

# CSIR GUIDE TO A CAREER IN RESEARCH

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September 2006



**CSIR**  
*our future through science*

# CSIR MANDATE

The CSIR's mandate is as stipulated in the Scientific Research Council Act (Act 46 of 1988, as amended by Act 71 of 1990), section 3: Objects of CSIR:

“The objects of the CSIR are, through directed and particularly multi-disciplinary research and technological innovation, to foster, in the national interest and in fields which in its opinion should receive preference, industrial and scientific development, either by itself or in co-operation with principals from the private or public sectors, and thereby to contribute to the improvement of the quality of life of the people of the Republic, and to perform any other functions that may be assigned to the CSIR by or under this Act.”

[www.csir.co.za](http://www.csir.co.za)

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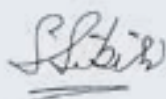
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## Foreword

The CSIR is entering an era of regeneration in science and technology to deliver solutions that will address our country's national priorities. In our quest to be at the forefront of research both nationally and internationally, we place a great deal of emphasis on the development of people to ensure that we continue to foster technological innovation and generate new knowledge. Providing career development opportunities for research staff is thus of paramount importance.

The CSIR has therefore introduced a new system of professional job ladders to clearly map out career growth opportunities for staff members based on skills, performance, qualifications and experience. It will facilitate the process of career development as well as provide a dynamic recognition and reward system that relates to the contribution and performance of our staff. The introduction of this system also aims to raise the profile of researchers in the CSIR and provides a means for assessing the true research capacity of the organisation.

I would like to convey my appreciation to the CSIR Fellows and their team for the considerable effort they have put into developing this guide. Not only does it cover a host of practical issues relating to a career in research at the CSIR, but it is also informative and inspiring. I am confident that it will make an important contribution to rebuilding our research capacity.



**Dr Sibusiso Sibisi**  
CSIR President and CEO



**Dr Sibusiso Sibisi**  
CSIR President and CEO

## Purpose of this document

At the heart of the CSIR's operations resides the obligation to adhere to its founding purpose and mandate. The CSIR was constituted as a science council by the Scientific Research Council Act (Act No 46 of 1988, as amended by Act 71 of 1990), with the following objects (referred to here as the mandate):

"The objects of the CSIR are, through directed and particularly multi-disciplinary research and technological innovation, to foster, in the national interest and in fields which in its opinion should receive preference, industrial and scientific development, either by itself or in co-operation with principals from the private or public sectors, and thereby to contribute to the improvement of the quality of life of the people of the Republic, and to perform any other functions that may be assigned to the CSIR by or under this Act."

This means the CSIR undertakes research to foster development to improve people's quality of life. Over the past two decades, the CSIR has been very successful in developing close relationships with clients and stakeholders, using science, engineering and technology (SET) to address their more immediate needs, and improving the financial and project management skills of its staff. However, recent external reviews have highlighted that this success has come at the expense of research output and capacity. The challenge that faces the CSIR now is to rebuild its research capacity to properly address its mandate – of course, without losing the skills and capacity developed over the past few years. A renewed focus on research careers is one of the responses in this regard.

This document describes how research careers will be managed in the CSIR, and provides a few suggestions on how researchers could improve their positions through gaining recognition and experience. These suggestions are not domain-specific. By recognising some of the aspects required for development as a researcher, it is hoped that this document could be used as some form of "self-help" manual. It focuses on a career in research and development at the CSIR, but few individuals remain in one organisation for their entire career. Building a career in research requires attention to aspects that will make individuals "marketable" in a wider context. This guide tries to provide such a view.

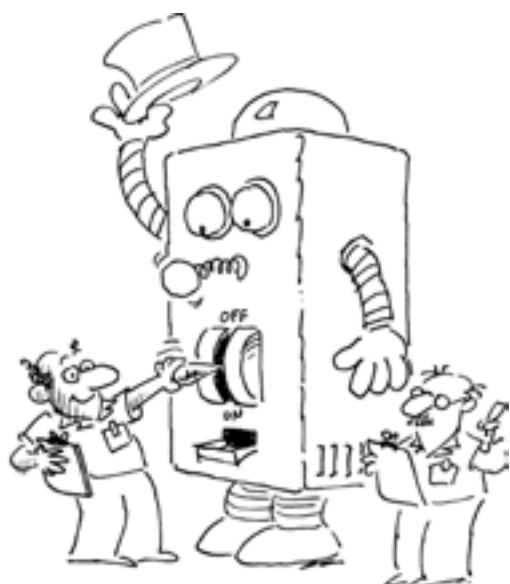
No relatively brief work can hope to address the complexities of progression through a career which, while encompassing some basic similarities, is in its nature a step into the unknown. It is hoped that the suggestions contained here will prove to be of use to those who wish to participate in the glorious uncertainty and excitement of scientific discovery and innovative experimental development.



## What is research?

As a science council, the CSIR focuses on research and innovation in the broader domains of SET, and it employs scientists and engineers in a research capacity. Research encompasses all activities that generate new knowledge; innovation is the translation of this knowledge into new products, processes and services, including their implementation. These activities include basic

research, applied research and experimental development, steps along what is sometimes known as the "innovation chain". In line with its mandate, the CSIR does not pursue "pure" basic research (i.e. research with no idea of what its usefulness might be, sometimes called "blue sky" research), but everything from directed basic research onward. Brief definitions<sup>1</sup> of each of these are given below.



Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Basic research analyses properties, structures and relationships with a view to formulating and testing hypotheses, theories or laws. The results of basic research are not generally sold, but are usually published in scientific journals or circulated to interested colleagues. Occasionally, basic research may be "classified" for security reasons. Directed basic research is that subset of basic research that has been deemed, in line with the mandate of the CSIR, to be in the national interest and that should receive preference.

Applied research comprises original investigation undertaken to acquire new knowledge. It is, however, directed primarily towards a specific

<sup>1</sup> For a full account, see the Frascati Manual (2002). The measurement of scientific and technological activities: proposed standard practice for surveys on research and experimental development, published by the Organisation for Economic Cooperation and Development, Paris.

practical aim or objective. The results of applied research are intended primarily to be valid for a single or limited number of products, operations, methods or systems. Applied research develops ideas into operational form. The knowledge or information derived from this type of research is often patented, but may also be kept secret.

