Inter-American Development Bank

Good Practice Recommendations for the Governance and Management of Modern Agricultural Research, Development and Innovation Organizations in Latin America and the Caribbean

Environment, Rural Development and Risk Management Division

Tom Richardson
Josep Monfort
Fabio Montossi
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AUTHORS

Tom Richardson
Former CEO of AgResearch and Scion in New Zealand and current consultant in R+D+I systems
tom.richardson@outlook.co.nz

Josep Monfort
Former CEO of IRTA (Spain) and current consultant in R+D+I systems
josepmobol@gmail.com

Fabio Montossi
Former National Director and current Senior Researcher for INIA, Uruguay
fmontossi@inia.org.uy

Gonzalo Muñoz
Rural Development Sr. Specialist
Inter-American Development Bank
gonzalom@iadb.org

Álvaro García Negro
Rural Development Sr. Specialist
Inter-American Development Bank
alvarog@iadb.org

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1.1. Context for agricultural research, development and innovation institutions

Agriculture is the world's largest enterprise and underpins the economic and social fabric in many countries. In Latin America and the Caribbean (LAC) agriculture accounts for more than 5% of GDP in approximately 20 countries. However, the conventional way of measuring the contribution of the sector leads to an underestimation, because when all the linkages and their associated multiplier effects are considered, the impact of the agricultural sector and its contribution to growth and reduction of poverty is much higher (Morris et al., 2020). Recent studies have shown that, in 2007, 2008 and 2012, the most recent years for which disaggregated input-output matrices are available, agriculture sector contributed 7.3, 3.8, and 2.9%, respectively, to the global added value GDP in Peru, Chile and Mexico (Foster and Valdés, 2015; World Bank, 2017ab). However, when all the agri-food system linkages were considered, the share in the value added of GDP of these three countries amounted to 11.3, 6.4 and 11.9 %, respectively. In fact, LAC today is the world's leading net food exporting region —surpassing that of the EU and of the USA and Canada combined (Morris et al., 2020).

Moreover, the expected impact of this LAC agri-food activity is growing. Morris et al. (2020) points out that in the past, agriculture in LAC was seen primarily as a system aimed at producing enough food, fodder, fiber, and fuel to meet the consumption needs of people and animals. This vision has been superseded. Today the region's agriculture and food systems are expected to contribute to multiple goals that go well beyond the production of primary products. Among these multiple objectives, four main ones stand out: (1) the growth and diversification of the economy, (2) the increase of employment and the reduction of poverty, (3) the improvement of food security and nutrition, and (4) the implementation of ecosystem services with capacity for climate resilience. (Ibid)

Clearly, if the development goals of LAC are to be achieved, then the regional agri-food system will underpin that success. If the agri-food system continues to under-perform, then these development goals will not be met. There is much at stake. These opportunities and expectations coexist at a time when agricultural practices in all parts of the world are being challenged to operate more sustainably and to demonstrate transparently to consumers that their food/fiber products meet the nutritional, animal welfare, environmental and social (e.g., labor practices) expectations of these ever more discerning consumers. At the same time, food and fiber production in many areas is being impacted by climate change induced environmental factors which is requiring changes to existing practices and the anticipation of even greater changes in the future. These factors, and more, are increasing the demand for new and innovative approaches to all aspects of food and fiber production.

Fortunately, many technological advances emanating from both traditional agricultural science disciplines and new areas such as data science, bioscience, digital agriculture, machine learning, and geographic information systems are providing exciting new avenues for scientists and scientific organizations to address these challenges. However, the pace of these technological changes and the changing career expectations of highly qualified professional workers makes it challenging for nearly all research institutes to adapt, remain relevant, and enhance their positive contributions to economic, social and environmental advancements. To achieve these aims, an ongoing commitment to continuous improvement and evolution is now a requirement for modern agricultural research organizations.

Agricultural research organizations in LAC are not immune from these global macro trends, nor the need to continually improve. In fact, it is especially imperative given the relative importance of agriculture (and on-going innovation) to the prosperity of LAC and the role that research organizations, especially public institutions, contribute to agricultural innovation in LAC.

Like most developing regions, LAC is characterized by having generally higher portions of the economies involved in agriculture and lower levels of private sector participation and investment in research, development, and innovation (R+D+I) than in more advanced economies (FONTAGRO, 2019).

These characteristics highlight the potential importance of the public R+D+I institutions and indeed it has been shown

that investment in public sector LAC agricultural R+D+I institutions can generate significant national benefits (IICA, 2021). Such national benefits from well-functioning public R+D+I institutions will likely increase as agricultural economies in LAC expand.

There is much evidence that well targeted and executed investment in public agricultural R+D+I in LAC can be expected to produce sizeable national benefits in the economies, food security and poverty reduction (Stads et al., 2016). To achieve this, however, requires LAC R+D+I institutions to meet the challenges described above and to mesh this with strong national relevance and support for their activities. In fact, many LAC countries have been making efforts since the beginning of this century to adapt national R+D+I systems to the new scenarios with greater research capacity, both in the number of researchers and the level of academic training, with renewed management and governance models, with more participatory research processes, networks and public-private platforms (Gianoni and Trigo, 2021).

Despite the economic and social challenges of the Covid-19 pandemic, many LAC institutions remain intent on making these improvements and are being supported by IDB (and other agencies) to transform their institutions.

Indeed, the recent work of Gianoni and Trigo (2021) reinforced this strongly: *"In order to face the pre and post Covid-19 threats, and thus take advantage of the opportunities, strategic decisions are required that ensure the necessary levels of investment in R&D —today dramatically below what occurs in other areas of the world— and the improved performance of R&D institutions and the entire innovative system in the region. It is essential to review the current institutional arrangements, not only to strengthen capacities in new fields of knowledge and technologies but also for producers to acquire the skills to take advantage of them effectively. R&D must generate knowledge and place it in context to empower producers to make the changes necessary to make food systems more sustainable. These efforts are of particular importance in smaller countries that lack specialized endogenous capacities to face these tasks or that have economies very much deteriorated by the pandemic (p. 19)".*

The authors agree with IFPRI and IBD (Stads et al., 2016), who concluded that having well-developed national agricultural research systems and adequate levels of investment and human resource capacity is the prerequisite for growth in agricultural productivity growth, food security, and poverty reduction. It seems the question of "**Should** LAC agricultural R+D+I institutions be transformed?" has been answered in the affirmative. The challenges of course then become: "Transform to **what?** and "**How** to conduct such a transformation?

At a high-level, policy makers can often agree that achieving an alignment of institutional expectations between the owner (government) and the key stakeholders (private and public sector and staff) is essential and that the mode and quantum of financial support should optimize a flow of new knowledge creation and transference to practice. However, to effect real and durable transformations, a much more sophisticated understanding of the role of appropriate governance and investment models, organizational structures, technology development and transfer pathways, and performance evaluation must be considered, selected and implemented. This is a complex and intertwined ecosystem, which can be difficult for policy makers to grabble with.

This technical working paper seeks to demystify the R+D+I ecosystem transformation process by drawing on the global best practice experiences of three experts whose countries have embarked on the long journey to improve their national agricultural R+D+I systems. In this and related papers, the authors draw on their expertise to provide practical insights to policy makers and others who seek to accelerate progress towards positioning LAC agricultural R+D+I institutions for success.

1.2. Methodology

As part of the process to assess global best practices for the transformation of agricultural R+D+I institutions, the IADB engaged the consultancy team of Drs. Fabio Montossi, Josep Monfort and Thomas Richardson, for many years the CEOs of INIA-Uruguay (www.inia.uy), IRTA Catalonia-Spain (www.irta.cat), and Forest Research (www.scionresearch.com) and AgResearch (www.agresearch.co.nz) in New Zealand, respectively. The authors and these national ecosystems have been selected by the IDB because all three countries have well established histories of strong agricultural R+D+I institutions from which many LAC institutions have drawn inspiration. Much more importantly however, each country has sought to transform their institutions and each author has played a leading role in effecting that transformation. A brief summary of each country's institutional transformation and the roles of the consulting team member is provided below to provide a context for this report.

In New Zealand, the major economic and social reforms of the 1980s and early 1990s culminated with a complete overhaul of the state science system which had begun in 1849. The Crown Research Institutes Act (1992) set out the CRI mission: to undertake, promote and disseminate research that benefits New Zealand. In so doing, the New Zealand Crown Research Institutes (NZCRI) must pursue excellence, be ethical and socially responsible, good employers and financially viable. The ten original

NZCRI were created on 1 July 1992 by dis-establishing long-standing government-owned research entities (e.g. DSIR, MAFTech, Forestry Research Institute etc) and recombining their staff (more than four thousand) and infrastructure into new crown-owned companies designed to consolidate scientific capability around key aspects of New Zealand's economic, social and environmental requirements. Consistent with the philosophy of the time the reforms separated science policy (the Ministry of Research Science and Technology was created) from science "purchasing"/funding (the Foundation for Research Science and Technology (FRST) was created) and science provision functions (the NZCRI). Whilst nearly three decades have passed, and several of the key initial settings have been modified, the fundamental model for government-owned research in New Zealand has remained essentially unchanged from this 1980s commercial construct. As a result, New Zealand's science investment practices and institutional arrangements are often cited as "extreme" examples of a highly competitive, commercial, market-led model.

Dr. Richardson joined the newly formed NZCRI in 1992 and retired 27 years later having been a post-doctoral researcher, a scientist, a science group leader and start-up business founder, an executive manager and Chief Executive Officer (CEO) of two NZCRI. Dr Richardson served on the board of FRST (the major "investor" of public funds to R&D in NZ) and numerous R&D centred companies and has reviewed international programmes and research institutes. All these experiences have contributed to his views on national innovation systems and science institute governance and management. His observations and recommendations in this IADB project are drawn from the totality of these experiences, but most especially from his time as CEO of the New Zealand Forest Research Institute - Scion (2005-2010) and the NZ Pastural Agricultural Research Institute - AgResearch (2010-2019).

In Spain, the promulgation of the Spanish Constitution on December 29th, 1978 represented the creation of the State of Autonomies. In 1979, the first two autonomies were established, the Basque Country and Catalonia, and the first transfers of powers from the State to the Autonomy of Catalonia were immediately carried out.

It was in 1985 that all this was merged into a single entity by means of the Law of Creation of the IRTA (Institute for Food Research and Technology). IRTA was established as a public law entity whose activity was subject to private law regulated by the law of the statute of public companies. This allowed for a profound paradigm shift in terms of governance, management, performance evaluation, professional career under a company-employee collective agreement, and capacities to exploit their own discoveries and creation or participation in private companies. With all this, in a few years, IRTA became the agricultural research institute that obtained the most competitive resources from public calls for financing research and development projects throughout the State, the most competitive institute in attracting resources from the European Framework Program, the institute with the highest degree of self-financing, and the Spanish agri-food institute that occupied the highest position in the international ranks of agricultural research and one of the most competitive in Europe in relation to its size. Subsequently, a new way of managing and structuring technology transfer was conceptualized over the following years, constituting a new model that has been analyzed by many other research institutes.

Dr. Monfort, in 1985, joined IRTA, being director of the then IRTA Meat Center, later expanded to IRTA's Food Division, and at the same time he was part of the IRTA management team, overseeing designing the staff's R&D scale of the institute, the system for evaluating the performance of IRTA researchers and their category changes. In 2008 and after an international public competition he reached the position of executive manager and Chief Executive Officer (CEO) of IRTA, leaving the position ten years later by his own decision, one year before his retirement, to facilitate the transition to the new CEO. During Dr. Monfort's tenure as CEO, IRTA created six start-ups, built three new research centers, established the new Innovation and Technology Transfer system, and modernized performance evaluation systems incorporating objective measurement indexes, while incorporating a system of decision-making assisted by indicators.

For Uruguay the year 2019 marked the 30th anniversary of the creation, by law, of the National Institute for Agricultural Research of Uruguay (INIA). In the 1980s there began a deep questioning of the institutional model for national agricultural research, and in particular of the "Alberto Boerger" Research Center (CIAAB). It should be noted that the institutional crisis of CIAAB occurred during the period of generalized institutional and economic crisis in Uruguay which resulted in management and human resources deficiencies, and the loss of the most highly qualified technical personnel who took advantage of better paid job opportunities, mainly in the private sector (national and international).

