1. National Research Priorities

Green Paper Questions on Priority Setting

1. What principles could be used to determine the scope and focus of national research Priorities?
2. What principles should guide a national research Priority-setting process? How can the process best give effect to Te Tiriti?
3. How should the strategy for each national research Priority be set and how do we operationalise them?

Suggested Guiding Principle

The principle of scientific humility: Scientific research is only a small part of the solution for many of the wicked problems (and opportunities for progress) we face, because of the problems of physical, moral and economic boundary conditions (in which usually lies most of the wickedness or opportunity).

Corollaries:

- Rather than promising more, we as scientific researchers should promise less. We are only a small part of the solution.
- But our current CRI regime is predicated on promising a great deal (things like, "achieving within a decade ambitious targets for a more productive, sustainable and inclusive economy").
- Promising less may inspire a more cost-effective regime better suited to humble-science: less oversight, less politically dictated (and hence usually scientifically unachievable) research targets, and fewer layers of bureaucracy. (That regime could look a little more like an Agricultural University (on commercial-service-steroids) than a CRI).

Discussion

"*Successful policy and preparedness require more diverse evidence than researchers often encounter*" - Nature 603, 203 (2022) "Taiwan's pandemic vice-president — from lab bench to public office and back" https://www.nature.com/articles/d41586-022-00649-8

"*...scientific training teaches us to seek out all the variables that might affect a system. My work as a minister taught me to expand that list of variables far beyond what is typical. Budgets, laws, staffing levels and more enter the picture. So do values and priorities*" - Chen Chien-jen in Nature 603, 203 (2022) cited above.

"*Theories provide answers to the "What," "How," and "Why" questions (Dubin, 1978; Whetten, 1989). "What" refers to the variables that are involved in a causal model, "how" denotes the effects that relate these variables to another, and "why" identifies the causal mechanisms that explain the connection between these variables. Yet there is a fourth, somewhat less prominent feature, namely boundary conditions (BC). BC refer to the "Who, Where, When" aspects of a theory (Whetten, 1989). These conditions relate, most importantly, to boundaries in time, space, and the researcher's values (Bacharach, 1989) and describe the limits of generalizability of a theory (Whetten, 1989)*" - Busse, Christian & Kach, Andrew & Wagner, Stephan. (2017). Boundary Conditions: What They Are, How to Explore Them, Why We Need Them, and When to Consider Them. Organizational Research Methods. 20. 574-609. 10.1177/1094428116641191.

"*Ten geographers who think the world is flat will tend to reinforce each other's errors . . . Only a sailor can set them straight*" – John Ralston Saul (1992)

There are three broad kinds of boundary condition relevant to research priority setting: moral, physical and economic. I'll illustrate these with examples.

A simple example of *moral* boundary conditions: Suppose the problem is to set minimum flow rates in a river that is subject to draw-off by agricultural irrigators. While scientific and economic research can (in principle) discover functional relationships between water flow rates and such things as how much biological diversity the river ecosystem will support at various flow levels, and how much of various kinds of downstream agriculture can be supported, that is only a fairly small part of the solution. The larger and more complex part is moral inquiry and reasoning: what are the local community's values, and what can be deduced from them, concerning the minimum flow rate that should be set (informed by the functional relationships discovered by the scientific and economic researchers), so as to best give effect to those values? These aspects can be viewed as examples of moral boundary conditions.

A simple example of *physical* boundary conditions: Suppose our scientific research discovers a functional relationship linking topography, rainfall, rates of fertilizer application, and nutrient runoff into streams, etc., and releases a software utility an individual farmer can use to help plan and target precision fertilizer application on their farm, to keep their nutrient runoff within an acceptable range. There is an important physical boundary condition however: how many farmers are discharging into the catchment? Unless the research output is applied very carefully (e.g. re-running the model specifically for each catchment, constrained by the boundary condition of how many farmers are contained within it), the total nutrient runoff will be uncontrolled, even if the research findings are sound and original, and every farmer has adopted the researchers' findings and software.

