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Office of the
Principal Scientific Advisor
to the Government of India

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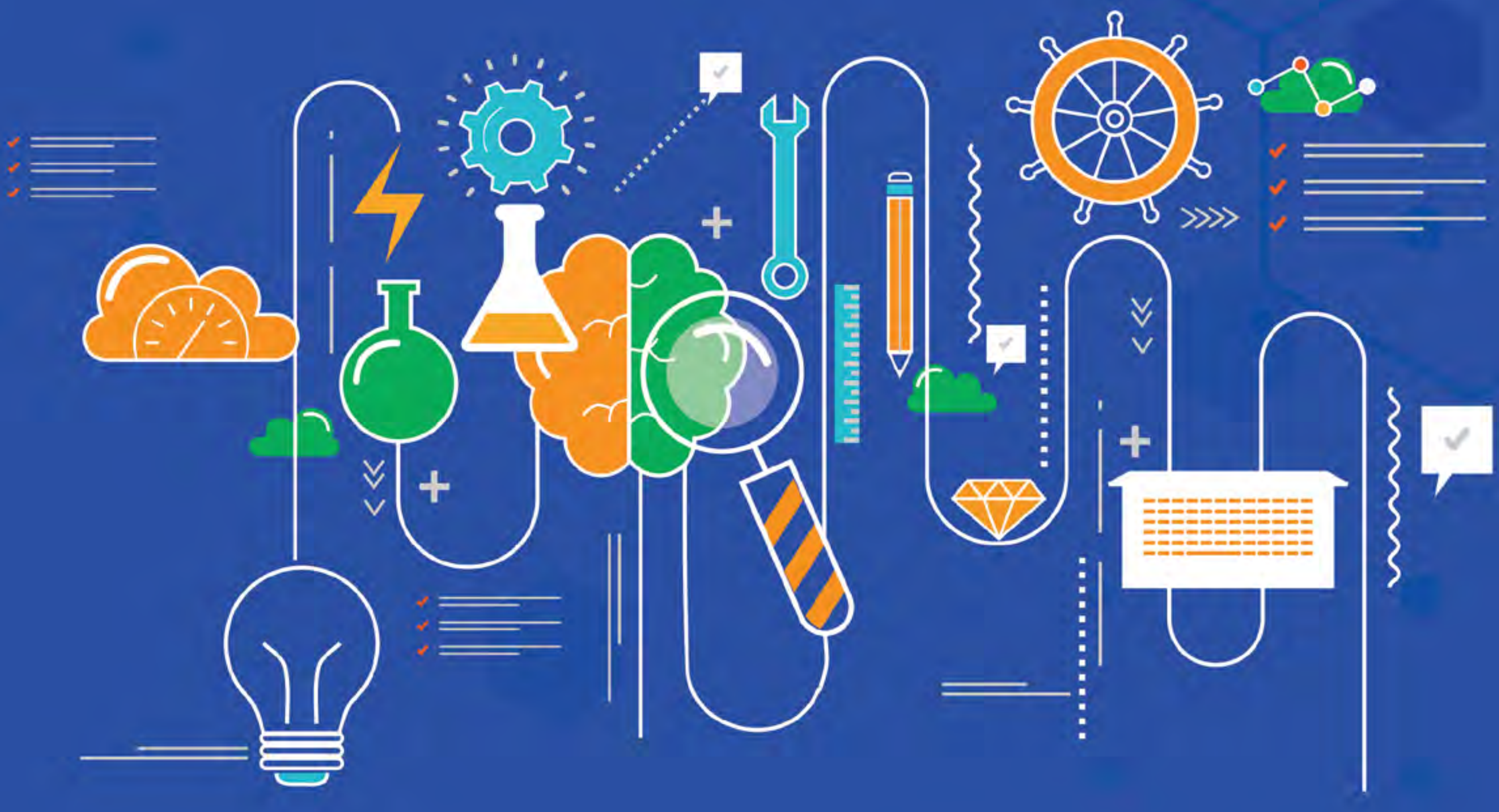
CTIER CENTRE FOR TECHNOLOGY, INNOVATION AND ECONOMIC RESEARCH

EVALUATION OF INNOVATION EXCELLENCE INDICATORS



Report on
Public Funded R&D Organisations (Round 2)

Volume I

2025

Table of Contents

Preface

Prof Ajay Kumar Sood

Principal Scientific Advisor to the Government of India

As India advances towards new frontiers in science and technology, our publicly funded R&D institutions continue to play a pivotal role in shaping the nation's innovation landscape. The first round of this study, on "Evaluation of Innovation Excellence Indicators of Public Funded R&D Organizations" established critical benchmarks for evaluating innovation excellence within publicly funded organizations. This round represents another stride in evaluating these institutions, building upon the initial insights of first round with an expanded set of parameters that reflect emerging priorities at national level.

India's public-funded R&D organizations are essential to realizing the nation's vision for Viksit Bharat through their commitment to innovation, advancement in scientific research, and promotion of leading-edge technology across diverse sectors. These institutions have consistently contributed to India's global standing in areas such as agriculture, manufacturing, deep tech, healthcare, renewable energy, and many others. Their mission aligns with creating sustainable and inclusive development solutions, reflecting the national agenda for economic resilience and social equity. With an unwavering focus on R&D and innovation, these organizations are catalyzing India's transformation into a technology-driven economy, empowering industries, academia, and society to build a prosperous future for all.

Keeping in view the learning of the first round the O/o PSA decided to undertake the Round 2 with an objective to deepen our understanding of public R&D institutions and their contributions to addressing national priorities and emerging challenges. It was targeted to have larger participation in this Round of study.

The present study was designed to capture a more comprehensive view of the contributions of these public funded R&D Organizations in areas critical to India's growth. The basic framework of NITI Aayog with three main pillars: Socio-economic Impact, Science, Technology and Innovation (STI) Excellence, and Organisational Effectiveness remain the backbone of this study as well. The pillar on 'Socio-economic Impact' captures the outcomes of a R&D lab's activities and its impact towards achieving national priorities. The pillar on 'Science, Technology and Innovation (STI) Excellence' captures the outputs of a R&D lab's activities. The pillar on 'Organisational Effectiveness' captures the effectiveness of a R&D lab in quality delivery of its mandate. Depending on the nature of R&D activities undertaken by the labs, the framework classified them into three categories – Basic, Applied or Services.

Further to that, the present study brings a fresh focus on indicators that align with India's evolving STI ecosystem. The evaluation now tracks the number of deep-tech and deep-science startups supported by these institutions, along with emerging technology patents and contributions to policies that foster innovation in critical fields. Additionally, as sustainability becomes an ever-more essential goal, this study now highlights R&D efforts in green technology, sustainable practices, and waste management, reflecting the institutions' commitment to environmental stewardship.

This report also emphasizes inclusivity and accessibility within the R&D landscape. New indicators have been introduced to account for support extended to women and young scientists through conference funding, sabbaticals, and other professional opportunities. Moreover, the opening of research facilities to startups, industry collaborators, external researchers, and students marks a notable shift towards a more open and interconnected innovation environment.

This report introduces new sections that add depth and breadth to the findings. This includes a section dedicated to the R&D labs in the North-East, showcasing the region's scientific contributions, and a new segment highlighting the top-performing labs for select indicators. The report also delves into science clusters, startups, and sustainable practices, reflecting the multifaceted contributions of our R&D institutions across the country. Additionally, an expanded chapter on startups captures trends in incubated ventures, spin-outs, and deep tech startups, along with insights into the types of support extended, the rise of Section 8 companies, and the number of successful startup exits.

A total of 244 labs participated in this study, and their engagement brought valuable insights into the diversity and impact of India's publicly funded R&D ecosystem. The Confederation of Indian Industry (CII) and the Centre for Technology, Innovation, and Economic Research (CTIER), Pune, served as dedicated knowledge partners, working tirelessly over the past year to shape this report with enthusiasm and rigor. Covering 62 parameters, the report captures a comprehensive view of each lab's contributions. It was heartening to witness the enthusiastic participation of the labs, reflecting their eagerness to engage in this learning journey and to align their efforts with the evolving goals of national development.

The report underscores the critical role of our R&D institutions in supporting a technologically advanced, inclusive, and self-sustaining India. It reflects the combined efforts of our nation's researchers, industry partners, and policymakers, united by a shared goal of transforming India's R&D outcomes into impactful, sustainable contributions. I thank all those who have contributed to the success of this study and look forward to the new paths it will open for collaboration and innovation. This study reaffirms our commitment to assessing, enhancing, and celebrating the impact of publicly funded R&D institutions on India's growth and innovation landscape. By encompassing emerging domains and underscoring the principles of sustainability, diversity, and collaboration, this exercise aims to empower our R&D ecosystem to make measurable contributions to an Atmanirbhar Bharat.

I would like to extend my gratitude to the Directors of these R&D Organizations whose contributions helped in bringing the report to this shape. I also thank the members of the Expert Committee constituted by my office for their valuable insights, that have immensely enriched this report.

I wish to thank the panel of experts for their valuable suggestions in making this study robust and outcome oriented. The panel of experts consisted of Dr. Ranjit Rath, CMD, Oil India, Mr Nagesh Kumar, Director, Institute for Studies in Industrial Development (ISID), Mr J B Mohapatra, Former Chairman CBDT and Prof Dinesh Abrol, Retd Chief Scientist, CSIR – NISTADS.

I wish to place on record my sincere appreciation for the dedicated work done by my team consisting of Dr (Mrs) Parvinder Maini, Scientific Secretary, O/o PSA, Shri B.N. Satpathy, PSA Fellow, Dr Preeti Banzal, Adviser, Scientist G, O/o PSA Ms Remya Haridasan, Scientist D, Dr Hafsa Ahmad, Scientist D, O/o PSA and Mr Suneet Mohan, Former Consultant (O/o PSA) for their valuable contribution to the formulation and finalisation of this Report.

I also acknowledge the support provided by the team from Confederation of Indian Industry (CII) and Centre for Technology, Innovation and Economic Research (CTIER) for completing this gigantic exercise.

To conclude, I wish to extend my deep appreciation to the Prime Minister's Office for giving this opportunity to produce this pioneering report on the nation's public-funded R&D institutions. I am confident that this report will serve as a catalyst for ongoing progress and partnership across India's scientific community.

Prof Ajay Kumar Sood

February 2025
New Delhi
India

Foreword

Dr. (Mrs.) Parvinder Maini
Scientific Secretary
Office of the Principal Scientific Adviser to the Government of India

India's journey in science and technology has seen remarkable advancements, with publicly funded R&D institutions at the forefront, translating national priorities into transformative solutions and laying the groundwork for a resilient innovation landscape. This study on Evaluation of Innovation Excellence Indicators of Public Funded R&D Organizations marks a significant step forward, allowing us to evaluate our institutions with greater depth and a broader scope, essential in today's rapidly evolving science and technology environment.

India boasts a longstanding tradition of public-funded R&D organizations, with some established even before independence. These institutions are vital centers of knowledge creation and engines for driving New India's innovation-led economy, unlocking immense potential for collaborations. As major stakeholders in the nation's R&D framework, they play a key role in, fostering technological breakthroughs that shape India's future.

At the direction of the Prime Minister's Office, the Office of the Principal Scientific Adviser initiated a comprehensive assessment of innovation indicators within India's public-funded R&D organizations. This initiative, grounded in an initial framework developed by NITI Aayog, aimed to capture both qualitative and quantitative insights into the contributions of these institutions. Its purpose was to analyze each lab's unique strengths and weaknesses, enabling them to re-examine their mandates and align their research outputs with current national priorities and missions. This study also captures new set of nuanced indicators aligned with emerging national priorities, such as deep-tech startups, sustainability practices, and the growing importance of inclusivity in research. In doing so, it offers a clear view of the contributions of our R&D institutions towards an innovation-driven economy and a sustainable future. It is heartening to see our institutions increasingly opening their research facilities to startups, industries, and external researchers, fostering an interconnected ecosystem that encourages collaboration.

Additionally, this report includes fresh perspectives on key areas, from the contributions of labs in the North-East to highlighting top-performing labs and science clusters. The dedicated chapter on startups showcases the diverse trends in incubation, deep-tech ventures, and emerging industry partnerships, reflecting the dynamic role of public R&D in our innovation ecosystem.

The preparation of this report has been a collaborative effort, and I extend my gratitude to the Confederation of Indian Industry (CII) and the Centre for Technology, Innovation, and Economic Research (CTIER), Pune, for their dedication and hard work over the past year. I am also grateful to the directors and teams of 244 participating labs for their enthusiastic involvement, which has enriched this study and provided an extensive view of India's publicly funded R&D landscape. Multiple stakeholder meetings, chaired by myself and including representatives from key scientific departments and R&D organizations were held to ensure the initiative's successful completion.

I wish to place on record my sincere appreciation for the detailed work done by Mr. B. N. Satpathy, PSA Fellow in the O/o PSA. His tireless efforts and constant interaction with CII have resulted in the development of a flawless report supported by robust data analytics.

This report will serve as a valuable resource for policymakers, scientists, and stakeholders, helping us all to identify areas of strength, address gaps, and inspire new approaches to research and innovation. As India progresses towards an Atmanirbhar Bharat, I am optimistic that this study will be instrumental in guiding and supporting our R&D institutions in achieving their fullest potential.

Dr (Mrs) Parvinder Maini

February 2025
New Delhi
India

Foreword

Dr Naushad Forbes

Past President, CII
Chairman, CII National Committee on Technology, Innovation, & Research
Co-Chairperson, Forbes Marshall

At the outset, I wish to congratulate the Office of the Principal Scientific Adviser to the Government of India on this comprehensive study of India's public funded R&D institutions. As India strives towards becoming a developed nation, the rapid pace of technological change and increasing global geopolitical uncertainties offers an opportunity to reassess, transform and prioritize our public research funding. The rich data, insights and recommendations from this report will allow policymakers and industry leaders to meaningfully engage and chart out a path to help India become a more prosperous and inclusive nation.

The report also offers the participating institutions themselves an opportunity to increase their focus on areas that would best serve the nation, be it in the areas of healthcare, food security, climate change or even critical emerging technologies to name a few, all of which have global implications. This is particularly important in the context of the newly implemented ANRF, where additional funding opportunities could be availed of through collaborative efforts with higher education institutions and industry.

Opening up the research and testing facilities of the public funded institutions to industry and startups, while providing educational institutions access to their scientific resources would help build the next generation of entrepreneurs and innovators. Industry on the other hand must seek to identify research being performed at these institutions where the TRL levels are closer to commercialization. There is a collective responsibility on the part of all stakeholders to ensure India achieves her full innovation potential.

There is much to be gained through this evaluation exercise. I wish to commend CII and CTIER for their dedicated effort in working closely with the Office of the Principal Scientific Adviser to the Government of India, and to all the participating institutions for nominating dedicated individuals to complete this very important and useful exercise.

Dr Naushad Forbes

February 2025
New Delhi
India

Acknowledgements

The present report on Innovation Excellence Indicators of Public funded R&D organizations would not have been possible without the invaluable support and leadership from Prof. Ajay Sood, Principal Scientific Adviser, and Dr. (Mrs.) Parvinder Maini, Scientific Secretary. Their guidance and encouragement were pivotal in steering the project to completion.

We also extend our heartfelt gratitude to Mr. B.N. Satpathy for his constant guidance and strategic inputs, which enriched the quality and direction of the study.

We also convey our sincere thanks to Ms. Remya Haridasan for her regular support and help during the study.

The findings of the study, as well as the comprehensive, timely data collection and research outcomes, owe their success to the dedicated efforts of several individuals and teams.

From the Confederation of Indian Industry (CII), this effort was spearheaded by Shri S Raghupathy, Principal Adviser, Dr Ashish Mohan, Executive Director, Technology, Ms Namita Bahl, Director and Head, Technology, Dr Rahul Katna, Associate Counsellor- Technology, Ms Priyanka Thakur, Executive Officer, Technology, Ms Tiksha Madan, Deputy Director - Technology, Ms. Divya Arya - Deputy Director - Technology whose dedication and teamwork played a key role in shaping this initiative.

The contributions of the CTIER team were equally instrumental, with significant efforts from Shri Janak Nabar, CEO, Ms Swati Joshi, Senior Research Associate, Mr Nishant Dewaney, Research Analyst, Mr Chaitanya Lekharaju Research Associate, Ms Neha Kumari, Research Analyst, and Mr Yash Karmarkar Research Analyst. Their commitment to research and data analysis added depth and rigor to the study.

We would also like to extend our sincere gratitude to the Nodal Officers from the participating ministries, whose unwavering support, timely coordination, and active engagement were integral to the successful completion of this study.

Lastly, we extend our special thanks to all the Directors and data officers from the participating institutions for their active involvement, dedication to the exercise, and invaluable feedback during the pilot phase and the larger study. Their participation in webinars and their continuous inputs were critical in ensuring the success and relevance of this initiative.

To all contributors, we express our profound appreciation for your support and efforts in making this report possible.

About the Report

This report captures findings from the second round of the Evaluation of Innovation Excellence Indicators of Public Funded R&D Labs/institutes undertaken between November 2023 and October 2024. Building on the foundational framework established by NITI Aayog for the first round (conducted between August 2019 and March 2022), this study led by the Office of the Principal Scientific Adviser to the Government of India continues to assess the absolute and relative strengths and weaknesses of India's public-funded R&D organizations.

Recognizing the evolving landscape of research and innovation, and responding to feedback from Round 1, several modifications were introduced in this round. These changes were designed to enable participating organizations to showcase their contributions to the domestic and global economy, particularly in areas aligned with national priorities. These include contributions towards the startup ecosystem as well as in tackling issues around sustainability. The report helps gauge performance of the labs with respect to their socio-economic contribution, STI excellence and organizational capabilities and practices. Several actionable recommendations have emerged both in Round 1 and Round 2 of this exercise, which would need to be considered to enhance the output and outcomes of the participating labs/institutes and that can also be used as a guide to transform public funded research in India.

This report is divided into two volumes. The Volume 1 has three main sections and Volume 2 has two sections. The first section offers a broad overview of the exercise with details of the framework and methodology, the second section captures the public R&D ecosystem, the startup ecosystem and spinout supported by these labs, sustainable practices and also the labs of North-east. The third section captures the Basic, Applied and the services R&D Labs. The fourth section captures the findings from the analysis of the data collected, offering an overview of public R&D in India along with a spotlight on the contribution of these labs/institutes to the startup ecosystem in India, the sustainability practices adopted by these labs/institutes, and a spotlight on the labs/institutes in the north east. The fourth section contains the individual lab/ institution sheets as well as details of individual labs/institutes that participated in this exercise. The appendix is in the fifth section.

Executive Summary

Background

India is at a pivotal moment in her growth trajectory. In the last decade, India has made significant strides in improving her innovation landscape. India's ranking in the Global Innovation Index rose from 81 in 2015 to 39 in 2024. Public funded R&D organizations have long been a key pillar of the country's scientific progress. These institutions have consistently contributed to India's socio-economic development through research and innovation in diverse fields such as health, agriculture, environmental sustainability, and defense. However, there is a recognition that several key areas require substantial improvements including a focus on critical technologies such as Artificial Intelligence (AI), quantum computing and bio-engineering. The Government of India has showcased its commitment to elevating India's scientific capabilities, improving research infrastructure, and building bridges between academia, industry, and the public sector through various initiatives in recent years.