On October 6, 1989, the "INIA Creation Law" (No. 16,065) was approved, which would mark the beginning of a new approach to the national agricultural research system. The financial support for the new INIA were to be derived from the private sector through a tax on the sale of agricultural products, from the Government, and from INIA via the provision of services or sale of agricultural production or intellectual property. The following main objectives were enshrined in the INIA creation Law:

1) formulate and execute agricultural research programs aimed at generating and adapting appropriate technologies to the country's needs and to the socio-economic conditions of agricultural production; 2) participate in the development of a national scientific and technological heritage in the agricultural area through its own activity or through efficient coordination with other agricultural research and technology transfer programs carried out at public or private levels; and 3) articulate an effective transfer of the technology generated with technical assistance and extension organizations that operate at the public or private levels. These original institutional settings remain in place today, with only some minor adjustments in the regulatory framework.

Dr. Fabio Montossi graduated from the University of the Republic of Uruguay in 1989, obtained his doctorate degree at Massey University (New Zealand) in 1996 and did his sabbatical studies at Colorado State University (USA) in 2012. He is currently a Senior Researcher at INIA and has contributed to the organization as Head of the sheep and goat national research program (1999-2006), Head of the wool and meat national research program (2006-2014), Interim Chief Research Scientist (2015-2016), and as an international consultant. Of particular relevance to this consultancy, he served as National Director of INIA ("CEO") from 2014-2019 where he was responsible of the implementation of several management changes, amongst others, orientated to improve organizational scientific and technological productivity, management organizational structure and roles, strategic planning toward the achievement of goals and key performance indicators, organizational and human capital evaluation systems, and to promote private-public innovation consortiums and new models of technology transfer.

For this project, the authors have produced two pieces of work. In the first component, the authors each produced a detailed characterization and evaluation of R+D+I transformations as it relates to governance, funding and management based on their experiences within the Spanish, Uruguayan, or New Zealand national and institutional R+D+I ecosystems. These reports can be found at the following links: 1) Monfort (2021)[1]; 2) Montossi (2021)[2]; 3) Richardson (2021)[3].

These detailed reports cover aspects of policy, governance, organizational structure, financial operations, research management, human resources, performance evaluation (at all levels), technology transfer and innovation, and institutional branding and communication. These reports explore both the theory of "best practice" approaches and also the "real life" challenges encountered as leaders and institutions implement these theories, and inevitably co-evolve with them. In addition, each report contains numerous examples and templates related to the governance and management of research organizations. These resources are generally freely available and can be used to greatly accelerate continuous improvement programs in other institutions. If while reading what follows you desire to see more explicit examples of a topic, we commend you to consult the previous reports (Monfort, 2021; Montossi, 2021; Richardson, 2021).

In this, the second component, the authors have combined their expertise and experiences to produce a summary of what they regard are the key aspects with the greatest impact to promote modernization, continuous improvement, and competitiveness of the LAC agri-food R+D+I institutions. Like the previous national assessments, this report covers governance, organizational structure, financial operations, research management, human resources, performance evaluation (at all levels), technology transfer and innovation, and institutional branding and communication. At the conclusion of each topic are the recommended critical factors to achieve best practice and the tools used to support that activity.

Because each country's history, laws, socio-economic context, culture, agroecological conditions, agri-industry, scientific resources and the wider agri-innovation ecosystem amongst other factors, have established and still substantially influence the objectives, functions, emphasis and nature of the national agricultural R+D+I institute, there is no unique global model for successful transformations. By necessity then, the observations and recommendations in this report reflect best practice principles based on the author's extensive experiences. The specific application of these principles, the rates of change to be expected and the success measures must be developed with a deep understanding of the current state and desired state for a specific institution and national context.

1. Consultancy on the new institutional framework for agricultural innovation in LAC: Contribution from IRTA, Catalonia-Spain (only available in Spanish)

2. Consultancy on the new institutional framework for agricultural innovation in LAC: contributions from INIA, Uruguay (only available in Spanish)

3. Consultancy on the new institutional framework for agricultural innovation in LAC: New Zealand national and organizational reviews.

2. Governance

Good governance of R+D+I institutes is conceptually easy to understand and yet challenging to achieve in practice. This is because an effective governance body should provide the critical linkages and inputs from the owners (government) and the essential stakeholders (public and private entities and staff), whilst owning the development of short, medium and longer-term strategic plans and auditing the performance and impact of the institute. This is a complex and difficult set of requirements and relationships to balance and if the board fails to strike an appropriate balance, then the institute can be severely impacted.

2.1. Legal basis and scope

The creation of a research institute requires a legal basis (law and legal regulations) that clearly establishes the mission, vision, and objectives of the organization, with a clear definition of the roles and responsibilities of ownership, governance, and management.

The legal mechanisms and the governance policies that are developed to clearly define the roles of government (the owners) and the governors are different in each socio-political context (public company, foundation, consortium, autonomous body, etc.) but in any case, they must guarantee two things. Firstly, that key stakeholders in the institution (government and other significant investors, science, and private sector) are somehow represented in the governance body to ensure that the strategies developed reflect their requirements and are relevant to current and future challenges. Secondly, that political independence is maintained in the appointment processes of those responsible for managing the organization and executing the agreed strategies (i.e., the institution's managers and staff).

High-level documentation concerning the responsibilities and operation of the board are generally established in the founding documents (i.e., set out by the government) whilst the more detailed descriptions of how the board operates to fulfil their mandate and how the board integrates with management are contained within board policies which are generally produced and reviewed regularly by the board.

2.2. Strategic development

In most modern public R+D+I institutes, the board has the formal role of leading the development of the institute's strategy and overseeing its execution by the management team. In this regard, it is the board's responsibility to ensure that the key stakeholders (including the employees of the institute) are involved in the formulation of strategy and establishing the key metrics that will be used to regularly assess progress. The board is generally responsible for appointing and monitoring the performance of the CEO of the institute, but the day-to-day management of the organization is typically delegated to the CEO. The development of strategy and all components of performance evaluation will be covered in subsequent sections of this report.

The board's strategic planning process should result in a medium-term strategic plan covering 3-5 years. It is increasingly necessary to incorporate an annual review of the strategy, to adapt to the rapid and disruptive changes of the external environment, and as a result, to re-prioritize and adjust the institutional strategy as appropriate.

In both creating the strategy and regularly reviewing progress and updating the strategy most boards establish processes to access the contributions from a wide span of public and private stakeholders who make use of the institution's outputs, key clients, and the leaders and staff from the institution. Inevitably, this process will reveal different, strongly held opinions and priorities amongst the stakeholders and the board's crucial role is to reconcile these to establish a viable strategic plan whilst at the same time providing reassurance to all participants that their views have been considered and the basis for the priorities that the board ultimately establishes. The credibility of the organization in the eyes of key stakeholders is heavily influenced by how well the board conducts these processes.

As part of the strategic planning process, it is necessary to incorporate a deep and strategic analysis of the whole national R+D+I ecosystem to clearly define the role of the public institution within the national ecosystem and the essential roles played by others. In many cases this analysis reveals the need for more formal agreements between institutions where the co-dependence is

deemed to be high. A similar evaluation of international activities that the institution will draw upon in delivering its strategy is also typical as part of the strategic plan development. In total, these actions should make clear the rationale for the established priorities and strategies of the institute.

The success of a strategic planning process is not achieved solely with the approval by the authorities of the proposed plan and its communication, but with the successful achievement of the indicators and goals established therein and with the degree of satisfaction of the external and internal stakeholders of the organization. In fact, a significant ancillary benefit of the strategic planning process is the generation of new ideas and demands and questions it raises, and the human inter-relationships that it helps create which can be subsequently harnessed to guide the institute.

2.3. Profile and representativeness of the Board of Directors

How the very many interested stakeholders are represented in the governing bodies of R+D+I institutes is key to their legitimacy and sustainability. The board membership must ensure representation of the key stakeholders (i.e., those with an interest in the institute and who can either affect or be affected by the institute and its outputs) and ensure that the specific skills of board members (specialties, experience, strategic thinking, etc.) are matched to the needs of the organization. This can be difficult to achieve, given that effective boards normally seek to contain no more than 7-12 members. Because of this size limitation, most board's develop processes to capture the involvement of wider groups during the formulation of strategies and evaluation often through workshops, advisory groups, or in some cases regional-level sub-governance mechanisms. In these processes, boards should be proactive and transparent in soliciting input from stakeholders and staff to the organization's strategy and performance, without diminishing the accountability of the board. The participation and contribution of internal and external actors add value, credibility, and sustainability to the processes of institutional transformation and the achievement of goals.

By way of example, we illustrate below, the typical composition and characteristics of the boards we have worked with during our CEO careers. As with all sections, more details are available in the individual reports.

Reports by organization

INIA-Uruguay

The Board of Directors of INIA Uruguay is composed of four members —50% appointed by the government, 50% appointed by the private sector. The president and vice-president are appointed by the Government's Executive Branch, at the suggestion of the Minister of Livestock, Agriculture and Fisheries (MGAP), with the support of the entire cabinet of ministers and the President of the Republic. These two are therefore political positions, appointed by the Government. The two positions (two full representatives and two alternates) representing the private sector are drawn from two groups —a full representative and alternate is suggested collectively by the Federated Agricultural Cooperatives (CAF), National Commission for Rural Development (CNFR) and the Uruguayan Federation of Regional Centers for Agricultural Experimentation (FUCREA) and another full representative and alternate is nominated from the Association and the Rural Federation of Uruguay. In total, these producer organizations are the most important in the country, and they have a wide national coverage and regional presence. The members put forward by the private sector are formally approved by the Executive Branch.

Regarding the members from the private sector, there are agreements between the different producer organizations to alternate their delegates over time (3 years) and for the position they occupy (representative or alternate, although both positions attend all board meetings). Within producer organizations, there are no formally established mechanisms for the selection of their representatives.

From 1990 to 2021, eight presidents and eight vice presidents were appointed by the Executive Branch in different political administrations. In general terms, the presidents were largely producers and agronomists with some degree training, although with less experience in R+D+I management, agricultural unions, academic functions, or political positions. Few were members of the INIA's technical staff. In the case of the vice-presidents, there has been a higher proportion focused on science and technology, and a higher degree of training (some to a PhD level), most of these have not been INIA staff, and they have been predominantly academic agronomic engineers with less experience in private sector management. To date, none of the Presidents or Vice Presidents have held similar or significant positions internationally. The first female member of an INIA Board of Directors, as vice president, held her position in the period 2018-2020.

The profile of the members from the private sector on the Board of Directors reveals that these have all been Uruguayan males —predominantly producers, unionists,

and rural entrepreneurs and generally with degree training. These members have had no or little academic activity during their tenure on the INIA board and very little training in the management of R+D+I organizations, practically no experience in previous political positions.

The leadership capabilities and knowledge of the board are critical in the modernization, credibility, and sustainability of R+D+I institutions. Therefore, the selection process, both for the public and private sector roles on the board, must be clearly defined and evolve to adapt to the requirements of leading a complex organization with highly qualified personnel and growing demands and pressure from the public and private stakeholder and wider society.

The INIA President is deemed a full-time role and is paid by the government an amount equivalent to the Vice Minister of Agriculture. The remaining board members are compensated for attendance at each board meeting. The INIA board is strongly supported by the governing bodies aligned with five regional research centers.

IRTA-Spain

The highest governing body is its Board of Directors and contains 14 members. Eight of these members are drawn from government ministers' representatives, four members are drawn from the private sector, one member is chosen by the IRTA staff representative bodies, the CEO of IRTA is the final member.

The Presidency is held by the Minister of Agriculture of the Autonomous Government of Catalonia and the vice-presidency is held by the Minister holding the portfolio responsible for research and universities. The other government-associated roles are high level staff (minimum rank of Director General) of the Departments (equivalent to a Ministry) of the Autonomous Government of Catalonia — specifically, two members appointed by the Ministry of Agriculture, and one member from each of the departments responsible for research, economics and finance, health, environment, and industry. The final government-associated role on the board is a single member who represents the collective interests of the provincial councils that participate in the financing of the institute.

The private sector is represented by 4 members on the Board of Directors. These representatives are directly appointed by the President of the board based on the requirement that at least one is appointed on the proposal of the major trade union organization of the agri-food sector, and the other three are drawn from among professionals and prestigious entrepreneurs in the agri-sector. All board members exercise their vote in their personal capacity and are legally accountable for their actions with their own assets, except for the trade union representative who exercises it on behalf of his trade union. IRTA board members do not receive any financial compensation, not even meeting attendance fees.

