7
Lack of peer support	4.5
Personal or family opportunities	3.1
Other	2.3

The option with the highest average score, and the one chosen as the top challenge by the most respondents, was 'Lack of funding opportunities'. Funding availability has also been the most commonly cited challenge in our previous surveys and, while the IVVN will continue to make as much funding available to members as we can through our catalyst funding schemes, this is likely to remain a challenge.

Access to collaborative opportunities and to scientific equipment were also challenges that scored highly among respondents. Increasing collaboration between members is one of the core objectives of the IVVN, and one we hope we can build on in the next funding phase of the Network with improvements to our members' database and more in-person networking opportunities.

The average score of the challenge 'Lack of access to scientific equipment' was higher among respondents in LMICs (5.4) compared with those in high income countries (HICs) (3.5). The IVVN

What are the greatest professional challenges and barriers that have negatively affected your scientific research?
% of respondents who ranked each option as the most challenging

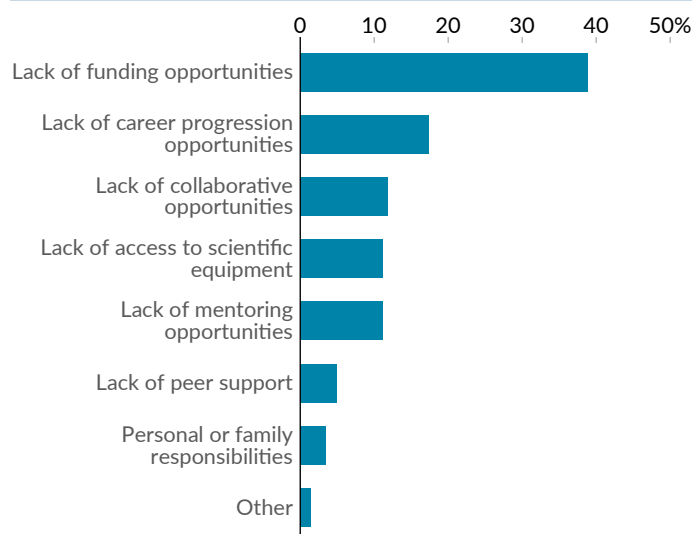


Figure 2 The proportion of all survey respondents who assigned the highest score to each of the options presented.

was looking to establish an equipment exchange programme before the Covid-19 pandemic, and this is something we may look at again in the coming months.

Lack of career progression opportunities was another challenge that scored relatively highly. This challenge was also highlighted in a recent report on the UK veterinary vaccinology research landscape, which was jointly published by the IVVN and the British Society for Immunology.

In previous years' surveys, 'lack of mentoring opportunities' has been particularly described as a challenge by women respondents in LMICs, and this information was used to establish the IVVN Fellowship programme for women postdoctoral researchers in LMICs. In the 2022 survey, however, there was little difference between the average scores assigned to

Average score for the challenge 'lack of mentoring opportunities' among men and women respondents in LMICs and HICs

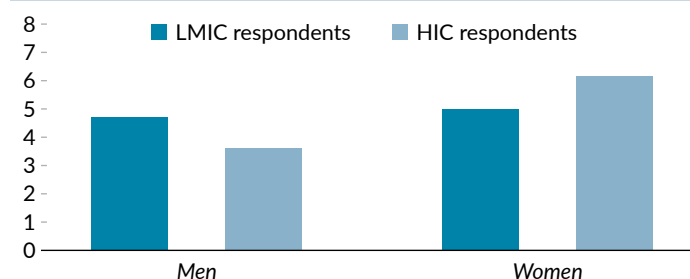


Figure 3 The average score of 'lack of mentoring opportunities' when respondents were asked to rank various challenges, with 8 being the highest possible score; the data have been aggregated according to respondents' gender and the economic status of the country where they work.

this challenge by LMIC-based men (4.7) and women (5.0), while the highest score was from HIC-based women (6.2) (figure 3). It should be noted that the methodology used was different from previous surveys, when respondents were simply asked to select all applicable challenges without ranking them. It is also difficult to draw meaningful conclusions when the numbers of respondents in each aggregated set is so small. However, there may be a need to look at additional ways we can offer mentor-based support for all our members.

We also gave respondents a text option where they could write additional challenges they had faced. Common themes raised here included access to training opportunities, the burden of administrative responsibilities, and access to specialist animal testing facilities.

Which IVVN activities do members find most valuable?

The IVVN has offered a wide range of activities and opportunities to its members since launching in 2017. Some of these activities have been in place since the start of the Network, while others have developed in response to member feedback, including from past members' surveys.

To gauge how members feel about our current programme of activities, we asked respondents to rank seven options from most to least valuable.

Please rank the IVVN's current activities according to how valuable you find them as a member. Rate the activities from most to least valuable.

We assigned a score to each ranking of decreasing perceived value from 7 to 1. The average scores for

Table 2 Average scores for each of the answer options for the question 'Please rank the IVVN's current activities according to how valuable you find them as a member.' Respondents ranked the options from most valuable, which was given a score of 7, to least valuable, given a score of 1.

Activity	Average score
Online events	5.8
Online training courses	5.2
Monthly newsletters	5.1
Catalyst funding schemes	5.0
Listings for events, jobs, etc	4.9
Fellowship programme	3.9
Searchable members' directory	3.9

these options are shown in table 2.

The activity that scored highest among respondents was the online events programme, which is a new activity developed partly in response to member feedback, and partly in response to Covid-19's impact on travel. These online events have included webinars, symposia and workshops. Given that a large proportion of the Network Management Team's time since mid-2020 has been spent developing this programme, it is reassuring to see that survey respondents value these events.

The average scores from this question for our online training courses, monthly newsletters, catalyst funding schemes and listings of externally advertised activities were all moderate – between 4.9 and 5.2. Our programme of online training courses is another new activity that we have made available to members since our last members' survey. Separate feedback from participants at each of the courses has also been very positive.

Given the targeted nature of the IVVN Fellowship programme, it is unsurprising to see the lower average score for this activity among survey respondents as a whole. However, separate feedback from those who have received funding from this programme has been much more positive, and IVVN Fellows recently [discussed how the programme has benefited their scientific research and career development at a special online event](#).

Finally, the searchable online directory did not score as highly as most other activities. We believe that this directory can help address the challenge of finding new collaborative opportunities in veterinary vaccinology. However, this feedback suggests that improvements to the directory's content and functionality are necessary to help make this happen.

We also asked members if they could name other IVVN activities they had found valuable. Common activities listed here included in-person conferences, travel grants for attending conferences and content advertised on social media.

How do members find out about IVVN activities?

We use a number of different channels to reach our members. As part of the survey, we asked respondents through which of these channels they usually found out about our news and activities.

How do you find out about IVVN activities?

More than three in four respondents said they did so through the monthly newsletter (figure 4). It should be noted that the monthly newsletters, and

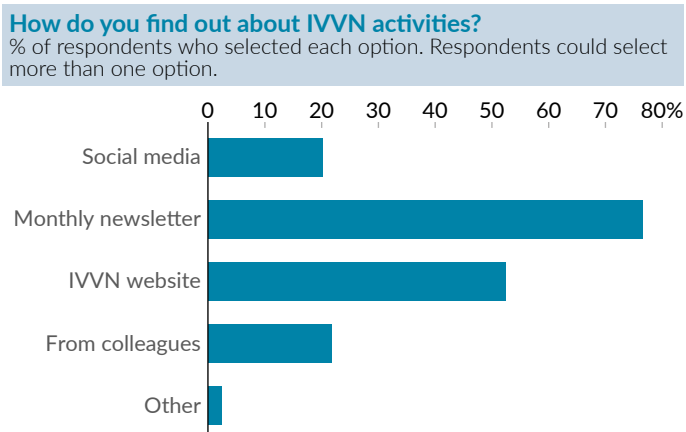


Figure 4 The percentage of respondents who selected each answer to the question ‘How do you find out about IVVN activities?’ Respondents could select multiple options.

additional email correspondence sent to the same mailing list, were the main channels used to distribute this survey. However, the newsletter’s popularity as a dissemination tool is supported by website analytics data, which shows that most traffic to news and events pages is generated from newsletter clicks.