The purpose of this report is to capture and evaluate innovation indicators of public funded R&D labs/institutes to qualitatively and quantitatively comprehend the contributions made by these organizations. The analysis and recommendations in this report are meant to guide the public funded R&D labs/institutes to increase their contributions meaningfully towards a number of SDG goals and national priorities through their research capabilities, to help the nation navigate the various challenges she faces on the socio economic front, from health challenges to ensuring a more diverse scientific base through opportunities for women scientists, and finally to contribute to skilling and creating meaningful employment by working alongside industry and startups. It is hoped that public funded R&D labs/institutes and their parent ministries/departments will use the findings from this report to reassess their mandate and re-evaluate research output.

If India is to achieve her goal of Viksit Bharat by 2047, and take her rightful and deserved place as one of the leading nations measured not only by the level of GDP but also by the safety and well being of her citizens, then it is incumbent on every institution and every capable individual in the private sector, government machinery and the higher education sector to rise up to the occasion and perform to their full potential to deliver on the ambitious and achievable goal of Viksit Bharat. This includes the publicly funded organizations that span a number of key scientific ministries and government departments and are the subject of analysis in this report.

The framework used for the evaluation of innovation excellence developed by NITI Aayog in discussions with several stakeholders and on the lines of other global evaluation frameworks had the following objectives:

- Capture innovation indicators and the research being undertaken by various public funded R&D organizations.
- Assess the performance of the labs with respect to their socio-economic contribution, STI excellence and organizational capabilities and practices.
- Identify areas of untapped potential and interventions to improve the labs' performance in the identified areas.
- Propose a roadmap for improvement of the outputs and outcomes from these R&D organizations.

Framework - Salient Features and New Additions

The framework in Round 1 had been finalized through extensive and wide-ranging consultations with representatives from various ministries having provided their inputs during the entire process. As in Round 1, given the tremendous diversity in the nature of R&D carried out by various publicly funded R&D organizations, the labs/institutes were grouped into three categories - Basic, Applied, and Services. The framework has three main pillars – Socio-economic Impact, Science, Technology and Innovation (STI) Excellence, and Organizational Effectiveness. The three main pillars cover a total of 11 sub-pillars and 62 evaluation parameters.

The aim of the first pillar, 'Socio-economic Impact', is to capture the outcomes of an R&D organization's activities and its impact towards achieving national priorities. The second pillar, 'Science, Technology and Innovation (STI) Excellence' seeks to capture the outputs of a R&D institution's activities. While the third pillar, 'Organizational Effectiveness', captures the effectiveness of a R&D organization in quality delivery of its mandate.

Within the overarching framework established in Round 1, new indicators were introduced in this round that aimed to capture the activities of publicly funded R&D organizations in areas of national importance. These new indicators include number of deep tech/deep science startups supported, patents granted in emerging technologies, policy contribution towards emerging technologies, non-worked patents, waste reclamation and sustainability, support provided to young and women scientists and opening up of testing and research facilities.

Scope, Data Collection, and Data Validation

In this round, 292 labs were invited to participate in the study. This list of 292 labs was put together using the DST Directory, DSIR Directory, individual websites and annual reports. This list of labs was vetted by the Office of the Principal Scientific Adviser.

A total of 244 labs/institutes across ministries participated. At the time of analysis, 10 labs/institutes were dropped due to poor quality of data despite multiple attempts of verifications. The distribution reveals that the majority of the participating labs/institutes are from the Indian Council of Agricultural Research (ICAR), followed by the Council for Scientific and Industrial Research (CSIR), Indian Council of Medical Research (ICMR), Department of Biotechnology (DBT), and Department of Science and Technology (DST).

Data was collected through an online portal (www.indiascienceindicators.gov.in). Labs/institutes self-selected themselves as Basic, Applied or Services or as a hybrid i.e. a lab/institute whose research straddles more than one of the three research categories of basic, applied and services. All the data submitted by the labs/institutes was accompanied with the Director's signoff indicating that the submitted data was authentic and valid. The raw data was validated and where possible, inconsistencies were corrected.

Data Quality

The collection of high-quality data was facilitated through multiple measures. Templates were created in a downloadable format (excel) to facilitate the collection of lab-level data in a standard format across labs/institutes for validating the responses entered by labs/institutes. Templates were automated such that once a lab had inputted the required data, the response was auto generated and could be used by the data officer to input as a response on the questionnaire. The automation was adjusted to allow different versions of Excel to generate an automated response.

Data entered through templates was compared with data reported in the online instrument, followed by data validation for questions that did not require templates as supporting documents. A similar process was followed for the validation of cover page data. An additional step for validation was conducted for labs/institutes that identified themselves as hybrid. This was done to ensure consistency in responses under different categories the labs/institutes may have responded to. Where possible, any inconsistencies due to minor errors were corrected for.

Key Highlights

The report gauges the performance of the organizations with respect to their socio-economic contribution, their STI excellence and current organization capabilities and practices. The analysis of the data reported by labs/institutes has been showcased in dedicated chapters focussing on an overview of all labs/institutes, basic R&D labs/institutes, applied R&D labs/institutes, and services R&D labs/institutes. Furthermore, separate chapters put spotlight on the linkages of public R&D labs/institutes with the startup ecosystem, on the contributions to sustainability practices, and on labs/institutes in the northeast.

The chapter showcasing analysis of all labs/institutes highlights the research done by these labs/institutes, the share of women and young researchers, opening up of testing and research facilities, spending on training, collaborations with industry and academia, Intellectual Property Rights (IPR), earnings and extramural R&D funding, technologies targeting SDGs and national programmes, outreach activities, and engagement with the startup ecosystem.

The report provides an overview of:

A. Research undertaken and performance of public funded R&D organizations on innovation excellence indicators

B. Assessment of the public R&D ecosystem with respect to socio-economic contribution, STI excellence, and organizational capabilities

C. Identification of untapped potential

A. Research undertaken and performance of public funded R&D organizations on innovation excellence indicators

Individual lab sheets provide the raw data submitted by labs/institutes scaled by either the budget of the lab or the scientific staff at the lab. These sheets can help labs/institutes identify their strengths and decide future courses of action.

Highlights of the individual lab sheet

- The sheet provides the response of the lab/institute for each indicator under the pillars of socio-economic contribution, STI excellence, and organizational effectiveness
- The sheet also displays performance of the lab indicator wise through a color code depending upon the quartile to which the response belonged

- The sheet also contains information of the lab/institute's location, year of establishment, budget, staff, parent ministry/department, and type of R&D performed

B. Assessment of the public R&D ecosystem with respect to socio-economic contribution, STI excellence, and organizational capabilities

Some of the areas of strengths and innovation excellence by pillar are shown below:

Socio-economic Impact

- Public R&D labs/institutes are harnessing digital technologies like IoT sensors, drones and big data analytics to create solutions that address societal challenges like developing new genotypes that enhance farmer incomes, developing predictive models for disease outbreak, and enhancing the quality of life of citizens
- Close to 50 percent of the labs/institutes contributed to national policies and regulations
- Nearly 50 percent of the organizations were developing technologies targeting the Make in India initiative. The Skill India Mission was being targeted by around 35 percent of the organizations while around 30 percent of the organizations said they were targeting the Swachh Bharat Mission.

STI Excellence

- The share of the participating organizations that had collaborations with domestic as well as international academia/other public research organizations was at 78 percent and 44 percent respectively.
- The area of industrial technologies (for example, advanced manufacturing, 3D printing etc.) saw the highest number of patents being granted - this category received 195 grants in 2022-23.
- Over the two years under consideration, there were a total of 1,014 new products that were introduced and 1,746 new services that were introduced.

Organizational Effectiveness

- Over 90 percent of organizations have a structured career progression plan in place for their scientific and non-scientific technical staff.
- Nearly all participating organizations adhere to several important policies and guidelines like ethics guidelines, sexual harassment mitigation cell, and grievance redressal cell.
- Around 65 percent of labs/institutes had at least six safe waste reclamation policies.

C. Identification of untapped potential

The areas of untapped potential have been identified. Some of these areas by pillar are provided below:

Socio-economic Impact

- While labs/institutes have made significant contributions to national policies, there remains scope to enhance global presence and become a part of global policy making.
- Currently only 64 labs/institutes provide incubation support to startups while only 40 report providing any support to deep tech/ deep science startups. Labs/institutes should be encouraged to increase engagement with the startup ecosystem.

- Only 13 labs/institutes have set up section 8 companies to support startups. Encouraging and setting up section 8 companies can deepen the engagement with the innovation ecosystem and further provide IPR support.

STI Excellence

- With just 48 percent of labs/institutes collaborating with industry in Indian and around 15 percent collaborating with industry overseas, there is a need to increase engagement with industry.
- While earnings from non-government sources were higher than government sources, these earnings were dominated by consultancy fees. Increasing earnings through technology commercialisation fees should be encouraged.
- Close to 900 domestic patents and over 200 international patents granted to labs/institutes were reported to be not worked. Converting these into technology opportunities can boost the impact of labs/institutes.

Organizational Effectiveness

- Only around 50 percent of labs/institutes opened their facilities to outside researchers and students. Increasing access to the cutting-edge research infrastructure to students and outside researchers can deeply impact the talent pipeline and improve linkages with higher education institutions.
- Only 33 percent of labs/institutes had a presence on the I-STEM portal, suggesting significant scope for improvement on the part of organizations that are currently not on the portal to engage with the wider innovation ecosystem.
- Labs/institutes would need to address increasing the share of women researchers in their scientific staff; the median value of remains low at 29 percent in 2022-23.

Recommendations of the Study

The recommendations are arranged as follows and are imperative to pave the road to Viksit Bharat:

A. A Broad Set of 7 Strategic Recommendations

B. A Detailed Set of 4 Actionable Recommendations:

   1. Becoming a Science Superpower
   2. Strengthening Public R&D Linkages with India's innovation ecosystem
   3. Boosting Lab Competitiveness
   4. Institutionalizing the process of data collection and validation

The broad set of 7 strategic recommendations are as follows:

1. Every lab should be mandated to review their existing mandates and release a roadmap for technology development in line with the Viksit Bharat vision.
2. The mandate should focus on the science and technology behind the critical technologies identified by the Government of India and should be taken up on a war footing by public funded R&D organizations.

3. Research activities of labs/institutes should be made available on a dedicated portal along with TRLs for wider use by different stakeholders like industry, startups, VCs, etc.

4. India's public funded R&D organizations should work in close collaboration with other research centers and academic institutions.

5. All labs/institutes should strive to increase collaborations with industry and attract firms to invest in projects by aligning research objectives with industry needs and availing of funding under ANRF.

6. Adopt practices or support research scholars for industry intensive PhD programs like the Prime Minister's Fellowship Scheme for Doctoral Research.

7. Support the creation of a dedicated IPR Management Cell with the incubation centers in all institutions.

The set of actionable recommendations include:

1. Becoming a Science Superpower
    a. Invigorate Public Research to addressing development and societal challenges in alignment with national needs and priorities
    b. Improve access to scientific resources by educational institutes to encourage younger generations
    c. Increased participation in global forums and contribution to global policy
2. Strengthening Public R&D Linkages with India's innovation ecosystem
    a. Setting up of Section 8 companies to provide support to startups
    b. Opening up of research and testing facilities
    c. Improve cross-linkages with HEIs
3. Boosting Lab Competitiveness
    a. Continued focus on increasing share of women researchers needed
    b. Encourage labs/institutes to attain certification and accreditation for lab procedures
    c. Converting non-worked patents into technology opportunities
4. Institutionalizing the process of data collection and validation
    a. Build data capabilities within labs/institutes
    b. Train and hire dedicated data officers
    c. Get labs/institutes to report key data in their annual reports and websites

Global Best Practices

Looking at the practices and policies of public R&D organizations like the Commonwealth Scientific and Industrial Research Organisation (CSIRO) of Australia, the French National Centre for Scientific Research (CNRS), and the Chinese Academy of Sciences (CAS) can offer pathways to strengthen public funded R&D in India.

An important policy of the CAS is ensuring competitive research funding. Institutes focusing on basic research and fundamental applied research receive competitive research funding for all additional grants apart from their core government grants. Further, institutes focusing on industrial technologies earn almost all of their funds through external funding.

CSIRO, CNRS and CAS have achieved a large degree of financial autonomy by reducing their dependence on core government grants and increasing revenue from opening up research facilities, IP commercialization, prototyping, and collaborative research projects with industry. CSIRO and CAS also support early-stage startups in exchange of equity when these startups may have limited resources.

These organisations have also established greater linkages with HEIs through co-location of labs with HEIs like CSIRO, setting up joint research units like CNRS, or converting them into universities like CAS.

Way Forward

Potential uses of the study

There are several ways in which this framework may be used by R&D labs/institutes and policymakers.

- For the participating organizations, the report provides guidance on areas of untapped potential or areas that may not currently be on their radar but nevertheless deemed a national priority
- For the policy maker, the report offers a broad long term strategic focus needed towards the goal of Viksit Bharat, the foundations and focus that need to start now
- It also offers very detailed operational recommendations that can be set in motion immediately, the implementation of which will contribute to the success of the longer term strategies

Recommendations for future rounds

The participating ministries and departments are key stakeholders and moving forward every effort should be made to show the immense potential of the framework. Further the following steps can be taken to enhance the impact of the framework:

- Ensuring the deployment of standardized, continuous reporting mechanisms for all labs/institutes to capture key indicators and the contributions of all labs/institutes to national missions like Deep Ocean Exploration Mission, AI (Artificial Intelligence) Mission, National Quantum Mission, and National Mission on Interdisciplinary Cyber Physical Systems
- Using this continuously reported data, future reports may be developed to provide thematic deep dives into areas of importance like IPR, startup ecosystem, or climate change and sustainability
- The location data can be used to identify, set up, and study science clusters. This activity can create clusters using the hub and spoke model in line with the programme launched by the ANRF.

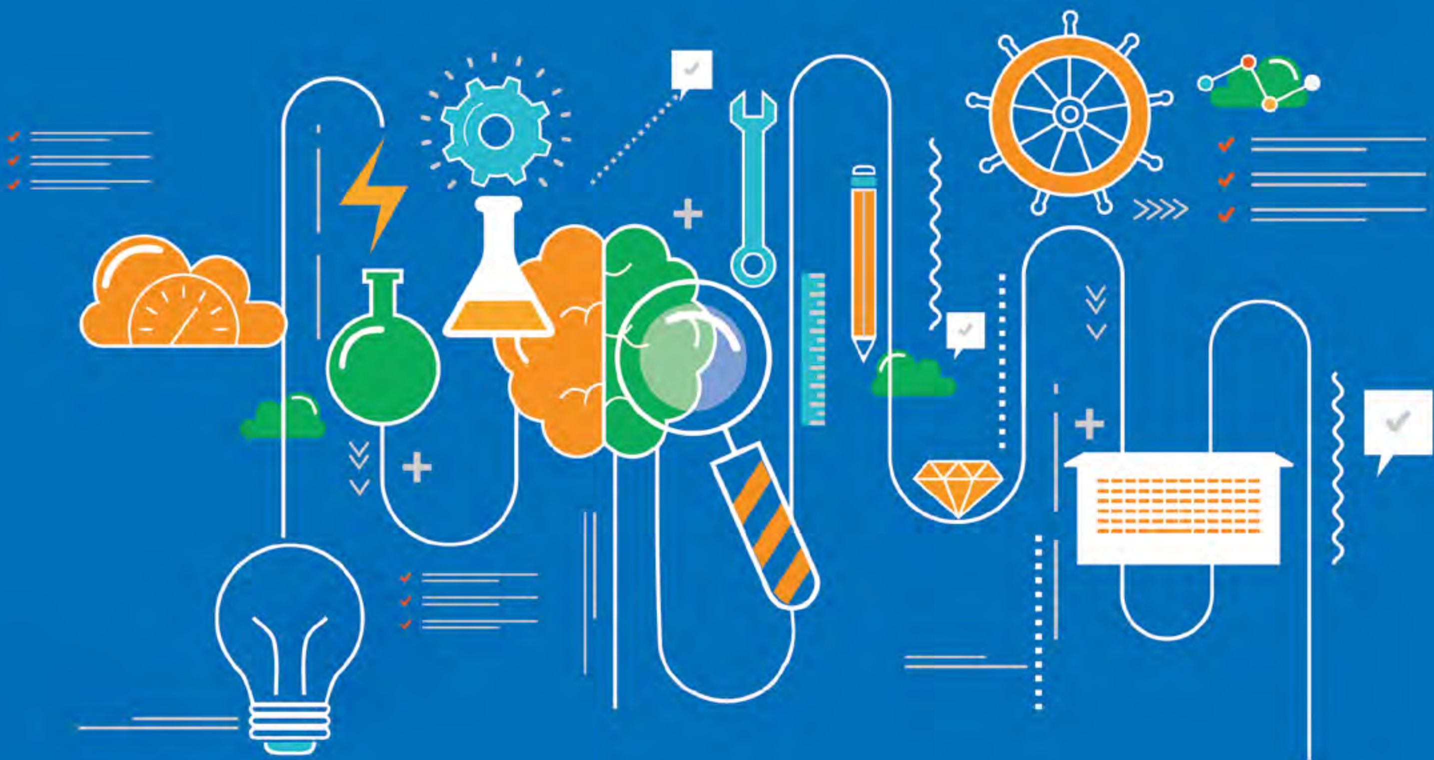
Acronyms

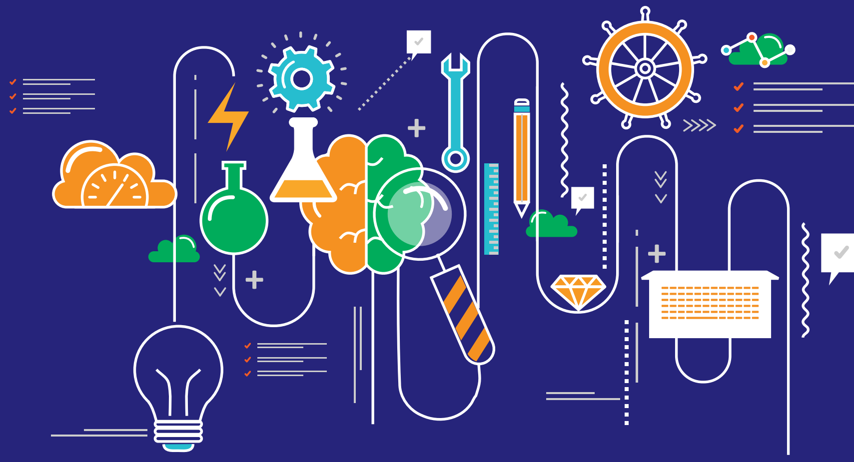
AIM	Atal Innovation Mission
AISHE	All India Survey on Higher Education
ANRF	Anusandhan National Research Foundation
ATL	Atal Tinkering Labs
AYUSH	Ministry of Ayush
BRSR	Business Responsibility and Sustainability Reporting
CAS	Chinese Academy of Sciences
CNRS	National Centre for Scientific Research
CSIR	Council of Scientific & Industrial Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DBT	Department of Biotechnology
DHI	Department of Heavy Industry
DoP	Department of Pharmaceuticals
DoT	Department of Telecom
DPIIT	Department for Promotion of Industry and Internal Trade
DST	Department of Science and Technology
EDI	Equity, Diversity and Inclusion
FDI	Foreign Direct Investment
GII	Global Innovation Index
GoI	Government of India
HEI	Higher Education Institutes
ICAR	Indian Council of Agricultural Research
ICMR	Indian Council of Medical Research
IPR	Intellectual Property Rights
MeitY	Ministry of Electronics and Information Technology

