Future Pathways Green Paper feedback from the AgResearch Science Council

The AgResearch Science Council provides a diverse collective voice on matters affecting AgResearch's science community. It is an advisory body, identifying issues and solutions and communicating them to the Chief Executive and Strategic Leadership Team.

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We acknowledge that the New Zealand science system needs reforming and that we were encouraged by AgResearch senior managers to make this submission to the Future Pathways Green Paper https://www.mbie.govt.nz/dmsdocument/17637-future-pathways-green-paper.

Our submission follows the structure of the Green Paper and addresses its 17 questions, some in more depth than others. We provide specific feedback on what needs to be retained and enabled in a future system.

While all AgResearch staff have had the opportunity to contribute to this submission, we do not claim that it represents the views of all staff; but it does reflect what we hear through our many discussions with science staff at all levels of the organisation.

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1. RESEARCH PRIORITIES

Question 1 *What principles could be used to determine the scope and focus of research Priorities?*

High-level Research Priorities with defined scope and focus are essential. Currently there is no structure to MBIE funding – it is a free-for-all and what gets funded is a lottery, there is minimal feedback, and it results in fragmented science effort. At least FRST had portfolio areas, which made sure that key areas got some funding allocated.

The National Science Challenges were a good idea. They established priority areas, and at that level, they were useful in establishing a set of priorities for mission-led research. If high level priorities were to be developed (e.g., biosecurity, climate change, water quality, etc.) and if the structure behind them leads to tangible projects that are well considered, then it should be possible to have teams of collaborating researchers contributing in a cohesive and focussed way to deliver to these priorities, as is the case in some of the Science Challenges.

Better Border Biosecurity (B3) is another good model for what could work as a Research Priority in that it is multi-agency, has distinct themes with flexibility to interact where it makes sense, and puts best teams together into projects. The ring-fenced funding for participating organisations is an issue for B3 but that would not carry though if the Priorities and institutes were aligned.

Research Priorities should be set to meet national goals. National goals should determine the scope and focus of Research Priorities – the high-level objectives of the research organisation(s). These goals should be set by the community (politicians, stakeholders and tangata whenua) with scientist input, but are surprisingly simple. We all want clean water, good air to breathe, to be ready for climate change, etc). The goals provide science with its purpose and direction and justifies the money spent on it.

Public-funded science must clearly prioritise actions for the public good. Public-funded science is paid for through the tax system and should have clear public good benefits. This is obvious for environmental and risk management research with broad outcomes (e.g., climate change research, biosecurity research). Public funded science supports sector-based initiatives, but these should be for the public good (improving product value for greater revenue and tax income and providing jobs and better environmental outcomes). Our aim must be to maintain critical thinking and transparent (open) processes. Public funding should not be captured for secret private benefit.

Research Priorities must be forward looking and flexible. Research priorities should be set using foresight as the outcomes may not deliver benefits for 20 years. The Priority should set the direction but the workplan should be regularly reviewed to keep to the best pathway for outcomes.

Each Research Priority must be allocated an indicative budget Without an indicative budget commensurate to the value of the goal there is no way to develop an implementation workplan.

Question 2 *What principles should guide a national research Priority-setting process? How can this process best give effect to Te Tiriti?*

A national scientific Research Priority setting process must aim to achieve National Goals and involve leading scientists across all relevant fields, industry leaders and the public. Over time national priorities will need to be revisited, and audited, to make sure they are still relevant, focussed, and delivering exceptional science. However, this should be kept high-level with reporting by exception as far as possible. Research Priorities should not separate the natural environment from the productive environment since the latter must exist along with the former, both potentially impact on each other, and the sciences involved in understanding them are the same. The process should be open and inclusive of a wide range of stakeholder views and should not be captured by an interest group, industry, or institution.

Question 3 *How should the strategy for each research Priority be set and how do we operationalise and implement them?*

The strategies should be set by scientists with proven track records in fields relevant to the Research Priority in consultation with relevant sector leaders and who know what is achievable within set time frames. Each Research Priority needs a working team to develop the strategy for implementation and management, with institutional support for financial analysis and budgeting. The strategy and operational plan should be co-designed with stakeholders and tangata whenua or developed with consultation.