Like INIA in Uruguay, the board of IRTA also utilizes a second level of informal governance associated with IRTA's experimental stations which brings additional private sector expertise. The private sector also influences the governance and direction of IRTA thorough an Advisory Council, which is the technical advisory body of IRTA.

New Zealand Crown Research Institutes (NZCRI)

The boards of NZCRI, which generally number 7-9, are appointed by the government's shareholding ministers with the support of the full cabinet. The appointment process is intended to follow best practice for commercial board appointments to create a diverse board membership whose skills reflect the requirements of the NZCRI at that point in time and balance the key functions of the board which are to manage risk and to chart and monitor the execution of the strategy. The existing Chairperson of the NZCRI is generally involved in the identification of the skills required, the short-listing of candidates and the interview process.

All NZCRI directors are "independent" —they are not staff of the institute nor part of the current government. Moreover, there are no guaranteed board roles for any sectoral body or organization. Any individual can make application for consideration and there is no requirement that the individual is a New Zealander or living in New Zealand, though in practice for convenience most directors are New Zealand-domiciled. The board composition is typically a mix of generic professional skills relevant to governing any organization (e.g., finance, human resources, strategy) and sectoral experience associated with that NZCRI's areas of operation.

In addition to their other professional skills, NZCRI board members should have a strategic vision and be able to work in the interests of the institute and the country through the institute. In the author's opinion, the inclusion within the board of a majority of active agri-sector and scientific leaders with the necessary skills and sectoral respect is extremely important —these individuals not only contribute positively within the board due to their knowledge and commitment to the sector, but they assist greatly towards enhancing the board's and institute's credibility with the non-government stakeholders.

The NZCRI director appointment term is normally for three years, with a high likelihood of a second three-year term if the performance and skills of the director are still

desired. This tenure is long enough to add value, but also allows for valuable and necessary refreshment as the institute's needs change. NZCRI board members are paid for their services by the government and many NZCRI directors are now full-time professional directors, often with several government-related board appointments.

NZCRI boards are given the freedom to establish any other advisory boards or sub-committees of the full board that will assist the board in discharging its duties, without diluting the accountability of the full board. This approach enables the board to remain effective in number (e.g., 7-9) whilst at the same time leveraging more expertise. For these reasons, most NZCRI establish some form of external scientific and/or private sector advisory boards and form board sub-committees to focus on audit/risk, human resources/culture and to oversee especially transformative projects.

The work of (Gianoni and Trigo, 2021) supports for LAC what we have experienced in practice in New Zealand, Spain and Uruguay: *"...the governance model of the agri-food R&D system of the countries of LAC should stimulate greater participation from the private, business, foundations, universities and agricultural and rural communities, having to also integrate the political-technical decision making sphere, not only of the ministries directly linked to the sector, but also to the health, economy and environment. And as Fontagro (2019) states "all this from a non-rivalry approach, but synergistic between public and private efforts."* (p. 20).

2.4. Final considerations

Based on the information analyzed in our previous reports and summarized above concerning the governance of R+D+I organizations, **Table 1** summarizes what we consider to be the critical factors and the tools that are utilized for best practice governance models. The previous reports provide specific examples, especially for strategic planning and reporting documents.

TABLE 1. RECOMMENDED CRITICAL FACTORS AND TOOLS FOR THE GOVERNANCE OF R+D+I ORGANIZATIONS

RECOMMENDED CRITICAL FACTORS	TOOLS
Clarity of the mission and expectations of the institute by the owners (government). Political independence of the decisions of the R+D+I organizations must be aligned with the law of creation of these, and for the consultation and agreements reached between public and private actors, and its measurement and communication.	Founding documentation, Government-approved strategic plan, consistent communication of expectations and performance.
Clear and well supported organizational priorities	Published strategic and annual operating plans and key performance indicators developed with the input of public and private stakeholders.
The inclusion of independent and private sector members in the main governance body	Defined by law and /or institutional policy.
A diverse and skills-based board of directors reflective of the key stakeholders and strategy of the organization.	Defined by law and/or institutional policy.
Empowerment of territorial or regional interests in the governance of the institute	Defined by law and/or institutional policies that defines the role of regional stakeholders in the governance of the institute either via membership of the board or through regional advisory committees.

3. Financial structure of operations

The long-term financial sustainability of public R + D+ I organizations is underpinned by the recognized contributions the institute makes towards economic, environmental and social advances. These national benefits originate in the institute's scientific undertakings and flow through their subsequent contributions to the design of public policies, new products and processes which increase the competitiveness of private sector business and myriad other "innovation pathways" which we will discuss in later sections. While it is an absolute necessity to do the quality science that contributes to these national benefits, this is not sufficient to guarantee long-term financial support —it is also important that the institute is recognized and valued for its contributions and that the credibility of the institution is enhanced as a result.

Committed co-investment plans by public and private entities in R+D+I organizations demonstrates alignment of their common mission and vision for the future. This alignment and cooperation provide a higher degree of financial certainty for the institute which, in turn, allows long-term planning especially in attracting, developing, and retaining talent.

3.1. Achieving the balance of funding mechanisms is a critical driver of behaviors

Striking the balance between stable institutional funding, performance-based funding, competitive government funding and financial contributions from the private sector is essential to creating the desired behaviors and culture in research institutes and their stakeholders. In broad terms —higher levels of non-contestable institutional funding promote stability and longer-term planning, but potentially at the risk of complacency for operational efficiencies, reduced innovation and new project development, and less focus on technology transfer and private investment. Conversely, high-levels of short-term competitive funding drives performance-based project systems and leads to higher-levels of project turnover and renewal, but potentially at the risk of reduced long-term program stability, more incremental science, and little strategic workforce planning owing to uncertain financial futures.

There is no internationally agreed funding ratio to achieve the ideal funding balance and many jurisdictions regularly review their investment models and their impact on institutional behaviors and performance and adjust them accordingly. In the authors experience it is absolutely the case that significantly changing the funding mixture will result in behavior changes both within the institution and by the investors and this lever is regularly used to underpin successful transformations.

Despite no "hard and fast rules" regarding the ideal funding mix, many jurisdictions target stable government funding covering approximately the cost of permanent or regular staff, which in most institutes equates to between 60% and 70% of the annual expenditure budget, as a reasonable balance point. This broad principle can apply even when the institutions are substantially funded via investment from the private sector.

In addition to providing a mix of stable institutional and project-based funding to individual institutions to achieve their mandate, in many cases the government will identify critical, long-term national priorities that require substantial contributions from multiple organizations. Current examples that may involve agricultural R+D+I institutes include freshwater protection, responding to climate change, sustainable food production, food science and technology, and human capability development. Oftentimes referred to as "national challenges", these should be supported via specific funding mechanisms to promote inter-agency collaborations to address the identified national challenges. Again, the explicit funding mechanism is a key lever to drive the collaborations required to address these challenges.

3.2. Direct non-government investment and revenue to the institute

The legal framework and/or policies of the institution should be constructed to encourage the institution to form close interactions and thereby attract direct investment from non-government sources and potentially sell services, products and capitalize on intellectual property. These frameworks and policies will vary

between countries, but in as much as is possible should allow the institute to operate in a commercial manner and form commercial relationships that are typical within their jurisdiction. Whilst being free to act commercially, the institute's statutes should reenforce that their primary mandate is to create national benefit, not maximize the commercial returns to the institute.

This commercial orientation is essential to gain the shared strategic links between the institute and those entities in the private sector who can assist in defining and financing the key problems to solve and who ultimately will translate the science into new products and services. Ideally, the private sector will see the institute as being "easy to deal with" and not overburdened with bureaucratic red tape. In addition to these strategic benefits, this orientation provides important additional revenue to most modern agricultural R+D+I institutions, which in turn enhances the national benefit that they can create.

Institutions should manage and coordinate the development of new knowledge and protect this intellectual property appropriately (via copyright, patents, plant variety rights, etc.) so that it can be utilized commercially by themselves or other entities, public or private. The legal framework and institutional policies should enable the institute itself to form commercial entities (e.g., joint-ventures, start-up, or spin-out companies) in order to create value from new knowledge when there are no existing entities able to do so. This orientation encourages the development of a more commercial culture within R+D+I institutes which assists in developing relationships with private sector firms which can generate commercial and intellectual property revenue streams. Moreover, this focus automatically leads to the orientation of activities to meet the needs of the sector and this is often advantageous when responding to competitive public and private funding calls.

A note of caution. An over-reliance on success in competitive public and private revenue and returns from intellectual property to compensate for inadequate stable government investment inevitably leads to thematic dispersion, the loss of research competitiveness and, in the long term, the loss of image and credibility of the institute. Critical programs and talented staff can thus be at risk. This funding imbalance situation was clearly revealed within the NZCRI model by the 2010 NZCRI Taskforce review and was subsequently addressed by the introduction of institutional "core funding". This is fully described in Richardson (2021).

3.3. Specific funding to promote national and international collaboration

Much like specific funding lines to support inter-agency collaboration described above, specific funding mechanisms should be developed within either the national investment processes or the institute itself to support international exchanges and professional collaborations. These experiences expose the institute and leading researchers and professionals to global best practices, and through this, enhances their value to the institute, industry, and country. These exchanges can be important aspects of human capability development and retention strategies, with the added benefit that the more highly trained individuals will improve the institutes' ability to attract competitive funds.

In collaboration with national governments, through international strategic agreements and alliances with multilateral credit organizations (e.g., IADB, World Bank), available loans can often be used to enable these strategic investments in human capital and research platforms.

3.4. The management of the organization's budget

Best management practices should promote a controlled, efficient, and balanced management of the different components of organizational expenditure that meets the strategy plan. To affect this, an annual budget and multi-year financial forecasts should be developed by the institution's management and approved by the board and owner. There is seldom enough money in public R+D+I institutes to do all the things that are desired or, in fact, that could create value. Inevitably there are trade-offs to be made. A well-run strategic budget process should ensure that over time, these trade-offs do not endanger critical elements, such as retaining the ability to remunerate high quality professional staff and refresh significant assets. Whilst this varies over time and between institutions approximately 60-70% of the total budget is generally allocated to personnel costs and the annual capital expenditure program is generally aligned with the deprecation charges against the assets.

To provide a safeguard against irreversible negative impacts of short-term economic and financial crises, it is essential to establish a reserve fund policy to maintain the medium- and long-term stability of the institute's core scientific programs and human capacity at these times.

3.5. Final considerations

Changes to the institutional funding mix will drive a change in behaviors. If fundamental changes to the funding matrix are being contemplated as a lever for institutional transformation, then it is important to carefully consider the current state, the desired state, and the realistic time frames for change when adopting or modifying these funding proportions. It is also important to plan on short (2-3 years), mid (5-7 years) and long (10-20 years) term reviews to determine if the desired behavior changes and outputs are being attained and to be prepared for further adjustments to the funding models as evidence is obtained.

Based on the information analyzed in our previous reports and summarized above concerning the financial structure of R+D+I organizations, **Table 2** summarizes what we consider to be the critical factors and the tools that are utilized for best practice models. The previous reports provide specific examples.

TABLE 2. RECOMMENDED CRITICAL FACTORS AND TOOLS FOR THE FINANCIAL STRUCTURE OF R+D+I ORGANIZATIONS

RECOMMENDED CRITICAL FACTORS	TOOLS
Clarity on the desired institutional investment mix (public and private) to balance long-term stability and encourage continuous improvement behaviors.	• Defined by law and /or institutional policies within the funding agencies. • Short, mid- and long-term reviews of the funding model and resulting behaviors and outputs.
Strong commercial orientation within the institute and an ability to engage easily with commercial firms in forming relationships, contracting for business, and forming commercial entities to advance intellectual property developed by the institute.	• Defined by law and /or institutional policies within the institution. • Appropriate professional commercial skills mix and training.
Clear expectations and processes for the development, management and commercialisation of knowledge (intellectual property) developed by the institute.	• Defined by law and /or institutional policies within the institution. • Appropriate professional commercial skills mix and training. • All contracts (public and private) for research contain clauses clarifying to all parties who owns, who has access to and who benefits from any intellectual property developed during the contracted work.
Specific funding mechanisms to promote national and international collaboration and staff exchanges.	• Funding to support collaboration and exchanges defined by law and/or institutional policies within the funding agencies and the institution. • Partnerships with international R+D+I institutions and lending agencies. • Identified in Strategic Plan with performance expectations.
A strong strategic review of the annual budget and future year forecasts to ensure a balance between longer-term strategic requirements and short-term activities is achieved.	• Budget approval process defined by law and /or institutional policies within the institution. • An approved Strategic Plan containing key performance indicators (KPIs) with clear linkages to budgeted programs/projects.