Members’ views on the IVVN online events programme

We dedicated a section of the survey this year to our new online events programme, which has been our main networking activity since early in the Covid-19 pandemic. Most respondents (86%) said they had attended at least one IVVN online event since September 2020, whether that was a webinar (69% of respondents), virtual symposium (32%) or training course (24%).

How satisfied are you with the following aspects of the current programme of IVVN online events:
 (1) The range of events?
 (2) IVVN virtual symposia?
 (3) IVVN webinars?

When asked about the range of online events offered (figure 5), 88% of those who had attended an event said they were either somewhat or very satisfied with the programme. One respondent was somewhat dissatisfied but did not offer additional feedback.

When asked specifically about online symposia, which ran as a series from late 2020 to early 2021, 78% of respondents who had attended these said they were somewhat or very satisfied (figure 6). Similarly, 85% of respondents who had attended an IVVN webinar were satisfied (figure 7). No additional

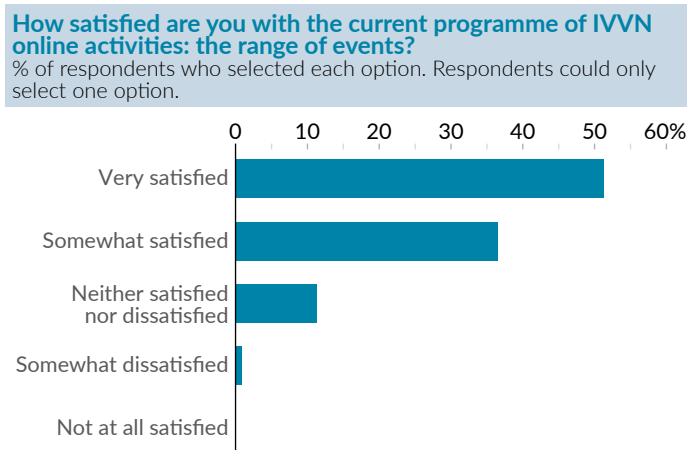


Figure 5 The percentage of respondents who selected each satisfaction rating when asked about the range of IVVN online events. Respondents could only select one option.

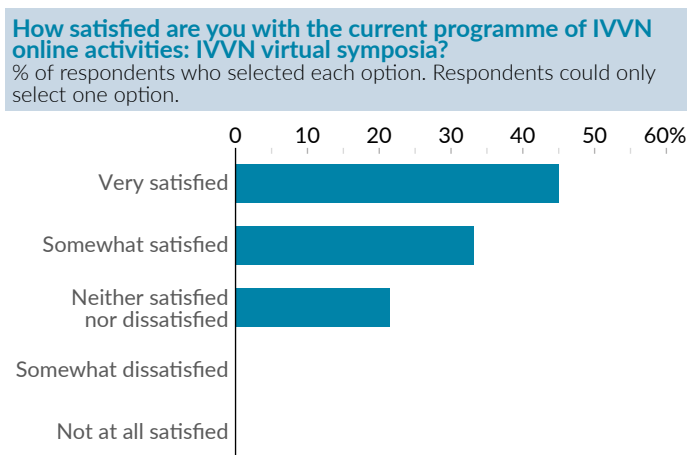


Figure 6 The percentage of respondents who selected each satisfaction rating when asked about IVVN virtual symposia. Respondents could only select one option.

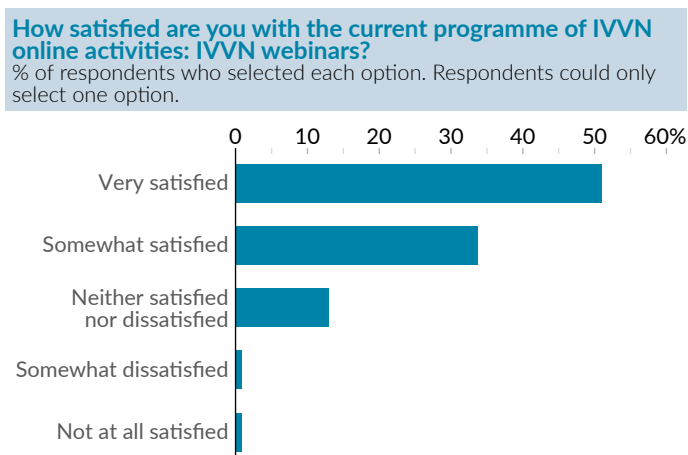


Figure 7 The percentage of respondents who selected each satisfaction rating when asked about IVVN webinars. Respondents could only select one option.

feedback was offered by the two respondents who were dissatisfied with the webinar programme.

These high levels of satisfaction with the online events are encouraging, given the important role they have played in bringing the IVVN community together online. We hope to continue these events on a regular basis.

In addition to the satisfaction questions, we also asked members how they thought our online events could be improved. Suggestions from respondents included:

- Calls for more interactivity during and after the webinars.
- More African/LMIC presence.
- Compiling related resources to accompany webinars and share with attendees.

Some respondents also suggested that the timing of the online events should be altered to be more convenient for their local time zone.

Respondents also suggested other types of online events the Network could host, in addition to those currently offered. Activities suggested included:

- Training workshops focused on specific scientific techniques.
- Discussion or focus groups.
- Informal 'getting-to-know-each-other' events, such as online coffee mornings.
- A conference/symposium for early career researchers.
- CPD-type courses that members can take in their own time.

Finally, we asked members to write what major topics in veterinary vaccinology they would like to see covered by our online events. The key themes in these responses were:

- Development of veterinary nucleic acid vaccines, especially mRNA vaccines.
- The role, use and development of adjuvant technology.
- Autogenous vaccines.
- Interactions between academia, industry and veterinary medical product regulators.
- One Health approaches to vaccine development.
- Vaccine approaches that allow differentiating infected from vaccinated animals (DIVA).
- Mucosal vaccine development.
- Vaccination that targets wildlife (eg TB and rabies vaccine programmes).
- Vaccines for food safety.
- Technological talks from scientists working at small and medium-sized enterprises.

All these suggestions will be useful in improving what we offer and in developing our programme of upcoming events.

Other activities the IVVN can offer

We asked members what additional activities they would like to see the IVVN offer in the future. We did not provide options here – respondents could make any suggestion they wanted. The most common requests were for the reintroduction of activities we have held in the past but have been unable to offer since 2020 because of funding limitations and the Covid-19 pandemic:

- Pump-priming funding (13 respondents suggested this as an activity they would like to see offered).
- Laboratory exchange-style funded visits (suggested by 11 respondents).
- In-person conferences (suggested by 11 respondents).

The first two are both activities we hope to offer again once we have the funding available to do so. We are also hoping to run an in-person or hybrid conference in the coming months as Covid-19 restrictions ease worldwide.