Research Priorities could form the basis of new research institutes. For example, a Biosecurity Research Institute would make a lot of sense for New Zealand. The scope of its Research Priority would be all science pertinent to the prioritisation, exclusion (nationally and regionally) and cost-effective management of pest organisms of all types.

Scientific research should not be placed under an operating agency whose paramount concern is anything other than research. Research will suffer when put in competition with operations. From an operational perspective, things worked better when funding was administered by the Ministry of Research, Science and Technology (MoRST) and the Foundation for Research, Science and Technology (FRST), using targeted calls for specific Research Priorities.

2. TE TIRITI, MATAURANGA MAORI AND MAORI ASPIRATIONS

Question 4 *How would you like to be engaged?*

Māori would like to do research not have research done on us. Māori would like to co-design research, not have research already drawn up and decided and then offered as a shared experience. Māori have strong values in belonging, the environment, in people before profit and in manaaki. One of the biggest problems is that Māori are often approached to become ‘partners’ in a programme when the proposal is almost ready to submit. In these cases, Māori are not true partners since they have been approached at the end of the research design and planning process. When a programme is appropriate for Māori codesign and leadership, Māori need to be involved at the start to enable meaningful interactions. Where a scientific research proposal is not giving effect to ‘Vision Mātauranga’ (VM), this should also be clarified at the early stage of developing the proposal. To solve these problems, scientific research institutes should be adequately funded to employ VM

advocates and require all research proposal leaders to consult with these VM advocates early on to determine if Māori need to be involved. VM advocates would be required to create appropriate connections with Māori, if necessary, to enable co-design of the research. When developing research with Māori organisations, acknowledgement that many groups do not have a legal governance structure and are not financially well resourced is important. Research institutes should not partner only with legally structured Māori trusts with money.

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

Mātauranga Māori needs to be respected, considered, and valued along with other knowledge systems. VM advocates could take a leading role here.

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

Māori already have regional hubs called runangas, iwi etc. What works for Māori is to maintain connectivity within communities and across regions and research organisations to be able to share information for the benefit of many people. If the government creates an artificial 'hub' based on location or even its existing relationships with Māori, this will leave out those already feeling the strain of being overlooked due to not being the official representatives of their respective organisation, whether it be iwi hapū, whanau or a trust. Why does tribe Y always get funded? Because they are the only Māori groups that CRIs and government know. The other tribes don't get a look in. Māori are not above securing benefits for their own group and excluding others, so it will be important for VM advocates in research institutes to arrange for appropriate consultation.

3. FUNDING

Question 7 *How should we determine what constitutes a core function and how should core functions be funded?*

Identification and mapping of core functions will be needed but this can probably only be undertaken in detail after deciding on, and operationalising, a single set of system level Research Priorities.

Definition of what falls within a core function will need to be resolved through discussion. This needs to be broader than the Ministries, CRIs and Māori proposed by Te Pae Kahurangi and include industry, university, and citizen voices (including a range of working scientists). This is a key decision and too important to be left in the hands of bureaucrats. Base funding of core function will provide an infrastructure and knowledge base to best address the science discovery needs of the future.

It goes without saying that general science support functions and national 'core functions' that underpin a broad range of science activities (data storage, management and sharing, database and collection maintenance and development, innovative IT services and streamlined computing facilities) will need to be adequately resourced. These must be considered early in design of a new system and not added as an after-thought.

It is expected that many 'core functions' will be common to all future organisations, and it is expected that efficiencies could be made by sharing resources, facilities, and equipment rather than duplicating over multiple organisations. More specialised core functions to support national priorities and needs (e.g., addressing natural hazards, Met Service, forensics, biosecurity) would need to be part of a mapping process undertaken following research prioritisation.

