SCIENCE FOR TECHNOLOGICAL INNOVATION

Kia kotahi mai – Te Ao Pūtaiao me Te Ao Hangarau

SCIENCE FOR TECHNOLOGICAL INNOVATION
NATIONAL SCIENCE CHALLENGE

Biosecurity Technology Research Development

Workshop Briefing 2020

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Introduction

The Biosecurity Technology (Tech) Mission is one of several new topics being explored by SfTI as a big idea for the next stage of this National Science Challenge.

In essence, SfTI's Biosecurity Tech focus is on employing cutting edge physical sciences and engineering to create new technology (processes and tools) that will better protect NZ from harmful biological elements such as non-indigenous flora, pathogens, marine pests, insects, and mammalian species. In terms of benefits, best practice (through enhancing effectiveness and lowering costs) biosecurity is largely about risk mitigation and/or eradication. Additionally, any resulting biosecurity tech will likely be valuable in the international marketplace.

As with all SfTI research, in order to be funded each new Mission is required to demonstrate how it would leverage NZ's unique strengths, capabilities and/or resources to take a measurable, future-oriented leadership position. Incorporating the relationship that Māori have with the environment is an obvious way to do this, and it is a cornerstone of the approach that SfTI wishes to take.

We are in the process of further refining this concept to identify where there is key 'stretch', and this extends beyond our borders to consider globally stretchy science, as well as 'NZ-sticky' research potential.

Refining the research programme

To date, we have begun speaking with industry representatives, Māori and other biosecurity initiatives, to explore where there are feasible technologically-based (non-policy) solutions. As we move this project forward, more in-depth engagement will take place to ensure the research meets identified needs and takes a partnership approach***. At this stage we are seeking to devise and prioritise research programme elements that would align to the recommendations and priorities established through our consultation to date.***

We want to develop a plan for a bold new research program, including what might be achieved (with indicative milestones) and more detail for the first two years of the project. The plan may have 3-4 work streams but there must be an over-arching (longer-term) logic and internal connectivity to what is going to be attempted. A key element of the process will be the formation of a 'best NZ team', and looking for opportunities to collaborate with other organisations working in aligned areas.

Ultimately, this technology Mission will meet all or most of the following criteria:

- Involves new, emerging and potentially world-leading science and/or technologies;
- Takes advantage of an opportunity or set of conditions that is unique to NZ;
- Makes good scientific sense to carry out original research in NZ;
- Is relevant to Vision Mātauranga, i.e. to unlock the innovation potential of Māori knowledge, resources and people. This criterion is considered essential for the Biosecurity Technology Mission;
- Can be applied in a unique way in NZ to generate economic growth for NZ; and
- Builds capability in biosecurity technology areas where NZ cannot afford to be deficient.

Potential research directions

Our vision for this Mission includes supporting both the identification of biohazardous incursions before they arrive in New Zealand in order to keep them out, and mitigating and/or eradicating the biological threats we already have through developing novel solutions.

New Zealand is uniquely positioned to combine both Māori philosophies such as kaitiakitanga (guardianship of the land) and traditional Mātauranga with Western Science when developing biosecurity technology. In this way, we can capitalise on one of NZ’s unique assets.

It is clear that partnership has a central place in developing best approaches that lead to the improved health and wellbeing of Aotearoa’s people and land. Establishing and building long term relationships and growing shared understandings will support two-way knowledge and technology transfer between Western Science and Mātauranga Māori. With regard to Biosecurity Technology, this can be achieved through:

- Partnering with local communities to both draw on their knowledge of the local environment and understand their needs. Māori have been managing local environments for hundreds of years and have a great deal of relevant knowledge.

- Ensuring Mātauranga Māori is recognised as science during the research process and is incorporated into projects from the outset. This includes valuing the in-depth knowledge and wisdom of kaumatua. One project already being undertaken in New Zealand uses existing knowledge about toxins found in native plants to develop and test alternatives to 1080.

- Understanding that any technology solutions to biosecurity problems have to be accepted and used by communities. The ongoing controversy around the use of 1080 demonstrates this point.

The eventual Biosecurity Tech research will need to strongly address VM, and will likely be overseen by a governance group that supports co-leadership and co-innovation with Māori.