Other suggestions made by members in response to this question included:

- Training opportunities. Some specified a preference for in-person training courses here, while others preferred to see more online training.
- Establishing a mentoring platform or programme.
- Building links with industry.
- A database of veterinary vaccinology information.
- More webinars.

A mentoring platform, such as one that pairs up early career researchers with established researchers for advice, or a chat-based community where members can answer each other's questions, could help address the mentorship and career development challenges identified in the first question. Other suggestions reflect areas already under consideration or development by the IVVN team, such as building better links with industry and developing a database of vaccinology information.

Conclusions

The positive nature of the responses and comments suggest that members value being part of the Network. The enthusiasm for more networking and training activities in particular reflect work we propose to include in the next phase of the Network:

- In-person or hybrid conferences.
- Continuation of the online events programme.
- Early-career researcher symposium.
- Expansion of the training courses.

As evidenced by the large proportion of

respondents who had attended an IVVN online event, it is likely that only the most engaged IVVN members completed this year's survey. We hope that future Network improvements will help engage more of the membership.

- Website and directory improvements.
- Engagement with industry on the development of a veterinary vaccinology database.

We have also previously seen greater levels of member engagement during catalyst funding application periods.

We are grateful to all members who completed the survey for taking an interest in the future of the Network and in helping us develop and improve our future work.

The IVVN African
Schools Outreach
Programme



IVVN
AFRICAN SCHOOLS
OUTREACH
PROGRAMME

African Schools Outreach Programme

The activities of the IVVN's flagship outreach programme have continued to recover from Covid-19-related disruption over the past year. We look back at recent workshops in Kenya.

About the IVVN African Schools Outreach Programme

The IVVN African Schools Outreach Programme focuses on promoting gender balance in veterinary vaccinology, one of the four work areas of the Network.

The programme equips a network of women African scientists with the knowledge and tools they need to host interactive workshops in their local schools, with the ultimate goal of inspiring young girls to be the next generation of scientists. Since its launch in Kenya, Nigeria and Zambia in 2019, the Programme has expanded to include instructors in South Africa, Ethiopia, Cameroon and Uganda.

This year's International Women's Day theme was #BreakTheBias, underlining the need for a gender-neutral world free of bias, stereotypes and discrimination. Such stereotypes are perpetuated in agricultural science by the relatively low representation of women – data collected by the International Food Policy Research Institute highlights that women in agricultural research in Africa represent just 24% of researchers on average.

The IVVN African Schools Outreach Programme challenges these stereotypes by giving the students in the workshops hands-on experience of scientific techniques and giving them the chance to interact with inspiring African women researchers. The workshops are accompanied by careers sessions, where the team discuss their work and how they became scientists.

The Programme was shortlisted for a Nature Research award in 2020. After a period of disruption because of the Covid-19 pandemic, the outreach workshops resumed last year, and activities continued in 2022.

Thanks to our IVVN African Schools Outreach Programme delivery partners for their support. These partners include African Women in Agricultural Research and Development, the Roslin Institute, the Easter Bush Science Outreach Centre, the International Livestock Research Institute, the Global Challenges Research Fund, the Scottish Funding Council, and the outreach team members' institutes and universities. Visit our Outreach page for more information.



Team delivers workshops on Covid-19 vaccination at three schools in Kenya

The IVVN outreach team, working with members of Kenya's chapter of African Women in Agricultural Research and Development (KeAWARD), has continued to sustain mentorship and role modelling activities to grow the number of high school girls pursuing science courses and future STEM careers.

In November 2021, the team visited two schools in Taita Taveta County and one school in Nairobi County, delivering the IVVN vaccination workshop to 195 students over three school visits.

On 4 November, the IVVN-KeAWARD Outreach team visited Canon Kituri Secondary School in Taita Taveta County. At Canon Kituri Secondary School, the afternoon started with motivational and career guidance talks to the entire school of 805 students consisting of 354 girls and 451 boys. 52 students aged 15-19 years were then engaged in the experimental workshop on Covid-19 vaccination. During the workshop, students learn about the science of COVID-19, case numbers in Kenya and prevention using vaccination and other measures. They then learn how to use micropipettes and have the opportunity to perform a hands on experiment using their new skills.

Feedback collected from the Canon Kituri students indicated that they found the interaction to be rewarding, enjoyable, fun, inspiring, interesting, informative and exciting. A quarter found the exercise challenging. The favourite parts of the workshop included using pipettes and testing and analysing the samples. All the students agreed that women can be scientists, reported learning that vaccines are used to prevent animal and human diseases and that they would tell their families about the experience they

had during the workshop. All of them indicated they could become scientists and one student commented: "I would like to thank the scientists and acknowledge the efforts of my school for bringing us scientists. I have really thought myself a lot of things and I now know that anybody can become a scientist. This session was really exciting. I know that YES I CAN."

Two days later on 6 November, the team visited Mwakitawa Girls Secondary School in Taita County to deliver the interactive mock vaccination experiment to 80 girls aged 15-18 years old. Reflecting on the workshop, Mwakitawa girls said:

"Thank you very much. You are really inspiring women".

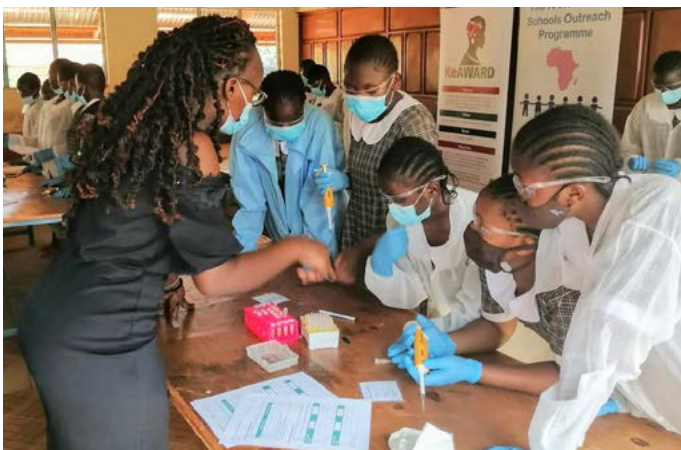
"My favourite part of the workshop is that I have to change my attitude that from today I will be an Agricultural Scientist. You have inspired me and I would like to join Nairobi University to improve my skills".

"I really appreciate the doctors for their good job. It is inspiring and it has made me change my career to a Vaccinologist. THANK YOU ALL!!"

On 27th November, the IVVN-KeAWARD Outreach team visited Loesho Secondary School, Nairobi where they delivered the interactive mock vaccinology experiment to 63 students.

Congratulations to the Kenyan Outreach Team for three fantastic engagements!

- Dr Esther Kanduma (UoN/KeAWARD)
- Dr Virginia Wangondu (UoN/KeAWARD)
- Dr Felister Nzuve (UoN/KeAWARD)
- Dr Dora Kilalo (UoN/KeAWARD)
- Ms Susan Njuguni (National Museums of Kenya/ KeAWARD)
- Ms Celestine Makokha (KALRO)
- Dr Esther Maina (UoN)



Kenyan Outreach Team celebrate International Day of Women and Girls in Science

In 2015, the United Nations General Assembly declared 11 February as the International Day of Women and Girls in Science to acknowledge and celebrate the participation of women and girls in science.

To mark International Day of Women and Girls in Science 2022, Dr Esther Kanduma and the IVVN-KeAWARD outreach team visited Our Lady of Mercy Secondary School in Nairobi to provide mentorship, advice on scientific careers and deliver the African Schools Outreach Programme interactive laboratory experiment.