(Another example of a physical boundary condition, to illustrate that boundary conditions limit what science can promise, in *all* the science departments: scientists studying the first few nanoseconds of the big bang invariably come up against the mother of all boundary conditions: the deeply mysteriously brute fact that there is "something rather than nothing"!)

Example of economic boundary conditions: In an internal memo, a colleague noted that "*Tech transfer is often a slow, sophisticated burn and inevitably costs more and takes longer than expected. Too many technologies end up in the valley of death while industry weighs up the risks and costs and institutions struggle to bootstrap funding and, in some cases, maintain viable patent life.*" I suggest that these kinds of problem are part of the more general one of failing to appreciate the importance of boundary conditions: just as setting the minimum flow rate for a river is only in small part a science problem (and in larger part a moral problem for the community to solve), so creating a commercial product is only in small part a science problem, and in much larger part a complex economic (and moral – what people value) problem.

<u>Conclusion</u>

The problem of the brute contingent fact of physical and moral boundary conditions, is at the core of our most wicked problem: climate change. Ignoring physical boundary conditions and externalities – how much load our environment can take on – is what got us into this mess; ignoring the urgent need for moral courage and leadership and action in changing what and how much we consume and produce (and not necessarily just more scientific research) is contributing to the ongoing failure to get ourselves out of it. Indeed a number of climate scientists have recently called for a moratorium on accepting climate-change research funding until governments take real action (Bruce C. Glavovic, Timothy F. Smith & Iain White (2021) The tragedy of climate change science, Climate and Development, DOI: 10.1080/17565529.2021.2008855). To avert catastrophe, what is clearly needed at this point is primarily moral courage and leadership.

The existence of complex moral, physical and economic boundary conditions limiting the range of applicability and problem-solving efficacy of our research leads to the *principle of scientific humility*, and implies that we should promise *less* not more.

Perhaps that in turn might allow some rethinking of the governance and organisational infrastructure of science in New Zealand: if less is promised, this implies less ruinously expensive and demoralising micro-management and oversight is required to track the smaller promises; if less is promised, there is less temptation for scientifically unachievable top-down politically driven research agendas and hypotheses to be imposed; and all of that implies fewer layers of bureaucracy. The outcome could be a more cost-effective national science regime with lower overheads and bureaucracy, producing more and better science.

Perhaps this humble line of thinking leads to organisations that look more like Agricultural Universities (but with more of an emphasis on commercial services to industry, than traditional Agricultural Universities) than CRI's?

At the very least, the problems of physical, moral and economic boundary conditions implies that "national research priorities" should first be walked back, without prejudice, as "national priorities"; and then walked forward again for triage into their respective "*needs scientific research*", and "*needs something else*" components; and only after that clarification, passing down the "*needs scientific research*" component to the research priority-setting process. If we don't do that, and pass down untriaged national challenges for prioritisation, that have been misconstrued as purely scientific problems when they are in fact more complex "*science + moral reasoning + economic boundary condition problems*", then our research programs and institutions will tend to misfire, and the reputation of science will be unfairly damaged.

2. Te Tiriti, Mātauranga Māori and Māori aspirations

4. How would you like to be engaged?

5. What are your thoughts on how to enable and protect mātauranga Māori in the research system?

6. What are your thoughts on regionally based Māori knowledge hubs?

<u>Green Paper Questions on Funding and Institutional Structure</u>

3. Funding

7. How should we decide what constitutes a core function and how do we fund them?
8. Do you think a base grant funding model will improve stability and resilience for research organisations, and how should we go about designing and implementing such a funding model?

4. Institutions

9. How do we design collaborative, adaptive and agile research institutions that will serve current and future needs?
10. How can institutions be designed to better support capability, skills and workforce development?
11. How should we make decisions on large property and capital investments under a more coordinated approach?
12. How do we design Tiriti-enabled institutions?
13. How do we better support knowledge exchange and impact generation? What should be the role of research institutions in transferring knowledge into operational environments and technologies?

Suggestion: The current CRI corporations should be broken up and federated into around 15 smaller science institutes. Some institutes will be more commercial science-service oriented, others more research oriented and others more outreach oriented. Administrative and branding services would be shared under a franchise model. Closer relations and joint appointments between universities would be mandated as part of the franchise's terms of membership, and privately funded institutes would be granted access to the franchise, contingent on agreeing to the franchise's terms of membership. (This idea is loosely modelled after Germany's Leibniz association).