Experimental development is systematic work, drawing on existing knowledge gained from basic and applied research and practical experience, which is directed at producing new materials, products and devices; installing new processes, systems and services; or improving substantially those already produced or installed. Experimental development is typically driven by a user requirement and is aimed at solving a problem, satisfying a need or exploiting an opportunity. The process often includes the generation of several concepts and designs that are evaluated against one another to find a practical approach that is optimal in terms of the user requirement. It includes the creation of mathematical models and simulations, followed by the design and construction of prototypes that can be used to verify the achievement of the technical performance predictions through a series of tests and evaluations. The process usually generates some new knowledge – often engineering or process knowledge.

## Research as a career

Research can offer a very rewarding career, in which a researcher embarks on a voyage of discovery, and in which opportunities may arise to develop new and important solutions to challenging problems. The South African research community is relatively small (there are less than 20 000 full-time researchers), which limits the networking potential, but offers individuals the opportunity to make a substantial impact – in this respect, South African researchers are very lucky.

Not all careers in research follow the same route. If your career is in directed basic research, you will find yourself involved in data collection to test ideas, and you will seek to publish your work in scientific journals. If your career is in experimental development, you will develop technology demonstrators, and you will work with clients in the implementation of these new products. Often, you will have to work in research teams tasked with the investigation of challenging questions, or the development of new products. This guide has been written to help individuals to develop their research careers, but it should not be forgotten that many important contributions are made by teams. Many of the points made in this guide are as applicable to research teams as they are to individuals.



The CSIR has used the four-stage career model as a guide to staff in their career development<sup>2</sup>. This model, based on extensive research among knowledge-based workers, recognises four stages in research careers. In stage 1, researchers will work under supervision; in stage 2, researchers are competent enough to work without supervision, usually within the organisation; stage 3 researchers work largely through supervising others, and interact widely outside the organisation that employs them; and researchers at stage 4 provide high-level leadership and develop overall organisational strategies. Advancement from one stage to the next requires adjustments (termed “novations”) to the way in which researchers think and go about their business, and it is making these novations that presents the greatest challenges to researchers.

Examples of the challenges that need to be overcome to move from stage 1 to stage 2, for example, include the need to gain confidence, establish a reputation and manage growing independence. Moving from stage 2 to stage 3 requires researchers to go beyond their original area of expertise, take responsibility for others, develop relationships with external stakeholders, as well as to let go of stage 2 responsibilities.

Moving to stage 4 will require the ability to deal with

ambiguity, articulate points of view in a lucid manner, influence people and make tough decisions. Not everyone will reach stage 4, or even stage 3, but this does not preclude a rewarding career in research for those who do not move beyond stages 2 or 3.

## The CSIR's research career ladder

The CSIR has recently introduced a formal system of career ladders, one of which is a career ladder for researchers<sup>3</sup>. The incumbents of “career ladder jobs” are able to grow their job size as they gain experience, expertise and profile. The introduction of this system aims to:

<sup>2</sup> See Gene Dalton & Paul Thompson (1986). *Novations: Strategies for career management*. Dalton & Thompson, Provo, Utah.  
<sup>3</sup> See Appendix 1 for details of the CSIR's research career ladder.

- raise the profile of researchers in the CSIR
- ensure a meaningful and transparent progression to measure and reward career advancement
- provide career guidance through a focus on relevant attributes
- provide a means for assessing the true research capacity of the CSIR.

The career ladder for researchers in the CSIR has five rungs. Staff employed as researchers will be promoted from one rung to the next as they gain experience and skills. The rungs are:

- **Candidate researchers** – These are researchers who work under supervision. It is desirable for such researchers to have basic qualifications and skills to generate and disseminate knowledge. Candidate researchers will focus on developing their skills.
- **Researchers** – These are competent professionals who work independently within a given field. A masters degree is usually seen as a prerequisite at this level. Researchers should be aware of trends in their relevant field, and be able to formulate ideas and/or define concepts; they should have demonstrated the ability to generate and disseminate knowledge; and contribute to the development of funding proposals. The main focus of researchers would be to gain experience and to build a track record in research and development.
- **Senior researchers** – These are seasoned professionals with a track record in research and development. At this level, a doctoral degree is usually seen as desirable. Senior researchers provide strategic direction within a research group, and their track record indicates that they are established researchers in the field. They provide some guidance to junior staff, and attract sufficient funds to cover their individual activities. It is expected that their research would have had some impact within the field of research and development.
- **Principal researchers** – These are specialists whose sustained track record has led to widespread recognition within their field, and who are able to lead research and development programmes (groups of related projects), often integrating approaches across fields. Principal researchers generally hold a doctoral degree, and provide strategic direction in interdisciplinary research projects within competency areas or operating units. They have a significant track record that indicates that they are leading researchers in the field; they play a leading role in guiding junior staff, and attract sufficient funds to cover research and development projects of small teams. Their research typically has impact across several fields of research and development.
- **Chief researchers** – These are specialists whose sustained track record in research and development has led to international recognition as leaders. They provide strategic direction in interdisciplinary research projects in collaboration with global partners; they have a track record as leading researchers, and have obtained international recognition. They



create an environment where others can achieve their full potential, and attract sufficient funds to cover large interdisciplinary projects. Their research has significant international impact.

CSIR Fellows are appointed by the President of the CSIR from the ranks of chief researchers, while operating unit (OU) Fellows are appointed from the ranks of chief or principal researchers by OU executive directors. The appointment of a fellow is a mechanism that allows the most experienced researchers to have influence on the research environment at appropriate levels. Chief and/or principal researchers do not automatically become fellows, and fellow appointments are not regarded as an integral part of the career ladder for researchers. The key factor distinguishing fellows from other chief or principal researchers is their capacity and willingness to be effective science and technology leaders.

## Progressing up the research career ladder

Researchers progress up a career ladder as they gain the experience necessary to deal with increasing complexity. This increase in complexity comes in two different forms. The first is increasing complexity in the technical aspects of the job, which requires leadership in research, while the second relates to complexity in management, which requires leadership of research. This model (see Figure 1) implies that reaching higher levels on the career ladder is not possible by simply increasing one's technical or managerial capacity alone. It required, for example, for principal researchers to manage aspects of the research projects that they are directing. It is also logical that executive directors will have to have a sound technical grounding. The relative balance will determine where a person's job focus will be (Figure 1).

Making progress in a research career will initially require the ability to master technical aspects of the job. However, as a researcher's career progresses, additional responsibilities will need to be shouldered that require a different set of skills.