The day began with the team of six, comprising four women scientists and two final year university students from University of Nairobi and Kenya Agricultural & Livestock Research Organization (KALRO), hosting a presentation on “Road to a successful science career: Tips from successful women scientists” to 880 girls aged between 14-18 years old and 12 teachers.

During the presentation, the scientists each shared their journeys to successful and enjoyable careers as biochemists, cancer geneticist, animal health scientist, microbiologist and biotechnologist. They gave guidance on successful study habits, creating a positive attitude and perception towards science subjects. The presentation ended up with an interactive question and answer session, with most of the questions focussing on science courses selections and pathway to science careers.

In the afternoon, the outreach team delivered the interactive vaccination workshop to 50 girls. During the workshop, the girls learned about important infectious diseases of humans and animals and the use of vaccines to control their spread. The emphasis was on the cause and control of COVID-19 infection and the practical steps to follow in the lab to test samples. They used harmless dyes to practice micropipetting then proceeded to screen mock human sera samples purportedly collected from people in their Sub-County.

Reflecting on the experimental workshop, the girls said:

“My thoughts on this workshop is that we should have one every weekend and I liked the experience. I felt like a scientist even though I learned that I have been a scientist all along. The experiment has motivated me to work towards being a scientist. I loved the experience. Science rocks!!”

“Today’s session was very interesting for me and I have learned new things and now I believe that women can be scientists”.

After the experiment, Dr Kanduma narrated to the girls the story of More Milk Zuri?!, a comic developed by Easter Bush Science Outreach Centre, Roslin Institute and Centre for Tropical Livestock Genetics & Health, that explores how genetics and biotechnology can be used to help an African cow called Zuri produce enough milk to feed her community. Copies of the comic were then distributed to the girls to read and share with their friends and family.

Congratulations to the Kenyan Outreach Team for hosting these inspiring activities to celebrate International Day of Women and Girls in Science and thank you to Dr Esther Kanduma for writing this article.



IVVN Fellowships

First cohort of IVVN fellows share their achievements and reflect on the programme's impact at a special online event

The Fellowship programme was developed to address the underrepresentation of women in agricultural science in low- and middle-income countries. As the first cohort of award recipients complete their projects, they presented and discussed their achievements at an online dissemination event.

Members of the International Veterinary Vaccinology Network (IVVN) have come together to celebrate the work of the first cohort of IVVN fellows. At a special online event, members joined the six fellows to hear about the work they have been doing and the impact the Fellowships have had on their career development. The session was moderated by Dr Timothy Connelley, Director of the IVVN, and Wendy Manchur, Senior Program Specialist at the International Development Research Centre (IDRC), which co-funded the programme.

Women continue to be underrepresented in agricultural research and in leadership positions, particularly in low- and middle-income countries (LMICs). Data from the International Food Policy Research Institute shows that women account for only 27% of researchers in LMICs. Even fewer women are represented at senior levels, with many leaving science soon after completing their PhDs.

The Fellowship programme, which launched in 2020, is designed to support the careers of women postdoctoral researchers from LMICs. The programme provides fellows with the support of a local and international mentor, along with the funding required to complete a short research project. Through regular meetings, the mentors offer support and advice, helping the fellows with their projects and future career development.

The first cohort of six IVVN fellows was announced in 2021, with researchers from Brazil, Egypt, India, Kenya and South Africa awarded funding:

- Dr Mercy Yvonne Akinyi, Institute of Primate Research, Kenya.
- Dr Amany Hassan, Alexandria University, Egypt.
- Dr Sreeja Preetham, Kerala University of Fisheries and Ocean Studies, India.
- Dr Angela Makumi, International Livestock Research Institute, Kenya.
- Dr Laura Oliveira, Federal University of Rio de Janeiro, Brazil.
- Dr Tanja Smith, Council for Scientific and Industrial Research, South Africa.

At the dissemination event, the fellows each gave a presentation about the work they had achieved during their project, followed by questions from the online audience. After the presentations, there was an opportunity to reflect more generally on the impact of the programme, and the challenges and opportunities for women in science.

Several of the fellows said they had benefited from learning new skills in genomics and bioinformatics through their Fellowships. Dr Laura Oliveira said:

“For me, the opportunities for acquiring research skills that I didn't have at the beginning of the Fellowship was very important, because it helped me fill some gaps of knowledge that we had in our lab and helped me to analyse the genomic data and acquire this expertise.”

Dr Sreeja Lakshmi praised the guidance she had received from her mentors, especially her international mentor, Dr Kim Thompson, who she said had been extremely supportive in dealing with the disruption caused by Covid-19. She said:

“She is such a wonderful person. I always say in every fellow meeting that she has a solution for everything.”

The fellows also benefited from the interaction with other members of their cohort and hearing what they were working on. Dr Angela Makumi said

she had particularly benefited from her interactions with Dr Tanja Smith who had provided useful tips and contacts to help secure the necessary antibodies for her work.

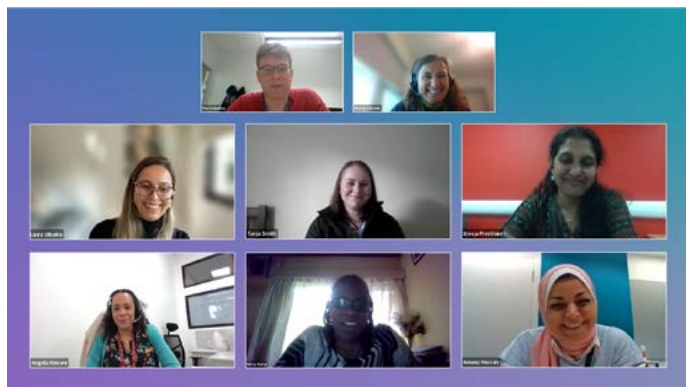
Speaking at the session, the IVVN's Director, Dr Timothy Connelley, congratulated the fellows on their phenomenal work and achievements. He said:

"Congratulations to you all, and it's nice to see so many of you lay out very clearly what you've achieved, what it's meant to you, and how you've gained so much from the Fellowship opportunity."

IDRC's Wendy Manchur also congratulated the fellows and hoped they would continue to help support each other as alumni of the programme. She said:

"We've learned from many of the fellowships we've funded the value of building up the cohort and having mentors who were formerly fellows to help support other women fellows.

"So congratulations to all of you and it's been a delight to hear about all the advances and challenges that you've overcome."



Read more about each of the presentations below. You can also view a recording of the event on our website.

Dr Mercy Akinyi spoke first about her project on coronavirus surveillance in understudied non-human primates. Mercy's work involved molecular and serology screening for coronaviruses and virus susceptibility in wild primates. The project also allowed capacity building at the organisation in Kenya where Mercy works, the Institute for Primate Research, with the purchase of a MinION sequencer and training for Mercy on how to use it. Mercy was mentored locally by Dr Lucy Ochola and internationally by Professor George Warimwe from the University of Oxford and the KEMRI-Wellcome Trust Research Programme.

The second speaker, Dr Amany Hassan, used her Fellowship to study the tick-transmitted cattle parasite *Theileria annulata*, using immunopeptidomics to help inform vaccine development. This work involved isolation and identification of the peptides involved in the cellular response to the pathogen, which benefited from the mass spectrometry expertise of Amany's international mentor, Dr Nicola Ternette at

the University of Oxford. Amany was also mentored by Dr Amir Hamed at her host institute, Alexandria University in Egypt.