4. Human Capital Management

“Leadership and management are the most neglected issues in Latin America and yet they are indispensable. They are the number one success factor in any organization”.
Enrique Baliño, CEO Xn Partners (Uruguay)

The professional workforce (scientific and support) is the most important asset within any research institute and the research groups are the productive units of the institution from which new knowledge and opportunities emerge. Therefore, the attraction, hiring, induction, training, evaluation, motivation, and retention of high caliber professionals are the most fundamentally important policies within the institution. Such policies must be formalized, promoted, and communicated with total transparency so that all stakeholders (including staff) can appreciate the current profile of the organization’s workforce, the challenges, the future direction, and the mechanisms that will be used to achieve the future state. Strategic human resource (HR) management is thus one of the key positions in the executive management group that supports the work led by the CEO and the upskilling of leaders at all levels is essential for the incremental improvement of the professional workforce.

HR policies and practices for R+D+I institutions reflect the legal and regulatory framework and employment practices of each country. However, to achieve the long-term national benefit from these institutions it is imperative that the founding statutes provide an expectation that the institute places priority on comprehensively developing the highly skilled human capital which is essential for modern R+D+I institutions.

4.1. Human Resource Policies

A clear set of institutional human resources policies is essential to guide internal processes and to attain the strategic goals for human capability. In addition to articulating “best practices” for that jurisdiction, these policies should include the expectations of the organization to promote diversity (ethnic, gender, nationally, etc.) at all levels. The specific policies and how these are implemented within the institute depend very much on both the national frameworks and the employee profile within the institute, but special effort needs to be applied to ensure that under-represented cohorts of talent are brought into the organization and can progress through the organization. An “unconscious bias” towards hiring and promotion is often very real and will limit the attraction and development of talent if not proactively countered by both formal HR processes spanning recruitment, development and promotion and the education of those managers involved in these processes.

Finally, the growing importance of health, safety and wellness at work should be highlighted. This covers the employees, contractors and visitors to the institute and its facilities. In addition to the legislative requirements, these aspects have a substantive influence on the institutional climate and culture and increasingly the attraction and retention of talent. The importance of these areas should be reflected by the skills within the board and senior management, and a focus should be given to them in HR policies and staff training.

4.2. Identifying, attracting, and retaining talent

The proactive hiring of technical, scientific and corporate staff should be based on a formal process of auditing the existing workforce and comparing that with the workforce needed to address the organization’s future needs. These future needs will become apparent from the strategic science and innovation reviews which must consider both new skill sets for the organization and the replacement of skills that may be lost due to retirements of existing workers. Particularly in new areas of activity or where increasing long-term needs are anticipated, the co-supervision of doctoral and master’s students funded by the institute, or by third parties through research staff training grants, is an effective approach to developing such skills pipelines.

Once talented staff are attracted to, or developed by an institute, their retention and motivation must be considered because talented staff are noticed not just by the institute, but by outside organizations as well. Every person will have different expectations and desires for their career, and an institute cannot expect to meet everyone's wishes. However, institutional policies that balance consistency for all staff with flexibility to meet personal needs should be developed. Including questions related to retention drivers in staff surveys and conducting formal interviews with staff who elect to leave the institute provide valuable insights on the effectiveness of the current retention approaches and additional options.

One area that deserves consideration during retention policy development is whether or not mechanisms should be established to reward staff members (financially or otherwise) for their participation in successful innovation processes that bring financial benefits to the institute. The resolution of this should be captured in the institute's HR policies related to remuneration and benefits because it is important that an overall institutional balance is achieved and not all staff will work in areas where this type of reward is possible.

Whilst the drivers for retention differ widely, it is generally the case that remuneration itself is seldom the most important aspect in R+D+I institutions. This statement does assume that the institutes' remuneration is seen by staff as fair and equitable in the market. If over a period the institutes' remuneration practice has fallen significantly behind those which competitors offer, then there may be a need to significantly lift the remuneration levels in order to attract and retain top talent. Benchmarking remuneration practices annually will avoid falling into this situation.

Talent retention strategies for high performing staff should focus on learning opportunities, lifelong retraining, and meaningful performance evaluations linked to promotion, salary progression and professional development. In addition, one of the best predictors of staff retention is the quality of that person's direct line manager. If one wishes to retain high caliber staff - make sure they have a good manager. Section 5.7 below expands on these aspects of learning and development.

While retaining top talent is clearly desirable, it should be expected that the composition of a research group can, and surely should, vary over time because of the evolution of successive Strategic Plans and their objectives. It is advisable to ensure that institutional employment practices anticipate this healthy turnover. Indeed, most of the reference institutes determine what they consider a healthy annual turnover as well as longer-run strategic evolution of the workforce and create employment conditions that allow these to happen.

4.3. Leadership and high-performance team and culture building: an important focus for all levels

Many organizations associate "leadership" and "leadership development programs" only with the highest-ranking executives within the organization. It is inarguably important that these senior positions have strong leadership skills, however the managerial and leadership training of middle level corporate managers and scientific research group leaders is an essential part of creating a high-performance organization. These managers represent the key link between high-level organizational strategies and the daily activities of front-line workers. As such, they provide (or fail to provide) most of the institute's staff with the motivation and alignment to the overall goals of the organization and the sense of purpose that comes with contributing to larger benefits. Both aspects are increasingly important in retaining high performing talent.

A common reason why management and leadership training are so important (and often so impactful) for these mid-level managers is that it is common to promote staff into these roles by virtue of their strong technical skills and success as practicing researchers or support professionals. In many instances, their educational backgrounds and professional development have not exposed them to the frameworks and approaches to lead and manage groups of staff. However, their promotion to these management roles should reflect the institutes confidence in their willingness and ability to augment their technical skills. For the reasons highlighted above, investment to improve the management and leadership skills of technical line managers is an investment well-made and with a high return to the organization via the performance of these teams.

Continual improvement of leadership skills is important at all levels within the organization and the implementation of well-considered and constructive 360° feedback and coaching processes for all managers assists in identifying strengths and improvement opportunities, both for individuals and for leadership teams. The incorporation of such approaches should be part of a modern human capability development plan for R+D+I institutions.

R+D+I organizations must also have on their agenda the periodic evaluation of the "organizational climate", which reveals the satisfaction of the institute's staff in four dimensions: the organization, their boss, their work, and their colleagues. There are many approaches to conducting these surveys (frequent and focused through to biennially and comprehensive) and each institute should select an approach that suits it. In all cases however, the survey must be supported by the leaders of the institute, it should

ask questions that are meaningful to that institute, the results of the survey should be reported to staff, and an action plan should be developed based on the results. By repeating these processes over years, improvements will be made on the levels of motivation and quality of working life for the staff and their commitment to the organization. Given the importance of middle managers on talent retention and development it is especially important to recognize outstanding survey results within teams and to address the areas where team culture is lagging. Such interventions at the local team level can lead to very rapid positive changes.

4.4. Internal communication

Doing the "right" things is not always sufficient to achieve the desired response. Consistent and reliable internal communication is a critical component to building a positive culture. Internal communication is fundamental to staff motivation, creating a sense of belonging and, ultimately, transparency. The many ways to achieve effective communication must be tested and modified from staff feedback. These modalities range from electronic "all organization" messages (now commonplace and even more effective when using videoconferencing platforms) to face-to-face presentations and Q&A sessions with the CEO and executive leadership team. The normal trade-off is that most staff will want to have "much more" communication from senior leaders, while most senior leaders have very high demands on their time. Finding the right sustainable balance is assisted by growing the leadership effectiveness of middle managers for the reasons described previously.

4.5. Career progression and personal development

The greatest incentive for an employee is to see their effort and success recognized and rewarded. A high performing research institute therefore must have a clear career progression system, linked to salary increases and greater responsibilities. It is recommended that the scientific professional career has between four and six categories, so that, in an optimal situation, a high performing junior scientist admitted as a researcher-in-training has the possibility of moving up through categories every 4-5 years.

It is essential that promotion and remuneration systems are transparent and applied over time in a coherent manner because all staff must consider them fair and equitable, and with criteria stable enough to allow personal career plans to be developed and actioned.

Promotions and rewards should reflect, in a balanced way, the key aspects of the institution's activities as it strives to create national benefit and as recorded and measured in the Strategic Plan. So, for example, the aspects of high-quality scientific discovery and publication are essential and should be reflected in the promotion assessment of technical staff, but equally important in the creation of national benefit from those discoveries is the development and implementation of the new technologies. These "downstream activities" should also be reflected in the promotion assessment. It is important that each staff member not be expected to excel in all aspects -some will be excellent in scientific discovery, others in forging strong ties with private sector innovation partners. Both should have clear promotional career pathways. In totality, the executive managers must ensure that the workforce, the annual staff performance targets and assessments, and the promotion process are fair and transparent and that they reflect the overall needs of the organization. For this reason, the executive management team plays a vital role in ensuring that there are no "favourite" or disadvantaged areas within the organization. Section 6 expands on all aspects of performance evaluation.

4.6. Human resources education and training plans

To strategically develop the organization's human capability, an organizational training and development plan should be created by the senior HR executive, with the support of their executive colleagues. By way of example, at INIA Uruguay an intersecting set of plans create a clear talent development and retention program. This set of plans includes: (i) a long-term training plan for researchers and non-research professionals, ii) an academic updating plan for researchers, iii) a training plan for graduate students and postdocs supervised by researchers, with a scholarship system that supports it, iv) a plan for the development of critical cores in strategic areas of knowledge, and (v) a talent succession plan to ensure that anticipated retirements in important areas are covered (Montossi, 2021). Similarly, IRTA has produced a very well-structured staff training plan which may serve as a valuable resource for constructing institutional-specific plans (Monfort, 2021).

4.7. Final considerations

Based on the information analyzed in our previous reports and summarized above concerning the human capital management of R+D+I organizations, **Table 3** summarizes what we consider to be the critical factors and the tools that are utilized for best practice models. The previous reports provide specific examples.

TABLE 3. RECOMMENDED CRITICAL FACTORS AND TOOLS FOR THE MANAGEMENT OF HUMAN CAPITAL OF R+D+I ORGANIZATIONS

RECOMMENDED CRITICAL FACTORS	TOOLS
Clear human resource policies that define best practice approaches to all aspects of capability attraction, development, diversity, retention, health, safety and wellness.	• Defined by law or institutional human resource policies and best practice guidelines for staff to follow.
Strategic workforce planning	• Strategic plan, research groups reviews, workforce audit.
Attraction of high caliber staff	• Renumeration and benefits benchmarking. • Positive institutional brand image and reputation. • Transparent career progression and learning and development pathways. • Pre- and post-doctoral scholarships.
Talent retention and progression	• Renumeration and benefits benchmarking. • Positive institutional brand image and reputation. • HR Training Plan. • Transparent career progression and continuous learning and development pathways. • Collaboration and exchange programs. • Learning and development programs for middle managers. • Staff surveys.
Timely turnover of personnel	• Workforce plan. • Renewable contracts. • Retirement system and incentives for early retirements.
Highly skilled leadership and management teams	• Institutional HR training plan. • Leadership and management development plans for all individuals and groups. • Constructive 360 feedback processes. • Staff surveys.
A positive organizational culture	• Strategic Plan. • Renumeration and benefits benchmarking. • Positive institutional brand image and reputation. • Transparent career progression and learning and development pathways. • Learning and development programs for middle managers. • Constructive 360 feedback processes. • Staff surveys. • Consistent and effective internal communication.

5. Organizational structure

“The best structure does not guarantee results or performance, but the wrong structure is a guarantee of failure”. Peter Drucker

Comparisons between the organizational structures of successful agri-food research institutes reveals that while very different organizational structures can be successfully implemented, the structure must be aligned with, and reinforce, the operational model that the institute has adopted to deliver its Strategic Plan. An effective structure must ensure that all required functions are well covered, without duplication or ambiguity, management units and reporting lines are clear and that every role within the structure has an acceptable span of control and number of staff reporting to it.

5.1. The organizational structure

The basic organizational structure of most modern R+D+I research institutes reflect common commercial business structures. Although various role titles are used, there is a single top executive (typically referred to as the “CEO” or L1) who reports to the Board of Directors and has overall accountability for managing the organization. The CEO is supported by a group of “executive managers” (sometimes referred to as L2 managers, and collectively as the “Executive Team”) who control the various functions and departments of the institute. Each of the executive managers will in turn have a number (ideally 6-8) mid-level managers (L3) who lead specific functions within the organization. Each component of the organizational structure should conform to best practices regarding the number of direct reports to any individual, to ensure that each staff member has the appropriate supervision and guidance from their line manager.

