Australia's National Science Agency

Inquiry into the adequacy of Australia's biosecurity measures and response preparedness, in particular with respect to foot-and-mouth disease

Senate Standing Committee on Rural and Regional Affairs and Transport

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Contents

Executive Summary

CSIRO has a long and rich history helping Australia maintain a biosecurity system that is the envy of much of the world. We work across a range of research and diagnostic-related areas in plant and animal and environmental biosecurity.

With the increased threat of Foot and Mouth Disease (FMD), Varroa Mite and other pests and diseases exotic to Australia, CSIRO is bolstering its capability, through increased staff numbers and laboratory resources. CSIRO is working closely to support the Department of Agriculture, Fisheries and Forestry (DAFF), focusing on prevention and preparedness activities including developing novel diagnostic and modelling tools and vaccines.

In this submission, we outline CSIRO's work in pre-border biosecurity preparedness, our national and international collaborations and advisory role, as well as capability and role in the event of incursions and outbreaks.

CSIRO's goal is to deliver solutions to ensure Australia is prepared and ready to respond to existing and emerging risks to protect our environment, our agricultural industry, and our way of life.

CSIRO operates infrastructure central to Australia's response to disease – the Australian Centre for Disease Preparedness (ACDP) in Geelong. The ACDP is a high-containment facility designed to allow scientific research into the most dangerous infectious agents in the world.

Foot & Mouth Disease (FMD)

For FMD the facility plays a critical role as the National Reference Laboratory for emergency animal diseases, which includes research and laboratory testing in outbreaks. ACDP was built with outbreaks such as FMD in mind.

If an outbreak of FMD were to occur in Australia, ACDP has emergency plans in place to respond, as well as extensive experience responding to other outbreaks and pathogens to draw upon

FMD key action points to note

CSIRO asserts that if access to the FMD virus was made available to Australian Centre for Disease Preparedness facility (ACDP) in Geelong, this would significantly improve Australia's capacity to prepare for and respond to FMD outbreak threats. Access to the live virus would allow improved national and regional surveillance, along with the ability to develop new diagnostic tools and future next generation vaccines including an mRNA vaccine for FMD.

Currently there are no laboratories in Australia authorised to attempt isolation of FMD or to work on the live virus. Any work CSIRO researchers conduct on the live virus is completed when they visit collaborators overseas.

CSIRO, through ACDP- a high-containment facility designed to allow scientific research into the most dangerous infectious agents in the world - has all of the biosecurity processes and technical capability in place to work on the live virus while ensuring containment within the facility.

Specifically, ACDP can perform vaccine typing, improve diagnostics and develop improved vaccines. It can also receive samples from the region, to better inform risk and preparedness.

Varroa Mite

CSIRO has been at the forefront of Varroa Mite research for over 20 years. In 2007 CSIRO developed model of a hypothetical invasion of Varroa Mite in Australia. It predicted that the economic costs avoided by keeping Australia free from Varroa Mite would be $21.3–$50.5 million per year. The National Bee Pest Surveillance Program is an effective way to detect Varroa Mite. Hives that are part of the Program at the Port of Newcastle first detected the current Varroa Mite incursion

In the current Varroa Mite outbreak, CSIRO is working with the Australian National University in supporting DAFF in the NSW Government-led eradication program by sequencing the mite genome to support tracing, and in using deep sequencing to determine whether the mites are carrying viral bee diseases. CSIRO is also validating a honey eDNA method to support current Varroa incursion.

Varroa mite key action points to note

Improved detection and diagnostics are possible through greater use of genomic technologies. Currently Varroa Mite is detected using dissection, a labour-intensive process. PCR testing could be used.

Environmental DNA/CRISPR Diagnostics approaches under development by the CSIRO and in collaboration with University of Canberra and James Cook University could be applied to detect a range of exotic pests and diseases from honey, pollen and/or hive debris.

Pre-border security preparedness

Australia has world leading biosecurity and quarantine measures. Pre-border biosecurity prevention and preparedness to reduce threat risks before they get to the border remain Australia's best defence against all biosecurity threats, including outbreaks of exotic animal diseases.

In 2020, in partnership with Animal Health Australia, Plant Health Australia and the Centre for Invasive Species Solutions, CSIRO published the Australia's Biosecurity Future report, which built on the 2014 (Australia's Biosecurity Future) report describing the megatrends and megashocks Australia's biosecurity system faced.

The Australian Biosecurity Future report proposes 20 recommendations under three themes to help transform Australia's Biosecurity System and ensure biosecurity resilience into the future. These themes are: system connectivity, shared responsibility and innovation in science and technology. This report is guiding our research towards a One Biosecurity and One Health approach, considering the impact of human, agricultural, environmental, and marine health sectors to biosecurity, along with strong collaboration across governments, industry, research, and the community. Biosecurity requires a collaborative effort across jurisdictions, government, and borders.