Next, Dr Sreeja Lakshmi from the Kerala University of Fisheries and Ocean Studies, India, presented her work on the development and testing of a nanoparticle vaccine against *Aeromonas hydrophila* for use in Indian tilapia aquaculture. Working with her local mentor, Dr Elumalai Preetham, and international mentors, Dr Kim Thompson and Dr David Smith at the Moredun Research Institute in Scotland, Sreeja showed that her cobalt nanoparticle vaccine candidate elicited an enhanced immune response in vaccinated fish.

The next Fellow to present was Dr Angela Makumi, whose project involved surveying *Salmonella* antigens for use in a bacteriophage-based poultry vaccine that targets locally relevant *Salmonella enterica* strains. Angela's work showed that, based on the screening method used, oral inoculation with different strains of *Salmonella* did not elicit antibodies and that some vaccine types do not elicit an antibody response in the indigenous chickens used in the study. Angela was mentored by Dr Nicholas Svitek at her home institute, the International Livestock Research Institute in Kenya, and by Dr Andrea McWhorter at the University of Adelaide, Australia, and she is currently writing additional grant proposals to develop this work further.

Up next was Dr Laura Oliveira, who worked on contagious bovine mastitis vaccine development. This infectious bacterial disease causes great economic losses to Brazil's dairy industry. Laura's project has led to the establishment of an extensive research network in Brazil that will improve collaboration and resource sharing. Her results on the bacterial lineages circulating in Brazil will allow better control practices and identified vaccine targets for future investigation. Laura's mentors were Dr Tatiana Pinto at the Federal University of Rio de Janeiro, Brazil, and Professor Ruth Zadoks at the University of Sydney, Australia.

The final speaker was Dr Tanja Smith from the Council for Scientific and Industrial Research in South Africa. Tanja's project focused on producing Newcastle disease virus like particles using plants. Newcastle disease is a poultry disease that poses a significant risk to global food security. The project has led to the successful establishment of an effective plant production platform and the virus-like particles produced are immunogenic in chickens when used with a commercial adjuvant. Tanja's local mentors in South Africa were Dr Martha O'Kennedy and Professor Celia Abolnik, while Professor Nicola Lewis from the UK's Royal Veterinary College served as international mentor.

Online workshop

Optimisation of the production of sporozoite stabilate for *Theileria parva*

The IVVN facilitated an online workshop that brought together groups interested in *Theileria* sporozoite production.

East Coast Fever (ECF) is an important disease of cattle in a large area of eastern, southern and central sub-Saharan Africa that is caused by the tick-borne apicomplexan parasite *Theileria parva*. At present the only vaccine commercially available for *T. parva* is the 'infection-and-treatment method' (ITM), in which animals are concurrently inoculated with *T. parva* sporozoites and treated with long-acting oxytetracycline.

Generation of *T. parva* sporozoites requires the use of the tick vector *Rhipicephalus appendiculatus* (brown ear tick of cattle) in a process that enables the tick to 'pick-up' *T. parva* piroplasms from the blood of infected cattle and then, during a subsequent partial feed, mature the parasite to the sporozoite stage. This process is long, complex, resource- and time-intensive and involves use of a significant amount of animals. There remain a number of key 'bottlenecks' and challenges in the production of *T. parva* sporozoites for ITM vaccination.

This workshop aimed to bring together groups actively involved in the industrial-scale production of *T. parva* sporozoites, groups researching methods that could be used to improve sporozoite production and others interested in this area of work to:

- 1 Share information on ongoing research projects.
- 2 Identify what are the most important obstacles to optimising sporozoite production.
- 3 Explore how groups can collaborate to most effectively address these challenges.

There were 38 attendees at the workshop. Notably, in addition to delegates from areas where ECF is an endemic disease, there were several attendees from other parts of Africa and Asia where the topics discussed are of potential relevance to

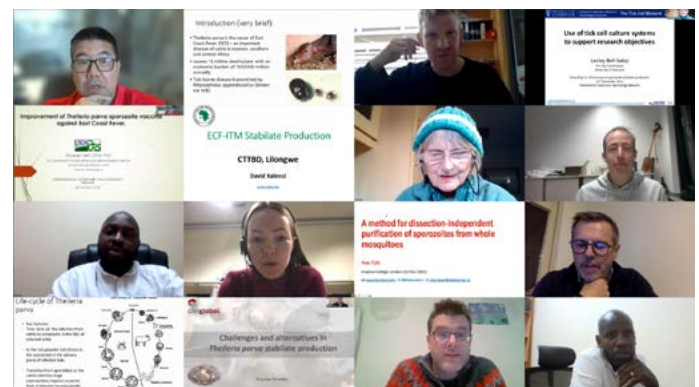
related parasites, such as *Theileria annulata*.

Also attending the meeting were delegates who have a primary interest in malaria. In keeping with some of the work being presented, this reflected the interest in translational knowledge between groups working with human and veterinary pathogens.

Summary of the meeting

The meeting started with Dr Tim Connelley (Roslin Institute) providing a brief introduction to *T. parva*, its importance as the causal agent of East Coast Fever, its lifecycle and the bovine immune response against this pathogen. The talk highlighted that there is as yet no alternative vaccine for ECF and that therefore ITM, and consequently the production of *T. parva* sporozoites, remains central to vaccine-based control strategies for ECF.

Dr David Kalenzi (Centre for Tick and Tick-Borne Diseases) then provided a comprehensive overview of the production of sporozoites at a commercial scale. The CTTBD has recently generated three batches of sporozoites and is currently generating a fourth batch, which will hopefully provide sufficient material for $\sim 1 \times 10^6$ doses. Dr Kalenzi's talk highlighted the long



time required to produce a batch of sporozoites (18 months), the number of different processes involved and the rigorous QC required for the final product (viability, safety, efficacy and external QC validation by AU-PANVAC). A key point made by Dr Kalenzi was how the processes involved in sporozoite production have not changed significantly since the ITM vaccine was first produced around 40 years ago.

Professor Maxime Madder (Clinglobal) then provided his perspective on where there remain major challenges in sporozoite production and potential alternative routes to circumvent these. The challenges (and possible solutions) included:

- 1 Challenge: The need to balance parasitaemia with welfare on cattle used for tick 'pick-up' of *T. parva*.
 - Potential solution: In vitro systems for generating piroplasm-infected red blood cells and using these to infect ticks - thus removing animals from this stage of the production cycle
- 2 Challenge: The need to use large number of rabbits to mature the parasite to the sporozoite stage ('pre-feed' of infected ticks)
 - Potential solution: In vitro feeding system for maturation of sporozoites (see presentation by Dr Massaro Ueti) to remove animals from this stage of the production cycle
- 3 Challenge: The difficulty in effectively and efficiently harvesting sporozoites and separating them from contaminating tick material
 - Potential solutions:
 - i In vitro feeding system for maturation of sporozoites with collection of sporozoites in medium after emission from the ticks (see presentation by Dr Massaro Ueti) so that there is no need to separate tick material from the sporozoites.
 - ii High throughput sporozoite purification system (see presentation by Alexander Fyfe) - transfer of technology from malaria research.
- 4 Challenge: The need to use large number of cattle (up to 60-70 animals) for the titration of sporozoites to be used in ITM to achieve robust quantification of viable sporozoites
 - Potential solutions:
 - i Purification of sporozoites may assist in permitting better quantification of sporozoites - reducing the range over which in vivo titrations are required (see above).
 - ii Reproducible in vitro system for quantification - a standardised WBC infection assay that correlates to in vivo infectivity.
 - iii Systems to accurately and directly quantify the number of viable sporozoites.
- 5 Challenge: the need for cold chain distribution of the sporozoites when used for vaccination.