Whilst this cascade of roles is almost universal, the number of roles at each level and the span of each role can vary greatly and each option will create different degrees of emphasis and drive different behaviors within the organization. Because of this, organizational structure should be considered as “fit for the current priorities” and expected to be flexible to adapt to the priorities established in the successive Strategic Plans. A current example of this in many R+D+I institutions is the information technology (IT) function. Historically the IT function was responsible for ensuring that the computers and telephones worked, and that scientific staff had enough computational storage space for their datasets. The head of IT was often a very operational L3 role who reported to an L2 “corporate services” manager. In modern R+D+I institutes, the growing importance of data science, computational modelling, machine learning and artificial intelligence, geographical information systems (GIS), globally distributed teams, etc., is changing the way science is being done and hence IT is now a key strategic priority area for most institutions. Thus, the IT leadership is frequently now an L2 role reporting to the CEO and playing a key role in organizational strategy.

Similarly, knowledge and intellectual property management (KM) is now a much more strategic and complex function for R+D+I institutions and the traditional HR functional role, is now a more strategic and holistic “people and culture” role in many institutions. While the three examples of IT, KM and HR escalating in importance within the structure of R+D+I organizations are likely to be durable for the foreseeable future, in other instances the structural change may reflect a shorter-term strategic priority and a leadership role may move from L3 to L2 for a period and then revert to back L3. In other words, organizational leadership structures should reflect the institute’s strategic priorities and management roles, or functions should reflect the strategic approach. Therefore, achieving the right overall structure to support the strategy, mission, vision, and culture of the organization is an art and an organizational culture that embraces this flexibility should be a goal of the organization’s leadership team.

Against this backdrop of flexibility and evolution —one feature is imperative in a R+D+I organization and that is that any structural change must always be in pursuit of a better adaptation to the objectives of the Strategic Plan and there must be a coherent narrative that justifies the changes in a way that the entire organization and its key

stakeholders can understand. The Strategic Plan is the key guide (and that should have achieved strong support) and the organizational structure is one of the tools to achieve that plan. To improve the success and communication of strategic plan progress and achievements a of planning, monitoring and evaluation capability, should be established to work closely with research and innovation leaders and report to the CEO.

The processes of reviewing and adjusting the organizational structure will in turn cause changes to many internal processes and procedures. These changes should be planned for and well-designed before communicating and implementing any structural modifications. The success in establishing a change in the organizational structure is enhanced by having and executing an effective communication plan (internal and external) on the reasons for the change in organizational structure, the expected benefits compared to the existing structure, who are responsible, how the different levels (internal and external) participate, how the process will be implemented (times and milestones), and how the effectiveness of this proposed change will be measured.

5.2. Strategic organization of research activities

Within the overall institute structure, the organization of the research units deserves special mention as they are the core of the activities where knowledge creation that will underpin future benefits occurs. In the same way that changing strategic plans and priorities influence the high-level organizational structure, so too are the changes to the way science is done and the expectations on R+D+I institutes influencing how scientific activities are structured in many modern agri-institutes.

Traditionally, the scientific structure of most public R+D+I institutes reflected and strongly reinforced the scientific disciplines of the staff (e.g., chemistry group, plant breeding group, animal health, food science, etc.) with budgets, outputs and assessments aligned with these "departments". However, as the expectations have grown for these institutes to produce solutions for industry and to address significant national challenges, so too has the need to easily form the interdisciplinary teams needed to address these. To successfully meet this challenge the reporting structure (and as importantly the critical organizational processes and infrastructure) must enable the easy assembly of scientific staff from a range of disciplines into project teams focused on the problems prioritized within the Strategic Plan. So, for example, it is now common to find research teams called "sustainable farm systems" comprised of scientists with training in plant biology, pest management, soil science, environmental modelling, animal nutrition, data science, robotics, machine learning, etc., all in one structural project-based team. As described above, the structure should reinforce the importance of, and the delivery to the strategic priorities and thus this evolution of science structures is rationale.

Within the scientific structure, the roles of the "Scientific Director(s)" and an International Scientific Advisory Committee (ISAC) are often considered key to achieving greater degrees of scientific excellence. The person who holds the Scientific Director role is the senior scientific executive(s) for the organization, reporting to the CEO. They are charged with developing and executing the scientific strategy and the human capability plans to support that strategy. In both these endeavors, the senior Scientific Director is support by other institutional colleagues and external expertise. This role must provide the strategic science leadership for the organization and represent the organization professionally to key stakeholders and the wider scientific community. This role is typically filled by a scientist of recognized prestige, and who has developed strong leadership and management skills.

To support the development of the scientific strategy and provide regular independent assessments of progress to the management and governance teams, most modern institutes establish some form of ISAC. This advisory body does not dilute the accountability of management and the board for the institute's performance, rather it provides additional expertise and experience to management's considerations and provides the board with an independent expert assessment of the organization's scientific performance and strategy. The authors have all found this a valuable additional source of expertise, especially during times of transition or organizational transformation processes.

In summary, the science structure should align with the activities carried out by the organization and contribute to the formation of interdisciplinary teams, continuous operational improvement and the attraction, development, and retention of talented scientific staff.

5.3. The role of leaders in R+D+I organizational transformations

"Only three things happen naturally in organizations - friction, confusion and under-performance. Everything else requires leadership". Peter Drucker

In any organization, strong consistent (persistent!) leadership is essential for transformational change.

Alignment from the owners/board through the CEO and the executive management and to the leaders of research and support lines (where most staff will seek reassurances) is critical. All these leaders need to be clear and to be able to clearly explain to their teams (in ways that resonate to them) the reasons for the changes in organizational structure, the expected benefits from the changes compared to the existing structure, who is responsible for each activity, how the different levels participate, the timelines and milestones for implementation and how the effectiveness of the change will be measured.

All the above is true for any organizational change process —but in R+D+I institutions the requirement to logically explain these aspects, to provide objective measurements, and to involve staff are heightened because of the professional training of the staff— they seek data and proof and are trained to be skeptical and find holes in proposals. They will exercise these skills in the face of proposed organizational change. However, if these challenges are met with solid, rationale explanations, then the staff will support them because in general R+D+I staff have a strong loyalty to the organization and are committed to making contributions to society through their work in the organization.

The final component of leadership is to establish and manage the speed of change. This too is far more art than science and relies heavily on the maturity of the organizational culture for change. In some instances, it may be best to pilot changes in a small area, assess the effectiveness and then widen the implementation. At other times it is best to do the whole program at once, confine the inevitable staff uncertainty to a shorter timeframe, quickly move to the "new state" and refine thereafter. Regardless of which approach is taken it is important to roll out the changes to the communicated schedule and to avoid backtracking, otherwise staff confidence and trust in the process and leadership will decline and the introduction of subsequent changes will be much more difficult.

Some of the main threats that must be anticipated and avoided in any modern R+D+I organizational change program are:

1/ Creating a structure that makes incorporating new research themes difficult.

2/ Creating a structure (or supporting processes, like budget management) that makes it difficult to form, dissolve and reform interdisciplinary project teams.

3/ Providing insufficient support for middle managers to input into the change process and to effectively communicate the changes and benefits to their team members.

4/ Excessive slowness in decision making and implementation.

5/ Allowing a proliferation of structural elements, specialized units, or a regional replication of assets. This leads to excessive growth of small research units, uncertain management relationships, a reduction of critical mass, inefficient replication of infrastructure and frequently a non-alignment with the overall mission of the institution. Sometimes this is referred to as the "dinosaur strategy" because the unwieldy size hastens extinction.

5.4. Final considerations

Based on the information analyzed in our previous reports and summarized above concerning the development of optimal structures for R+D+I organizations, **Table 4** summarizes what we consider to be the critical factors and the tools that are utilized for best practice models. Previous reports provide specific examples.

TABLE 4. RECOMMENDED CRITICAL FACTORS AND TOOLS FOR THE STRUCTURE OF R+D+I ORGANIZATIONS

RECOMMENDED CRITICAL FACTORS	TOOLS
A well supported Strategic Plan	• Board-led process to develop and adopt a Strategic Plan that is supported by the owners, staff, and external stakeholders.
A well-planned organizational design process to review the existing structure against the Strategic Plan and test alternative structural models.	• Strategic Plan. • External organizational design expertise. • Internal staff and external stakeholder involvement.
Appointment of high-quality managers to lead the implementation process.	• Output from Organizational Design process with clear management roles, reporting lines and accountability. • Clear internal and external communication plans.
Well-developed and communicated process to obtain input from stakeholders: staff, clients/collaborators and owners.	• Appropriate consultation mechanisms (staff workshops, technical advisory groups, regional and national sector groups etc.) to obtain input from stakeholder. • Clear internal and external communication plans.
Identification and redesign of internal procedures and processes impacted by the organizational changes.	• Process flowcharts for all organization activities. • Strong participation by all levels of the operational teams.
Strong, consistent and visible leadership during time of change.	• Strategic plan. • Leadership training programs. • Internal and external communications plans.
Efficient implementation of organizational changes	• Clear timelines, milestones, and responsibilities shared with all stakeholders. • Internal and external communication plans effectively led by managers at all levels within the organization. • Planning, monitoring and evaluation unit.
Selection and appointment of the executive scientific director	• A clear role description. • A selection process that ensures high caliber internal and external candidates are attracted to apply.
Selection and appointment of the **International Scientific Advisory Committee (ISAC)**	• Strategic Plan. • Board-led process to identify and appoint 4-6 renowned scientists and/or R+D+I institutional leaders (current or former) whose expertise aligns with the scientific and organizational priorities.

6. Performance evaluation

“You can’t improve what you don’t measure”.
Peter Drucker

A culture that embraces objective performance evaluation is important in a modern, successful, and constantly improving research institute. Assessment and reporting processes that are well constructed and reliable provide benefits to the organization at large, to research areas, and to individual staff members by clarifying expectations, providing opportunities to modify activities so that changing circumstances can be met, and enabling corrective actions to be taken where needed to improve future contributions. In their entirety, these processes reflect an organization that is confident to agree what it will provide to owners/investors and is willing to accept an objective assessment of its performance. These attributes, combined with good performance, build trust between the institute and its stakeholders in government, the business sector, the community at large, and staff.

To derive the greatest benefit from organizational, research group and individual performance evaluations, it is important that the key performance indicators (KPIs) themselves relate strongly to the prioritized and agreed strategic and operational plans, that the indicators represent the full breadth of expected results and do not focus too much on “easy-to-measure areas” at the expense of areas that are difficult to measure but of greater strategic importance, and that the measures are developed and agreed upon by those who actually fund and produce the work.

6.1. Organizational performance assessment

It is essential that the indicators developed to measure the performance of the organization relate directly to the agreed strategic and operational plans, which should reflect the contributions and expectations of the key funders and stakeholders of the organization. These indicators should cover the entire set of expectations on the organization.

Some areas have “easy-to-quantify” indicators, such as financial performance and scientific publications, making them easy to measure once the budget and scientific strategy are set —the key budgeted financial metric becomes the performance measure (e.g., budgeted surplus, budgeted revenue from strategic sources, etc.) and the publication targets set in the science strategy become the metrics assessed (e.g., total number of refereed publications, number of international publications, patents, licensed cultivars, etc.). However, even in these relatively objective measurement categories it is important to carefully consider the metric —ideally the metric is established to drive behaviors and one needs to ensure that it is the desired behaviors that are being incentivized.

Conversely, many equally important aspects of institutional performance and contribution such as the success of technology transfer activities and attracting, retaining, and developing talent are much less easy to quantify and are dependent on many externalities which makes it more difficult to measure and establish the institute’s specific contribution. Therefore, a significant effort is often required to develop appropriate measures to assess the institute’s performance and progress for such areas. Fortunately for those who wish to initiate this process, all research institutes face these challenges and many now freely share their performance indicators as part of their strategic planning and annual reporting processes. A lot can be learned, and a quick start can be made on implementation by reviewing how other institutes have constructed these metrics and then modifying them to the circumstances and priorities of the institution. Our three prior reports demonstrate how our organizations approached these metrics: INIA-Uruguay (Montossi, 2021), IRTA-Spain (Monfort, 2021) and AgR-New Zealand (Richardson, 2021). The examples of AgR KPIs reporting for 2019 are described in Annexed.