Consider, for example, the difference between a post-doctoral researcher working on one or a few research projects in a laboratory, and the laboratory director. The post-doctoral researcher will focus almost entirely on aspects of leadership in research, working on technical problems and guiding post-graduate students. The director, on the other hand, will be involved in quite different activities.

In addition to providing guidance in technical research matters, he or she will (for example) travel extensively to talk to government and private sector funders; liaise with publishers to produce books or special issues of journals; and speak to companies to refine the instruments that they make. None of these tasks are regarded as traditional research, but they are necessary, if not vital, for research to take place effectively. The traditional view of a researcher as a white-coated laboratory worker is therefore not accurate in the case of the director, whose job could not be done by any manager unqualified and inexperienced in research.

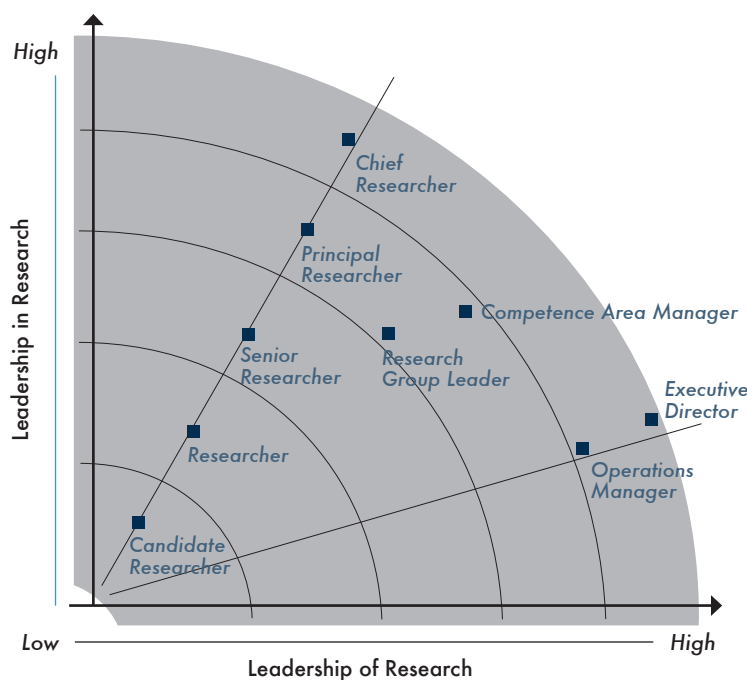


Figure 1. The relative position of researchers in relation to their proficiency along two axes of leadership (the concentric arcs represent zones of equal seniority)

Advancing up the research career ladder is usually done in step-wise increments, which provide the opportunities to increase either technical or managerial aspects of the job – both are necessary. Completing a PhD, or finalising the publication of results from a completed research project, are examples of advancing in terms of technical skills and experience. Managing a challenging research project, or assuming responsibility as a research group leader, are examples of advancing in terms of management and leadership. Researchers should assess, from time to time, where they are in terms of this model, and should look for opportunities to gain appropriate experience.

## Training, qualifications and professional registration

### Formal qualifications

University training (including universities of technology, formerly called technikons) is required for a career in research. The question usually asked is whether it is necessary to obtain further post-graduate training in order to do research, and if so, how much? Essentially, a bachelor degree provides basic understanding of a SET field; a science honours degree provides basic training in research methods; a masters degree indicates that the holder has demonstrated the ability to conduct research, and report on it effectively; and a doctoral degree indicates that the holder has an ability to understand the existing frontier of knowledge within a specific field, formulate novel ideas or define concepts, test them through research, and thereby generate new knowledge.

Is this all necessary? Possibly not, but in most developed countries, a doctoral degree is seen as almost a minimum requirement for a research career that goes beyond the entry level. Gaining a PhD indicates that a researcher is serious about his/her research career. In some fields (for example engineering, medicine, veterinary science, forestry and agriculture), professional degrees are offered – these normally involve training in the application of knowledge, but do not necessarily qualify the holder for a career in research. The CSIR would therefore encourage researchers to gain appropriate post-graduate qualifications wherever possible. This would also make them marketable for a research career in a much wider sense, and this aspect is formally built into the CSIR's research career ladder (see Appendix 1).

### On-the-job and ongoing training

Additional learning can and should augment formal degrees. Short courses can add value to the development of a researcher's career. These can cover a range of topics, from managerial to technical. On-the-job training is also important. Researchers should take the opportunity to learn from more experienced colleagues, and solicit their help where appropriate.

### Professional registration

In South Africa, registration with professional bodies may be legally required for natural scientists and engineers engaged in research. Two Acts are relevant in this regard, and in terms of both of these Acts it is necessary for the relevant Minister to formally identify the types of work that are reserved. As this has not yet been done, it is not yet compulsory to be registered.

In the case of engineers working in experimental development, a Pr Eng Registration (in terms of the Engineering Professions Act, Act 46 of 2000) may be required. Registration may also be required for natural scientists in terms of the Natural Scientific Professions Act (Act 27 of 2003). This Act explicitly states that only a registered person may practise in a consulting capacity. Research staff members who are not registered may therefore have to work under supervision of those with a Pr Eng or Pr Sci Nat registration when preparing reports, and all such work would have to be signed off by registered natural scientists or engineers. As a professional, it would be advisable to at least keep abreast of developments regarding these two Acts, or simply to register to avoid complications.

### Rating by the National Research Foundation

Researchers in any field can apply for a National Research Foundation (NRF) rating, which is valid for five years. While the system is mainly oriented towards universities, CSIR researchers can also apply. Once rated, researchers can participate in a number of NRF programmes, including obtaining bursary support for students working under their supervision and access to various grants. The CSIR uses the NRF rating system as an independent benchmark to assess its researchers at the top level.



## Building a research track record

### What counts in a research track record?

There are many tangible research products that, when assessed collectively, make up the elements of a research track record. They include (but are not limited to) research reports, published research papers and books, patents, technology demonstrators and prototypes. Depending on the type of research in which an individual is involved, the basket of measures that make up a track record will vary. For example, the major products generated by work in basic or applied research in the natural sciences would be publications in peer-reviewed literature. Experimental development in an engineering environment would produce a track record made up of technology demonstrators or working prototypes.

At the CSIR, people are assessed in terms of their position on the career ladder according to a basket of measures that would be appropriate to the type of research in which they are engaged.