- Potential solution: lyophilisation? Has been demonstrated to work in a 'one-off' experiment but has not been repeated

Dr Massaro Ueti then gave a presentation on work to develop an in vitro *R. appendiculatus* feeding system. This work uses devices that can feed approx. 800 ticks per unit. Feeding of adults using silicone membranes in this unit has been successfully used to mature sporozoites. The feeding system uses an alternate blood (21hr)/harvest medium (3hr) cycle, with sporozoites then being recovered directly from the harvested medium. This allows sporozoites to be (i) generated without the need for rabbits (Challenge 2) and (ii) harvested free from contaminating tick material (Challenge 3/4). The system can easily be scaled up making it of potential utility in industrial-scale production but has not yet been successfully adapted to the feeding of nymphs and this remains an area of research in the hope that it could also be used to achieve tick 'pick-up' of infection (Challenge 1 - although this would still require the infection of animals to provide a source of piroplasm-infected RBC).

Alexander Fyfe (Imperial College London) presented work that has been ongoing in the laboratory of Professor Jacob Baum to develop a method of dissection-independent purification of *Plasmodium* sporozoites from mosquitoes ('MalPure'). This work uses a combination of size-exclusion filtration and free-flow electrophoresis to generate purified *Plasmodium* sporozoites from homogenised infected mosquitos. The work in malaria has demonstrated the ability to generate purified sporozoites in a (near) aseptic technique with minimal contamination of mosquito proteins. Purified sporozoites are infective in both in vitro models and in vivo mouse experiments and have also been shown to generate immunity in a murine infection and challenge experiment (including by sporozoites administration by intra-muscular as well as intra-venous routes). Working in collaboration with the group at Roslin there is an attempt to transfer the technology to the purification of *T. parva* sporozoites (Challenge 3).

Dr Lesley Bell-Sakyi gave the final presentation which focused on the use of tick cell and organ culture systems to look at fundamental aspects of tick biology and tick/pathogen interactions. Dr Bell-Sakyi currently runs the 'Tick Cell Biobank' project at the University of Liverpool, which is in the process of establishing satellite units (Outposts) in Kenya, Malaysia and Brazil. Dr Bell-Sakyi and the Tick Cell Biobank have provided training and materials to many working in the field of tick research and continue to expand the accessibility of specialised resources and knowledge to researchers across the globe. There are a number of *R. appendiculatus* cell lines in the Tick Cell Biobank collection, although none of these are known to support *T. parva* growth or development (they do however support the growth of a number of

other important veterinary pathogens such as Nairobi Sheep Disease Virus and *Ehrlichia ruminantium*). Although not able to directly address the challenges identified, resources in the Tick Cell BioBank can be used to answer basic biological questions that in turn will support the development of technologies that do.

After the presentation there was a number of questions from the meeting attendees across a broad range of issues including: the parameters of the in vitro tick-feeding system, techniques for quantifying *T. parva* sporozoites using qPCR, details of the lyophilisation technology used for *T. parva*, the use of alternative cryoprotectants (and the approval by regulatory bodies), details of the industrial-scale production of sporozoites (size of production runs, stability and viability assessment) amongst other issues.

Conclusions

The meeting was set up with three objectives:

1 Share information on ongoing research projects

Information from two ongoing projects were shared:

- The WSU/Clinglobal/CTTBD collaboration looking at adoption of in vitro feeding for *Rhipicephalus appendiculatus* funded by the Livestock Vaccine Innovation Fund programme of the IDRC (Canada).
- The Roslin/Imperial collaboration looking at transfer of sporozoites purification technology from malaria to *Theileria* funded by the BMGF.

The opportunity to bring the participants of these projects together and enable them to share information with each other and the wider community was very beneficial in initiating discussion between these collaborative groups. No other ongoing research projects were identified by meeting attendees.

2 Identify what are the most important obstacles to optimising sporozoite production

- Maxime Madder gave a summary of the main challenges that are faced in the production of *T. parva* stabilate and the deployment of the ITM vaccine:
- The need to balance parasitaemia with welfare on cattle used for tick 'pick-up' of *T. parva*.
- The need to use large number of rabbits to mature the parasite to the sporozoite stage ('pre-feed' of infected ticks).
- The difficulty in effectively and efficiently harvesting sporozoites and separating them from contaminating tick material.
- The need to use large number of cattle (upto 60-70 animals) for the titration of sporozoites to be used in ITM to achieve robust quantification of viable sporozoites.

- The need for cold chain distribution of the sporozoites when used for vaccination.

Other challenges are known (eg the need for parasite diversity in the vaccines deployed in some geographical areas) but these largely summarise the challenges to the optimised production and delivery of sporozoites. The two projects discussed are largely relevant to challenges two and three (in vitro feeding for the maturation of sporozoites to reduce rabbit use and the purification of sporozoites using high throughput technology).

3 How groups can collaborate to most effectively address these challenges

It was discussed that some of the other identified challenges could best be achieved by recruiting other groups with complementary expertise (in for example in vitro culture of apicomplexan parasites) into the *Theileria* research field.

The other issue that became apparent during the meeting was divergence of methodologies being used (for example the media used for suspension of the sporozoites and the technique used for grinding ticks during sporozoites harvesting). Additionally there is ambiguity in details in some of the steps in protocols (e.g. in the rate of addition of glycerol cryopreservant) and in some cases protocol variants have not been directly compared to identify the optimal method (e.g. different cryoprotectant formulations such as trehalose, combination of glycerol with a sugar-cryopreservant and commercially available cryopreservants have not be compared for efficiency against sucrose or glycerol). Furthermore, there were other areas where standardised methods could be beneficial (e.g. in the in vitro titration assay which currently uses PBMC from locally accessible animals – so lacks a global standard). Many of these issues could be addressed by the community coming together to produce a set of standardised protocols and compile a list of steps in the production pipeline that need further research to be optimised.

View a recording of the event, and read about other online and in-person workshops we have facilitated, on our website:
intvetvaccnet.co.uk/events/workshops

News Funders publish survey results giving insight on veterinary vaccinology gaps, priorities and barriers

29 June 2022

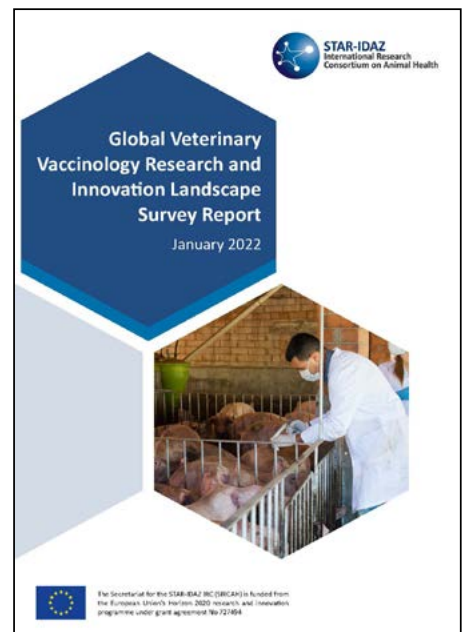
A survey of veterinary vaccinology researchers has highlighted the need for more collaboration with industry and investment in novel vaccine technology platforms.

UKRI-BBSRC, one of the funders of the International Veterinary Vaccinology Network (IVVN), surveyed the veterinary vaccinology community in July 2021, with 122 respondents taking part. The survey was conducted on behalf of the Star-Idaz International Research Consortium on Animal Health and in consultation with other research funders and programme owners, including the IVVN.