Once these metrics have been developed for the organization’s performance, they should be made public to ensure that stakeholders (including the public and staff)

understand what the organization is expected to deliver and how it will be evaluated. Within the institute, the progress against these metrics should be an integral part of the internal communications plan and collateral such as posters and intra-net updates can be used to keep the focus areas front of mind for staff and to celebrate progress.

In our experience, this process of making the organization's performance targets widely known is especially important when those expectations are changing or when confusion has developed among stakeholders regarding the institute's approach. Without this public knowledge of the agreed priorities, the board, managers, and staff of the institute may well be pressured to address areas of special interest (some of which may have been priorities previously) to meet the needs and demands of specific stakeholders, even though these are no longer priorities. On the contrary, when the Strategic Plan and performance indicators of the organization are widely known, the action of the organization can be clearly understood, and an environment of greater trust and understanding can be created.

As part of this culture of measurement and evaluation, some institutes establish a project management office (PMO), often under the mandate of the CEO or an executive manager. The PMO has staff with experience in planning, monitoring, and evaluating key organizational performance indicators and their alignment with the objectives of the strategic plan. In addition, the expertise within the PMO often assists major institutional projects and can assist in training general staff in project management competencies and methodologies.

In addition to self-evaluation by the organization, the performance evaluation process should involve external parties such as scientific advisory committees as described previously, clients, business experts, financial auditors, etc., on appropriate time scales. The involvement of these independent subject matter experts not only provides the opportunity to gain new knowledge, but also provides a degree of third-party validation that is healthy and needed. External review by knowledgeable experts is at the heart of the scientific ethos and should be for institutional performance as well.

Timelines for the evaluation of the organization's performance vary, but a significant progress report against the Strategic Plan should be made annually, and a thorough review of the existing plan, progress, and next steps should be conducted every 3 to 5 years. In many cases, institutes provide more frequent and less formal updates to the government on a quarterly or six-monthly basis.

Over longer periods of time (approximately every 10-20 years), a national assessment of the policy and institutional settings for the innovation system should assess whether the various settings are appropriate and are encouraging the desired behaviors, outputs and outcomes for national benefit from the investments being made. For example, as described previously, the systemic interventions that followed such a review in New Zealand in 2010 successfully addressed significant sub-optimal aspects of the NZCRI funding and governance models which lead to immediate changes in the performance measures for organizations (Richardson, 2021).

6.2. Performance evaluation for areas of activity

As discussed previously, the research groups within the institute are the engines that generate the knowledge to underpin future innovations and benefits. The priorities of the various research groups are driven from the Strategic Plan, and it is the performance of research groups/science programs that primarily determine the degree of progress made against the plan. It is therefore surprising that many organizations conduct comprehensive evaluations of organizational and individual performance but fail to set targets or evaluate the performance of research teams and scientific programs.

Many of the characteristics described for the evaluation of organizational performance also apply to the evaluation of areas of activity within the organization —the indicators must cascade from the strategic and operational plan to the specific scientific (or corporate support) group, show connectivity with the indicators of organizational performance, and the metrics must be clear to all members of the different groups and their stakeholders. A thorough assessment of activities at this level requires the involvement of scientific partners, customers, and key stakeholders in the area under review.

All key aspects of scientific activity, technology transfer and innovation planning must operate in an effective and coordinated manner for successful innovation to occur. The process of establishing targets, objectively assessing, and then agreeing action plans applied regularly at all levels greatly increases this likelihood.

6.3. Evaluation of individual staff performance

Attracting, developing and then retaining qualified professional staff is an ongoing challenge for most R+D+I institutes. Fortunately, one of the keys to retaining talent is under the control of the organization and that is to provide honest and constructive performance feedback,

and then back it up with performance-based development, compensation, and promotion opportunities.

When establishing personal performance indicators, it is important that they are aligned with the group's operational plan and show a link to the organization's Strategic Plan and targets. This demonstrates how the staff member's efforts are contributing to the organization's achievements. Not only is this important to ensure that these plans are met, but this "line-of-sight" of an individual's contribution to the broader goals and benefits of the organization is increasingly attractive to young talent who want to "make a difference" and yet, very often, don't see how they can do so. For managers at all levels, this line-of-sight benefit should be captured, and they have a critical leadership role to ensure that it is.

The individual performance measures themselves must be agreed between the staff member and their line manager and reflect the full range of the priorities for that individual, including any professional development activities.

While frequent constructive feedback on performance should be encouraged, there must be a formal and recorded review of each staff member's performance at least once a year. This process should allow for self-evaluation and evaluation by line managers and colleagues so that a holistic assessment of the person's contributions to the performance of the group and the organization can be attained. Once the process is complete, both the staff member and their manager must develop and agree an individual next-stage development plan.

Providing honest and constructive feedback is not easy for most managers. Some find it hard to praise good work and almost all find it difficult to provide feedback when there is a gap in expected performance. However, this is a critical function for managers and can be greatly improved through training programs designed to assist managers develop the skills to provide and receive feedback on performance. This training should be implemented throughout the institute.

Research consistently shows that high-performing staff respond negatively to performance systems that do not discriminate between different levels of performance. For example, if performance assessment scores in an organization range from 1 (low) to 5 (high) and 90% of staff are scored 4 or 5, then this is not an effective and fair system. This is not, however, an uncommon initial distribution and is observed in many institutes, including those that the authors have led. Some organizations require a "normal" distribution of staff performance scores and achieve this by requiring all managers to score their staff accordingly. Other organizations focus on moving the distribution more gradually over time through manager training and greater staff awareness and trust regarding the outcomes of performance assessment. Each institute must decide on the approach that best suits the desired culture of their institution.

Even with successful training programs in place, managers will vary in their expectations for staff and how they rate staff in performance evaluation processes. For these reasons, it is important that the institute has a process (usually coordinated and supported by human resources and led by the executive management team) to calibrate across the organization so that all staff are evaluated comparably. Staff should view the overall process as fair and equitable, and this executive level calibration process is an important component in achieving this.

It is essential that the performance assessment result is then strongly and transparently linked to both promotions and remuneration processes. Most modern R+D+I institutions develop a matrix of performance assessment versus remuneration increases to guide this process, which is generally conducted annually. The forms of remuneration (e.g., permanent increase in salary, one-off payment, etc.) and promotion are guided by the policies of the institution and the affordability at any given time, but regardless of potential restrictions it must be clear that remuneration and promotion is strongly linked to good performance as defined by the institutional needs. It is advisable that evaluation, promotion, and reclassification committees include staff representatives among their members. This better conveys the objectivity of the system to all workers.

It takes several years to evolve processes, managerial experience and, most importantly, the culture of high trust required to achieve an effective performance-based evaluation system. However, the performance of the organization and the ability to attract and retain quality staff will depend on this process, so you must be constant and demanding of progress at all levels of the organization.

6.4. Final considerations

Attaining alignment between the goals of the organization and the activities of every staff member is a goal worth pursuing. While this will never be achieved in totality, high performing R+D+I institutes strive for such alignment. **Table 5** provides hypothetical examples of how a cascading performance setting system can be constructed to assist in this pursuit.

TABLE 5. EXAMPLES OF HOW PERFORMANCE METRICS CASCADE THROUGH AN R+D+I ORGANIZATION

LEVEL	FINANCIAL	SCIENTIFIC	TECH TRANSFER
Organization performance measure	Grow institute's private sector revenue by 5% from the previous year.	Increase the total number of peer-reviewed publications by 25 from the previous year.	Increase the technologies licensed to the private sector by five from the previous year.
Science group performance measure	Secure $200k additional funding from the sheep wool sector.	Complete the publication process for manuscripts A, B, C, and D.	Showcase ten wool fiber technologies at the annual Wool Expo and agree at least one license arrangement.
Individual staff member performance measure (potentially different staff)	Successfully complete Project A for the sheep wool sector.	Submit the manuscript on wool characterization to an international scientific journal.	Complete the development of wool fiber technology Z for inclusion in the Wool Expo presentation.

Based on the information analyzed in our previous reports and summarized above concerning performance evaluation within R+D+I organizations, **Table 6** summarizes what we consider to be the critical factors and the tools that are utilized for best practice models. Previous reports provide specific examples.

TABLE 6. RECOMMENDED CRITICAL FACTORS AND TOOLS FOR PERFORMANCE EVALUATION WITHIN R+D+I ORGANIZATIONS

RECOMMENDED CRITICAL FACTORS	TOOLS
Develop key organizational and group performance indicators based on the strategic and operational plans. This includes targets for the total duration of the plans (i.e., 3-5 years), as well as metrics associated with annual or biennial operational plans.	• Strategic and implementation plans, project plans, key performance indicators, and related metrics.
Open and professional communication of **organizational and group performance measures and assessments.**	• Strategic Plan. • Annual Report. • Internal and external communication channels.
Transparent processes to evaluate organizational and group performance.	• Existing performance review mechanisms, project management office, key stakeholder involvement.
Open and professional communication of the **evaluation of organizational and group performance indicators.**	• Annual report. • Internal and external communication channels.
Establish a career plan for staff (researcher and non-researcher), which gives a clear and predictable horizon for professional growth and development.	• Career plan implemented and linked to the evaluation system.
Agree on individual annual performance plans with links to the strategic plan and operational plan for each staff member.	• Human resources performance evaluation processes, strategic and operating plans.
Train managers to be effective in personnel management processes, including providing frequent and constructive performance feedback.	• Organizational training plan and human resource processes.
Conduct formal performance reviews with each staff member and agree actions.	• Agreed performance plans and human resource processes.
External and independent evaluation of the long-term economic, social, and environmental impacts of the organization (10-20 years).	• Organizations/groups of external, professional, and independent consultants who carry out an assessment of the economic, social and environmental impacts of the organization (national and sectoral).

7. Technology transfer and innovation systems

The fundamental premise underpinning investment in agricultural R+D+I institutes is that the funding will enable research teams to create new knowledge that will be used to generate economic, environmental, or social benefits. This assumption requires that the new knowledge is relevant (e.g., that the "right" research is conducted), that it is developed into a form that makes it deployable (e.g., software, a new plant variety, a new farm practice, a new hardware device, etc., often referred to as "technology"), and that this technology is then deployed in ways that create improved products, services or ways of working ("innovation"). Public R+D+I institutions in all jurisdictions are charged with conducting high quality, relevant research, and the previous sections of this report have focused on how to achieve this. However, the vast majority of innovation (and the benefits created by it) does not occur within the R+D+I institutes, but rather within other entities or by individuals who ultimately utilize the technologies. The explicit mandate for the public R+D+I institution's role within the oftentimes complex networks that lead to innovation in firms varies greatly between countries. However, regardless of the formal mandate, the sustainability and national value of the R+D+I institute hinges on innovation and national benefit occurring, and therefore R+D+I institutions typically spend considerable effort understanding and influencing the innovation pipelines relevant to their areas of activity and seeking to continually improve their contribution to these processes.

7.1. Definitions and roles for R+D+I institutions

Before seeking to describe the potential roles that R+D+I institutions can occupy in national innovation systems and how to achieve best practice within these systems, it is useful to define some of the most common terms and relationships. In this report we consider "new knowledge" to be the direct result of the research activities; "technology" to be created when this new knowledge is developed into a form which is useable; "technology transfer" to occur when the technology moves to another entity either to use or to develop further; "extension" is to demonstrate how the technology performs (often in comparison to others); and "training" is teaching others how to make use of the technology. "Innovation" is the new products, services, or ways of working, and in the context of this report we assume that the innovation arises, at least in part, due to the scientific knowledge created by the R+D+I institute or other agencies. We will describe the totality of these activities as the "innovation (eco)system".

Whilst there is no universal model for what role the R+D+I institutes of a country occupy within the national innovation system, the wide-spread use of the term "technology transfer", and the focus on it, accurately reflects the fact that the path to creating national benefit from innovation nearly always involves the transfer of this knowledge or technologies from those entities that specialize in generating that knowledge (e.g. R+D+I institutes) to those who specialize in developing and delivering new products or services. The roles of R+D+I institutes and the institutional responses within the three countries represented by the authors serves as examples of this variation.