In Australia, we work closely to support DAFF, focusing on prevention activities and developing suites of tools that can be used during control and response. We are also supporting the Australian Government's Commonwealth Biosecurity 2030 roadmap through the Catalysing Australia's Biosecurity (CAB) initiative under CSIRO's Missions program co-designed and delivered with the DAFF. Internationally, we have been working for decades with international partners to build laboratory and biosecurity capacity in the region, including Indonesia, Vietnam, Thailand, Timor-Leste, and Papua New Guinea. Our overseas work is strongly supported both by the Australian Government and by the Food & Agriculture Organisation of the United Nations, under which we hold three Reference Centre designations.

CSIRO is also well represented at the World Organisation for Animal Health (WOAH), an inter-governmental organisation coordinating, supporting, and promoting animal disease control globally. We have a member on the Scientific Commission, we hold WOAH Reference Laboratory designations for 10 diseases, three WOAH Collaborating Centres and have representatives on several working groups, including for FMD.

Foot and Mouth Disease

FMD has been a key focus of research efforts by disease experts at CSIRO for many years, including through the FMD Ready project (see below). Our researchers play a critical role in providing scientific advice to inform policy and responses, and in the event of an incursion, in diagnostics. We also have the biosecurity processes and technical capability in place to work on the live virus, should access be granted in order to perform vaccine typing, improve diagnostics and develop improved vaccines.

CSIRO is a member of Australia's Animal Health Committee (AHC), which drives and manages Australia's high level strategic policy development, operational strategies, and standards for government in animal health, domestic quarantine, animal welfare and veterinary public health. The Director of our high security laboratory facility, the Australian Centre for Disease Preparedness (ACDP), chairs the Sub-Committee on Animal Health Laboratory Standards, which provides scientific and technical advice to AHC on diagnosis, also providing a forum for networking among National Reference Laboratories, State and Jurisdictional laboratories.

Since 2014, ACDP has been providing proficiency testing materials to state and jurisdictional (S&J) laboratories, and also to laboratories in other countries of the region, to demonstrate test competency in diagnosis of priority notifiable animal diseases, including FMD.

CSIRO is a member of the Vaccine Expert Advisory Group which assesses the global FMD situation and recommends the vaccine strains to be included in the Australian Vaccine Bank. CSIRO also serves on the group that develops and updates the AUSVETPLAN, which documents the nationally agreed approach for the response to emergency animal disease incidents in Australia.

Although CSIRO does not currently have access to live FMD virus, CSIRO has built strong international collaborations with research institutions that have programs on FMD such as the Pirbright Institute (UK), Friedrich Loeffler Institute (Germany), National Centre for Foreign Animal Diseases (Canada), Plum Island Animal Diseases Centre (USA). These collaborations allow CSIRO to perform research projects on FMD that in turn assist in disease preparedness.

The FMD Ready project

For 10 years CSIRO led the Foot and Mouth Disease Ready project (FMD Ready) designed to reduce the economic, social, and environmental impact to Australia posed by the outbreak of an emergency animal disease. The project used FMD as a model, reasoning that if Australia can be prepared for FMD, it can be prepared for any emergency animal disease. FMD Ready aimed to improve preparedness for animal disease outbreaks, improved animal disease surveillance, and improved ability to support proof of freedom of FMD for faster return to trade.

FMD Ready was supported by Meat & Livestock Australia (MLA), through funding from the Department of Agriculture, Water and the Environment (DAWE) as part of its Rural R&D for Profit program, and by producer levies from Australian FMD-susceptible livestock (cattle, sheep, goats, and pigs) industries and Charles Sturt University (CSU). Research partners included CSIRO, CSU, the Bureau of Meteorology and DAWE, supported by Animal Health Australia (AHA).

FMD Ready developed valuable collaborations with international researchers and facilities in areas where FMD is endemic. Importantly, the project has shown that Australia's current FMD vaccine bank will be efficacious to the FMD strain circulating in Indonesia.

In addition, FMD Ready delivered the following.

- Rapid and accurate diagnostic tests suitable for confirming an outbreak, assisting control actions during an outbreak and for providing proof of freedom of disease to regain our trading status.
- A new producer-led emergency FMD surveillance system piloted across multiple livestock sectors for consideration by the States and Jurisdictions. This would ensure rapid reporting

of unusual events on farm and along the production chain. (The sooner a disease incursion is recognised, the smaller the outbreak and impact.)