Respondents taking part in the survey were asked to rate the importance of research and innovation gaps within different fields of veterinary vaccinology. These gaps were identified by a working group, and respondents were also given the opportunity to provide additional gaps.

The report highlighted the importance of partnering with industry as well as maintaining sustainable and open access to immunological tools and associated databases. The survey also showed a need to develop and validate new tools that will enable immunological research in the natural host and/or the best model species for animal diseases. Additional gaps identified included the need to discover and validate new adjuvants, and to incorporate tools such as bioinformatics with wet lab work to assist in veterinary vaccine research and development.

For the full survey results and conclusions, [please download the full survey report](#).



Catalyst funding

The IVVN has funded 13 pump-priming projects and 11 laboratory exchanges. Five years since launching our first call for applications, we look back at all our funded collaborations and their outcomes.



Pump-priming grants

IVVN pump-priming grants worth up to £100,000 are awarded to collaborative teams seeking to address a key bottleneck in the development process of a vaccine.

Low-cost thermostabilisation of a Rift Valley fever vaccine for veterinary use

A common barrier to vaccine deployment in rural settings is the need for refrigeration. This project tested methods of thermostabilising a Rift Valley fever vaccine and evaluated the vaccine's viability after prolonged periods at low, medium and high temperatures. [Read more on our website](#)

OUTCOME: A stabilised liquid vaccine formulation could withstand short periods outside a cold chain, while a freeze-dried vaccine was viable even after six months at 30°C, which will greatly facilitate use and distribution in LMICs.

Scientists

Professor George Warimwe, Dr Alexander Douglas, Dr Michael Francis

Collaboration map



A single dose vectored *Taenia solium* vaccine

The tapeworm *T. solium*, a cause of seizures in humans, uses pigs as an intermediate host. The two vaccine doses required for protection in pigs is logistically problematic in rural settings. This project tested the use of an adenoviral vector, which can protect against other diseases after a single dose, to deliver the *T. solium* antigen to pigs. [Read more on our website](#)

OUTCOME: Antibody titres in pigs vaccinated using the adenoviral vector were lower than the levels required for protection. This project showed therefore that this is not a suitable way to immunise pigs against *T. solium*.

Scientists

Professor Adrian Hill, Professor Marshall Lightowlers, Professor Bryan Charleston

Collaboration map



Rethinking 'impossible': creating a platform for developing novel vaccines against animal trypanosomiasis in Brazil

The blood parasite *Trypanosoma vivax* causes substantial mortality and economic loss in Brazil's beef cattle sector. Related human trypanosomes are known for their antigenic variability, thought to make vaccination elusive – but research on *T. vivax* has identified invariant antigens. This project was set up to test the efficacy of these antigens as vaccine candidates. [Read more on our website](#)

OUTCOME: The proteins tested were shown to be immunogenic in mice and goats, but this antigenicity was not sufficient to confer immunity. Therefore, these proteins are not yet proven to be robustly protective against *T. vivax*.

Scientists

Professor Andrew Jackson, Professor Marta Teixeira, Dr Gavin Wright, Professor Rosangela Zacarias Machado

Collaboration map



New antigen identification in the African swine fever virus genome through a plasmid DNA library

African swine fever causes high mortality in pigs and is becoming a global threat, with no vaccine available. Recombinant attenuated isolates show promise, but a subunit vaccine would be safer and cheaper. This project used a plasmid library to identify antigens for future vaccine use. [Read more on our website](#)

OUTCOME: Screening assays allowed the selection of seven antigens for further investigation; the next stages will test these antigens' immunogenicity.

Scientists

Dr Anna Lacasta, Dr Fernando Rodríguez, Dr James Johnson

Collaboration map



Development of immunological tools for monitoring the immune response of Nile tilapia

Tilapia and other fish are increasingly important food sources, but as farming intensifies, so does disease prevalence. Developing vaccines for these diseases will require a better understanding of immune responses in tilapia. This collaboration used synthetic antibodies (sAbs) to study how these responses work. [Read more on our website](#)

OUTCOME: The team was successful in producing sAbs to bind one of their cell marker targets, which they used in a challenge study, and made good progress in identifying several other candidates. Work on refining and optimising these sAbs is continuing.

Scientists

Dr Kim Thompson, Professor Sachdev Sidhu, Professor Alexandra Adams, Dr Alasdair Nisbet, Dr Hoang Nguyen, Dr Nguyen Ngoc Phuoc, Professor Ruth Zadoks

Collaboration map



Efficacy testing of novel immersion and oral vaccines for *Aeromonas hydrophila* in tilapia and Vietnamese catfish

Aeromonas hydrophila is a major cause of aquaculture disease especially on fish farms in low- and middle-income countries, harming the livelihoods of many low-income families. The only vaccine available for Vietnam's catfish farmers is hard to administer and has uncertain efficacy; no vaccine is available for tilapia farmers in Egypt. This collaboration tested novel vaccine candidates delivered orally and through immersion. [Read more on our website](#)

OUTCOME: The team developed and tested an inactivated vaccine by oral, immersion and injection routes. A challenge study showed good survival in fish primed by immersion and boosted by injection. Boosting with immersion also showed promising signs worth repeating with more replicates.

Scientists

Dr Thao Ngo, Professor Dang Thi Hoang Oanh, Professor Alaa Eldin Eissa, Professor Alexandra Adams, Dr Kerry Bartie, Dr Andrew Desbois, Professor Dirk Werling, Dr Callum Scott

Collaboration map



Construction of foot-and-mouth disease (FMD) virus-specific phage-display libraries and epitope identification for improved FMD vaccines generation

Foot-and-mouth disease is one of the most economically important livestock diseases and is endemic in large parts of Africa, Asia and South America. The virus has a high mutation rate, causing antigenic variation between strains and affecting vaccine efficacy. This project seeks to identify antigenic determinants within the viral capsid in strains from different parts of the world. This will help in identifying critical epitopes, which can be implemented to produce improved vaccines. [Read more on our website](#)

OUTCOME: This project is ongoing.

Scientists

Dr Pamela Opperman, Dr Melanie Chitray, Dr Francois Maree, Dr Alejandra Capozzo, Dr Mariano Perez-Filgueira, Dr Anna Ludi, Dr Richard Reeve

Collaboration map



Isolation and purification of Nairobi sheep disease virus for development of a thermostable vaccine

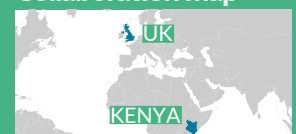
The tick-transmitted Nairobi sheep disease virus causes severe illness in sheep and goats, with fatalities reaching up to 90% in affected animals. The disease causes considerable losses, especially to small scale farmers in Eastern and Central Africa. This project aimed to generate and test an inactivated vaccine candidate using virus isolates collected from ticks. [Read more on our website](#)

OUTCOME: The team collected ticks from three sites and inactivated a vaccine candidate for use in vaccination. They tested this candidate in sheep, and showed that a double dose has protective potential.

Scientists

Dr Caroline Wasonga, Dr Joel Lutomiah, Dr Jennifer Duncan, Dr Michael Muthamia Kiraithe, Dr Allan Ole Kwallah, Edna M Ondari

Collaboration map



Towards edible vaccines for chickens

Drug resistance and vaccine limitations have prompted development of recombinant vaccines against the important poultry parasite *Eimeria*. This project tested the use of an innovative oil formulation for delivering antigens to chickens orally. Mixing this formulation into feed could enable routine *Eimeria* vaccination in the broiler and backyard sectors. [Read more on our website](#)

OUTCOME: The formulation was able to bind to chicken intestinal epithelial cells and induce both a systemic and mucosal immune response, serving as an important proof-of-concept for this technology.