7.2. Institutional examples

For **IRTA**, technology transfer and extension activities are a fundamental aspect of its role in the innovation ecosystem and IRTA produces an Annual Technology Transfer Plan to co-ordinate these activities which consume approximately 30% of staff annual time allocation. IRTA is directly funded by the Ministry of Agriculture to undertake activities such as demonstrations, workshops, fact sheet production, etc., which are agreed in an Annual Transfer Plan. In addition to that specific set of actions, IRTA records the many other avenues that knowledge transfers in the form of conference and course registrations, the sale of technical dossiers, subscriptions to IRTA newsletters, etc. IRTA also captures the hours that researchers dedicate to these activities and the agri-food sector to which the effort applies as well as surveying the satisfaction levels of the external participants. This information allows IRTA to measure and demonstrate both the resources it applies to these activities and the satisfaction of the recipients.

The legal framework that established **INIA** Uruguay makes clear that technology transfer and extension is not within its direct responsibility, but that INIA must carry out its work within the framework of effective coordination with technical

assistance and extension organizations that operate in the public and private spheres. As part of this coordination role, by law INIA must dedicate 10% of its annual budget to the Agricultural Technologies Promotion Fund (FPTA) to support the financing (direct or competitive) of projects and strategic alliances with other R+D+I organizations (national and international) in the arena of technology transfer. Over the last 30 years, the public and private systems of technology transfer and rural extension have changed radically in Uruguay. As a general observation, there has been a decline in the public sector role in the transfer of technology and a sense that the various productive sector value chains (e.g., cattle ranching, horticulture etc.) now operate more independently. In the current model, INIA has sought to be a "facilitator and promoter of the exchange of knowledge, experiences and mutual learning" between researchers, producers, technicians, and entrepreneurs in the innovation process in the commercial and public environments. In recent years, INIA has sought to clearly define the role of INIA for each technology development stage. A unit specialized in communication and technology transfer and another dedicated to the development of agribusiness have been created to develop goals and indicators linked to the improvement of the dissemination, validation, and transfer of technologies. Since 2018, there has been the incorporation of a technology certification process (CERTEC, http://inia.uy/productos-y-servicios/Productos/Certificacion-de-tecnologias), developed by the organization, which include external evaluators in charge of approving or rejecting the postulated technologies by INIA researchers or in collaboration with other R+D+I national or international organizations.

The **NZCRI** operations are broadly like INIA in that the establishing Act makes clear that "research undertaken by CRI should be undertaken for the benefit of New Zealand" and that, while there is no direct funding from government to NZCRI for technology transfer activities, NZCRI "should promote and facilitate the application of the results of the research and technological developments". As such, over the nearly 30 years since the creation of NZCRI, the coordination of technology transfer activities has largely become the domain of the private sector, and especially the levy-collecting sectoral bodies associated with, for example forest growing, dairy production, sheep and beef farming, the meat industry, kiwifruit production, or deer farming. These entities are the key partners for NZCRI in determining the science to undertake (which the sectoral bodies support via significant funding) and the technology transfer/development pathways required to deliver benefit to their members (farmers, co-operatives, and corporate entities). The NZCRI, in turn, have invested heavily in understanding these sector-specific innovation pathways and NZCRI contribute strongly to the sectoral technology transfer strategies and of course, to the specific activities through scientific staff involvement in seminars, workshops and fieldays which the NZCRI tabulate and report. AgResearch, has extended this expertise by establishing a dedicated research activity to explore technology transfer networks and develop generic tools which can be applied to enhance the success of innovation pathways.

7.3. Institutional actions to enhance the success of technology transfer and innovation

Despite the wide variation in the expected role of R+D+I institutions in technology transfer and indeed the even larger differences that exist between national and sectoral norms of technology transfer, we believe that there are some broadly transferable "best practice" methodologies that should be applied by modern agricultural research institutions to maximize the benefits derived from their scientific efforts.

All R+D+I institutions should devote considerable effort to understanding and optimizing the essential components of technology transfer within their areas of activity. This is necessary because the way in which this transfer and adaptation is carried out is influenced by the rules of the country or region where the companies exist, the investment models that created the knowledge, the characteristics of the value chain(s) within which it will be applied, the scale and innovation capacity of the companies within that value chain, the current and projected financial and market conditions in which the companies operate, and many more considerations.

Successful technology transfer starts with doing the right science in the first place. For mission-led public institutions, this is the science that has the potential to help solve problems or create new opportunities. In addition, the findings of science must be implemented in some cost-effective manner if a positive benefit is to be achieved. For these reasons, the prioritization of scientific research lines (which are discussed in detail elsewhere in this report) should anticipate technology transfer requirements and initiate these relationships and discussions from the outset in the prioritization of research. Both scientific staff and potential "next downstream users" of science should play roles in determining the appropriate lines of research based on technology transfer requirements, such as an assessment of the intellectual property landscape, analysis of collaborators/competitors, the likelihood that the results of science will be leveraged, the cost of further development, and the impact/value that could be created through the successful application of science. Certainly, it is not always possible to identify *a priori* the specific private user or collaborator, especially

in long-term scientific projects. In this case, it is essential that technological monitoring is carried out throughout the project to identify the universe of possible recipients or partners of the planned innovations.

Once the lines of scientific research have been established, any significant project/work program must develop an anticipated "innovation pathway" that clearly describes the role of each participant in the pathway and their contribution. This process should also include the required investment components (how much investment, at what stage and by whom) to ensure that before embarking on the work there is an early planning path for how the knowledge could lead to uptake and innovation. These planning documents provide an essential basis for a shared understanding of how the work is intended to proceed, periodic review, reporting and coordinated responses if critical circumstances change. To ensure that important phases of development can proceed in a timely manner, it is recommended that the institute has "seed capital" for when its financial contribution to an innovation project can ensure that the project continues. The IRTA annually establishes a seed capital budget for this purpose. AgResearch New Zealand has developed a suite of best practice planning resources for developing these documents and these are available free of charge (htpps://www.beyondresults.co.nz).

To improve technology transfer and innovation processes within institutions, many institutions establish (or bring together existing staff into) specialized units or project teams that focus on evaluating and exploiting intellectual property opportunities, disseminating knowledge and technology, and participating in the ongoing evaluation of the benefits derived from innovation. This is certainly the case for NZCRI, INIA and IRTA. The staff in these units can originate from a range of relevant backgrounds (e.g., business, science/technology, investment, etc.) but an essential characteristic is that they can gain the trust and confidence of both the scientific and commercial partners. Good communication skills, curiosity, a passion for innovation and respect for all the participants in the innovation process are the attributes of staff we have seen succeed in these roles. In this regard, it is especially important that those with commercial and business skills and external networks can work well with their scientific colleagues. These groups often leverage information and communication technologies and social media platforms as an efficient means of keeping all of the innovation network participants engaged and updated during the protracted research and development processes.

Many organizations do not clearly define the role and scope of their processes for knowledge dissemination, technology transfer, extension and innovation. This lapse can generate gaps in the institutional design and create uncertainty for staff, collaborators, stakeholders and clients. To maximize the likelihood that it's R+D+I activities are transformed into economic, social and/or environmental benefits, the modern R+D+I institution must align a suite of mechanisms (research consortia, inter-agency agreements, start-up entities etc.) to successfully weave together the required mix of public and private contributions and investments.

Key policy frameworks for the organization can support or detract from the success of technology transfer and innovation activities and ultimately, national benefit. Policies that encourage the institute to operate commercially in the management of intellectual property, commercial contracting, business structures, etc., are likely to promote technology transfer and commercialization pathways. The future users of the scientific results should regard the institute as "easy to do business with" and "easy to build productive and mutually beneficial partnerships of trust with".

7.4. Performance evaluation

Because these technology transfer and related activities are so fundamental to the national benefit that R+D+I institutions are charged with creating there must be well-developed performance measures related to technology transfer processes and results at the organizational, research lines and key personnel levels. These metrics (e.g., new patents created, technologies licensed, presentations to private sector partners) will be included in all the relevant planning documents described previously. As part of the annual assessment, an independent survey should be conducted on the experiences and results achieved in technology transfer with the organization, as well as the fulfillment of the results and the action plans implemented in accordance with the established goals.

7.5. Final considerations

Finally, R+D+I leaders are often challenged by staff who claim that "you can't plan for innovation" or "you never know where science may be valuable" as justification that the planning described above is not necessary or valuable. This argument should not be entertained. The planning approaches described above do not restrict potential changes if circumstances warrant or the pursuit of new opportunities that arise to use discoveries in unforeseen ways. On the contrary - they provide the platform to turn quickly and with the support of the necessary partners and move forward. Or as is sometimes appropriate, make the hardest decision of all which is to stop and redirect resources to more beneficial areas.

Based on the information analyzed in our previous reports and summarized above concerning technology transfer and innovation within R+D+I organizations, **Table 7** summarizes what we consider to be the critical factors and the tools that are utilized for best practice models. Previous reports provide specific examples.

TABLA 7. RECOMMENDED CRITICAL FACTORS AND TOOLS FOR TECHNOLOGY TRANSFER AND INNOVATION WITHIN R+D+I ORGANIZATIONS

RECOMMENDED CRITICAL FACTORS	TOOLS
Establish the organizational policy framework to support the institute's role in technology transfer and innovation.	• Founding documents. • Policies that establish employment, commercialization and intellectual property practices to support technology transfer and innovation. • Cooperation networks with agreements with public and private agencies that support technology transfer and innovation.
Ensure that potential technology transfer and innovation partners influence **the prioritization of research activities.**	• Existing strategic and operational plans and processes for engaging with key stakeholders in setting research priorities. • Technology certification procedures. • Technology (awareness, application and satisfaction) surveys.
Establish a recognized group or project team of experts to coordinate technology transfer and innovation activities	• Operational plans for each line of research and innovation pathway.
Develop innovation pathways for each major program/project.	• Operational plans for each line of research and planning resources.
Include technology transfer and innovation measures and evaluation in the organization, lines of research and, where appropriate, annual performance plans of staff.	• Strategic, operational and individual performance plan processes.

8. Corporate image and communication

In many countries, national agricultural research institutions have very little public recognition and/or awareness of their role in creating economic, environmental, and social benefits. This is especially true in relation to "non-agricultural citizens" who typically constitute the largest (and growing) portion of the population and thus exert an increasing influence on national policies and public spending by nationally and locally elected officials. This represents a danger to continued political support and, therefore, to the financial sustainability of these R+D+I organizations.

8.1. Corporate image and communication activities

Modern research institutes use traditional and social media, the corporate website, event promotion, public workshops and lectures, and a host of other channels to communicate their activities and successes and, through this, improve their image and legitimacy. A professionally developed communication activity is now an essential component in raising public awareness of the contributions of the institute, and its stakeholders, towards important economic, environmental, and social challenges. Specifically, this can contribute positively to greater "agricultural awareness" and "social licensing" of agri-food sector activities in the eyes of urban citizens. This increased awareness can improve dialogue, trust and understanding between rural and urban citizens and thus, the communication plan should pay special attention to non-agricultural sectors of society (general press, urban public, NGOs, local and national politicians and government agencies, "influencers", etc.).

Social media is now the mostly commonly used platform to raise awareness of the institute's activities and capabilities among stakeholders and potential future employees and with it build a positive "employer brand" for current and potential staff. The reach of social media is also being exploited by R+D+I institutes to solicit public opinion on current scientific issues and to recruit participants in scientific activities.

Regular institutional awareness and brand image surveys are a key mechanism for understanding the degree and accuracy of knowledge about the institute's activities and for identifying areas for improvement within the corporate image and communication plan. Examples of surveys to measure these indicators are given in Montossi (2021).

In our institutions, this function is staffed by professionals in marketing, branding, scientific writing and social media. In addition to these institutional roles, external experts are regularly used in areas such as major events, publishing, website design, annual report production, etc. The reporting line for the leader of this function can either be directly to the CEO or to an amalgamated role at level 2 such as "corporate support executive".

8.2. Final considerations

In our shared experiences, we did not expect these activities to be a direct contributor to significant new business development. On the contrary, the key performance measures for this corporate function must derive in every way from the strategic and operational plans of the organization and be evaluated according to their contribution to these plans and the public awareness of the institute, its activities, and its benefits.

Based on the information analyzed in our previous reports and summarized above concerning corporate image and communication within R+D+I organizations, **Table 8** summarizes what we consider to be the critical factors and the tools that are utilized for best practice models. Previous reports provide specific examples.