MoC&F	Ministry of Chemicals and Fertilizers
MoEFCC	Ministry of Environment, Forest and Climate Change
MoES	Ministry of Earth Sciences
MoFPI	Ministry of Food Processing Industries
MoHUA	Ministry of Housing and Urban Affairs
MoM	Ministry of Mines
MoP	Ministry of Power
MoRD	Ministry of Rural Development
MoRTH	Ministry of Road Transport and Highways
MSME	Ministry of Micro, Small & Medium Enterprises
PMO	Prime Minister's Office
PSA	Principal Scientific Advisor
R&D	Research and Development
S&T	Science and Technology
SDGs	Sustainable Development Goals
SME	Small and Medium Enterprise
STI	Science, Technology and Innovation
TRL	Technology Readiness Level

SECTION 1

Overview of the Study



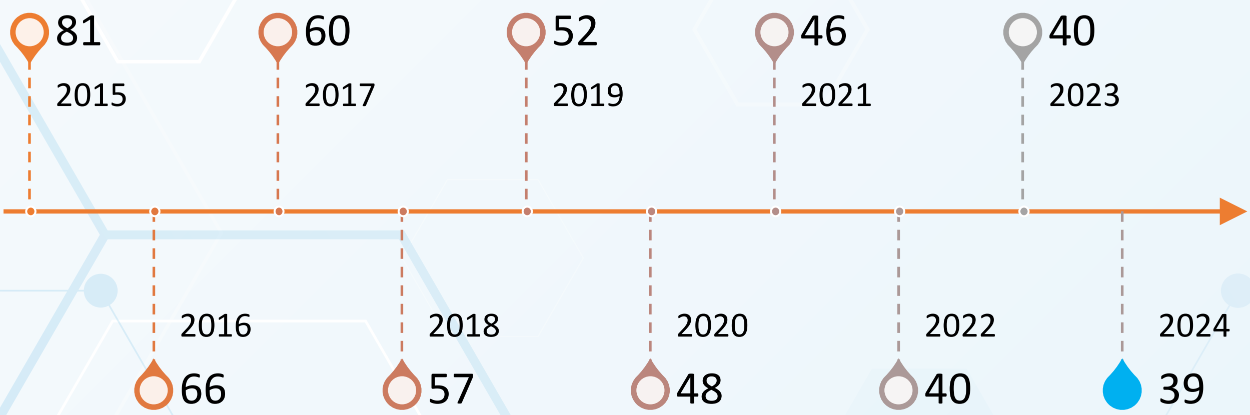


Chapter 1

Public R&D: A Key Pillar in India's Innovation Ecosystem

India has the potential to become a global leader in innovation. A robust Research and Development (R&D) ecosystem and a transformational national strategy for the nation's Science and Technology (S&T) landscape is crucial in this journey. The roadmap for achieving this scientific excellence requires sustained efforts to build a world-class research ecosystem that fosters innovation at all levels. India has made much progress over the last decade as can be seen in the rise of India's rankings in the Global Innovation Index (GII), however much more needs to be done. Sustained efforts are required from every single individual, private sector firm, and government departments to ensure India's potential is realized.

Figure 1.1: India's rank in GII from 2015 to 2024



The Government of India (GoI) envisions a dynamic and globally competitive S&T landscape that establishes India as a leader in research and innovation. This vision underscores the role of S&T as a foundation for addressing the country's critical challenges—spanning healthcare, agriculture, energy, and climate change—while advancing economic self-reliance and global competitiveness. Positioned to lead globally in tackling pressing issues such as climate change, public health, food security, and clean energy, India is guided by GoI towards becoming a beacon of research and technological leadership.

The roadmap for Indian science and innovation needs to be both ambitious and pragmatic, grounded in the nation's need to address local challenges while simultaneously engaging with global S&T advancements. With substantial government funding allocated over the years towards public research organizations to strengthen R&D infrastructure across diverse sectors including healthcare, agriculture, space, and renewable energy, India must now focus on building high-quality research institutions that enhance cross-border collaborations and nurture the talent pipeline of young researchers.

There is an ongoing recognition that several key areas require substantial improvements including a focus on critical technologies such as Artificial Intelligence (AI), quantum computing and bio-engineering. Furthermore, strengthening industry-academia collaboration is pivotal to translating research outcomes into commercialized products, fostering innovation-driven startups, and creating a skilled workforce for India's bright future.

The Government of India has showcased its commitment to elevating India's scientific capabilities, improving research infrastructure, and building bridges between academia, industry, and the public sector, by introducing initiatives like the Anusandhan National Research Foundation (ANRF), announcing a Rs1 lakh crore innovation fund in the recent budget aimed at industry, as well as spearheading initiatives to support Make in India and Design in India. Several national missions like the Deep Ocean Exploration Mission, AI (Artificial Intelligence) Mission, National Quantum Mission, Waste to Wealth Mission, National One Health Mission, Electric Vehicle Mission, Hydrogen Mission, the Natural Language Translation Mission, National Bio-Diversity Mission, Bio-Science for Human Health Mission, National Aroma Mission and Mission: Science & Technology (S&T) for Sustainable Livelihood System have also been planned or announced to serve national interest.

The Indian government's initiatives like the Anusandhan National Research Foundation are positive steps towards transforming India's S&T landscape.

India's Public R&D Ecosystem

India's public funded R&D organizations have long been a key pillar of the country's scientific progress. These institutions have consistently contributed to India's socio-economic development through groundbreaking innovations in diverse fields such as health, agriculture, environmental sustainability, and defense. Anchored by renowned institutions such as Council of Scientific and Industrial Research (CSIR), Indian Council of Medical Research (ICMR), Indian Council of Agricultural Research (ICAR), Ministry of Electronics and Information Technology (MeitY), Department of Science and Technology (DST), Department of Biotechnology (DBT) and others, India's public R&D labs/institutes have made significant strides in various sectors, contributing to the country's scientific and technological excellence and helping solve the nation's social and economic problems.

Importance of Evaluation of Innovation Excellence to India's Economy

Evaluating innovation excellence is crucial for India's economy, given its role as a driver of growth and competitive advantage. Innovation is the cornerstone of progress in sectors such as technology, healthcare, and manufacturing, which are vital for economic advancement. Public R&D labs/ institutes play a critical role in advancing scientific research, developing new technologies, and solving complex societal challenges. By assessing innovation excellence in the public R&D labs/ institutes, India can identify and support high impact projects that boost productivity, create jobs, and stimulate economic development.

Effective evaluation helps in channeling resources into areas with the highest potential for economic returns. It allows policymakers to refine strategies and allocate funding more efficiently, ensuring that investments in research and development yield tangible benefits. This scrutiny also fosters a culture of accountability and continuous improvement within organizations, driving them to achieve higher standards and create cutting-edge solutions.

Furthermore, evaluating innovation excellence enables decision makers to benchmark progress against global standards, fostering competitiveness. It encourages collaboration between public and private sectors, academic institutions, and startups, leading to synergies that accelerate technological advancements and commercialization. This, in turn, can exponentially enhance India's position in the global market, attracting foreign investments and boosting exports.

The evaluation of innovation excellence is pivotal for optimizing the impact of R&D investments, nurturing a robust innovation ecosystem, and reinforcing India's economic growth. It can not only drive sectoral advancements but also enhance the country's global standing as a hub of innovation.

Need for Evaluation of Innovation Excellence Indicators of Public Funded R&D Organizations

Given this context and at the behest of the PMO and subsequent collaborations with the O/o PSA, the present exercise "Evaluation of Innovation Excellence Indicators of Public Funded R&D Organizations" was undertaken to evaluate and benchmark the scientific and technological excellence, socio-economic impact and organizational effectiveness of our very strong public R&D ecosystem. Through this exercise, the aim was to identify the strengths and areas of improvement within our institutions and find areas of opportunity to position India as a global leader in science and technology. The exercise also aims to evaluate current practices and contributions of R&D labs/institutes and create a roadmap for future growth by identifying areas needing support and reform.

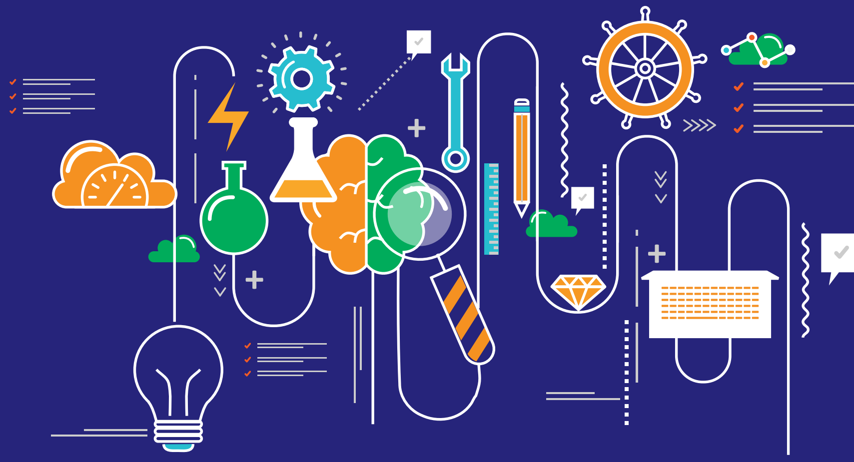
This exercise will provide critical insights into how Indian R&D can be optimized, scaled, and made globally competitive. This evaluation shall not only showcase the competitiveness of India's public funded R&D labs/institutes, but also encourage collaboration between stakeholders, accelerate technological advancements and strengthen India's position in the global market. This exercise is not merely a retrospective analysis, but a forward-looking framework designed to guide the country's R&D institutions toward greater relevance, impact, and global leadership.

The objectives are highlighted:

- Capture innovation indicators and the research being undertaken by various public funded R&D organizations.
- Assess the performance of the labs with respect to their socio-economic contribution, STI excellence and organizational capabilities and practices.
- Identify areas of untapped potential and interventions to improve the labs' performance in the identified areas.
- Propose a roadmap for improvement of the outputs and outcomes from these R&D organizations.

For the participating organizations, the report provides guidance on areas of untapped potential or areas that may not currently be on their radar but nevertheless deemed a national priority. It also provides an opportunity to strengthen existing activities which they may be currently working on through greater collaborations for instance both with industry and other public research organizations or HEIs.

For the policy maker, the report offers the broad long term strategic view needed to achieve the goal of Viksit Bharat, the foundations needed and the focus that needs to start now. It also offers very detailed operational recommendations that can be set in motion immediately, the implementation of which will contribute to the success of the longer term strategies. As India moves forward in its STI journey, the need for a more structured, purpose-driven, and sustainable innovation ecosystem is imperative.



Chapter 2

Realizing India's Innovation Potential

As India steps up its focus on Science, Technology and Innovation to achieve the goal of Viksit Bharat, there is a growing recognition of the importance of focusing on nurturing a talent pipeline, sustainability, effective collaborations, startup ecosystem and critical technologies.

Public R&D labs play a crucial role in nation building through their contributions to scientific advancements, technology development and impact on socioeconomic development. Labs that have participated in this round contribute in different ways to society at large. The research from these labs contributes to various sectors such as healthcare, agriculture, energy and environment, transport and infrastructure, livestock and industries like food processing, textiles etc. They provide critical data and analysis that informs government policies.

In this chapter, a synthesis of the top research areas/services introduced by labs/institutes and their contributions to the vision of Viksit Bharat is presented.

Public R&D: Leading the Charge on Science and Technology for Societal Impact

Currently, several national missions like the Deep Ocean Exploration Mission, AI (Artificial Intelligence) Mission, National Quantum Mission, Waste to Wealth Mission, National One Health Mission, Electric Vehicle Mission, Hydrogen Mission, the Natural Language Translation Mission, National Bio-Diversity Mission, Bio-Science for Human Health Mission, National Aroma Mission and Mission: Science & Technology (S&T) for Sustainable Livelihood System are underway to serve national interests.

Digital Technologies for Societal Impact

Public R&D labs/institutes are harnessing digital technologies to create solutions that address societal challenges, enhance the quality of life, and drive sustainable development. The labs/institutes are developing low-cost internet solutions, empowering communities through targeted digital programs to ensure digital inclusion and access.

Food Security and Livelihood Enhancement

Digital technologies like IoT sensors, drones and big data analytics are being introduced at scale to enhance agricultural output. Public R&D labs are developing new genotypes that enhance farmer incomes, seed varieties that are resilient to changing climatic conditions and disease.

Healthcare Innovation

Public R&D labs play an important role in managing disease outbreaks. These labs are using digital technologies like AI and machine learning to develop predictive models for disease outbreak, diagnostic tools and personalized medicine.

Sustainability and Green Technologies

Public R&D labs are innovating to develop green technologies that are aimed at reducing environmental footprint and combating climate change. These include innovations in renewable energy, sustainable materials, carbon capture and storage, and recycling technologies. Public R&D labs are also developing digital technologies like early warning systems, GIS mapping and predictive analysis to help prepare for, respond to and recover from increasing weather events caused due to climate change and natural disasters.

In conclusion, India's public R&D ecosystem is strategically advancing through robust collaborations between academia, industry, and startups to expedite innovation and commercialization. Institutions such as CSIR are actively engaged with academic institutions like IITs and IISc, driving joint research in pivotal fields including artificial intelligence, quantum computing, and biotechnology. These strategic alliances are instrumental in bridging the divide between academic research and industry application.

Additionally, initiatives like the Atal Innovation Mission (AIM) and Startup India are crucial in integrating startups into the R&D framework, fostering technology-driven solutions and accelerating technology transfer. These partnerships are essential for translating research outputs into commercially viable products, thereby bolstering India's competitive edge on the global stage.

Comparison of Select Labs/Institutes from Round 1 and Round 2

In this section, we capture the performance of 155 labs/institutes[1] that were common to both rounds of this evaluation. The select indicators are showcased below to capture the performance of these labs/institutes between 2017-18 and 2022-23.

Table 2.1: Comparison of common labs/institutes between round 1 and round 2

Indicator	Year				
	2017-18	2018-19	2019-20	2021-22	2022-23
Total budget of common labs/ institutes	9924	10669	10935	12543	13162
Median share of budget spent on R&D of common labs/institutes	41	40.6	40.9	48	49
Total scientific staff of common labs/institutes	23251	24077	24785	22732	24581
Median share of women in scientific staff of common labs/ institutes	27.5	29.5	30	29.2	31.4

[1] *Note: Analysis is done for 155 labs/institutes. Two labs/institutes were excluded due to poor quality of data.*

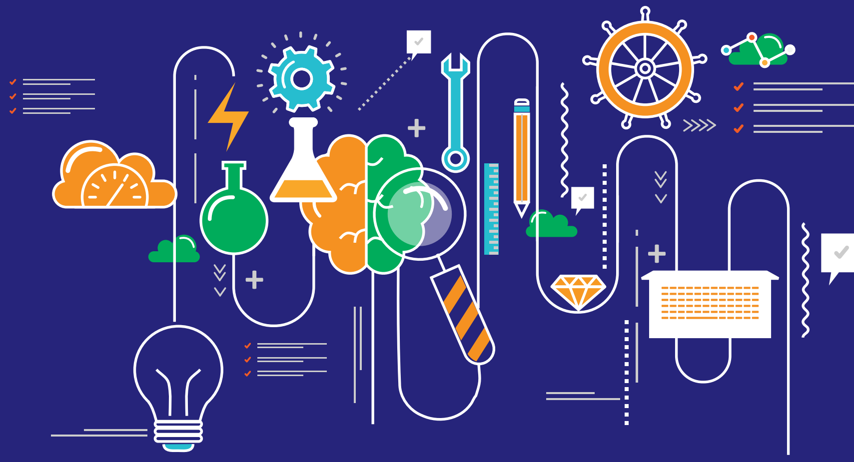
Indicator	Year				
	2017-18	2018-19	2019-20	2021-22	2022-23
Median share of young researchers in scientific staff of common labs/institutes	63.5	66	65	53.6	57.7
Total number of projects executed by common labs/institutes	9490	10504	10574	11644	11844
Number of common labs/institutes with industry collaborations	53	55	58	85	83
Number of publications by common labs/institutes	12982	12595	13282	14757	14857
Number of IPRs filed by common labs/institutes	792	757	782	854	1054
Number of IPRs granted to common labs/institutes	854	676	778	632	750
Number of startups incubated by common labs/institutes	184	203	289	387	517
Total earnings from government sources of common labs/institutes	480	693.5	728.8	995	1083.3
Total earnings from non-government sources of common labs/institutes	862.5	924.9	953.2	1440.2	1644.8

As can be seen in the above charts, labs/institutes have shown an improvement on most parameters. The combined budget of the 155 labs/institutes increased from INR 9,924 crores in 2017-18 to INR 13,162 crores in 2022-23. This was accompanied with modest increase in the median share of budget spent by the labs/institutes on R&D and S&T activities from 41% in 2017-18 to 49% in 2022-23. While the total number of scientific staff and the median share of women scientists in scientific staff remained fairly stagnant across the years as can be seen in the median share of young scientists and researchers in scientific staff saw a decline from 63.5% in 2017-18 to 57.7% in 2022-23.

The increasing budgets of these labs/institutes is accompanied by an increased number of projects executed and increased industry collaborations on projects. As seen in the number of labs/institutes reporting industry collaborations has increased from 53 in 2017-18 to 83 in 2022-23. The increase in project collaborations with industry was largely driven by labs/institutes that also had industry collaborations in round 1. Similarly, the number of publications in quality peer-reviewed journals by the common labs/institutes also saw a marginal increase from 12,982 in 2017-18 to 14,857 in 2022-23. We also see an increased focus on IPR by labs/institutes, with the number of IPR filings increasing from 792 filings in 2017-18 to 1054 filings in 2022-23. However, the number of IPRs granted to labs/institutes over the same period saw a decrease from 854 IPRs granted in 2017-18 to 750 IPRs granted in 2022-23.

Following the launch of the Startup India Initiative in 2016, labs/institutes have consistently incubated more startups every year. As seen in figure labs/institutes incubated 517 startups in 2022-23 against only 184 startups in 2017-18. Labs/institutes have also increased their earnings through consultancy services, training, and commercialization with earnings more than doubling from INR 1342 crores in 2017-18 to INR 2728 crores in 2022-23. These earnings include earnings from both government and non-government sources.