#### The imperative to publish in peer-reviewed literature<sup>4</sup>

Researchers are involved in a number of activities – they formulate research questions, gather data to test them, analyse the data, draw inferences and they record their work in reports and publications. It is these final outputs of research that provide evidence of a track record. The outputs of basic and applied research are usually publications in peer-reviewed journals, while those of experimental development can be in other forms, such as patents or working technology demonstrators. However, publication in peer-reviewed literature remains the global benchmark against which most basic and applied researchers are judged, and it is therefore essential that these researchers pay attention to this vital aspect of their career development.

There are many reasons why publishing is essential in basic and applied research:

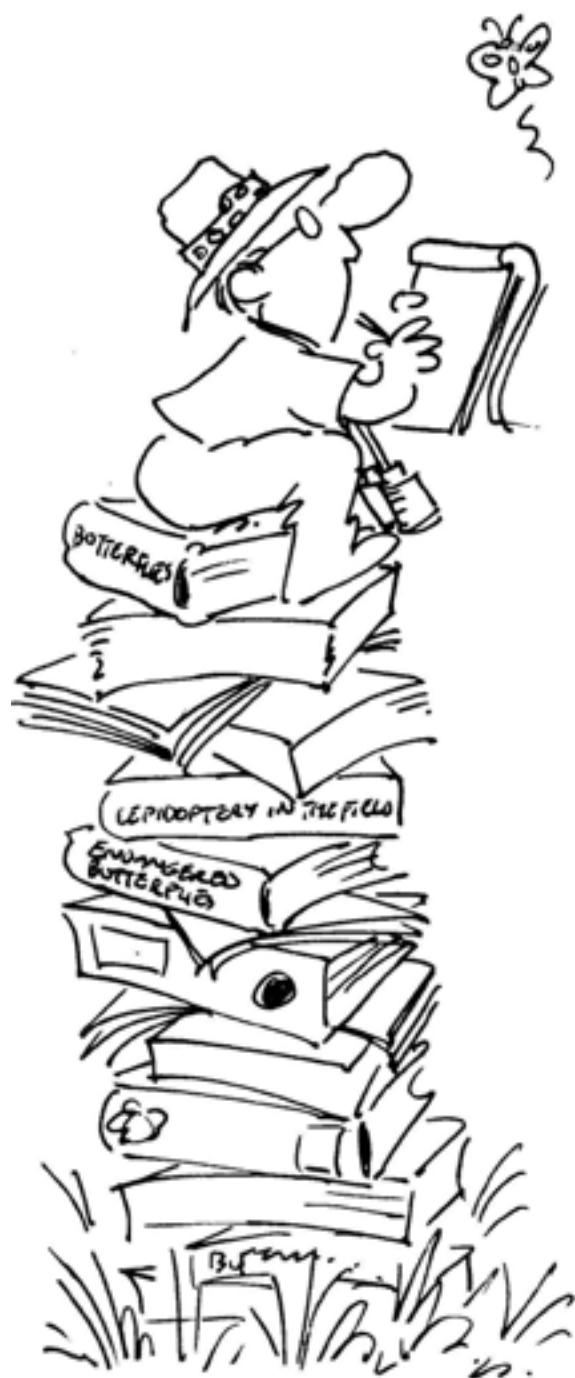
- The most obvious is that unpublished information is lost to the world. All researchers – especially if they receive public funding – have an obligation to publish their results. This is not simply done for amusement or academic satisfaction. Ultimately, judgments about any issue should be based on the best available scientific data. Information that remains unpublished for years is worthless to managers and other scientists. Publication is an implicit part of the “social contract” between society and the researcher: in one way or another, taxes pay for most of a researcher’s salary, and the expected return is that quality-controlled peer-reviewed findings are placed in the public domain.
- Another obvious reason to publish is to solicit rigorous peer review, generally a very useful, constructive process. Most researchers learn more about the business of conducting research from referee comments than from any other single source. Those who do not publish regularly do not gain these benefits, and their careers will not develop as rapidly as researchers who do publish.
- There are less obvious reasons to publish. Researchers who commit their work to paper are forced to think about their research in ways that would never have come about by simply talking about it. First, it requires that the data be carefully organised. The act of putting methods, results and discussion into words obliges researchers to define their thoughts quite precisely, and to consider the meaning of their work far more deeply than they ever would for a talk. Writing generates ideas that have never surfaced before. In addition, reading other papers will expose researchers to many concepts (and problems) that they may not have previously considered. If researchers do not do this, they will not be doing their research justice.

Preparing a research paper for publication is not an easy task for a novice, but the process becomes easier with experience. If researchers really cannot write well or they do not have the time to learn, then it pays to find someone who can. There are many experienced people who can help to write up research data, and in this way researchers can ensure that they get their work into the public realm, even if authorship credits are shared.

Finally, nothing does more to further a research career than publication – a very important point in a competitive job market. Publications indicate that a researcher is serious about research, and can take the scientific process all the way through to completion. It is important to set aside the required time to do this – not an hour a day between lunch and the next meeting. Researchers need to allocate a substantial period of time to do nothing else but explore their ideas to the full.

#### How many papers should be published?

Most successful researchers publish between 50 and 100 (sometimes more) research papers in a career. A researcher should therefore aim to publish at least one paper every year.



4 This section is summarised from *BioScience*: Vol 55, No 5, pp 390-391.

However, it is not only the number but the quality of papers that should count, so beware of getting into a “paper chase”. Especially when starting out in research, resist the pressure to publish prematurely – research should reach a stage where a decent account can be published, rather than publishing preliminary research to meet targets. At the same time, the sooner a researcher starts to publish creditable papers, the better. Post-graduate studies should provide enough material to make a start in this regard.

### Where should papers be published?

There are literally thousands of journals from which researchers could choose. For a start, consider where other researchers working in the same field are publishing their work – this should provide a good range of options. It is always best to choose journals where research will gain maximum exposure, and one of the indicators that could be used to gauge this is the “impact score” of a journal. Impact scores measure the degree to which papers published in the journal concerned are cited in other papers. Therefore, the higher the score, the more likely it is that someone will read (and cite) a paper. Finally, consider the target audience. In some cases, specific research may not be of interest to a large international audience, but of considerable interest locally, so a local journal with a lower impact score may be more appropriate. Seek to publish in a range of journals locally and internationally.

### Who qualifies as a co-author?

Deciding who qualifies as a co-author on a paper is a question that confronts all researchers at one time or another. The journal *BioScience* has provided useful guidelines in this regard. In accordance with these guidelines, authorship should be restricted to those individuals who have met three criteria:

- made a significant contribution to the conception, design, analysis and interpretation of data or other scholarly effort
- participated in drafting the article or reviewing and/or revising the content
- approved the final version of the manuscript.