Question 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?*

Move away from a fully competitive funding model. MBIE acknowledges problems associated with "unproductive competition" in the Green Paper. The enormous amount of time and energy that goes into competition for funds is disgraceful and wasteful of Aotearoa NZ's scarce research funding and scientific talent. Furthermore, the competitive funding system largely fails in reliably ranking proposals for science quality [1]. Hence, it represents a strikingly inefficient lottery [2]. In many cases, grants provide a negative net return, where the costs of the applicants' time invested in the proposals exceed the granted funding [3].

A favourable option is increased base grant funding [4]. The impact of base grants would depend on their size relative to the running costs of the organisation and how it was managed within the organisation. Increased base funding of future research institutions is a promising approach towards stability and resilience of both individual researchers and future institutions. We note that full salaries are included in CRI grant applications to external (e.g., Endeavour) and internal (e.g., SSIF) funds and that this is not the case for universities. So, if a CRI scientist's grant applications fail, the affected researchers and technical staff's jobs are placed at risk. A base grant model would provide stability by paying for both FTEs and infrastructure.

Base grants would go a long way to improving stability of science careers (currently seen as very precarious), retention of key capabilities, and recruitment of talent. Rather than being involved in long and demoralising funding competitions to retain employment for themselves and their teams and maintain capability, researchers can focus on what they have trained for – scientific discovery and delivery. We expect the stability of research institutions and the quality of science they deliver would likely be enhanced by base funding grants. This potentially allows greater focus on exploration of new opportunities, undertaking of stretchy, more risky science which can lead to significant breakthroughs.

Base grants which are guaranteed for reasonable lengths of time (6-10 years) and inflation adjusted, would support improved organisational science and workforce planning. This would be in contrast with the current system where organisations focus on reacting to the financial implications of disjointed, short-term, and fragmented funding sources. Greater funding security would allow organisations to invest in longer term research than the current short term funding rounds allow. NZ's current prosperity is largely based on historical long-term research in the productive sectors that is no longer possible in the current funding environment. Greater funding certainty would support enduring partnerships with industry who are equally frustrated with the discontinuous nature or the current science funding system.

Base grants may also provide organisations with flexibility and agility to respond to urgent/emergent issues e.g., direction of Plant & Food Research internal funding to respond to the PSA outbreak in kiwifruit.

A mixed model, where organisations receive base grants to undertake prioritised public good science that is not likely to be funded by other sources such as industry, could be beneficial. However, it is important to be realistic about NZ industry investment in R&D which has been low despite various government incentive schemes. If this model is pursued, care would be needed to avoid creating two tiers of scientists within our research institutes – those based-funded and so with job-security, and those whose research and job security depends on the short-term and uncertain nature of industry funding.

Base grants should be considered in conjunction with workforce planning and development. Perhaps use of base grants provides an opportunity to change from the early career researcher paradigm of using post-doctoral researchers as temporary cheap labour to deliver science, and instead provide more secure well-resourced positions that allow young scientists to establish careers and do their best work unencumbered by need to chase the funding necessary to secure their job (see Workforce section).

Can the science system be funded somewhat like the education system whereby funding is split into salaries, operational funding, and property funding? Funding the salaries of scientists and science technicians directly would acknowledge and maintain this core research capital. Salaries need to be separated from funding bids. The way education and science are funded could be more aligned as they have complimentary purposes where the benefits of the investment are for public good and may not be realised for many years.

There is a strong need to reduce onerous bureaucratic functions associated with competitive funding and its allocation. Grant proposals are too long and need to be significantly reduced to reduce the preparation costs and workloads [5]. Proposal requirements could be halved. In business, you quote a price, you say what you will do and if agreed, get onto it. The main project cost is doing the work. Imagine providing a customer a quote many pages long and then every month having to report pages and pages more on where you're at with it. Your overheads would be massive, and you would be bleeding money.

Fragmentation of institutional base grants needs to be addressed and measures need to be in place to ensure base grants are focussed squarely on public good science delivery. Despite the original purpose of the Strategic Science Investment Fund (SSIF) as a strategic non-competitive base fund to provide stable funding for CRIs, in some cases it has become a wasteful, fractionated and internally competitive fund with bidding costs often exceeding the value of the funds granted.