Scientists

Dr Kate Sutton, Professor Lonneke Vervelde, Dr Roger New and Professor Damer Blake

Collaboration map



Immunisation of tilapia broodstock as a strategy to prevent vertical transmission of tilapia lake virus

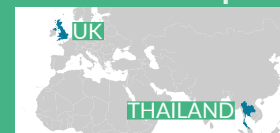
With tilapia fry traded for aquaculture, there is a risk of disease spreading worldwide. Immunising fry would help control and prevent this spread. Protective maternal antibody transfer to offspring has been confirmed in several fin fish species, but little is known about this in tilapia. Vaccinating broodstock against the rapidly spreading tilapia lake virus may help prevent vertical transmission – this project sought to test this. [Read more on our website](#)

OUTCOME: The project led to the development of two inactivated vaccines conferring significant protection in juvenile tilapia. Antibodies were detected in 1-3 day old larvae of vaccinated broodstock, but not in 7 day old larvae, suggesting a short persistence of maternal immunity.

Scientists

Dr Pattanapon Kayansamruaj, Dr Ha Thanh Dong, Dr Channarong Rodkhum, Dr Saengchan Senapin, Dr Jorge del-Pozo, Dr Janina Z Costa, Dr Kim Thompson

Collaboration map



Identification of virulence factors as novel vaccine targets for contagious bovine pleuropneumonia by whole genome saturated mutagenesis

Improved vaccines against contagious bovine pleuropneumonia are urgently needed, but this will require deeper insights into host-bacteria interactions. This project sought to generate a mutant library to identify bacterial genes involved in misleading of the host's immune response. [Read more on our website](#)

OUTCOME: A library of 800 mutants was successfully generated, with more planned, and a host cell cytotoxicity assay has been established.

Scientists

Dr Elise Schieck, Dr Musa Hassan, Dr Robert Kammerer

Collaboration map



Discovery of T cell epitopes of the intracellular parasite *Babesia bovis* using immunoproteomic and immunoinformatic strategies

The tick-transmitted parasite *Babesia bovis* causes babesiosis in tropical and subtropical regions, causing high mortality in infected cattle. Current live vaccines are effective but carry significant drawbacks, and there is an urgent need for new vaccines. This work aims to identify key protein fragments involved in the bovine immune response against *B. bovis* using mass spectrometry, advanced immunoinformatics and machine-learning. [Read more on our website](#)

OUTCOME: This project is ongoing.

Scientists

Dr Silvina Wilkowsky, Dr Nicola Ternette, Magali Valenzano, Professor Morten Nielsen

Collaboration map



Immunogenicity study of matrix 2 ectodomain proteins displayed on nodavirus-like particles as a universal avian influenza virus vaccine for chickens

Avian influenza causes severe outbreaks leading to economic and wildlife losses and potential human health risks. A vaccine targeting all strains is urgently required. A candidate has shown promising efficacy against human influenza A virus in mice. This work tests whether the candidate may confer universal protection against avian influenza in chickens. [Read more on our website](#)

OUTCOME: The virus-like particles constructed were shown to be antigenic, inducing a humoral response against the avian influenza virus *in vivo*.

Scientists

Dr Mariatulqabtiah Abdul Razak, Professor Wen Siang Tan, Dr Kok Lian Ho, Professor Abdul Rahman Omar, Professor Munir Iqbal

Collaboration map



Laboratory exchanges

IVVN laboratory exchange grants worth up to £10,000 are awarded to collaborations that help facilitate transfer of skills or expertise between laboratories and/or allow specialised proof-of-concept work.

Projects funded in the first round of laboratory exchange awards

1 Genomic analysis of antigenic diversity in Brazilian *Trypanosoma vivax* strains

Dr André Guilherme Costa-Martins (University of São Paulo, Brazil) and **Dr Andrew Jackson** (University of Liverpool, United Kingdom)

2 Isolation and molecular characterisation of *Mycobacterium* strains responsible for endemic bovine tuberculosis in Medea, Algeria

Dr Mammar Khames (University of Medea, Algeria) and **Dr Sharon Kendall** (Royal Veterinary College, United Kingdom)

3 Understanding the role of humoral immunity in vaccine development for *Streptococcus agalactiae* infection in tilapia

Dr Mugimba Kahoza Kizito (Makerere University, Uganda) and **Dr Kim Thompson** (Moredun Research Institute, United Kingdom)

4 Advancing the analysis of bovine class II MHC restricted T cell responses to vaccination

Dr Isaac Kombe Silwamba (University of Zambia, Zambia) and **Dr Bill Golde** (Moredun Research Institute, United Kingdom)



Projects funded in the second round of laboratory exchange awards

1 Evaluation of antigenic and genomic methods to assess foot-and-mouth disease virus vaccine selection and performance in Nigeria

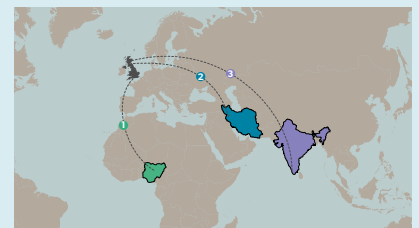
Dr David Ehizibolo (National Veterinary Research Institute, Nigeria), **Dr Anna Ludi** (The Pirbright Institute, United Kingdom) and **Dr Donald King** (The Pirbright Institute, United Kingdom)

2 Preparation of viral vaccines for Iranian aquaculture

Dr Nastaran Shahbazian (Iran Veterinary Organisation and Razi University, Iran) and **Dr Kim Thompson** (Moredun Research Institute, United Kingdom)

3 In vitro correlates of protective immunity in fish

Dr Preetham Elumalai (Kerala University of Fisheries and Ocean Studies, India) and **Professor Samuel Martin** (University of Aberdeen, United Kingdom)



Projects funded in the third round of laboratory exchange awards

1 Using cell sorting and transcriptomics to monitor immune responses in livestock

Dr Tshifhiwa Nefefe (Agricultural Research Council, South Africa) and **Professor John Hammond** (The Pirbright Institute, United Kingdom)

2 Laboratory exchange to facilitate testing for nairovirus reactivity in Serbian livestock

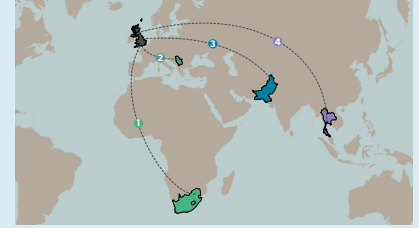
Dr Tamara Saksida (University of Belgrade, Serbia) and **Professor Teresa Lambe** (The Jenner Institute, United Kingdom)

3 Population genomics of *Strongyloides papillosus* – a parasite of bovids in Pakistan

Dr Kiran Afshan (Quaid-i-Azam University, Pakistan) and **Professor Mark Viney** (University of Liverpool, United Kingdom)

4 Evaluating the role of immunoglobulin IgT in vaccinated tilapia

Dr Wanna Sirimanapong (Mahidol University, Thailand) and **Dr Janina Costa** (Moredun Research Institute, United Kingdom)



The fourth round of applications for our laboratory exchange funding closed in October 2022. Projects awarded in this round will be announced on the IVVN website.