In the case of papers with multiple authors, the senior author (generally the first author) has the responsibility for:

- including as co-authors all those who meet the three criteria defined above and excluding those who do not
- obtaining from all co-authors their agreement to be designated as such, and their approval of the final version of the manuscript. Of course, any person can refuse to be a co-author if he or she elects to do so.

Co-authors assume full responsibility for all work submitted under their names and, as a co-author, they acknowledge that they meet each of the three criteria for authorship. Honorary or courtesy authorships are inconsistent with these principles and, as such, are unacceptable. But when in doubt, it is better to offer a co-authorship than to refuse one – if the person in question is ethical, he/she will turn it down if it is not well deserved. Sharing authorship is generally beneficial since a well-recognised name as a co-author does have certain advantages.

### Do other research outputs contribute to a research track record?

While publications in peer-reviewed literature are usually internationally regarded as the primary measure of a track record in basic and applied research, there are other outputs that obviously count to varying degrees. These could include papers (oral, posters or written) at conferences, research reports in other outlets (sometimes referred to as “grey literature”) and popular articles.

In some fields of research, patents count much more than papers or reports. In yet other fields of research, especially in experimental development, research outputs are in the form of technology demonstrators. A technology demonstrator is the output of a research and development project, which has demonstrated that a particular technology may be operationally exploited to enhance capability, manufacture a product or deliver a service in a previously unknown manner. Examples of technology demonstrators include a novel process to manufacture a chemical product, or a novel software package/user interface. Typically, such a project may have required an investment of between two and 10 million rand, and it may have taken two to three years to complete. The output is often defined in the form of software or a technology package that can be applied with no further development (although some incremental innovation may be required) to make a product or deliver a service. The package can be sold directly to a client who will seek to implement it. The number and complexity of such demonstrators provide a good indication of the experience and ability of researchers working in these fields.

## Leadership in research

As researchers grow in their careers, they will be required to lead others. At the highest levels, true leaders in research (as elsewhere) will always be rare, but developing skills as a research leader will enhance a researcher’s career and influence. Unlike the business and political worlds, where textbooks on management and leadership abound, obtaining guidance on leadership in the world of research is more difficult. This guide can only offer a few tips in this regard:

- Inspire others through enthusiasm. Research leaders are normally passionate about their field, and this rubs off on others.
- Be generous with experience and ideas. Ideas are the currency of research, and by sharing them with others, a researcher’s influence will be broadened. Offer short courses, for example in research writing skills or presentation skills. Give lectures to students from time to time.

- Be willing to do the “drudgery” of research administration and management – writing proposals, reviewing papers, serving on committees and providing information when requested.
- Provide stretching targets. Staff working under a researcher’s supervision will grow only if provided with real challenges. Their growth in skills and influence will also reflect on the research leader.
- Join a professional society and play an active role. Professional societies should be the breeding ground for leadership in any given field.
- Identify talented young researchers and play an active role in their development. Take on responsibilities as an academic supervisor, or co-supervisor, of masters or doctoral students, and spend quality time with them – it will pay off.
- Listen to the contributions of young or new members of research teams with special attention; they may shake the foundations of “group-think” and provide originality.
- Speak out against unethical behaviour, management decisions that may compromise research integrity, and on issues of importance to society.

## Obligations as a researcher

A research career involves a certain level of service to the research community. From time to time, a researcher may have to use judgment in professional matters, and may be called upon to undertake reviews and other activities. The question of how to deal with these in an ethical way therefore arises.

Ethics in research is an important issue. Researchers make decisions and judgments on a daily basis, involving the use of ideas (possibly generated by others), the collection and interpretation of data, conducting experiments involving living organisms and/or manipulation of the environment, the evaluation of colleagues’ work, and making recommendations for implementation and action based on research results. All of these can have important consequences, or can set precedents. Most professional societies have a code of ethics for their members, with which each researcher should be familiar<sup>5</sup>. Some typical examples include:

- Researchers should offer advice only in areas where they are qualified and experienced enough to do so, and they must clearly state what the level of certainty is around their statements
- Give full and proper credit to the work and ideas of others



<sup>5</sup> The Code of Conduct for the South African Council for Natural Scientific Professions can be found at [www.sarnap.org.za](http://www.sarnap.org.za) and the Rules of Conduct for Persons Registered with the Engineering Council of South Africa can be found at [www.ecsa.co.za](http://www.ecsa.co.za).

- Clearly differentiate between fact and opinion
- Inform clients and employers of any potential conflict of interest
- If any colleague should act in an unethical manner, bring this to his or her attention
- Do not unfairly injure the reputation of colleagues through false, biased or undocumented claims or accusations.

Researchers are also required to make inputs to peer-review processes. Peer review is an extremely important component of the way in which research works. Papers submitted for publication in learned journals, for example, will always be sent out for peer review. Researchers will undoubtedly receive requests to review papers, proposals, individuals or institutions, with no offer of compensation. The question arises as to whether this should be taken on. The short answer is that researchers should become involved in peer reviews – it is both their duty and a quid pro quo for the rigorous reviews they will receive when submitting their papers for publication. Other examples include the examination of theses, and taking up a position on the editorial board of a journal. The trick is to maintain a balance. If a researcher is really busy, it is acceptable to turn down a request for help with a review (but suggest another reviewer); aim to do a few of these duties each year.

## Tips on getting ahead

### Build a track record

Much energy can be dissipated in trying to do too much – “multitasking” is a well-known way to become ineffective. It is therefore very important for researchers in an early career phase to focus on one or a few chosen projects, and to take them through to completion. It is especially in the final stages of a research project that enough time should be dedicated to writing up and publishing results. Focusing attention on completing these tasks is one of the best ways in which a researcher can build a track record and further his/her career. Set targets and review them periodically. If other demands or administration prevents focus, then review the situation with relevant people in the organisation.

### Work with the right people

If a researcher joins a group whose members are active and recognised, then he/she is more likely to grow with them. This underscores the importance of selecting whom to work with, as far as possible. Distinguish between role models, mentors and coaches. These terms are often used interchangeably, but they imply quite different things:

- A role model is a person whom one aspires to emulate – a researcher may never meet his/her role model, but that person provides an image of how you would like others to see you.
- A mentor is a wise advisor, someone who can provide sage advice when needed, and can create opportunities. A researcher need not interact with a mentor more than once or twice a year, but he/she can provide important advice and guidance.
- Coaches are experienced people with whom researchers can interact regularly, almost on a daily basis, and who would provide training in how to go about a range of tasks.