In summary, public research institutions have the potential to contribute to significant breakthroughs in areas such as healthcare, food security, and drive transformative innovation through cutting edge areas like AI, quantum computing and bio-engineering. With continued investment, strategic reforms, and a focus on fostering collaboration, this ecosystem is poised to play an essential role in shaping India's future. In alignment with the government's vision of achieving a Viksit Bharat, India's public R&D sector will be pivotal in advancing national progress and achieving the country's long-term roadmap.



Chapter 3

Evaluation of Innovation Excellence Indicators

We describe the characteristics of the R&D labs/institutes that participated in this exercise. The aim is to provide a comprehensive understanding of the distribution and diversity of these labs/institutes, highlighting their affiliations and the range of research activities they undertake. This chapter outlines the methodology used for collecting and validating data, as well as the indicators employed in the evaluation of R&D labs/institutes. It provides a comprehensive overview of the questionnaire design, data collection processes, and the strategies used to ensure data quality and reliability.

3.1 Scope of the Exercise

In this round, 292 labs were invited to participate in the study. This list of 292 labs was put together using the DST Directory, DSIR Directory, individual websites and annual reports. This list of labs was vetted by the O/o PSA.

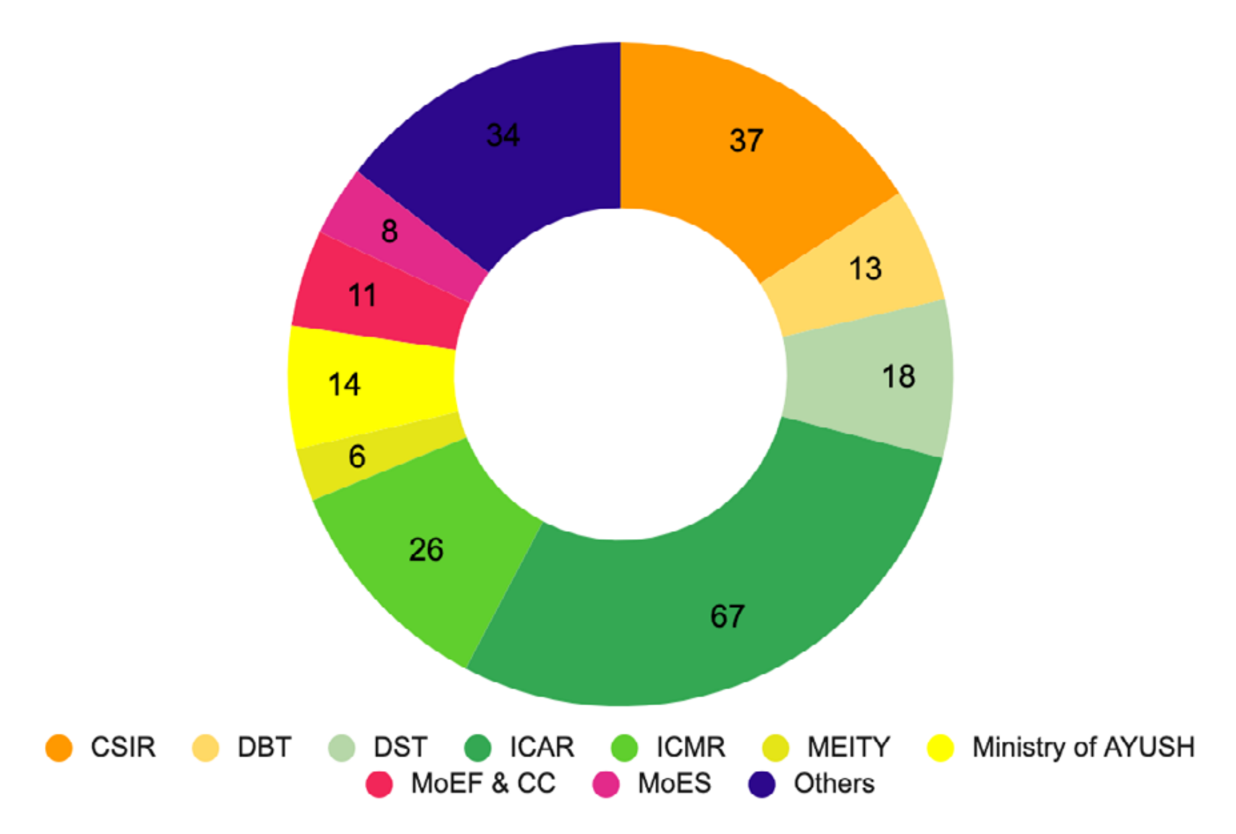
Of these, 244 labs responded. At the time of analysis, 10 labs were dropped due to poor quality of data despite multiple attempts to reach the organizations for verifications. The list of all participating organizations can be found in the appendix.

157 labs in Round 2 were common to the labs in Round 1. At the time of analysis, 2 labs were dropped due to poor quality of data. In Round 2, the scope was expanded from the previous round to include 87 new labs. In round 1 of this exercise, multiple labs had aggregated their data and responded as one organization. Some of these labs have responded as individual organizations in round 2 of this exercise. Analysis of individual organizations like the labs under the Indian Council of Forestry Research and Education or under the Ministry of AYUSH, have allowed for more detailed analysis in this round.

Organizations were given the option to classify themselves based on the R&D undertaken into one of three categories – Basic, Applied or Services. The organizations also had the option to classify themselves as a hybrid R&D organization i.e. one whose research coverage straddled more than one of the three research categories mentioned.

Figure 3.1 shows the distribution of the 234 participating labs/institutes across ministries. The distribution reveals that the majority of the participating labs/institutes are from the Indian Council of Agricultural Research (ICAR), followed by Council for Scientific and Industrial Research (CSIR), Indian Council of Medical Research (ICMR), Department of Biotechnology (DBT), and Department of Science and Technology (DST).

Figure 3.1: Ministry/Department wise breakdown of 234 labs/institutes



3.1.1 Geographical Distribution of the Participating Organisations

The participating organizations were spread across the country, with the Northern region having the largest concentration of labs, mostly driven by the significant number of labs present in states such as Delhi and Uttar Pradesh. The Eastern region had the lowest share of the 234 participating labs at around 17 percent. The majority of labs in the Western region were from the state of Maharashtra. The state wise distribution of these organizations is presented in Figure 3.2. There was representation across almost all states and union territories in the country.

Figure 3.2: Geographical distribution of Participating Labs/Institutes

State	Number of labs
Andhra Pradesh	2
Arunachal Pradesh	1
Assam	6
Bihar	3
Chattisgarh	0
Goa	2
Gujarat	7
Haryana	9

State	Number of labs
Himachal Pradesh	3
Jharkhand	6
Karnataka	19
Kerala	11
Maharashtra	29
Madhya Pradesh	7
Manipur	1
Meghalaya	2
Mizoram	0
Nagaland	1
Odisha	8
Punjab	6
Rajasthan	7
Tamil Nadu	15
Telangana	16
Tripura	0
Uttar Pradesh	24
Uttarakhand	9
West Bengal	12
Andaman and Nicobar	2
Chandigarh	2
Delhi	19
Jammu and Kashmir	3
Ladakh	1
Puducherry	1

3.1.2 Scientific Staff and Budget Distribution of the Participating Organisations

The total scientific staff at these labs/institutes ranged from around 29,287 in 2021-22 to around 31,667 in 2022-23. The scientific staff comprise both permanent scientists at these labs/institutes and the contractual researchers hired for projects. Figure 3.3 shows the distribution of scientific staff across the various participating ministries and departments. A majority of the scientific staff are hired under the CSIR department. CSIR and ICAR alone account for around 50 percent of the total scientific staff at these labs/institutes. 'Other institutions' which majorly comprise Cooperative Research Associations and Educational Institutions represent around 6 percent of total scientific staff.

Figure 3.3: Distribution of the total scientific staff across the various Ministries/Departments

Ministry	Scientific staff	Number of labs/institutes
CSIR	9,929	37 labs/institutes
DBT	1,328	13 labs/institutes
DST	2,452	18 labs/institutes
ICAR	5,216	67 labs/institutes
ICMR	2,236	26 labs/institutes
MeitY	3,706	6 labs/institutes
Ministry of AYUSH	1,387	14 labs/institutes
MoEFCC	1,551	11 labs/institutes
MoES	828	8 labs/institutes
Others	1,851	34 labs/institutes

The 234 labs/institutes under consideration reported an average budget of Rs. 17,176 crore per year for the period under consideration. CSIR represents the largest share of the total budget followed by ICAR. However, based on the number of labs/institutes participating from each major scientific department or ministry, the average budget per lab was highest for MEITY. The average budget for CSIR labs/institutes was Rs. 117 crore and for ICAR labs/institutes was around Rs. 39 crore.

Figure 3.4: Distribution of the total budget across the various Ministries/Departments

Ministry	No. of labs/institutes	Budget (in Rs crore)
CSIR	37	4104
DBT	13	664
DST	18	1515
ICAR	67	2578
ICMR	26	1235
MEITY	6	2445
Ministry of AYUSH	14	1530

Ministry	No. of labs/institutes	Budget (in Rs crore)
MoEFCC	11	311
MoES	8	903
Others	34	1891

3.1.3 Breakdown by the 'Type of R&D performed'

All labs/institutes had to self-select their category of R&D performed i.e. Basic, Applied, Services, and were also eligible to respond to the questionnaires of more than one category of lab in case they were hybrid labs/institutes. As seen in Figure 3.5, of the 234 labs/institutes whose data was considered for analysis, there were 43 labs/institutes that considered themselves as performing pure basic R&D, 46 labs/institutes that were performing both basic R&D and applied R&D, 1 lab that was performing basic R&D and services R&D, 71 labs/institutes that were performing pure applied R&D, 19 labs/institutes that were performing applied R&D and services R&D, 15 labs/institutes that were performing pure services R&D and 20 labs/institutes that were performing basic, applied and services R&D.

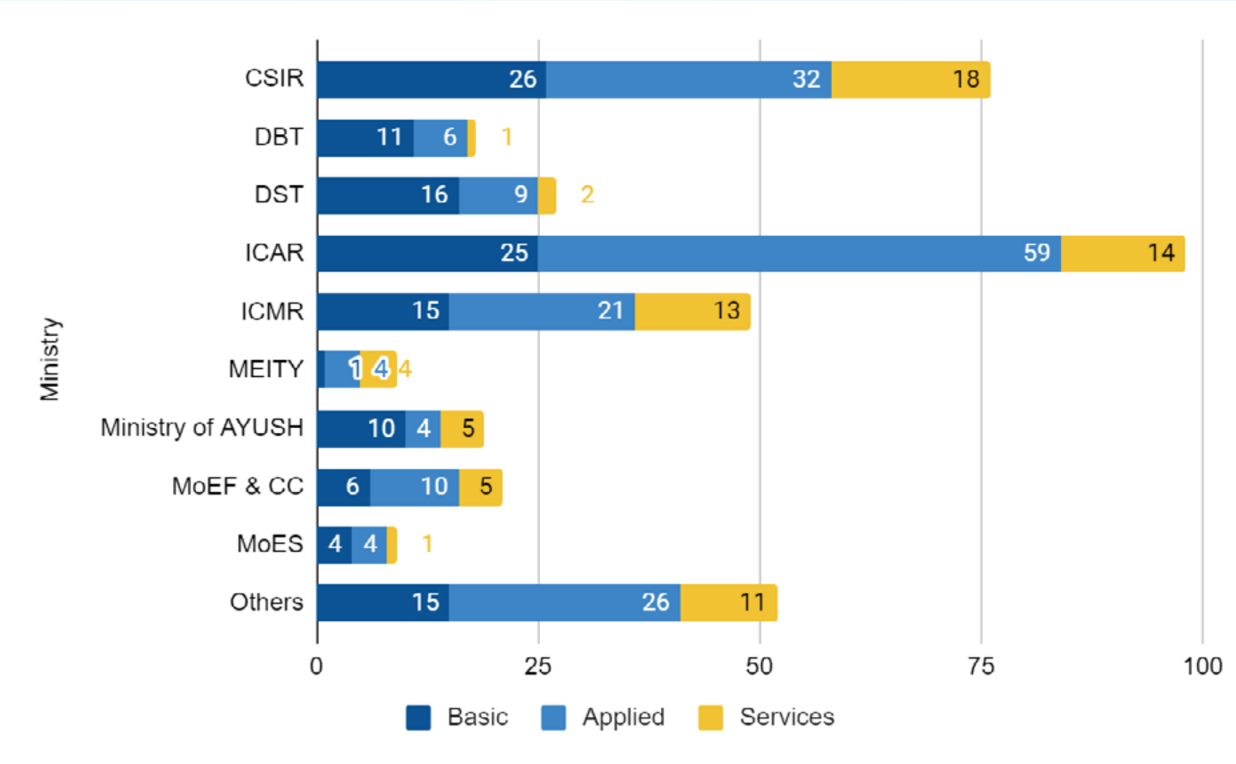
A majority of labs/institutes were performing only Applied R&D and accounted for a budget of approximately Rs. 5,442 crore. This was followed by 43 labs/institutes which were performing only Basic R&D and accounted for a budget of approximately Rs. 2,839 crore.

Figure 3.5: Distribution of 234 labs/institutes by the 'type of R&D performed' along with their budget

Type of R&D performed	No. of labs/institutes	Budget (in Rs crore)
Basic	43	2839
Applied	71	5442
Services	15	947
Hybrid, Basic & Applied	46	2665
Hybrid, Basic & Services	1	10
Hybrid, Applied & Services	19	1558
Hybrid, Basic, Applied & Services	39	3714

Figure 3.6 shows the ministry-wise distribution of labs/institutes by type of R&D performed. As can be seen, CSIR had the highest number of basic R&D labs/institutes. This would also include hybrid labs/institutes that perform basic R&D along with applied or services R&D.

Figure 3.6: Breakdown by department and 'type of R&D performed'



3.2 Key Data Indicators Portal

In this section, the methodology used for collecting and validating data, as well as the indicators employed in the evaluation of R&D labs/institutes is described. It provides a comprehensive overview of the questionnaire design, data collection processes, and the strategies used to ensure data quality and reliability.

3.2.1 Questionnaires - Innovation Excellence Indicators

To effectively capture the diverse aspects of R&D activities, three distinct questionnaires were developed based on the evaluation framework: one for Basic R&D organizations, one for Applied R&D organizations, and one for Services R&D organizations. Each questionnaire has three components: the questionnaire, the cover form and the templates.

Questionnaires

The questionnaires were designed to capture a comprehensive range of data specific to each category of R&D organization. Each questionnaire was designed to be user-friendly and efficient, reducing the burden on respondents while ensuring comprehensive data collection. Standardized templates with in-built formulas for quicker computing were introduced to streamline the data entry and ensure consistency across responses.

The questionnaires for basic and applied labs/institutes had a total of 62 questions while the questionnaire for services labs/institutes had 64 questions. Some questions had sub-questions and some questions allowed for choosing more than one option. Relevant explanatory notes, instructions and FAQs were provided for each question. There were three main types of questions as shown in the table below. The number of questions by types for each of the three questionnaires are listed in Table 3.1. Table 3.2 shows the number of questions by type in each questionnaire.

Table 3.1: Types of questions

Type of Questions	Description
Numeric	Response required in percentage terms or absolute numbers
Binary	Yes/No response required
Qualitative	Subjective in nature and required descriptive responses

Table 3.2: Number of questions by type, in the questionnaires for Basic, Applied, and Services labs/institutes

Type of Question	Basic R&D labs/institutes Questionnaire (No. of Questions)	Applied R&D labs/institutes Questionnaire (No. of Questions)	Services R&D labs/institutes Questionnaire (No. of Questions)
Numeric	45	45	46
Binary	15	15	15
Qualitative	2	2	3

Cover Form

The 'cover page' collected essential baseline information about the participating R&D Organizations including basic details about the labs/institutes, their location, correspondence addresses, labs/ institutes's budget and staff strength for the reporting period. The last element of the cover form is the Director's signoff.

Templates

Templates were created in a downloadable format (excel) to facilitate the collection of lab-level data in a standard format across labs/institutes for validating the responses entered by labs/institutes. In some cases, a template was designed on particular themes to cover multiple questions. This included questions that required mandatory supporting documents as well as questions that did not have this requirement. Templates were automated such that once a lab had inputted the required data, the response was auto generated and could be used by the data officer to input as a response on the questionnaire. The automation was adjusted to allow different versions of Excel to generate an automated response.

3.2.2 Data Collection

Data collection for this exercise was conducted from April 2024 to June 2024. All data was gathered on an online portal (www.indiascienceindicators.gov.in) through a structured process:

1. Registration and Introduction:
    - o Participating organizations registered on the exercise website
    - o They received an introductory email along with a copy of the questionnaires

2. Reporting Period:

   - Data was collected for the fiscal years 2021-22 and 2022-23

3. Facilitation Measures:

   - Orientation Webinars: Conducted for data officers to explain the questionnaire and its requirements
   - Preparation of Manuals: Manuals were provided to guide data officers in understanding the questionnaire and how to complete it accurately
   - Query Resolution: A systematic query resolution process was established to address individual questions and issues that arose during the data collection

Development of Supplementary Material

1. User Manual:

   - A detailed User Manual was created to guide respondents through the questionnaire. It included:
   - Background Information: Context and objectives of the exercise.
   - Instructions: Step-by-step guidance for completing the questionnaire.
   - Glossary: Definitions of key terms used in the questionnaire.
   - Do's and Don'ts: Best practices and common pitfalls to avoid.

2. Frequently Asked Questions (FAQs):

   - A dedicated FAQs section was established to address common queries.
   - Over 130 FAQs were compiled and updated regularly based on respondent feedback.
   - This section was made accessible on the web portal to provide real-time assistance.

3. Supplementary Presentation:

   - A presentation was prepared for the orientation workshops, summarizing key aspects of the questionnaire and exercise.
   - This presentation was also made available via email upon request.

Both the User Manual and the FAQs were accessible through the web portal to ensure participants had the necessary resources to complete the questionnaires accurately and efficiently.

Sensitization of Ministry/Department Appointed Nodal Officers

A meeting was convened under the leadership of the Scientific Secretary to sensitize the ministry/department appointed nodal officers about the exercise. The Scientific Secretary stressed the importance of this exercise in capturing the impact of India's public R&D labs/institutes, increasing healthy competition between labs/institutes, and aligning research efforts with national priorities. To facilitate smooth execution, the nodal officers were encouraged to develop internal mechanisms for the timely appointment of data officers in their labs/institutes. Additionally, they were urged to ensure that responses from these data officers were submitted in a timely manner, underscoring the need for effective monitoring and prompt action to address any potential delays.

Nomination of Data Officers

A directive was sent to all lab directors, from the 17 ministries that had nominated a nodal officer, to appoint a data officer for data aggregation. The role of the data officers was to coordinate the exercise and be the designated central point of contact for all future correspondence/ engagements. The data officer was also responsible for presenting and getting data duly vetted by the Director of the organization before final submission.

Orientation Workshops for Data Officers

As a part of orientation, 4 webinars were conducted between April to June 2024, to guide data officers about the questionnaires, supporting documents, and templates. In each webinar close to 150-200 data officers were taken through the entire process of participating in the exercise.