Greater transparency around funding decisions is necessary. The transparent review process adopted by open science journals serves as a template for how grant applications should be evaluated [6]. This includes full disclosure of score cards, reviewers (with consent) and other relevant metrics that affect grant success.

4. INSTITUTIONS

Question 9 *How do we design collaborative, adaptive and agile research institutions that will serve our current and future needs?*

It is vital to remove the barriers to collaboration, adaptability, and agility. These barriers are: 1) insufficient funding, 2) competitive funding for salaries, operating and overheads, 3) contractual basis of the current funding of science and 4) requirement of CRIs to make a financial profit.

Collaboration among scientists is inhibited under a competitive funding system when scientists must secure the funds to cover the costs of their salaries, operating costs, and overheads. Under these conditions, there is a huge incentive for the scientist to not involve other scientists from within the organisation, or from other organisations, in a proposed study, even though collaboration would greatly improve the value of the study. Similarly, the scientist's managers, incentivised to return a profit for the organisation, have been known to demand reductions in the size of contracts going out to collaborators when profit forecasts are looking unattainable. Collaboration is a necessity to produce solutions to complex problems. Collaboration naturally flourishes when scientists are not boxed into institutions and when they have clear high-level goals.

Adaptability, the ability to change the focus of a scientific research programme, or to respond to an unforeseen stakeholder need, is inhibited by the cumbersome contractual project nature of our current science system. This leads to scientists being unable to postpone a project or switch direction to a more productive avenue of science without potential financial penalties or protracted negotiation of contract variations. Adaptability is also constrained by the need to find a new source of funding for the new project within the high-risk competitive funding system.

Agility, the ability to quickly change tack, is also constrained by the requirement to find the funds for the new work through the competitive funding system.

Part of the solution to designing *collaborative, adaptive and agile* research institutions that meet our current and future needs is to replace competitive funding with core funding to an extent that at least covers the full costs of scientist and technician salaries, operating and overheads, and to contract at the Research Priority level rather than, as currently, at the research project level. Another part of the solution is to better connect scientific research programmes with the public through research institute open days, field days led be scientists on topical issues and strong public-focussed communications teams within research institutes.

Question 10 *How can institutions be designed or incentivised to better support capability, skills, and workforce development?*

Stop businessification of science, i.e., applying business models of operation to basic science. This is the wrong incentive. It results in dysfunctional hybrids or pseudo-businesses (by analogy to pseudoscience, an activity that pretends to be science but does not follow its basic rules). CRI business models have weakened science culture, stifled collaborations, and lost clarity of purpose for meeting common goals.

Science organisations should be science-led. Top administrators (for finances, IT, HR, government affairs, infrastructure, strategy) are now considered the 'leaders' in our CRIs. Instead, we should develop R&D institutes bottom-up with a directorate of top-level representatives that are high-calibre principal scientists. We should ensure that top earners within the institute bring in more money than they cost as in the case of Directors at other top research institutes who lead and secure major grants (e.g., Maurice Wilkins Centre CoRE, Max Planck Institutes). Future institutions should be led by scientists who understand the need for continuity and who can guide workforce development. Administration staff should support science leadership. This would enable an outward and forward-looking community rather that the internally focussed institutes that have resulted under the CRI model.

Flatten the hierarchy – we should have no more than 3 levels from top-to-bottom. The 'Dresden Model' exemplified flat hierarchies as being cost-effective and science-centric (https://www.mpi-

cbg.de/about-us/management/our-organization), with directors at the top, then PIs/Services, and lean admin.

Select leaders with the right skills and attitudes at executive level. We should appoint people who i) are willing to disagree and debate ideas; ii) do not execute blindly, iii) really listen and act upon the issues raised by employees, iii) know what's coming next to keep their institute relevant, iv) take responsibility, vi) accept accountability, and v) think independently. High quality leadership sets the standard for the organisation. Top research institutes practice a meritocracy in which leaders encourage creativity from outstanding subordinates [7].