Make a list of the people that you work with, the roles that they play, and plan to interact with them accordingly.

### Take a real interest in your work

Researchers are likely to be successful in research only if they are really interested in what they are doing. Good researchers have to think deeply about what they are doing, they have to formulate the right questions, and they often have to have lots of patience to test their ideas. The most successful researchers are really passionate about what they do, and really enjoy their work.

### Learn to communicate

Successful researchers need to be able to communicate effectively in writing and in speech. Perhaps the most important aspect of this is developing the skills to write clearly and concisely. There are good courses available in scientific writing, and it would be advisable to attend at least one of these. Oral communication is also very important. The art of giving informative and interesting presentations is another skill that all researchers should master to the best of their ability – again it would be useful to take a course. But in both cases, practice is what really matters!

### Build a network of contacts

Networking in research is an important activity. Members of networks will help researchers debate the important research questions in their field, they will help identify other people who are working in the field, and they will assist in reviewing research. Researchers should involve their peers in the design and execution of their research; attend conferences to present their work and to hear about the work of others. Networking can be a very rewarding activity. One meets like-minded people who share common interests, and good friendships are formed. But more importantly, a researcher's work will be better for having had the inputs of others. Networks will provide resources to gain information, generate ideas, collect and share data, and carry out reviews. Revisit current networks from time to time, and aim to expand them if necessary.

### Keep up with the literature and global developments

In any field of research, knowledge is constantly being improved. When writing research proposals or publishing research papers, remember to review the state of the field. Active researchers need to keep abreast of the latest findings in the field if their research is to be relevant. Make time to read the major journals, get copies from the library, or from the internet, and read them on a regular basis. Networks are the best way to alert a researcher to what is really important to read.

### Do not be afraid of failure

As research is a step into the unknown, it is very difficult to predict the exact outcome of a project. In research, only one in 10 projects reaches the initial targets or meets the initial objectives. The old adage of "if at first you don't succeed, try and try again" is very relevant here. In the end, successes will emerge, and one's track record will grow.

### Be prepared to tackle dogma

If research results contradict conventional wisdom, they can be rejected. Often this is done by established researchers whose ideas are being challenged. It may be difficult to overcome such barriers, but it pays to persist – that is often how many of the major breakthroughs in science are made!

### Keep an updated Curriculum Vitae

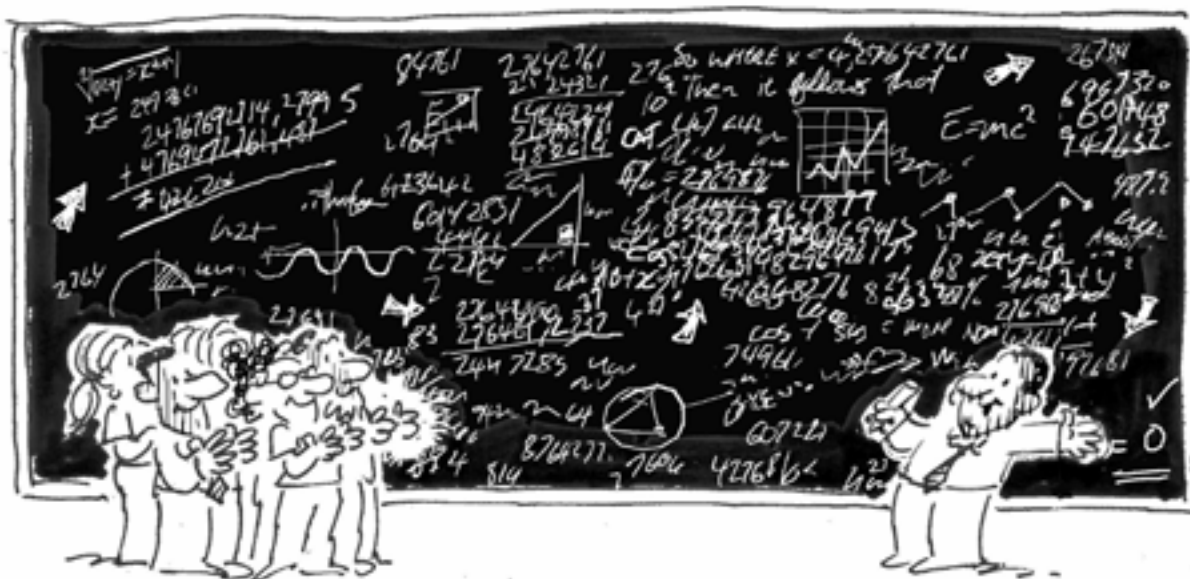
A Curriculum Vitae (CV) is a living document that needs to be kept up to date for a number of reasons. It provides people with the first impression of an individual, even before meeting for the first time. It is needed when applying for a job, when applying for research funding, and when assessing the suitability of a researcher for inclusion in research teams. It is a good idea to review a CV regularly, at least once a year, and if it is neglected it is often surprisingly difficult to gather the information needed. A full CV for a researcher contains the following information:

- Biographical information (name, address, contact details)
- Educational qualifications
- Career and employment history
- Career achievements
- Professional activities (such as membership of professional societies, editorial boards, research steering committees and review panels)
- Awards and recognition
- A full list of research outputs (under appropriate headings – books, papers in peer-reviewed journals, book chapters, conference proceedings, research reports, popular articles, patents, working demonstrators).

It is also useful to maintain a short CV, typically one or two pages, to attach to proposals. It should summarise the key features of the full CV, for instance by just mentioning the number of publications, and giving the details of only a few. Even a short CV is sometimes too long (and can seem boastful) to be used to introduce a researcher at a conference, or to append to the end of a paper. A paragraph-length biographical sketch, written in less formal language, should be used in this context.

### Beware of plagiarism

One of the challenges of good scientific writing is putting research down in one's own words. With the broad availability of research writing on the internet, it is often tempting to make use of someone else's words to express oneself. This is called plagiarism, which is the act of taking someone else's writing, or pieces or ideas therefrom, and pretending it is your own writing. Hacker defines three types of plagiarism: "(1) failing to cite quotations and borrowed ideas, (2) failing to enclose borrowed language in quotation marks, and (3) failing to put summaries and paraphrases in your own words."