This was done through a comprehensive presentation which was used to guide each webinar and take data officers through the structure of the instrument, the nature of the questions, the supporting documents required, and the format for filling up templates that were designed to support data aggregation. Data officers were also encouraged to put forth their queries during the orientation webinars and their queries and responses to the queries were recorded. In addition to this, multiple queries were resolved through phone calls, and meetings.

3.2.3 Data Validation

Lab names were first standardized to allow comparison across all three types. It was expected that since the labs/institutes had submitted data with the Director's signature validating the data as accurate, data validation would not require much effort.

Importance of Director's Signoff in Data Validation

The nature of this exercise is such that data reported comes from various sources for each lab. To reach a certain level of standardization across the data submitted by labs, templates have been introduced.

The Director's signature indicates that the information submitted by the lab in the form and supporting templates is accurate and to the best of their knowledge.

Some preliminary checks were on the raw data downloaded from the platform. The mismatches in early data checks meant that the data had to be validated using the data entered in the templates and other supporting documents.

Data entered through templates was compared with data reported in the online instrument, followed by data validation for questions that did not require templates as supporting documents. A similar process was followed for the validation of cover page data. An additional step for validation was conducted for labs/institutes that identified themselves as hybrid. This was done to ensure consistency in responses under different categories the labs/institutes may have responded to.

Where possible, any inconsistencies due to minor errors were corrected for. The processes of validation, comprising checking, correcting and query resolution that were undertaken internally have been described below.

Table 3.3: Brief Description of data issues and steps taken towards resolution

Issues	Steps towards data validation and correction
Mismatch in addition or calculation of share	• Responses were recalculated using the data reported by labs/ institutes
Blank data	• If the lab reported a blank for a year but had provided a response for the other year, then the reported response was taken for both years
Mismatches in reported data in the same questionnaire	• Templates checked to verify number • If template was not available or there are issues with the template and the lab was present in Round 1, data from last round was checked for data approximation • Data changes were based on information provided in the cover form where possible
Mismatches in data across different questionnaires for the same indicator	• Templates checked to verify number and corrected across questionnaires • If template was not available or there are issues with the template and the lab was present in Round 1, data from last round was checked for data approximation • If template is not available and number reported is same across two types, then the same number was taken for the third type • If template was unavailable and response is different across all questionnaires, then higher number was taken as response across questionnaires

In cases where none of the above strategies worked, queries were sent to the labs/institutes for clarification. Ten labs/institutes did not respond to the clarifications. Besides other data issues, these labs/institutes had responded with a zero for budget and/or scientific staff. The analysis, described in detail in the next chapter, requires data to be scaled using the budget and scientific staff number. These ten labs/institutes had to be excluded from the analysis. Thus, the total of labs/institutes under consideration for analysis was 234.

3.3 Methodology

This section outlines the approach undertaken for the purpose of analysis of validated data. Once the data had been validated and queries resolved with the labs/institutes, the corrected data was incorporated wherever available. For the purpose of analysis the data that could not be validated was also considered. Wherever necessary, the data was also treated for outliers. The analysis can be found in later chapters of this report, while the individual lab data can be found in volume 2 of this report.

3.3.1 Data Analysis

The aggregate data is presented year-wise for each of the two reporting years i.e. 2021-22 and 2022-23. The questions which were specific to Basic, Applied or Services labs/institutes have not been considered for the aggregate analysis.

An analysis of Basic, Applied and Services labs/institutes is captured in later chapters. The analysis looks at key indicators in various sub-pillars. Each chapter also has a spider chart that reflects the performance of the labs/institutes under each category across the 11 sub-pillars. The average pillar-wise performance for each category of lab is also presented in the respective chapters. The methodology used to derive the performance scores of the sub-pillars and the pillars can be found in the appendix.

For the charts presented for basic, applied and services analysis, the indicators were scaled using either the total budget of the lab or the number of scientific staff at the lab. This was to ensure comparability across labs/institutes. While most numeric responses were scaled by the lab's budget or scientific staff, binary responses and data reported as percentages were not scaled.

The scaled data and other numeric data were averaged over both years before the final analysis was undertaken. The individual lab responses for the reporting years can be found in Section 3 of the report. The following section explains the methodology of preparing the individual lab sheets.

3.3.2 Preparation of Individual Lab sheets

Individual lab sheets provide the raw data submitted by labs/institutes scaled by either the budget of the lab or the scientific staff at the lab. The numeric data has been adjusted to two decimal places. The sheet contains information on the lab's location, year of establishment, parent ministry/ department, and type of R&D performed.

The data submitted by the labs/institutes has been validated using templates, the step-by-step process of validation has been explained in Chapter 3. Where the data could not be validated, the data has been presented in its original form (scaled by budget or scientific staff where appropriate). The data that could not be validated were marked in a separate color.

In addition to the responses for each of the two years, the lab sheet also displays performance of the lab indicator wise. In order to determine the performance of each indicator, the two-year average of the scaled responses of the labs/institutes was taken and assigned a color code depending upon the quartile to which the response belonged. The responses of all 234 labs/institutes were taken into account when computing the quartiles for the indicators except those that were specific to Basic, Applied or Services labs/institutes. For the indicators that were specific to Basic, Applied or Services labs/institutes, the set of responses in each category of lab were considered when computing the quartiles. The color-codes for different quartiles is explained in table 3.4.

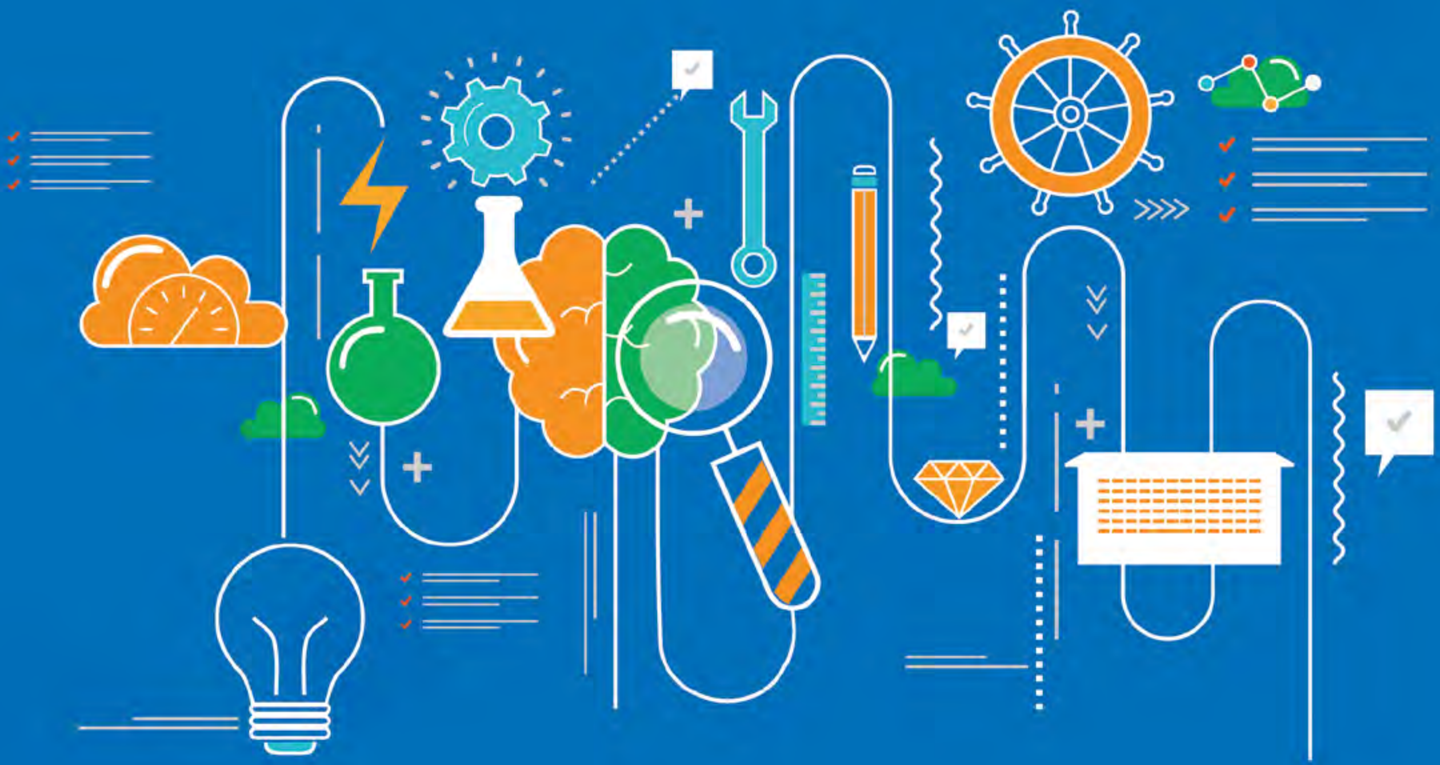
Table 3.4: Methodology for presenting indicator performance on the lab sheets

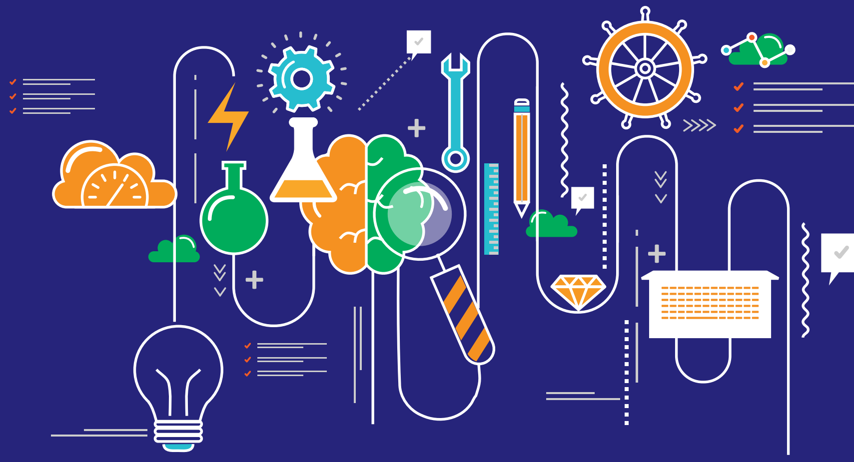
Step 1: Lab response received and validated	
Step 2: Numeric responses scaled using either total budget or scientific staff	
Step 3: Quartile calculated based on the average scaled response over the two reporting years	
Color codes for the quartiles	1st Quartile
	2nd Quartile
	3rd Quartile
	4th Quartile

Presenting information by each indicator is intended to provide forward guidance to the labs/ institutes to consider opportunities that may become an area of focus for them depending on their mandate. There are instances however where a large number of labs/institutes responded with a zero for a particular indicator, and hence all labs/institutes may appear in the top quartile for that indicator. Labs/institutes, nevertheless may wish to consider these indicators when defining their areas of focus going forward.

SECTION 2

Public R&D ecosystem





Chapter 4

Innovation in India: A Focus on Public R&D System

In this chapter, an aggregate analysis of the data reported by public funded R&D organizations is presented. Key findings are highlighted below.

4.1 Key Takeaways

- The participating labs/institutes accounted for nearly 13 percent of India's total national expenditure on R&D
- The research from these labs/institutes contributes to various sectors such as healthcare, agriculture, energy and environment, transport and infrastructure, livestock and industries like food processing, textiles etc
- Public R&D labs/institutes are leading national missions such as the Deep Ocean Exploration Mission, AI (Artificial Intelligence) Mission, National Quantum Mission etc
- Digital technologies like IoT sensors, drones, AI, machine learning and big data analytics are being introduced at scale to enhance agricultural output and develop predictive models for disease outbreak and personalized medicine
- The median share of spending on R&D and S&T in the overall budget for the participating labs/ institutes was around 45 percent
- Over 50 percent of the labs/institutes have an annual budget of up to INR 50 crore, around 56 labs/institutes are in the INR 50- Rs 100 crore range in terms of their budgets, while around 46 labs/institutes have a budget of over INR 100 crore
- The reported labs/institutes had 19625 contractual staff and 12042 permanent staff in 2022-23 with a median share of women scientific staff in total staff of 29.3 percent in 2022-23
- The median share of young researchers increased in 2022-23 to around 58 percent from 54 percent in the previous year
- Of the 234 participating labs/institutes, just 50 opened up their facilities to startups in 2022-23 while 83 labs/institutes opened up facilities to industry
- While over 90 percent of the labs/institutes have differently abled facilities only 30 percent of labs/institutes had an EDI cell

- The median share of the budget spent on training by the participating labs/institutes is very low at 0.2 percent
- There were 114 labs/institutes that had collaborations with domestic industry while just 34 labs/institutes reported having collaborations with international industry
- The number of patents filed in 2022-23 by the reported 233 labs/institutes was 872 compared to 750 in the previous year. Regarding patents granted to 232 labs/institutes, there was an increase from 661 patents in 2021-22 to 695 patents in 2022-23.
- For patents granted in emerging technology areas, industrial technologies saw the highest number of patents being granted - this category received 195 grants in 2022-23
- There were 954 technologies that were transferred domestically in 2022-23 compared to 885 technologies that had been transferred domestically in 2021-22
- Over the two years under consideration, there were a total of 1,014 new products that were introduced and 1,746 new services that were introduced
- The overall earnings from non-government sources in 2022-23 was higher at Rs. 1,684 crore compared to Rs. 1,271 crore that were received from government sources in 2022-23. The earnings for both government and non-government sources was largely driven by earnings through consultancy services
- The total funding from government sources saw a drop in 2022-23 to Rs. 3,264 crore from Rs. 3,661 crore in the previous year
- The total publication output rose slightly from 18,367 in 2021 to 18,717 in 2022. The median value for share of publications in the top 10 percent journals saw a drop from around 8.1 percent in 2021 to 6.7 percent in 2022
- There was a 23% increase in the number of technologies with TRL 0 to 4 targeting SDGs or national programmes while the number of technologies with TRL 5 and higher only saw 3% increase
- Close to 50 percent of the labs/institutes contributed to national policies and regulations while around 13 percent have engaged on the international policy front
- Currently of the reported participating labs/institutes, just 105 organizations reported that they were either incubating startups or supporting startups through other means

Spotlight on Public R&D Ecosystem

234 Labs that accounted for

31% of the Central Government's R&D Expenditure

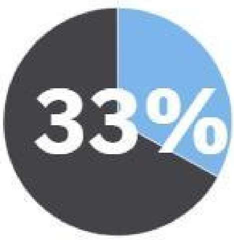
31,667 **Total Scientific Staff**

29% Median Share of Women in Scientific Staff

57% Median Share of Young Researchers in Scientific Staff

113 Labs Opened Testing & Research Facilities to **Outside Researchers**

18% of Women Scientific Staff Supported **for Conferences, Sabbaticals, Training**



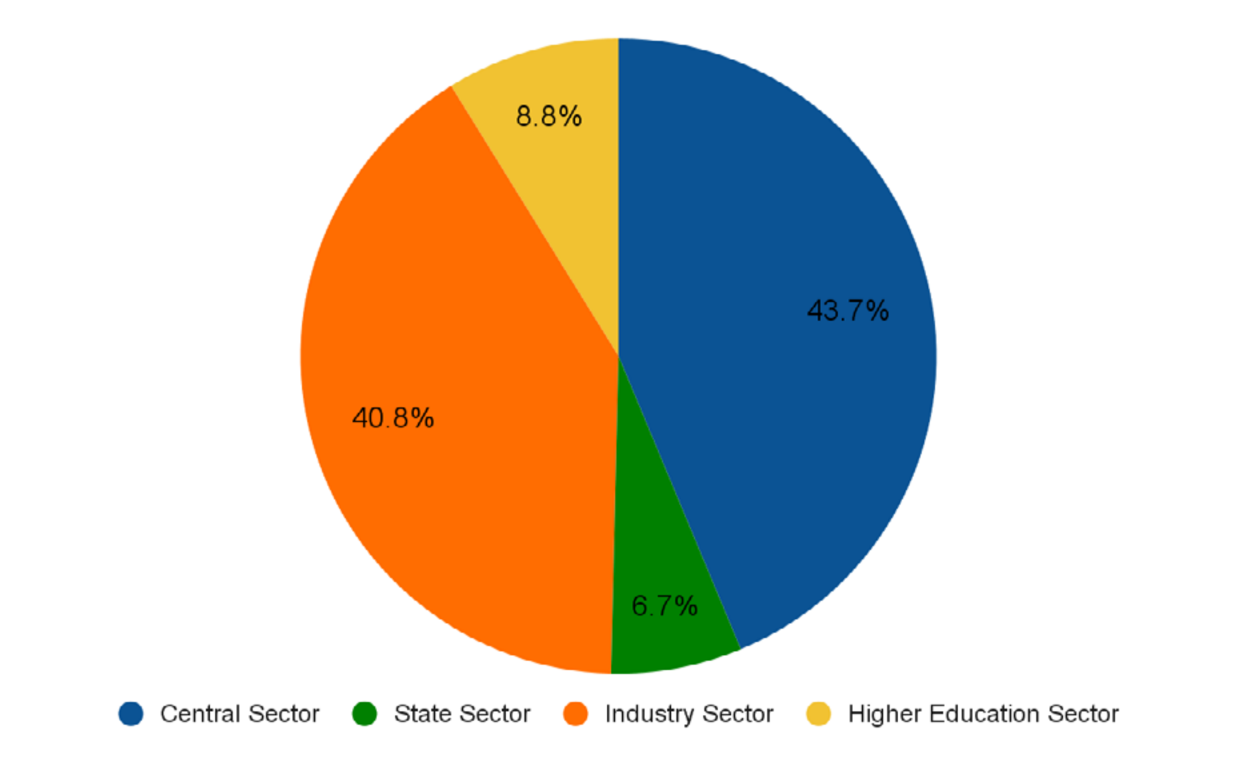
Labs Had Their R&D Facilities on **I-STEM National Portal**

154 Labs Had At Least 6 **Waste Reclamation Policies**

966 IPR Granted

India's Gross Expenditure on R&D (GERD) has been consistently increasing over the years and has more than doubled from Rs. 60,196.75 crore in 2010–11 to Rs. 127,380.96 crore in 2020–21. The largest contributor to India's GERD is the Central Government which comprises 43.7% of the GERD. This is followed by the Private sector (36.4%), Higher Education (8.8%), and State Governments (6.7%). During the year 2020–21, 84% of the R&D expenditure incurred by Central Government sources came from 12 major scientific agencies.[2]

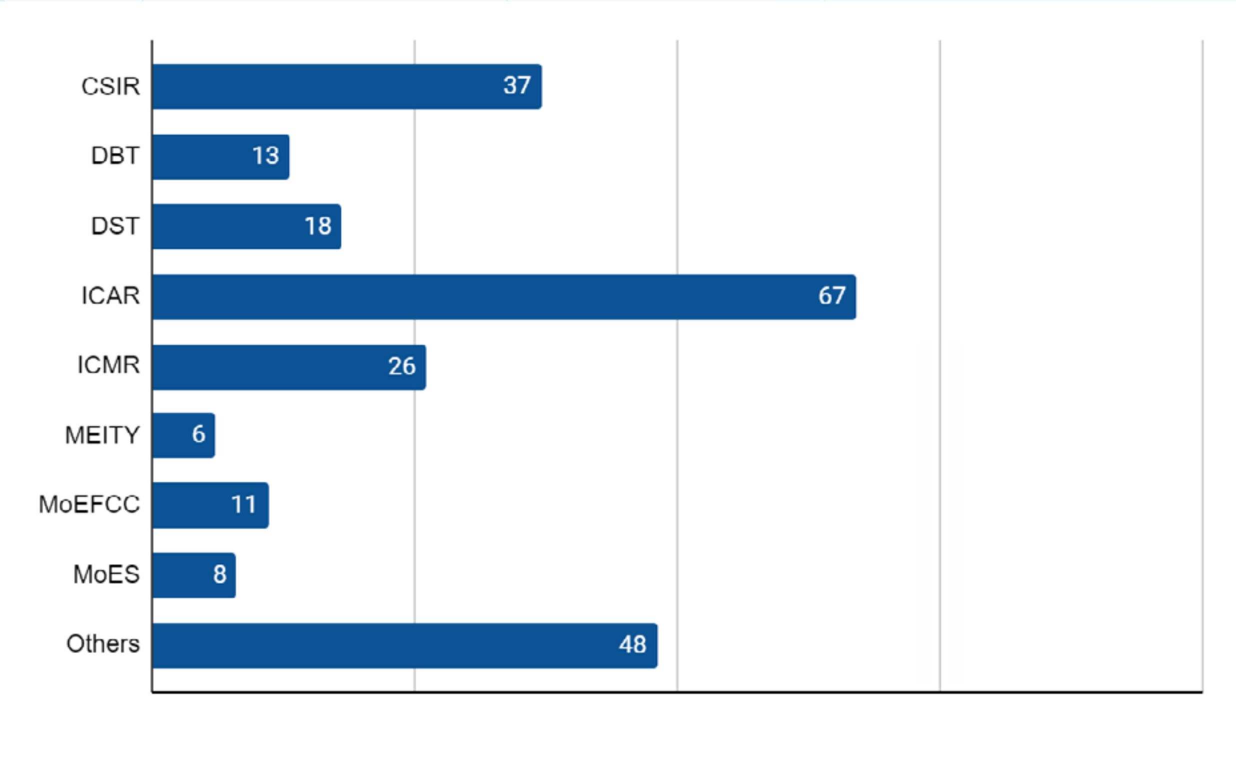
Figure 4.1: Central Government spending accounts for 43.7 percent of total National R&D Spending



The 12 major scientific agencies also include strategic departments like the DRDO, DAE, DoS. Labs/institutes from these strategic departments were not included in this exercise due to the sensitive nature of their work. Figure 4.2 shows the distribution of labs/institutes across the major scientific agencies, excluding the strategic department. Of the 234 labs/institutes that participated in this round, 186 labs/institutes were from major scientific agencies, while the remaining labs/ institutes were from the other central government departments or ministries.