Focus on the core purpose of science. The purpose of science is to make verifiable discoveries, whether they have a commercial value or not [8]. The primacy of discovery has defined how basic science is organized. First, scientists are measured by the discoveries they make and by their perceived potential to make more of them. This measure ('reputation') holds the components of the system together. Second, the reputation of scientific institutions is measured by their ability to enable discovery by attracting discoverers and continuously providing a supportive environment.

Institutions can only support capability, skills, and workforce development when they have clear goals, a development plan and security of funding.

Question 11 *How should we make decisions on large property and capital investments under a more coordinated approach?*

Base decisions on large property and capital investments on national need. This will become evident following decisions on organisational structure and Research Priorities. These decisions should be based on national science need rather than a business case for an individual institution. A national structure with regional centres will provide the opportunity for rational, coordinated investment rather than a piecemeal approach from several institutes

Question 12 *How do we design Tiriti-enabled institutions?*

Define problems with Maori and codesign institutions to resolve them

Question 13 *How do we better support knowledge exchange and impact generation? What should be the role of research institutions in transferring knowledge to operational environments and technologies?*

Bundle projects into a programme targeting a defined Research Priority and focus on outcomes. Regular scientist reviews (internal and external) will ensure that projects move towards outcomes and produce impact. Science involves a cycle of hypothesis–experimentation-evaluation to create solid building blocks needed for system change. Co-design of research with next- and end-users, communities and other stakeholders will be key along with clearly focussed extension activities.

Allow scientists time to be creative and produce the results that lead to impact. Science involves competition of ideas. Yuval Noah Harari notes: *"if you want to go deeply into any subject, you need a lot of time, and in particular the privilege of wasting time. You need to experiment with unproductive paths, to explore dead ends, to make space for doubts and boredom, and to allow little*

seeds of insight to slowly grow and blossom. If you cannot afford to waste time you will never find the truth" [9]. Do not lock scientists into fixed, detailed contracts with "tick the box" milestones, which stifle discussion and creative project outputs.

Under the competitive science system contracts are time bound. Once a project is completed this will often leave an initiative abandoned. In the case of technologies with commercial potential this can be the 'valley of death': too early to go to the market, too late for further research money. The results often remain unpublished, due to confidentiality, intellectual property, or lack of time as scientists move on to other areas. Targeted funding within Research Priorities will ensure research is well positioned to deliver impact. This may include close partnerships with industry as is current practice.

5. RESEARCH WORKFORCE

Question 14 *How should we include workforce considerations in the design of research Priorities?*

The workforce should be capable of maintaining core activities for meeting Research Priorities that have a long timeframe (10 years+), allowing adaptation to changing needs.

Question 15 *What impact would a base grant have on the research workforce?*

A base grant would make science a more attractive career choice than the current competitive funding model where scientists are employed, then soon find they only have a secure job if they are successful in funding it. A base grant should cover salaries, operating costs, and overheads (including key resources such as library services, statisticians, databases, scientific collections etc.). Base grant funds should not be contracted at the individual project level but rather at a higher level, perhaps at the Research Priority level. They should also not be competed for or subcontracted at the institutional level as currently happens with the SSIF. This would free scientists to be collaborative, adaptable, and agile in their work within the Research Priorities.

Base funding should be provided for key scientists to allow collaboration with international programmes and bidding into more sources of funding. At present high costs (staff, overheads, and profit) exclude us from bidding into international funds (e.g., World Bank, FAO, Gates Foundation). Scientists from overseas research institutions (e.g., USDA, JKI Germany, Universities) cover staff time and can give more for limited project funding. Missing out on these opportunities is more than a loss of funding, it means that scientists miss the opportunity of working in international teams on complex problems and the benefits that this experience can bring to New Zealand.

Base funding would enable research institutions to maintain and improve core functions. We cannot protect biodiversity or control biosecurity without the sciences of taxonomy and ecology. Water quality needs deep understanding of soils, climate, and land use. Base funding of scientists and their overheads for core functions will enable building of expertise to underpin several different Research Priorities. It would value expertise rather than the ability to capture new funding.