Some types of plagiarism are accidental and can be the result of poor use of references, poor planning or most often through a misunderstanding of what plagiarism is<sup>6</sup>.

## Ten frequently-asked questions

### How long will it take to get promoted on the CSIR's career ladder?

The CSIR's research career ladder has five rungs, each of which is linked to two salary bands (except the candidate researcher rung, which has only one salary band). There are thus nine stages, or eight opportunities for promotion from one salary band to the next. If a career spans 30 years, then promotions would take place every four years or so, on average.

However, this is an over-simplification. Not all researchers will reach the top levels, and advancement on the career ladder can be expected to be more rapid in the initial stages than in the later stages. There are examples of talented young researchers reaching the level of principal researcher in their early 30s, for example. In essence, the career ladder provides a transparent guide for researchers in terms of what they need to do to reach the next level – how rapidly they are able to achieve this is determined to a large degree by how quickly they develop their skills and track record.

### How do I build a track record if research outputs are confidential?

It does happen, in certain cases, that research outputs need to be kept confidential – for example, where there is intellectual property to protect, or issues of national security are involved. However, this problem is not as widespread as many people believe. Many clients are happy for the basic research behind their work to be published, and researchers can establish the situation in this regard quite easily by asking about the issue as early on in a project as possible. Total confidentiality is not an automatic requirement of work in these fields. It is a matter of negotiation in the contract to determine what is confidential, and for what period.

In cases where research is aimed at producing intellectual property, the work is normally patented. These patents (and the supporting publications) can be used to illustrate a track record in research. It is generally a requirement that the science behind patents should be published in peer-reviewed literature as soon as the patent is registered. Finally, the CSIR has access to Parliamentary Grant funds, which can also be used to build a research track record. This range of options should provide sufficient opportunities to build a track record in research.

### Should I apply for a rating with the National Research Foundation (NRF)?

The NRF maintains a system of rating researchers in terms of their standing in the field. This system was introduced to assist the NRF with the allocation of research funds to deserving recipients. Obtaining a rating as a researcher by the NRF is not compulsory for advancement in a research career in the CSIR; however, it does offer some advantages, and researchers should consider using the system if they so wish. The advantages include access to funding, and a confirmation of one's standing as a researcher (particularly important if you are considering moving to an academic environment). In some cases, it also provides confirmation of international recognition when motivating for advancement on the CSIR research career ladder.

### How can I focus on research when I am under pressure to earn income for the CSIR?

Maintaining a balance between generating income and building a track record in research is an important tension in research organisations such as the CSIR. There is no easy answer to this question, as promoting both aspects is important to both the researcher and the organisation. However, they need not be mutually exclusive – it is not always true that work paid for by a client does not afford the opportunity to do work that will build a research career. Working at the CSIR also offers research opportunities that may not be available in consulting agencies, and the trick is to make the most use of these. Universities have an additional tension between teaching and research. Having a clear research strategy in place for a research group will go a long way to helping clarify areas where a researcher should focus his/her work and thus avoid taking on consultancy work simply to “balance the books”.

Once there is a clear idea of where a research group wishes to build a track record, endeavour to secure contracts that include a significant component of research in them (in other words, contracts that generate new knowledge – there are many opportunities in this regard); prioritise larger, longer-term contracts rather than fewer, short-term ones; and take the time to publish research results before moving on to the next contract (Parliamentary Grant research funds provide a means for doing this).

### Why publish in scientific journals when clients do not read them?

Clients are not the CSIR's only stakeholders. Publication in scientific literature is recommended for all of the reasons outlined above. It is true that most clients do not read this literature (nor should they be expected to), but it does establish a researcher's credentials as a scientist who can speak and act on behalf of the organisation. There are other ways of communicating with clients and stakeholders (by means of popular articles, information brochures, talks and demonstrations). The truth is that communication with clients takes place through a variety of channels, and these should not be confused, as they require very different approaches and are done for different reasons.

### Is the expected level of publication the same in all fields?

No. In some fields, it may be easier to amass data and produce publications than in others. For certain research activities (like experimental development), publications may not form the primary outputs of research – for example, these outputs may be in the form of complex technology demonstrators and operating manuals. Normally, the expected level of output is benchmarked

<sup>6</sup> There are many useful websites about plagiarism and how to avoid it. See, for example, [www.plagiarism.org](http://www.plagiarism.org); <http://en.wikipedia.org/wiki/Plagiarism>; and <http://gervaseprograms.georgetown.edu/hc/plagiarism.html>.

against that of recognised peers and leaders in the same field, and this certainly varies across research fields. Similarly, the number of times a researcher's work is cited is determined in part by the field – there will be more citations if the field is large, and employs many researchers.

### **What if the focus of my work is not mainly on research?**

The CSIR has three distinct career ladders for staff employed in its core business of research and development:

- The research career ladder is described in this document.
- A second career ladder has been developed for people primarily involved in knowledge application. The primary activities of this group include technology transfer and industrialisation, and routine or non-routine knowledge-based services. People performing these activities need to be accomplished scientists or engineers, but they will find it difficult to produce the levels of research outputs expected of research staff.
- The third career ladder caters for staff in research support activities. This ladder has a range of levels, from staff members who perform routine tasks under supervision, through to those responsible for the operation and management of highly complex, sophisticated equipment and facilities, which often require high levels of innovation.

### **How important is it to be the main author of a publication or report?**

Being listed as the main (or senior, or lead) author on a report or publication usually indicates that the researcher has played the lead role in both the research and the production of the report. All people listed as co-authors, irrespective of the order, have also played important roles in the research reported. An overall research track record will take all of the researcher's publications into account; however, at the more senior levels, it is expected that a researcher should act as lead author of at least some of his/her papers. In papers that have just two authors, not much can be inferred from which of the two is in the first place.

### **Will my career suffer if I have not been involved in research for a long time?**

Many employees of the CSIR point out that they have been unable to maintain a focus on research in the recent past, and that a renewed focus on research will place them at a disadvantage. The concern is valid – many people have not built or maintained a track record in research. However, in rebuilding its research capacity, the CSIR cannot compromise the standards required for appointment to higher grades of the research career ladder. If you wish to return to a career focused on research, it should be possible to regain experience and recognition by focusing on aspects that will enhance your standing as a researcher – this guide attempts to outline the most important of these.