[2] *Research and Development Statistics at a Glance 2022-23*

Figure 4.2: Distribution of labs/institutes across major scientific agencies



According to the National R&D Statistics published by the DST, Central Government expenditure on R&D was around Rs. 55,685 crore in 2020-21. Excluding the expenditure of the strategic departments like DRDO, DAE and DoS, the spending by key scientific agencies and other central government departments was Rs. 24,587 crore. The average of the total budget for 2021-22 and 2022-23 for the 234 participating organizations was Rs. 17,175 crore.

The participating labs/ institutes accounted for **nearly 70 percent of total expenditure by key scientific agencies (excluding DRDO, DAE and DoS) and other central government departments.** This is a significant increase from Round 1 which had seen around 45 percent of total expenditure by key scientific agencies (excluding DRDO, DAE and DoS) and other central government departments being represented in the study.

4.2 Science and Technology for Societal Impact

Public R&D labs/institutes play a crucial role in nation building through their contributions to scientific advancements, technology development and impact on socioeconomic development. Labs/institutes that have participated in this round contribute in different ways to society at large. The research from these labs/institutes contributes to various sectors such as healthcare, agriculture, energy and environment, transport and infrastructure, livestock and industries like food processing, textiles etc. They provide critical data and analysis that informs government policies.

Leading the Charge on National Missions

Currently, several national missions like the Deep Ocean Exploration Mission, AI (Artificial Intelligence) Mission, National Quantum Mission, Waste to Wealth Mission, National One Health Mission, Electric Vehicle Mission, Hydrogen Mission, the Natural Language Translation Mission, National Bio-Diversity Mission, Bio-Science for Human Health Mission, National Aroma Mission and Mission: Science & Technology (S&T) for Sustainable Livelihood System are underway to serve national interests. These missions are designed to address specific national challenges within a given timeframe. Public R&D labs/institutes are leading some of the missions and contributing to the core research and innovation work required to achieve the objectives of these missions.

Digital Technologies for Societal Impact

Public R&D labs/institutes are harnessing digital technologies to create solutions that address societal challenges, enhance the quality of life, and drive sustainable development. Digital technologies have become all pervasive in our life. Public R&D labs/institutes are playing a critical role in ensuring that citizens can enjoy the benefits of digital innovations without compromising on safety and privacy issues. They are developing low-cost internet solutions, empowering communities through targeted digital programs to ensure digital inclusion and access.

Food Security and Livelihood Enhancement

Smart Agriculture has been a major area of focus for public R&D labs/institutes to optimize water and land usage, improving crop yields and reducing pesticide use. Digital technologies like IoT sensors, drones and big data analytics are being introduced at scale to enhance agricultural output. Public R&D labs/institutes are developing new genotypes that enhance farmer incomes, seed varieties that are resilient to changing climatic conditions and disease. These contributions not only enhance food security but also contribute to economic growth. Similar efforts are being made in fisheries, livestock, sericulture and allied sectors.

Healthcare Innovation

Public R&D labs/institutes play an important role in managing disease outbreaks such as the recent COVID19 pandemic. These labs/institutes are using digital technologies like AI and machine learning to develop predictive models for disease outbreak, diagnostic tools and personalized medicine. They are at the forefront of developing digital databases such as the Genome India project to exercise population-specific genetics of the major ethnic groups of India.

Sustainability and Green Technologies

Public R&D labs/institutes are innovating to develop green technologies that are aimed at reducing environmental footprint and combating climate change. These include innovations in renewable energy, sustainable materials, carbon capture and storage, and recycling technologies. Public R&D labs/institutes are also developing digital technologies like early warning systems, GIS mapping and predictive analysis to help prepare for, respond to and recover from increasing weather events caused due to climate change and natural disasters. They are deploying real-time monitoring environmental monitoring tools through satellite and sensor technologies for better management of natural resources and tracking climate change indicators such as pollution levels, deforestation, heat levels, etc.

In the sections that follow we look at the contribution of India's publicly funded R&D labs/institutes to India's scientific output and innovation outcomes. Before delving into details on output and outcomes, we begin by describing the institutional capabilities and practices of the labs/institutes.

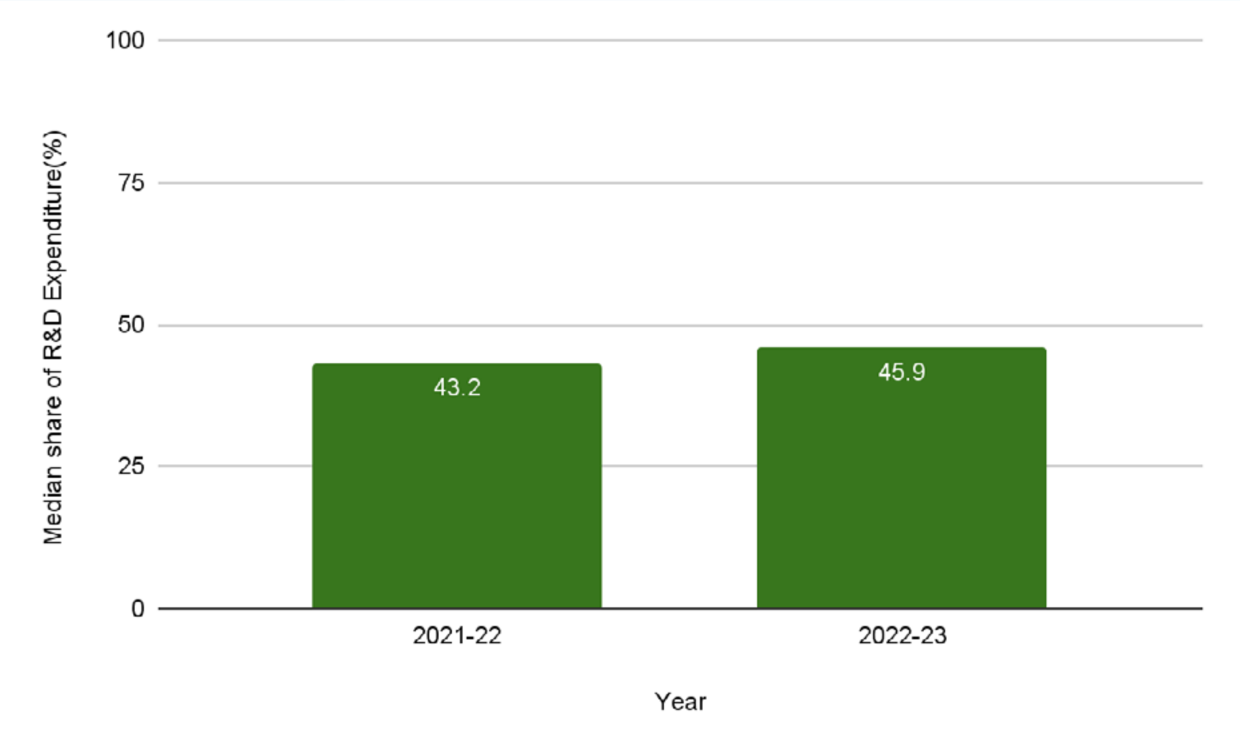
There is a wealth of information that emerges from the data that follows, and the public research ecosystem could use this data to constructively complement and at the same time scale up their existing activities to benefit India's R&D ecosystem better. Efforts have been taken to ensure that most of the data is presented in a manner similar to the data showcased in Round 1 for the purposes of comparability. We also introduce newer analysis for select indicators and themes for the discerning reader.

4.3 Institutional Capabilities and Practices

4.3.1 Median of share of spending on R&D and S&T in overall budget is around 45 percent

The median share of spending on R&D and S&T in the overall budget as reported by the participating labs/institutes was on average around 45 percent over the two years under consideration. This indicator is intended to capture all costs related to research activities including salaries and travel costs, and excludes administrative costs. Around 25 percent of the participating institutions reported spending between 75 percent to 100 percent of their budget on R&D. The organizations that reported less than the median share of spending on R&D and S&T in the overall budget were largely from ICAR, CSIR, ICMR, Ministry of AYUSH and DST.

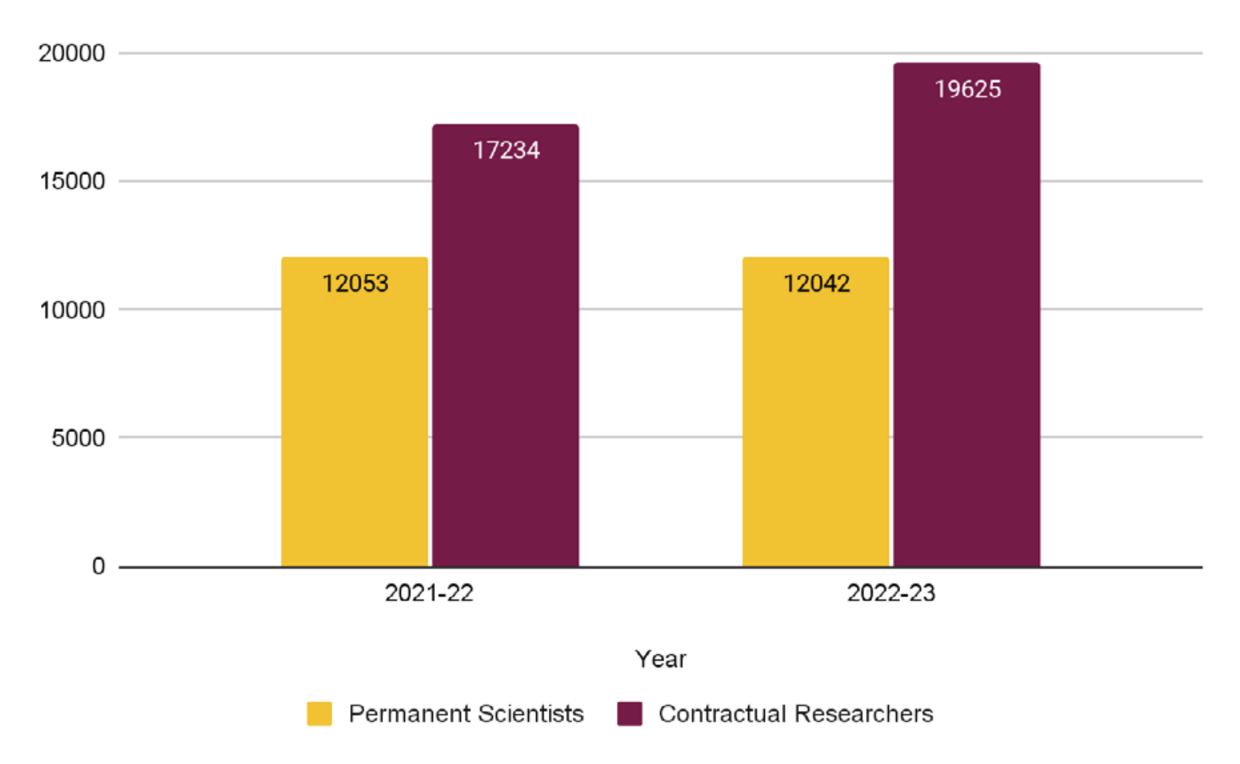
Figure 4.3: Labs/institutes report low share of spending on R&D and S&T in overall budget



4.3.2 Contractual hiring increased in 2022-23 compared to previous year

The chart below shows that while there seems to be a similar number of permanent staff reported in the two years under consideration, there has been an increase in the hiring of contractual staff.

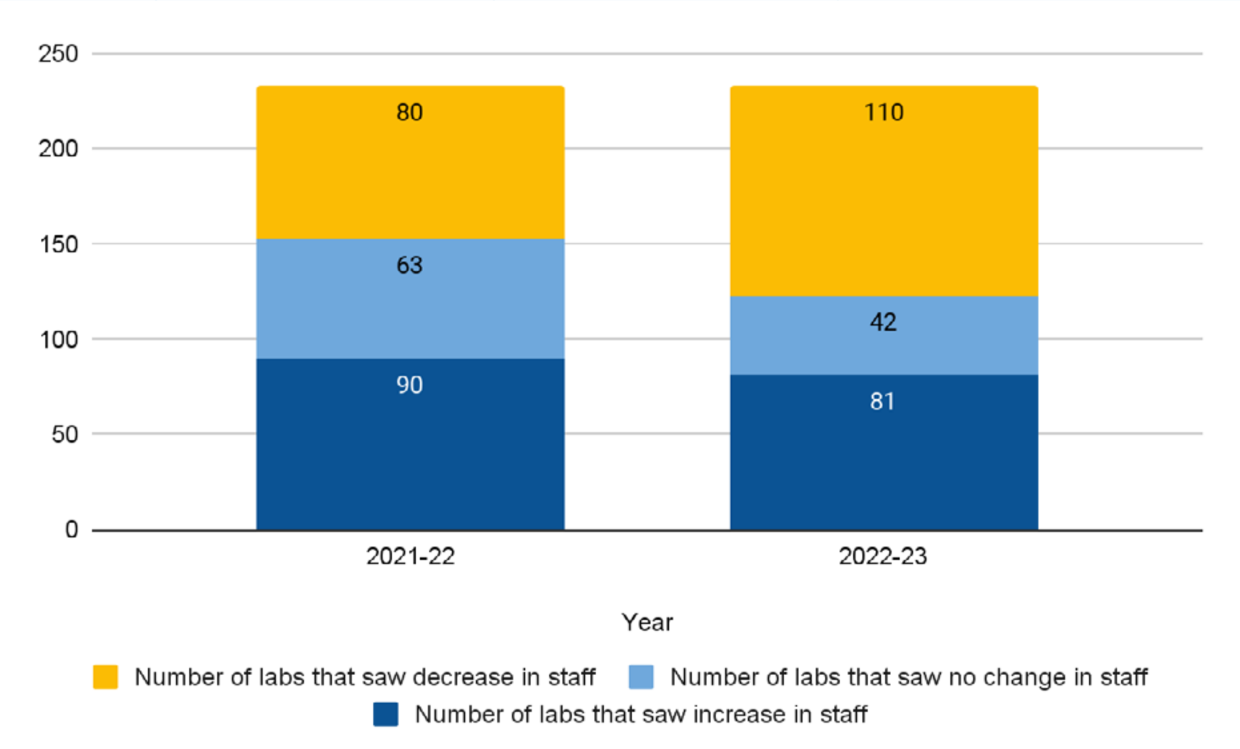
Figure 4.4: Number of permanent researchers has remained stable while increase seen in contractual researchers



Note: Analysis is done for 233 labs/institutes. One lab/institute was excluded as their response could not be verified.

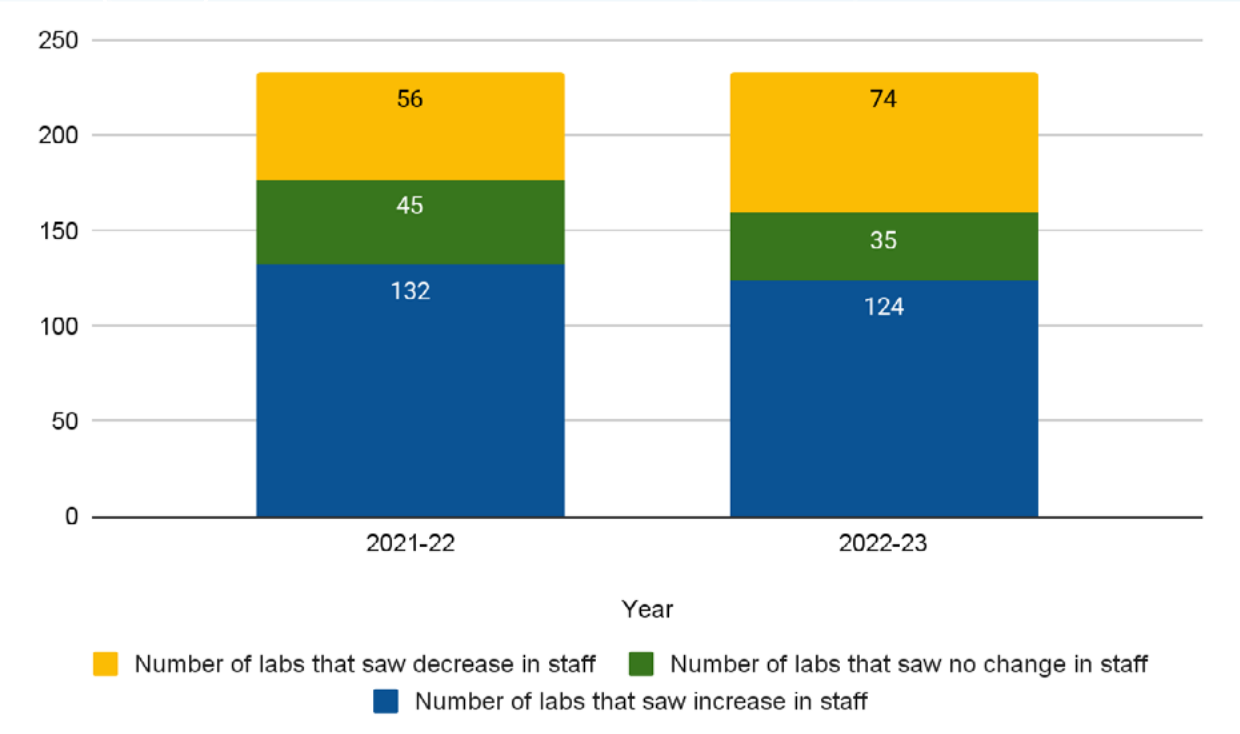
There were a large number of labs/institutes that reported a decrease in the number of permanent staff in 2022-23 compared to the previous year. There were also fewer organizations in 2022-23 compared to the previous year that reported hiring permanent staff. There were 110 labs/institutes that reported a decrease of 375 permanent scientific staff in 2022-23 while 81 labs/institutes reported an increase of 364 permanent scientific staff in 2022-23.