A considerable breadth of work is already being undertaken within the biosecurity space, both locally and internationally, so a key consideration is to ensure against duplicating the work of others; this research must constitute novel science. To this end, we expect the project team to actively engage with relevant organisations and initiatives during the proposal stage, these may include: Biosecurity 2025; other NSCs such as *Our Land and Water*; Predator Free New Zealand; Te Tira Whakamātaki (the Maori Biosecurity Network); Te Herenga; and the Cacophony Project, among others. There is good potential for this Spearhead to be aligned with work being carried out by the Biological Heritage NSC. That Challenge has already conducted a partial stocktake of relevant strategic and operational research, but a wider stocktake of current research work and industry investment will need to guide what should and should not remain in scope.

Given the obvious potential to align this Mission with the Biological Heritage Challenge’s efforts, some elements of their work stream can usefully be considered when developing SfTI’s research programme. For example:

- **Strategic Outcome 5:** We deploy novel tools, technologies & strategies for control or eradication of biotic threats. Autonomous systems and sensors feature here as key tools for controlling and eradicating threats both for border biosecurity and in dealing with legacy pests that have established in New Zealand.

- **Strategic Outcome 2:** We empower New Zealanders to demand and enact environmental stewardship and kaitiakitanga. People who are informed, motivated and enabled will effect change.

The just-released Predator Free 2050 Strategy includes the 2025 interim goal: "By 2025 we will have developed a breakthrough science solution that would be capable of eradicating at least one small mammal predator from the New Zealand mainland." This, and other goals from the strategy, present a substantial challenge that SfTI is well-placed to support.

Four potential research directions have been suggested that provide a basis for subsequent refinement by researchers, Māori partners and industry experts. The underpinning science/technology relates to *digital foundations* and *sensors*, while specific applications may include *smart traps* and *automated/remote capability*. These are described below.

1. **Digital foundations** – using software to enable specific applications that predict or detect incursions, and communicate risks and other information.

Data analytics, machine learning, novel modelling, virtual reality and other digital tools will likely underpin any application-focused science and technology within this Mission. When it comes to developing 'smart' tools, Māori values need to be integrated into the process from the outset.

One impact of better application of data science to biosecurity may be new methods for data collection, analysis and accessibility that ensure insights can be applied by any and all users to mitigate biosecurity harms. Given the significant work already happening around applying data analytics to biosecurity, ensuring any proposed project constitutes novel research will be vital.

Potential ideas include creating an open software platform that serves as a repository and analysis point for multiple data streams collected over time from multiple points around the country, or incorporating machine learning to develop predictive response models to understand how pathogens travel within New Zealand.

2. Sensors – developing novel sensors to detect and/or track unwanted pests or diseases to improve accuracy and lower costs.

While sensors constitute standalone devices as monitoring tools, they will also enable more complex applications such as smart traps, mobile traps and automated/remote biosecurity tools to be developed. Sensors that can better characterise disease/infection as well as identify the presence of target mammals, marine species, insects and plants are essential to improve biosecurity activities. Valuable potential would be released if sensors, including those in remote environments, were able to easily share data.

Potential areas for focus include: improved odour sensors; new materials (e.g. g-putty) to sense small insects such as brown marmorated stinkbug; particulate and fungus detection (e.g. to detect West Coast winds for Myrtle Rust); environmental DNA sensors and tracers; detection of human-borne pathogens arriving at entry ports; and thermal imagery (e.g. linked with machine learning for accurate species detection).

3. Smart Traps - significantly improving smart traps for animals and insects to improve mitigation and eradication efforts in terms of both effectiveness and cost.

Specifically, there is a desire for far more sophisticated traps to better identify and kill target pests while also avoiding non-target species. Further, they will ideally function remotely infield, and supply the added benefit of feeding valuable, real-time data into wider biosecurity efforts.

Smart traps could incorporate a range of technologies, including but not limited to: novel materials; sensors (using vision, sound, pheromone etc); electronics; actuation; communications; and g-putty. Ideally, improved smart traps would be self-clearing and resetting, and have remote monitoring capability for minimal human input.

4. Automation and Remote Capability – developing novel automated technology that transforms our ability to inspect/surveil, mitigate and/or eradicate biosecurity incursions that come across our borders.

New Zealand's vast borders and impenetrable forests mean that current manual methods to detect and treat invasions and infections are expensive and limited. Decisions about where and how to deploy resources at our borders are currently heavily influenced by factors such as a ship's country of origin, which is not an ideal proxy. Creating solutions that function in remote areas with limited human intervention has massive implications for this country.

Applications might include automated and remote capability robots and drones working individually or within connected networks. They may be used on land and sea, with tasks and pathways determined by predictive modelling.

Ensuring people's safety will be a key consideration, and community confidence in built-in safety features will be crucial, for example, ensuring a robot can distinguish between a possum and a small child.