### **How far can I advance in a career in research, compared to a career in management?**

A long-standing perception in the CSIR has been that following a career in management, as opposed to research, is the only way to advance past a certain level. The introduction of research career ladders is an intervention that seeks, as one of its goals, to address this perception by providing a transparent set of measures for people who wish to advance without accepting a management position. Thus, in theory, a principal researcher should have the equivalent job size, and salary range, as research group leaders and competency area managers (Appendix 1, Figure 1). However, as explained above (and in Figure 1), advancing to higher levels cannot be achieved without taking on some responsibilities around the leadership of research.

## Appendix 1: The CSIR's research career ladder

This appendix provides the basic details for the assessment of staff members on a research career ladder. For full details, see [http://intraweb.csir.co.za/csir\\_hr/career/index.html](http://intraweb.csir.co.za/csir_hr/career/index.html).

The career ladder for researchers in the CSIR has five rungs. These are:

1. Candidate researcher
2. Researcher
3. Senior researcher
4. Principal researcher
5. Chief researcher.

The use of titles by researchers is formally subject to their placement on the above ladder. The term "researcher" can be regarded as interchangeable with more descriptive terms that would be more appropriate to the researcher's field of expertise. However, the adjectives "candidate", "senior", "principal" and "chief" should be used only by researchers who have been placed on the rung concerned. Examples of titles could be "ecologist", "senior biochemist", "principal engineer", or "chief oceanographer". These titles should be used in external correspondence and on business cards.

A researcher's position on the ladder will be established by determining the sum of "personal value points" reflecting his/her level of competence with regard to six measures. The measures are:

- Qualifications
- Leadership and the ability to provide strategic direction to research and development activities
- Knowledge generation and dissemination
- Human capital development
- Generating impact
- Attracting funding for research and development.

Essentially, individuals are assessed with respect to their level of competence for each of the measures, and personal value points are awarded as shown in Table 1. The gradings are done on the basis of self-assessments, which are moderated by panels appointed for this purpose within each of the operating units of the CSIR.

**Table 1. Personal value points awarded for different levels of competence with respect to six measures, for the purposes of assessing a researcher's standing on the research career ladder**

Measure	Level of competence	Personal value points awarded
Qualifications	< Masters degree	20
	Masters degree	70
	Doctoral degree	150
Leadership and strategic direction	Works under supervision and is not required to demonstrate leadership	12
	Is aware of trends in the relevant field, and able to formulate ideas relating to research and development projects	27
	Provides strategic direction within a research group	45
	Provides strategic direction in interdisciplinary research projects within competency areas or operating units	90
	Provides strategic direction in interdisciplinary research projects in collaboration with global partners	150
Knowledge generation and dissemination	Has the basic skills needed to generate and disseminate knowledge	22
	Has demonstrated the ability to generate and disseminate knowledge	44
	Has developed a track record that indicates that he/she is an established researcher in the field	77
	Has developed a significant track record indicating that he/she is a leading researcher in the field	118
	Has a track record as a leading researcher that has led to international recognition as a leader	175
Human capital development	Focuses on developing own skills	22
	Focuses on establishing own track record	44
	Is still developing own track record, but provides guidance to candidate researchers and researchers	77
	Is well established in career terms, and plays a leading role in developing others	118
	Has a primary focus on creating an environment where others can achieve their full potential	175
Generating impact	Not expected to have impact	22
	Produces work that has potential for impact	44
	Work has had some impact	77
	Work has had noticeable impact	118
	Work has had significant impact internationally	175
Attracting funding	Not expected to attract funding	22
	Contributes to the development of funding proposals	44
	Attracts sufficient funds to cover own activities	77
	Attracts sufficient funds to cover projects involving several researchers and support staff	118
	Attracts sufficient funds to cover large interdisciplinary projects	175

Personal value points are calculated to determine a placing on the career ladder, as shown in Table 2. Each of the rungs of the ladder is associated with two salary bands, with the exception of the candidate researcher level, where there is only one salary band. The range of salary packages associated with the salary bands will be revised from time to time in line with market trends. The aim is to ensure that all staff will be paid salaries within the range associated with the salary band commensurate with their grading.

Table 2. The relationship between personal value points, grading on a research career ladder, and salary bands in the CSIR.

Rung on the research career ladder	Range of personal value points	Salary band
Candidate researcher	< 197	C2
Researcher	197 - 270	C3
	271 - 354	C4
Senior researcher	355 - 420	D1
	421 - 567	D2
Principal researcher	568 - 710	D3
	711 - 855	D4
Chief researcher	856 - 928	E1
	929 - 1 000	E2

Researchers become eligible for promotion at any stage, provided that improvements in their experience, track record, qualifications and impact are such that they are able to score the required personal value points needed for such a promotion. The remuneration policy would allow researchers who are promoted to be eligible for higher salaries in line with the corresponding rung of the career ladder. Each salary band is associated with a range of salaries, which increases in the minimum, midpoint, and maximum values for each rung of the ladder (Figure 1). While there is considerable overlap in the values between rungs, there is more than a four-fold difference between the lowest rung (candidate researcher) and the highest rung (chief researcher).

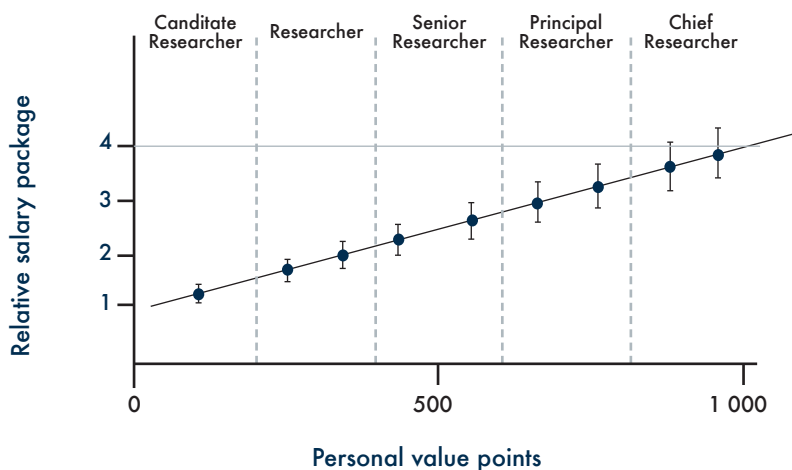


Figure 1. Relative salary packages associated with different rungs of the CSIR research career ladder (the midpoint salary for a candidate researcher = 1); circles on the line represent the midpoints of different salary bands, while the bars indicate the minimum and maximum values.

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