Figure 4.5: 110 labs/institutes saw a drop in number of permanent scientists in 2022-23



Note: Analysis done for 233 labs/institutes. One lab/institute was excluded as their response could not be verified.

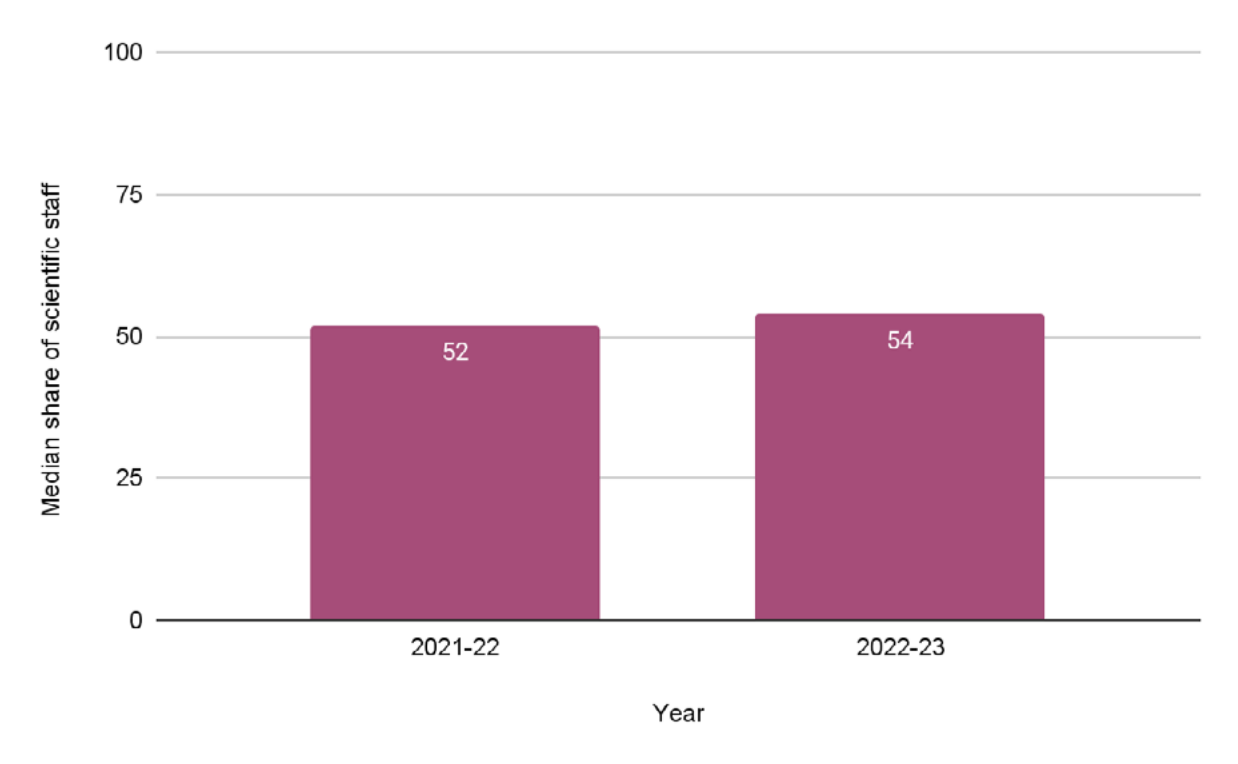
With respect to contractual researchers being hired in 2022-23, there were 124 organizations that saw their contractual scientific staff increase compared to 132 organizations that saw an increase in the previous year. There were 74 organizations that reported a decline in contractual research staff in 2022-23 compared to 56 in the previous year. The 74 organizations saw a decline of 879 contractual research staff while 124 organizations hired 3,277 contractual researchers in 2022-23.



Note: Analysis is done for 233 labs/institutes. One lab/institute was excluded as their response could not be verified.

The large jump in contractual researchers in 2022-23 compared to the previous year resulted in the median share of scientists in overall staff increasing to 54 percent in 2022-23 compared to 52 percent in the previous year.

Figure 4.7: Share of scientific staff (%)



Note: Analysis is done for 233 labs/institutes. One lab/institute was excluded as their response could not be verified.

4.3.3 Spotlight on Women Researchers

The share of women PhDs graduating across India in 2021-22 in Engineering & Technology, IT & Computer, and Science was 29.1%, 48%, and 46.3% respectively (All India Survey on Higher Education (AISHE) Report 2021-22). As these percentages increase over the years, the subject of the leaky pipeline and importance of increasing women participation in the scientific workforce cannot be stressed enough. This was also one of the key findings in the Round 1 exercise of this exercise and will remain an important topic that will require a concerted national effort to address. As we shall also see below the share of organizations that have established an Equity, Diversity and Inclusivity (EDI) cell is still very low at around 30 percent of all participating organizations.

There has been a steady increase in the median share of women scientific staff in total staff to 29.3 percent in 2022-23 compared to 28 percent in the previous year. In the previous round too, the findings had suggested a median share of around 30 percent. These shares are slightly lower than the share of women researchers globally in 2021 which stands at 31.7%.[3] Public funded R&D organizations would need to continually look for and support talented women researchers. One thing to note is that the hiring of women scientific staff as can be seen for the overall trend too, is being led by contractual women researchers.

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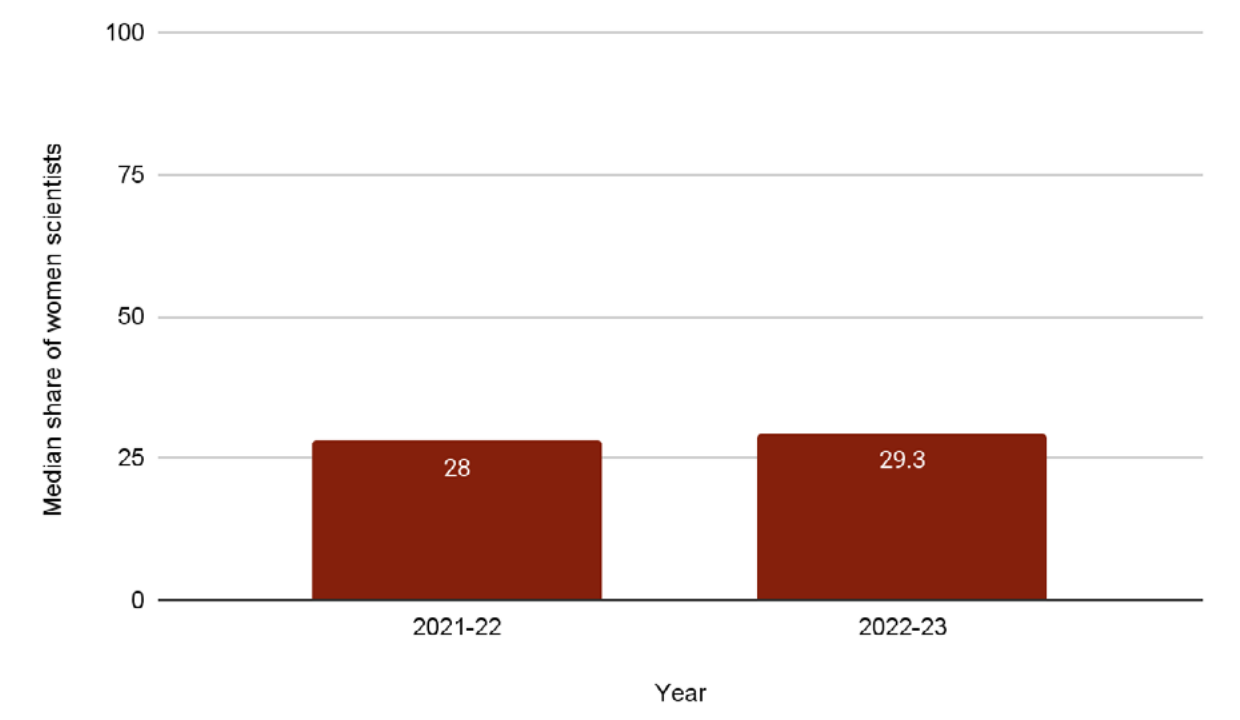
[3] *UNESCO, "The gender gap in science: status and trends, February 2024"*

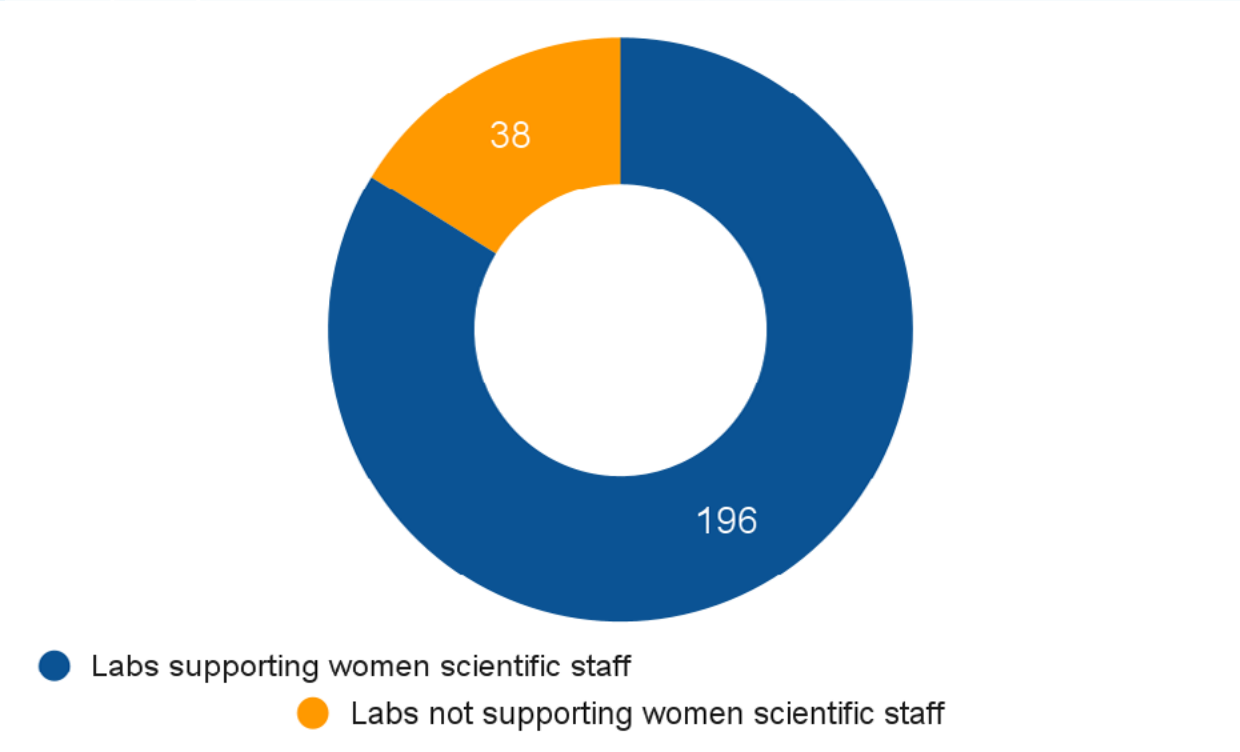
Figure 4.8: Median Share of Women in Scientific Staff



Note: Analysis is done for 233 labs/institutes. One lab/institute was excluded as their response could not be verified.

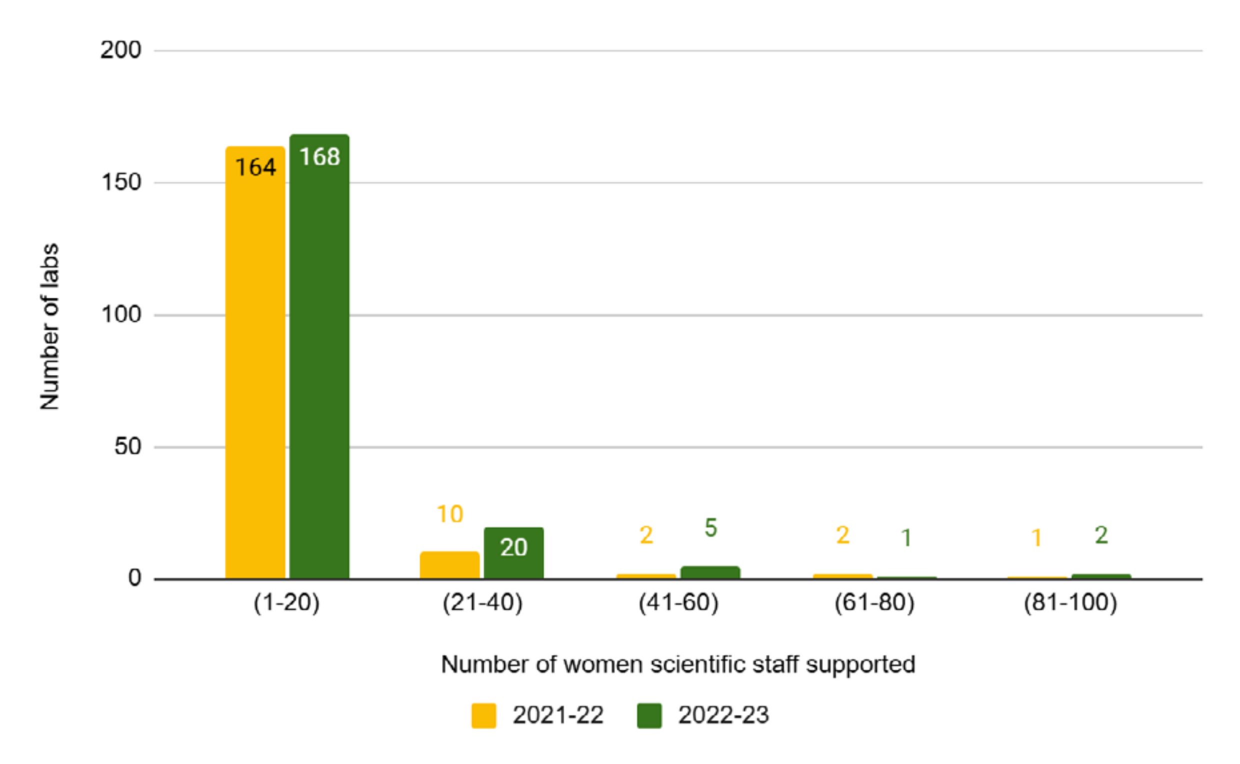
A large number of labs/institutes reported that they supported their women scientific staff for conferences, training, sabbaticals etc. Of the 234 labs/institutes participating in this exercise, there were 196 organizations that reported providing the necessary support.

Figure 4.9: Number of labs/institutes that supported women for conferences, training, sabbaticals, etc



Looking at the distribution of the 196 labs/institutes and number of women supported by these labs/institutes, it was found that around 168 labs/institutes supported between 1 and 20 women researchers for the activities like training, conferences and sabbaticals while there were 2 labs/ institutes that supported between 80 and 100 women researchers in 2022-23. In both cases there is a yawning gap between the median number of women scientific staff and the median number of women supported. For the 168 organizations, the median number of women scientific staff is 28 whereas the median number of women scientific staff supported for training, conferences, sabbaticals etc. is just 5. Looking at the organizations that supported between 80 and 100 women scientists, the median number of women scientific staff is 246 while the median number of women scientists supported is just 88.

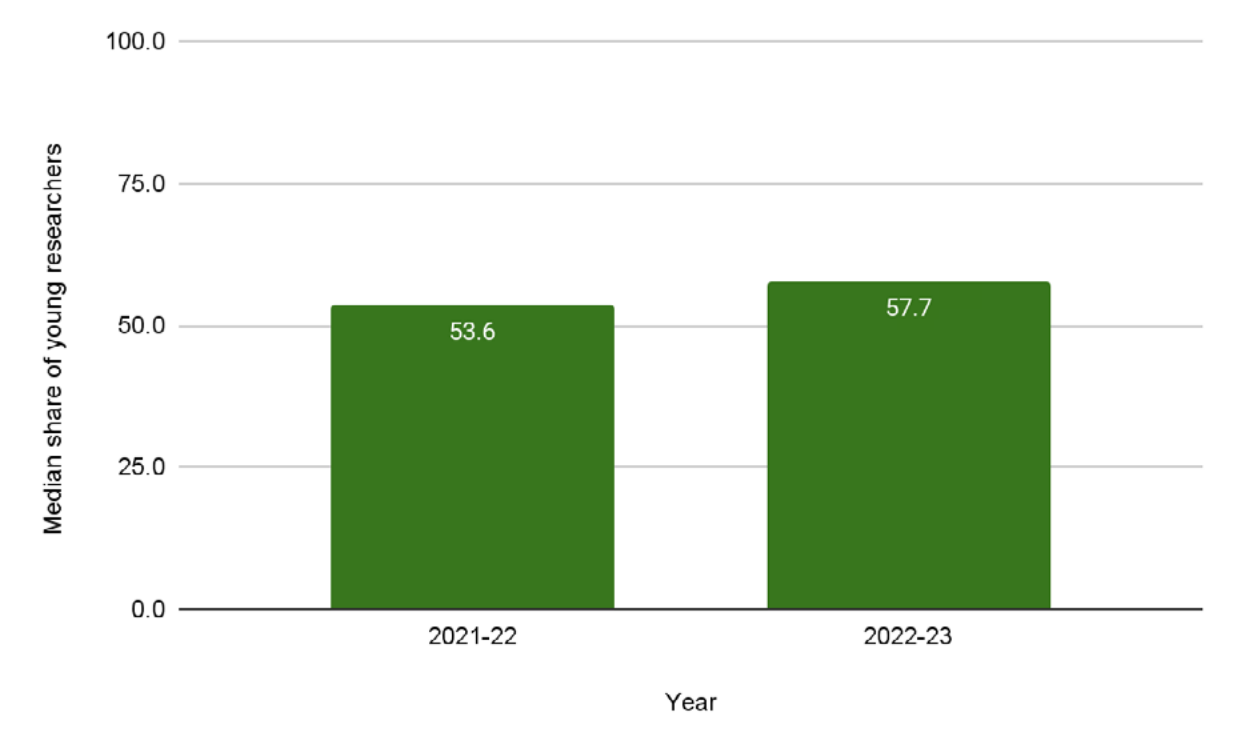
Figure 4.10: Distribution of labs/institutes by number of women scientists and researchers supported



4.3.4 Spotlight on Young Researchers

The median share of young researchers increased in 2022-23 to around 58 percent from 54 percent in the previous year. In the previous exercise, for around 193 organizations that had participated, this number was around 63 percent to 65 percent for the period 2017-18 to 2019-20. India has a large number of PhDs graduating in STEM each year. The number of PhDs in STEM were around 18,744 in 2021-22 as per the All India Survey on Higher Education (AISHE) Report 2021-22. Just as with women researchers, every effort must be made to modernize the current scientific organizations and attract the right talent from the pool of young researchers to keep the talent pipeline going. The emphasis here should be on creating permanent positions for young women researchers.