- Understanding of the value of developing a quarantine zoning approach to manage the impacts of an FMD outbreak to business continuity by allowing FMD free areas earlier access to return to trade.
- The Australian Animal Disease Spread Modelling framework (AADIS) as an integrated FMD outbreak management decision support system including:
  - Testing of outbreak and response scenarios on outbreak suppression and industry economic consequences to be rapidly explored and costed before and during outbreaks including the use of vaccination; and
  - Testing novel approaches to improve post outbreak surveillance to ensure a faster return to trade and reduced economic impact.
- A meteorological, pathway and next generation sequencing-based model (SPREAD model) to rapidly characterise and map real time outbreak pathogen spread to step change decision making for animal biosecurity emergency response.

Diagnostics and investigation

ACDP plays a critical role as the National Reference Laboratory for emergency animal diseases, which includes research and laboratory testing in outbreaks. ACDP was built with outbreaks such as FMD in mind. The only lab of its kind in the southern hemisphere, ACDP was instrumental in the rapid global response to the COVID-19 outbreak and previous outbreaks, such as Japanese Encephalitis and Avian Influenza, and would play a critical role in the event of an exotic disease outbreak in Australia.

ACDP delivers critical information to the State and Territory Chief Veterinary Officers and provides technical advice on sample collection, diagnostic test interpretation and surveillance strategies. ACDP also works closely with State and Territory Veterinary Laboratories, forming a network to ensure nationwide capacity and capability in diagnosis.

If an outbreak of FMD were to occur in Australia, ACDP has emergency plans in place for responding, including for workforce management. Already, we have doubled our FMD testing stockpile from 15,000 to 30,000 polymerase chain reaction (PCR) tests to ensure testing capacity during the first few weeks of a response, while further stocks are ordered.

The diagnostic process carried out at ACDP is detailed in the FMD Chapter of the AUSVETPLAN. Samples from animals showing clinical signs and lesions consistent with FMD are submitted to ACDP for testing. This involves completing multiple PCRs to detect FMD virus and other viruses which might cause similar clinical signs. Likewise, serological tests to detect antibodies to FMD and other viruses are performed on samples from affected animals and contact animals. Where clinical signs are not fully consistent with FMD, a more limited testing regime may be applied at State and Jurisdictional laboratories, in parallel with submission to ACDP, to provide an interim result for routine surveillance or testing for exclusion.

Should an FMD outbreak occur in Australia, our biosecurity system would be placed under increased pressure. To cope with such a situation the system would require sufficient highly skilled and highly trained personnel as well as infrastructure that is fit for purpose for level of risk the disease poses. The State Veterinary Laboratory network, which includes the ACDP, would share in the volume of testing, with a focus on surveillance and demonstrating freedom from FMD, to re-attain national FMD-free status and a return to international trading.

Capability to work on FMD

Currently there are no laboratories in Australia authorised to attempt isolation of FMD or to work on the live virus. Any work CSIRO researchers conduct on the live virus is completed when they visit collaborators overseas.

Hesitance from industry towards working on the live virus traditionally stems from the risk of exposing Australia to the live FMD virus through importation, storage, and experimentation when there is no live virus circulating within the country. ACDP does however have all of the biosecurity processes and technical capability in place to work on the live virus while ensuring containment within the facility. Specifically, ACDP is able to perform vaccine typing, improve diagnostics and develop improved vaccines.

CSIRO firmly believes that if access to the FMD virus was made available to ACDP, this would significantly improve Australia's capacity to prepare for and respond to FMD outbreak threats. Access to the live virus would allow improved national and regional surveillance, along with the ability to develop new diagnostic tools and future next generation vaccines.

Vaccination development and implementation

The DAFF would make the decision on whether to use vaccines in the control of any outbreak of FMD in Australia. While there are FMD vaccines available, the decision to vaccinate in Australia is a complex one, depending on the nature of the outbreak, trade implications, international experiences, and many other factors. Australia has an overseas FMD vaccine bank in the UK supplied by a commercial company and vaccine will be formulated and available for use if needed.

CSIRO's research has shown that the current FMD vaccine bank will be efficacious against the FMD strain circulating in Indonesia. This research was jointly funded by industry and the Commonwealth and is an excellent example of how research can ensure better preparedness for a disease incursion.

Although CSIRO has not previously developed an mRNA vaccine, it is technically possible, and we would do so in collaboration with a commercial partner. We are in discussions with international companies and an Australian research institute as part of an international collaboration concerning mRNA vaccine development, including for FMD. However, because CSIRO is not currently permitted to hold the live virus at ACDP, we currently need to collaborate with overseas facilities to perform the necessary studies to demonstrate its efficacy.