Some competitive funding should be maintained to encourage innovation, especially in developing concepts for new research priorities. They provide a way of incorporating new staff (Post Docs and students) into projects to develop and prove themselves.

With significant bulk grants, scientists will have less burden from preparing proposals, but more time for prioritisation, planning and evaluation of projects. Bulk funding and research prioritisation should be determined through negotiation with Government with strong science input. A Foundation with an independent board could manage the competitive funding. These changes would streamline the funding system, require less administration and free-up resources for science delivery.

Question 16 *How do we design new funding mechanisms that strongly focus on workforce outcomes?*

Stop treating young scientists as cheap labour. Young scientists are colleagues in exploring 'Science, the endless frontier', not an economical 'workforce' that is mass-produced in the quantities required to satisfy the demand of stakeholders. How can someone who struggles through a succession of short-term post-doctoral positions remain an inspired, passionate, independently thinking, and adventurous scientist? While Universities are 'out-of-scope', consideration of the future science workforce must include the issues resulting from training of large numbers of PhD students with limited future career opportunities. Often students are used in research grants as even cheaper labour than post-docs to address funding constraints, further limiting opportunities for early career researchers.

Empower the next generation of scientists and science technicians. In Europe, ERC grants brought a breath of fresh air to empower young investigators [10]. At the age of 30, top researchers should have their own grants, providing intellectual and financial freedom. Wellcome Trust (UK) Investigator Awards are similar but focus on investigators rather than projects. The focus is on quality of the candidates, rewarding those with the ability to innovate and drive advances in their field of study. They should be able to articulate a compelling long-term vision for their research and demonstrate the talent, track record and originality to achieve it. Researchers should be free to pursue whatever direction they find interesting within the framework of their award. The new funding does not cover salaries because recipients will already have salaries from their host institutions. ERC and Wellcome Trust grants are portable, in contrast to HHMI Early Career Scientist money, which is not portable. Giving young scientists and technicians more leeway and support to establish their own research teams makes NZ more attractive for kiwis coming back. Science is global. Very often people move out of the NZ for a period and then return when they're more senior. Young researchers should gain experience in the best labs, no matter where, because that's the best way to become the best scientists.

Close the pay gap and implement pay transparency. There is both a gender and an industry vs academia pay gap. One strategy to close this gap is by implementing pay transparency — when employees know each other's salaries [11]. The pay gap between men and women tends to shrink after workers learn what their colleagues earn. The relationship between academic performance, such as numbers of papers published, and salary also weakened after the transition to pay transparency [11]. Closing the gap would encourage the best and brightest into science careers. NZ scientists are underpaid by international standards, making it difficult to recruit top scientists from overseas and pay commensurate with their expertise. Not closing the gap for scientists while executive salaries are kept at market parity sends the wrong signal.

Enable researchers to perform their own cost–benefit analyses before applying for a grant. The funder should publish accurate success rates in previous calls, and evaluate the average time spent on proposals by applicants.

6. RESEARCH INFRASTRUCTURE

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

Government needs to take responsibility for maintaining major plant, equipment, research facilities and research farms that are national assets.

There are many opportunities to share science infrastructure and assets across future organisations and this should become standard practice wherever possible. An example of such an asset is the AgResearch engineering technology facility with centres at Lincoln and Ruakura (where there is also significant engineering capability and infrastructure in PFR). This facility contributes to the identification and development of opportunities to innovate, adapt, build, integrate and apply physical and cyber-physical technologies supporting the pastoral, agri-food, and agri-technology sectors. These two facilities could be developed further into two Regional Research and Development Engineering Technology Hubs to support a new public good science structure in NZ. These Hubs could be linked to collaborate with similar centres of excellence at other organisations and universities in NZ and internationally (for example CSIRO Data61) to innovate in multiple fields such as: distributed sensory networks and the Internet of Things; smart sensing technologies; instrumentation; automation and robotics; electronics and embedded systems; signal processing and machine vision; expert systems; software engineering; mechanical and process engineering; product design; prototyping and field testing; engineering and control systems manufacture, installation, and commissioning.

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