By comparison with the current system of CRI's, this would lead to a less top-heavy, more diffuse form of national research organisation; more science and service led, asking better scientific questions and providing better and more sustainable commercial science services to industry; with potentially greater access to non-government funding. Collaboration would be the rule rather than exception, so that rather than occasional six to seven year "pop-up" collaborations between CRI and universities (such as for example Genomics Aotearoa and Nutrigenomics New Zealand), collaboration would be cemented in, by new publicly or privately funded research units "popping-in" to the franchise. There would be less risk of losing crucial synergies between research and commercial science services, because the place of commercial science services institutes within the franchise would be respected, valued and assured, with no risk of a corporate entity selling them off to balance its books.

<u>Discussion</u>

In science it is generally accepted that one of the most important things is to ask the right question.

But it is clear that the kinds of question that are askable, depend highly on who or what they are being asked of (as well as on the intrinsic nature of the problem at hand): different questions can be asked of an individual scientist, as compared with a small team, a large team, a university department, or an incorporated conglomerate such as a CRI.

As a straightforward consequence of these premises, the way we organise our research entities is seen to have a significant effect on scientific productivity, via its effect on the kinds of scientific question askable of them: some kinds and scales of organisation will tend to encourage better questions than others.

The current CRI's are large highly branded incorporated conglomerates. The incorporated-conglomerate organisational construct has a number of advantages and disadvantages relative to other more diffuse kinds of construct that can be envisaged, such as a franchise model (for example Germany's Leibniz Association); or an agricultural research university (which would be a diffuse collection of departments, pursuing a diffuse set of goals including science-service, education and outreach as well as research, with a fairly minimal corporate head).

One of the *disadvantages* of a large highly branded incorporated research entity such as a CRI, may be that too much tends to be expected of it (or in other words, it may tend to lead to asking of it the wrong kinds of scientific question): it's muscular organisational corporeality, with access to such a wide range of resources (including scientific expertise and equipment), yet also with an apparent singularity of will and purpose capable of marshalling all those resources to great effect, fosters the impression that it is a match for grand challenges and wicked problems (such as "achieving within a decade ambitious targets for a more productive, sustainable and inclusive economy"). Yet many of these wicked problems are in fact only in small part scientific problems, and in larger part problems involving moral, physical and environmental boundary conditions.

Arguably, this leads to a perverse evolutionary battle between research funder and research provider: too much is expected (or in other words, the wrong sorts of question are asked), so too much is promised, so too much is expected, so . . . . . etc. The funder evolves ever longer, sharper and more numerous supervisory fangs (such as longer and more numerous meetings, forms to fill in and boxes to tick), the better to dissect the provider to discover whether they are on track to meet the overblown promises, and if not why not; while in turn the provider evolves an ever tougher hide to ward off the attacks of the predatory funder (. . . such as longer and more numerous meetings, forms to fill in and boxes to tick !).

<u>Conclusion</u>

This line of reasoning suggests searching for a more diffuse form of organisation of New Zealand science, that would promote asking better scientific questions. A commercial-service-oriented agricultural research university would be arguably more diffuse in this sense, but has other disadvantages, would be a huge stretch and is scarcely feasible in the foreseeable future. On the other hand a franchise model, along the lines of Germany's Leibniz association, could be a viable replacement for the CRI's: less top-heavy, more science-led, with potentially greater access to private funding, and more agile than our current CRI system.

(This reasoning also suggests avoiding one potentially popular option: merging the CRI's into a single entity. It predicts this would lead to even worse scientific questions being asked, and less realistic, more overblown promises being made; and a renewed evolutionary battle between the respective ever-expanding bureaucracies of funder and provider).

5. Research Workforce

14. How should we include workforce considerations in the design of national research Priorities?
15. What impact would a base grant have on the research workforce?
16. How do we design new funding mechanisms that strongly focus on workforce outcomes?

6. Research Infrastructure

17. How do we support sustainable, efficient and enabling investment in research infrastructure?