TABLA 8. RECOMMENDED CRITICAL FACTORS AND TOOLS FOR CORPORATE IMAGE AND COMMUNICATION WITHIN R+D+I ORGANIZATIONS

RECOMMENDED CRITICAL FACTORS	TOOLS
Identify and agree the role of this function in **delivering the Strategic and Operational Plans** and establish the desired "corporate image".	• Existing Strategic and Operational plans.
Establish a professional team of communication and corporate image.	• HR Processes. • Support from external communication experts.
Determine the internal and external communication channels (e.g., email, website, traditional media, social media, promotional events, etc.) that will be used to create a corporate profile and deliver communications to the different target audiences.	• Operational plans, institutional resources and existing modes of communication with differentiated stakeholders. • Support from external communication experts.
Establish, evaluate and communicate the key objectives of annual performance of the corporate image and communication function.	• Existing strategic and operational plans and existing reporting frameworks. • External surveys. • Support from external communication experts.

9. Final remarks

To conclude this report, **the authors wish to reinforce that there are no universal policy, governance, or management formulas for success in modernizing research, technology transfer and innovation institutions**. For each institution there are external and internal factors which will shape the most appropriate course of action. These factors must be analyzed and assessed with respect to the desired future state of the R+D+I institution before starting the processes of modifying institutional policies, governance models and management systems. Each section of this report provides a short table of best practice factors which can serve as a template for self-assessment.

Before beginning the transformation of institutional policies, governance and management systems it is critical to analyze the desired future state of the institution and it's role in the national R+D+I ecosystem

In our experiences, an audit carried out by a small panel of respected, independent specialists with experience in R+D+I transformations can provide a valuable objective assessment of the current state. Such an assessment can relatively quickly detect matters of significant misalignment and departures from best practice models. With these insights available, the panel can gather the key stakeholders of the institution together and explore their perspective on the diagnosis and their willingness to embark on a change program to address priority areas. Subsequent actions plans and indicative timelines for the process can then be developed and transparently communicated to stakeholders (including staff). This type of transparent, objective process provides credibility to the exercise and can greatly reduce the uncertainty and stress felt by institutional management and staff.

However, there is one additional fundamental premise that must be met before undertaking these transformations. **The owners, funders and key stakeholders of the institutes must have the political will and resources to invest in attracting and retaining highly skilled staff and ensuring the availability of effective infrastructure within sufficient time frames for these changes to succeed over the medium and long-term.** It is essential to take firm steps, without hesitation, but calmly enough to be assimilated by the entire organization and the main stakeholders. Early successes can be achieved and will build momentum and confidence, but a 5-10-year transformation process should be anticipated. If the owners, funders, and stakeholders cannot reasonably commit to these requirements, then the possibility of entering the process should be reconsidered.

In the authors' experience, the changes that can be made and the accumulated benefits for the R+D+I institute, its staff, stakeholders, and wider society can be substantial and well justify the extraordinary effort required.

In conclusion, we reiterate the timely challenge made by Gianoni and Trigo (2021):

"The question remains of whether institutional, financial and human resources in the region and the current processes of organizational and policy changes will be sufficient to harness these opportunities. Cooperation between countries is essential, as is a robust and solvent institutional framework around R&D systems. The pandemic has reinforced the importance of collaborative work and of a regional and hemispheric institutional framework. The way in which high-impact knowledge and technologies are generated through innovation must aim at collaborative work, through public-private partnerships, multi- and transdisciplinary approaches, and the participation of economy actors outside of the sector (p. 20)".

The LAC region is a significant global source of arable land, fresh water, and biodiversity. These resources create the potential to provide healthy, nutritious, and safe foods from sustainable production systems to enhance local food security and development aspirations whilst making a meaningful contribution to the global challenges of climate change and feeding the growing world population towards 2050. The adoption and application of new technological platforms and trans-disciplinary investigative approaches are required to deliver this potential for LAC and this will occur against a backdrop of dynamic social, economic, and environmental challenges which the COVID-19 pandemic has further intensified. In this context, the role of LAC R+D+I organizations is absolutely pivotal and provides the impetus to the urgent challenge to update themselves and accelerate their transformation processes as outlined by the authors in this publication. LAC R+D+I institutes with effective governance and investment models, creative and efficient scientific programmes, strong technology/innovation partnerships and transparent, continuous communication to the many stakeholders within society are a necessary condition to capture the potential of the region.

It is necessary to create and implement new technological platforms to foster innovation and develop transdisciplinary research approaches to realize the potential of LAC.

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ANNEXED (From AgResearch Annual Report 2019)

TABLE 1. AGRESEARCH KEY PERFORMANCE INDICATORS AS AT 30th JUNE 2019

	STRATEGIC GOAL	OBJECTIVE	KEY PERFORMANCE INDICATORS FOR FY19	RESULT FOR FY19
PEOPLE	**Innovative and high-performing workforce**	• Staff engagement increased.	• Increase Engagement Index (EI) from the previous staff survey result by 3%.	• In July 2019, our Staff Engagement Index was 68.0, up from 65.0 in 2018.
		• We will all have a safe workplace.	• Total Medical Treatment Injuries (MTI) and MTI causing lost time <30 per year.	• From 1 July 2018 to 30 June 2019, the total number of MTI and MTI causing lost time was 16, down from 34 last year.
			• No serious harm accidents.	• We did not have any "serious harm" incidents.
	Comprehensive understanding of the sector, including key and emerging players and their relationships	• Grow our understanding of the sector and the sector's recognition of that understanding.	• >90% of surveyed stakeholders rate AgResearch's understanding/ contribution to their strategy as good or better.	
STAKEHOLDERS	**Co-owned strategy with key stakeholders**	• Grow commercial revenue through closer alignment of stakeholder and AgResearch strategic goals.	• Successful engagement with Government, key industry and wider stakeholders to identify the new science that is needed to meet New Zealand's critical challenges around agricultural profitability, enhancement of the environment and mechanisms to fund that, resulting in significant new investment.	• In 2018, 83% of surveyed stakeholders rated AgResearch's understanding/ contribution to their strategy as good or better.
			• Deliver $32.4 million of stakeholder-driven commercial science revenue.	• We achieved $51.1m of stakeholder-driven commercial science revenue.
			• Deliver $2.48 million of international organisation-driven revenue.	• We achieved $4.7m of international revenue.
RESEARCH	**Research and Development solutions that meet sector needs and contribute to Impacts and Outcomes identified in our strategy (SCI)**	• Ensure AgResearch has the research portfolio and capabilities that will meet current and future stakeholder needs and deliver our strategy.	• Implement the recommendations from the 2017 Animal Sciences Roadmap.	• The Animal Science Roadmap 2017 developed a number of cross-team initiatives for potential funding applications. In addition, the recommendation to review internal funding for the area of gene-editing in livestock was ratified by the Executive Leadership Team, and resulted in SSIF funding being removed from this area of research and re-prioritised into other areas.
RESEARCH	**High-quality, relevant science**	• Deliver relevant, high-quality, reliable Research and Development outputs that meet stakeholder needs and deliver to our strategy.	• Implement AgResearch Science Plan.	• The Science Plan was fully implemented during FY19 and was used, for example, to inform changes in SSIF investments and focus areas for contestable funding applications and to establish new ways of working to deliver integrated, trans-disciplinary projects. The revitalization of our Science Plan is underway as one of AgResearch's five current Strategic Initiatives, including the development of challenge targets, impact measure and key performance indicators.
			• > 1.0 Scopus-indexed papers published per scientist.	• 1.29 Scopus-indexed papers were published per scientist.

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TABLE 1. AGRESEARCH KEY PERFORMANCE INDICATORS AS AT 30th JUNE 2019

	STRATEGIC GOAL	OBJECTIVE	KEY PERFORMANCE INDICATORS FOR FY19	RESULT FOR FY19
ENABLING SYSTEMS	**Robust business processes and systems that enable delivery on strategy**	• Improve the effectiveness and efficiency of business processes.	• Implement Idea to Impact (our new Project Management way of working) to plan and commence benefit realisation.	• Our Idea to Impact project management framework and the associated Waka technology solution have now been rolled out to all Science teams and the project has been closed. We are now in a phase of embedding the use of both the framework and tool to realise the benefits.
	Infrastructure aligned to strategy	• AgResearch infrastructure is fit for purpose.	• Develop Future Footprint Programme and campuses/hubs to agreed programme milestones and budgets for FY19.	• The Joint Food Science Facility located at Massey University is progressing to agreed milestones and due to open early 2020. • The Grassland Greenhouses are progressing to agreed milestones and due to open late 2019.
FINANCIAL	**Sustainable financial performance to enable achievement of strategic goals**	• Achieve financial targets.	• Operating Profit budget achieved.	• Our Operating Profit is ($7.0m), compared with a budget of ($2.2m).
			• Net Profit Before Tax budget achieved.	• Our Net Profit Before Tax of ($4.8m) compared to a budget of ($3.1m).

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AgResearch's 2018-23 Statement of Corporate Intent identified the following operating indicators against which progress to achieve the SCI operating outcomes is measured. Target figures in [brackets] are from AgResearch's 2018-23 SCI, the measure is the actual result to 30 June 2019.

TABLE 2. AGRESEARCH CORE OPERATING INDICATORS AS AT 30th JUNE 2019

ID	INDICATOR	DEFINITION	MEASURE [TARGET]
G.1	**End-user collaboration**	Revenue per full-time equivalent (FTE) from commercial sources.	**$85.4k** [$84.3k]
G.2	**Research collaboration**	Publications with collaborators. Percentage of publications with a) only AgResearch authors, b) other New Zealand authors, c) international authors or d) a combination of New Zealand and international authors. (Data for this indicator is reported for calendar years)	**(a) 11%** [14%] **(b) 34%** [39%] **(c) 33%** [26%] **(d) 22%** [21%]
G.3	**Technology and knowledge transfer**	Commercial reports per scientist FTE.	**1.29** [1.00]
G.4	**Science quality**	Impact of scientific publications. The average value of two-year citations per document for scientific journals assessed by SCImago, in which AgResearch staff published during the year, weighted by the number of AgResearch publications in each journal. (Data for this indicator is reported for calendar years)	**2.90** [2.70]
G.5	**Financial indicator**	Revenue per FTE, based on average FTEs over the year.	**$239.54k** [$225.76k]

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TABLE 3. AGRESEARCH-SPECIFIC INDICATORS OF END-USER ENGAGEMENT AND SCIENCE RELEVANCE AS AT 30th JUNE 2019

ID	INDICATOR	DEFINITION	MEASURE [TARGET]
1.1	External stakeholder engagement	Consistent implementation of agreed stakeholder services plans.	**Achieved**
1.2		Stakeholder relationship measure: "Very good" or "Better" satisfaction rating.	**58 %** [> 60 %]
1.3		Satisfaction with our service: "Very Good" or "Better" satisfaction rating.	**64 %** [> 70 %]
1.4		Dealing with us: "Preference to Work" rating.	**68 %** [> 60 %]
1.5		Familiarity with our capability: "Very Familiar" rating.	**32 %** [> 40 %]
1.6		Contribution to stakeholder strategy: "Good" or "Better" rating.	**83 %** [> 90 %]
1.7		Consistent implementation of agreed science service/interaction plan.	**Achieved**
1.8		a) Total revenue. b) Total science revenue. c) Commercial science revenue. d) Intellectual property revenue. e) International revenue. f) Māori revenue.	**a) $157.3m** [$145.4m] **b) $124.7m** [$107.5m] **c) $51.1m** [$54.3m] **d) $12.0m** [$9.8m] **e) $4.7m** [$4.1m] **f) $0.3m** [$0.3m]

TABLE 4. AGRESEARCH-SPECIFIC OPERATING INDICATORS OF DELIVERY TO VISION MĀTAURANGA AS AT 30th JUNE 2019

ID	INDICATOR	DEFINITION	MEASURE [TARGET]
2.1	**Collaboration with Māori**	Cultivate collaboration to support Māori agribusiness by co-developing funding proposals with stakeholders.	**5** [6]

TABLE 5. AGRESEARCH-SPECIFIC WORKFORCE INDICATORS AS AT 30th JUNE 2019

ID	INDICATOR	DEFINITION	MEASURE [TARGET]
3.1	**Staff engagement**	Increase Engagement Index (EI) by 5 points.	**68** [70]
3.2	**Health and safety**	No notifiable injuries and <2 notifiable events.	**0** [<2]

TABLE 6. AGRESEARCH-SPECIFIC FINANCIAL PERFORMANCE AS AT 30th JUNE 2019

ID	INDICATOR	DEFINITION	MEASURE [TARGET]
4.1	**Financial target**	Operating Profit budget achieved.	**Not Achieved**

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