Additional FMD research capability

CSIRO has developed a freight supply chain model, the Transport Network Strategic Investment Tool (TraNSIT). It was initially developed to examine and provide solutions for the long-distance cattle supply chains in northern Australia, before being extended to all agriculture chains and since then to broader freight supply chains with more than 170 commodities included. It is able to, and has been applied, to understand the movement of livestock through the supply chain (for all paths to market) and scenario planning on the impacts of disruption from natural disasters and biosecurity threats. The development of the model has sourced information on livestock flows via Australia's National Livestock Identification System (NLIS) as well as through incorporating information and expert knowledge from over 400 agencies and organisations across Australia. It provides a rigorous representation of logistics and supply chains.

CSIRO has also developed the capability to conduct wastewater effluent surveillance in the early community detection of SARS-CoV-2, the virus that causes COVID-19. This technology can be applied to intensive animal production systems and wastewater streams for the early detection of diseases in those farming systems. It can provide early indication of the presence of pathogens within the animal herd prior to symptoms being visible. With some investment it is possible to develop and deploy a cost-effective pathogen detection/quantification platform that provides near-real time bio-surveillance capabilities that can be deployed anywhere in fixed (high throughput laboratories) or mobile modes (deployable methods), both within Australian and with trading partner countries.

Varroa Mite

Varroa Mite preparedness

CSIRO has been at the forefront of Varroa Mite research for over 20 years. Varroa Mite (*Varroa destructor*) was described by a CSIRO researcher who also demonstrated how one strain of Varroa Mite jumped from an Asian honeybee to the European honeybee, a new naïve host, and spread around the world. This study included the unique genetic and physiological context that led to the naïve host switch. This was part of a vast body of work, much of it overseas, on all the parasitic mites on the Asian honeybee and enabled risk analysis around which mites could impact the European honeybee. CSIRO also studies bee pathogens that are associated with these mites, particularly those that could exacerbate the recent Varroa Mite incursion.

In 2007 CSIRO developed model of a hypothetical invasion of Varroa Mite in Australia. The model determined the negative flow-on consequences of lost free pollination services from reduced honeybee populations on crop yields, and the associated additional costs of having to pay for these lost services. The model estimated that the economic costs avoided by keeping Australia free from Varroa Mite would be $21.3–$50.5 million per year. This number could be considered as justification for increased investment in prevention. Beyond the significant impacts from Varroa Mite to commercial beekeepers and pollination-dependent agriculture in Australia, there will also be additional impacts to the approximately 28,000 recreational beekeepers in Australia.

Recreational beekeeper numbers have declined significantly in all countries after invasion by the Varroa Mite.

Varroa Mite detection

Plant Health Australia leads the National Bee Pest Surveillance Program which is the backbone of bee biosecurity in Australia. This is a network of sentinel hives and catch boxes at high-risk ports that are inspected approximately every six weeks. There are typically four to six hives at each port. Additionally, there are general port surveillance operations and industry awareness efforts aimed at detecting exotic bee swarms, pests or diseases. Research by CSIRO demonstrated that the lag time in detection of Varroa Mite was dependent on a range of factors, including the number of sentinel hives and the frequency and sensitivity of hive inspections. Reliable detection within weeks of arrival would require more frequent inspections, for example fortnightly, in conjunction with need a greater number of sentinel hives.

The current Varroa Mite incursion was first detected in sentinel hives at the Port of Newcastle, a clear example of the value of this network. However, further investigation showed that the Varroa Mite incursion started several months to a year before it was detected in the sentinel hives. Sentinel hives are designed for detecting incursions via shipping networks. Another potential incursion pathway is through illegal importation, which if successful in passing through border control, would lead to the incursion establishing initially in managed hives. Rapid response therefore also relies on detection, diagnostics and reporting by beekeepers.

Improved detection and diagnostics are possible through greater use of genomic technologies. Currently Varroa Mite is detected using dissection, a labour-intensive process. PCR testing could be used such as the process being developed for tracheal mite (*Acarapis woodi*) detection on Norfolk Island. In this case, dissections are only completed in the case of positive PCR detection. In addition, environmental DNA approaches under development by the CSIRO in collaboration with University of Canberra and James Cook University could be applied to detect a range of exotic pests and diseases from honey, pollen and/or hive debris.

In the current Varroa Mite outbreak, CSIRO is working with the Australian National University in supporting DAFF in the NSW Government-led eradication program by sequencing the mite genome to support tracing, and in using deep sequencing to determine whether the mites are carrying viral bee diseases. CSIRO is also validating a honey eDNA method to support current Varroa incursion surveillance.

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