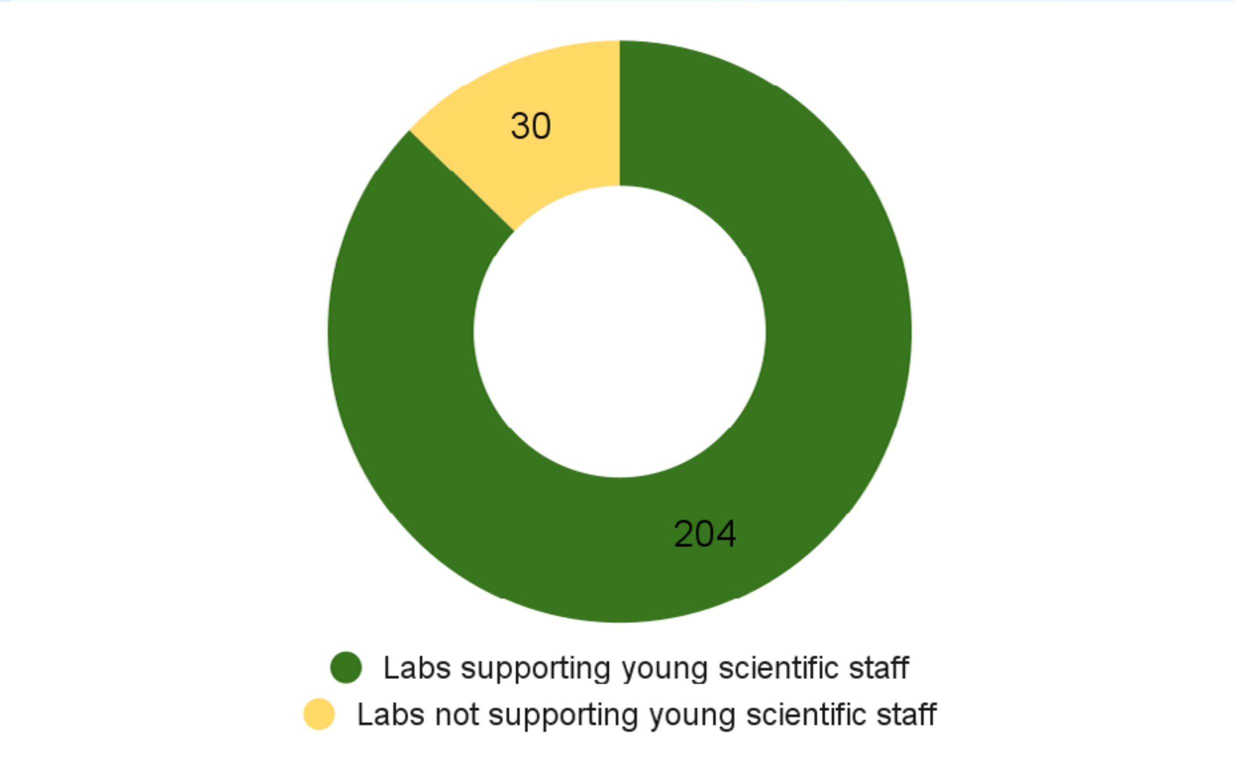
Figure 4.11: Median Share of Young Researchers in Scientific Staff



Note: Analysis is done for 233 labs/institutes. One lab/institute was excluded as their response could not be verified.

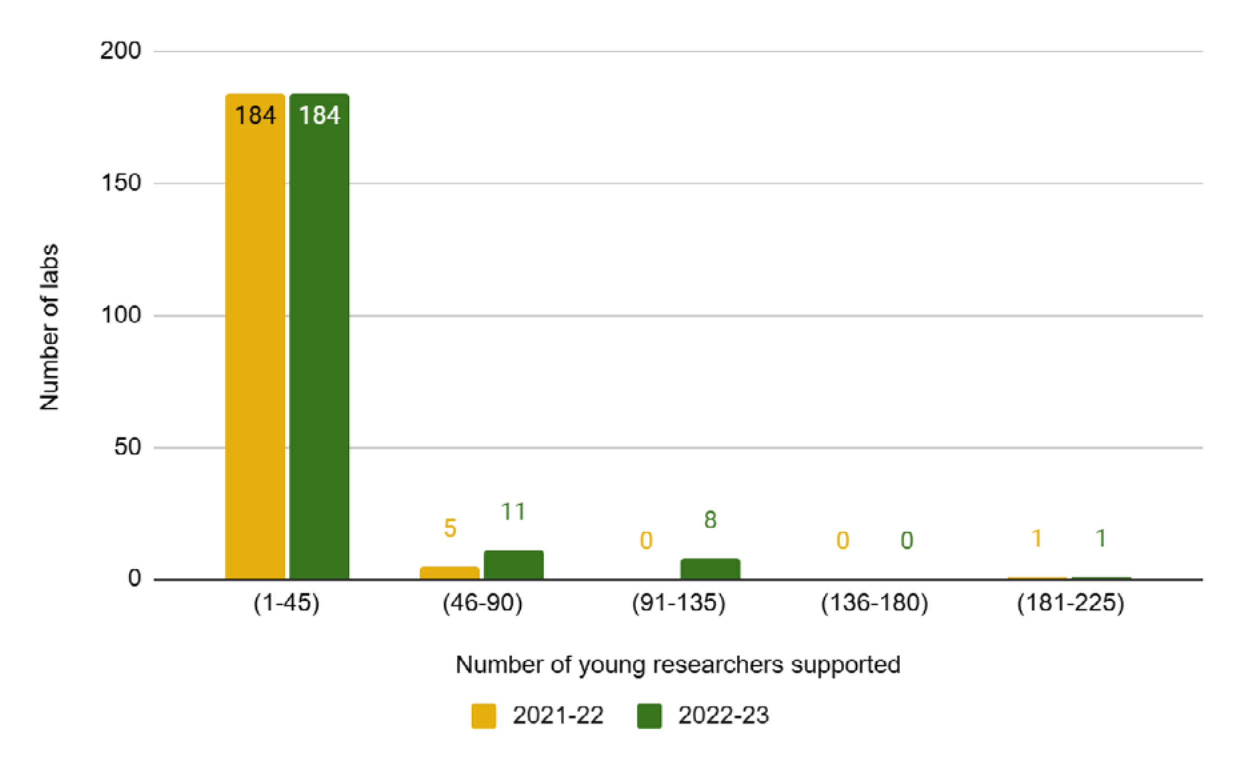
There were 204 labs/institutes that responded in 2022-23 as having supported young researchers for conferences, training and sabbaticals. These incentives are important to attract younger talent from our PhD programmes across the country.

Figure 4.12: Number of labs/institutes that supported young researchers for conferences, training, sabbaticals, etc



There were 184 organizations that supported between 1 and 45 young researchers for conferences, training, sabbaticals etc. The distribution of labs/institutes by the number of young researchers supported can be seen in the chart below. Here too in these organizations, the support for young researchers mirrors the level of support extended to women researchers - the median number of young researchers for the 184 organizations was 40 while the median number of young researchers supported for conferences, training, sabbaticals etc was just 9. From the section on capability development, the budget allocated towards training is very low and much more needs to be done especially in supporting young researchers with respect to training and for conferences given the fast pace at which scientific methods as well as technology is changing. Of the 19,298 young researchers working at the 234 public R&D organizations, only 4,092 received support towards attending conferences, training, sabbaticals etc.

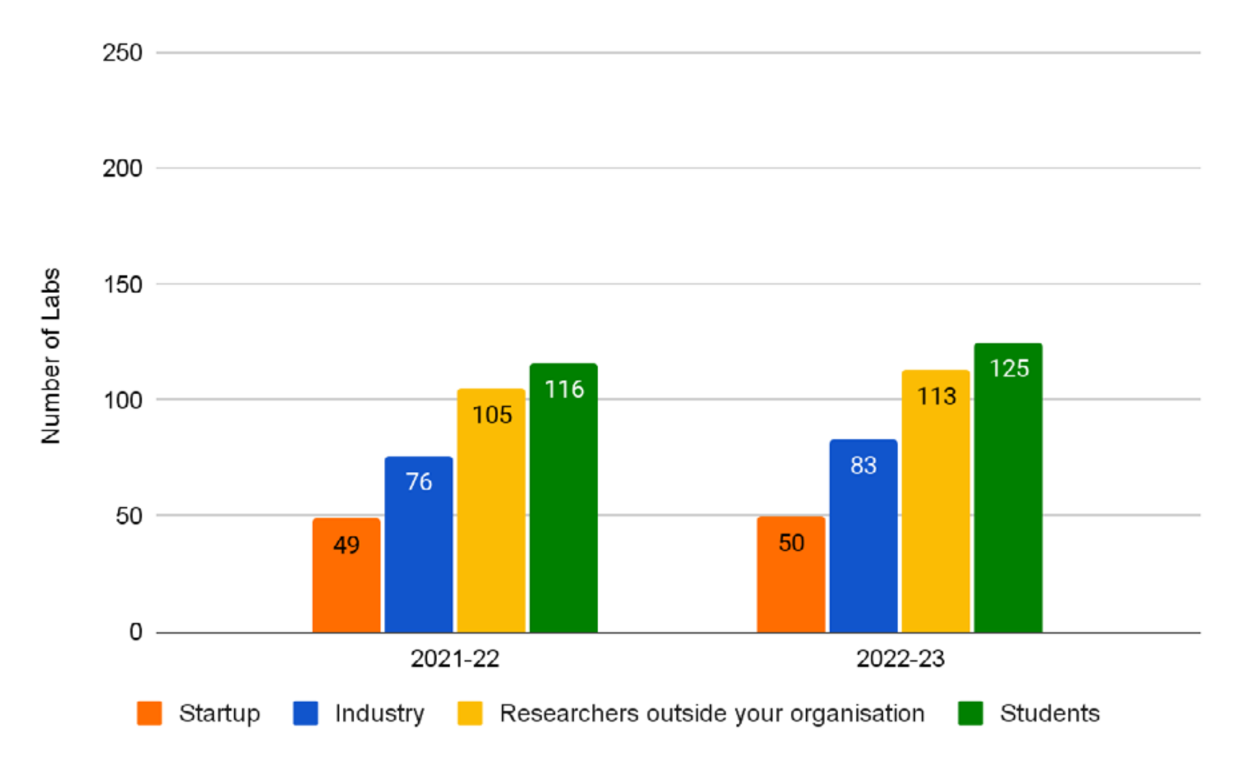
Figure 4.13: Distribution of labs/institutes by number of young scientists and researchers supported



4.3.5 Opening up research facilities to other stakeholders in Innovation ecosystem

As can be seen from the chart below, the public funded organizations are engaging with the wider ecosystem in varying degrees. Of the 234 participating organizations, just 50 opened up their facilities to startups in 2022-23, 83 organizations opened up facilities to industry, 113 opened up to outside researchers while 125 organizations opened up their facilities to students. Every effort should be made to attract startups and industry to use resources of the labs/institutes to their full potential, including making their facilities available on the I-STEM portal (currently as we shall see below, just 33 percent of organizations have a presence on I-STEM). Ensuring greater access to students by the organizations will also contribute to growing the scientific temper in the country and contribute significantly to growing the talent pipeline in the country.

Figure: 4.14 Opening up of research facilities



4.3.6 Policies and guidelines being adhered

Nearly all participating organizations in Round 2 adhere to several important policies and guidelines. Some of the areas where organizations were found lacking was with respect to having an explicitly Equity, Diversity and Inclusivity (EDI cell), national and international accreditation for their lab procedures, having differently abled friendly websites and having a presence on the I-STEM portal. However, if these organizations wish to attract the best talent from across the country as well as ensure fruitful collaborations with startups and industry, addressing several of the areas that were lacking would be imperative.

From having initiatives to promote intra-organizational collaborations, to having a sexual harassment mitigation cell with requisite policies and a public grievance redressal cell, over 98 percent of organizations responded that they had the requisite policies and guidelines in place. An area of improvement for around 20 percent of the organizations would be in adopting digital technologies that have the potential to enhance their R&D activities.

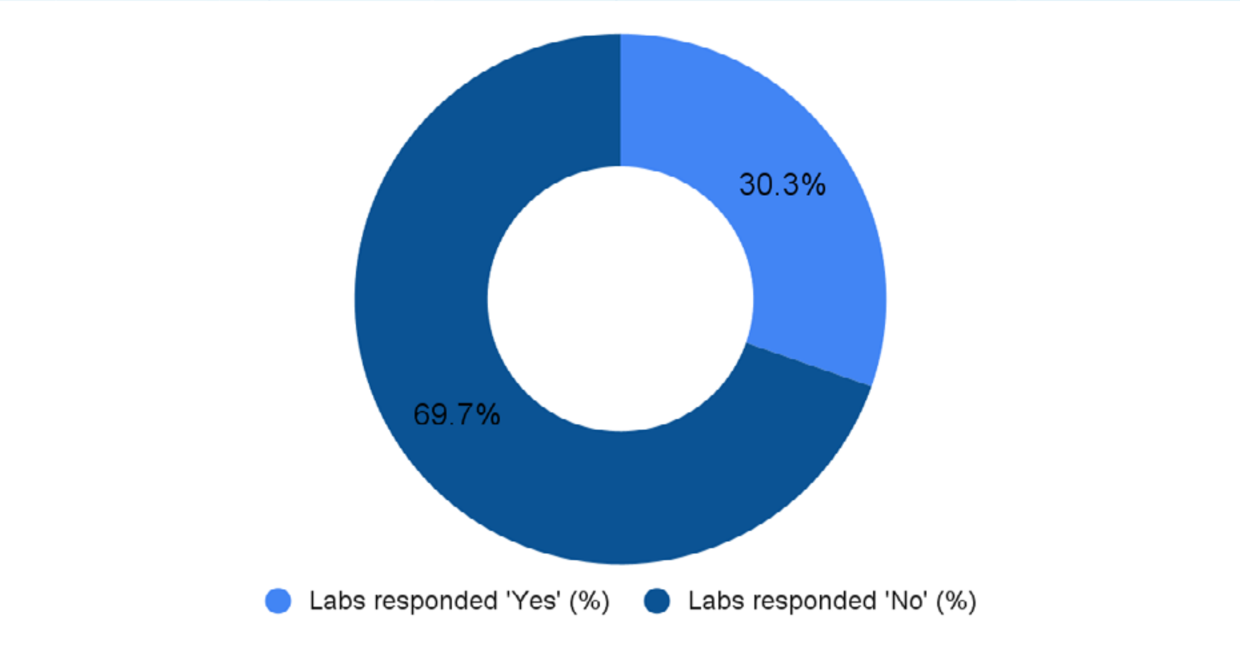
Table 4.1: Share of labs/institutes with policies and initiatives in place for intra-organisational collaborations, digital adoption, necessary ethics guidelines and policies, sexual harassment mitigation, public grievance redressal

Question	Share of labs/institutes that responded 'Yes' (%)
Does your organization have initiatives in place to promote intra-organisational collaborations?	99.1
Has your organization adopted any digital technologies that would enhance R&D activities?	82.1

Question	Share of labs/institutes that responded 'Yes' (%)
Does your organization have necessary ethics guidelines and policies in place?	98.3
Does your organisation have a sexual harassment mitigation cell with requisite policies and procedures?	99.6
Does your organization have a public grievance redressal cell?	98.7

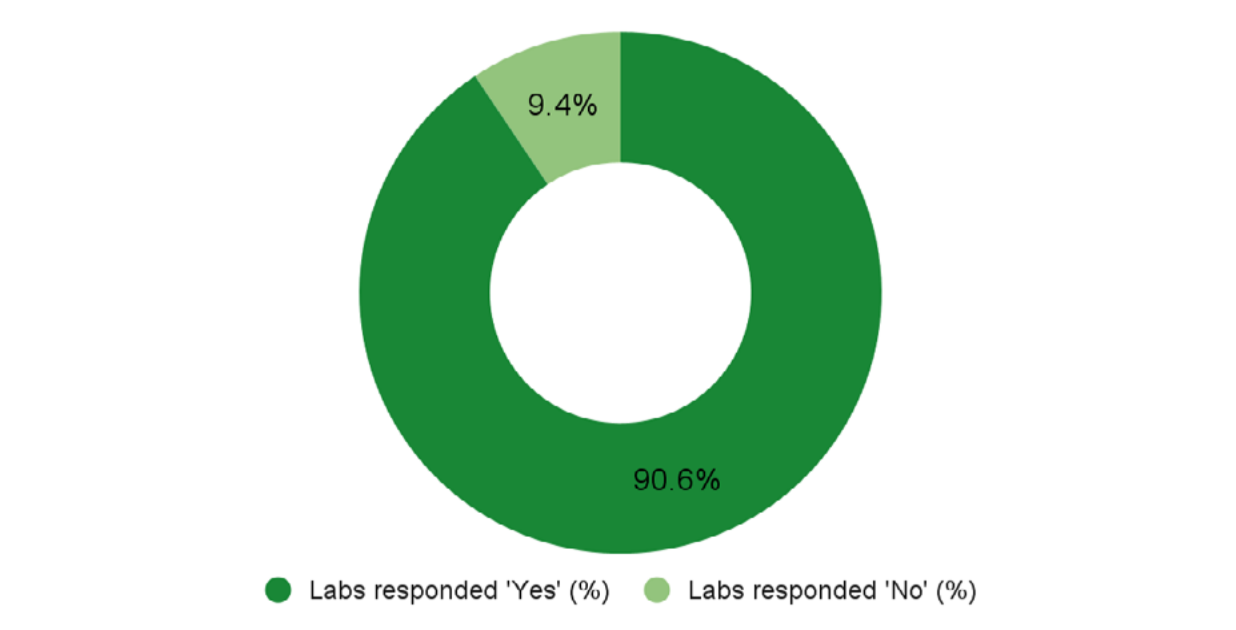
In terms of having an Equity, Diversity, Inclusivity cell, nearly 70 percent of the organizations were found wanting in this area. The public funded organizations would need to ensure that they have a dedicated cell equipped with the right individuals to drive equity, diversity and inclusivity forward. Apart from the need to hire more permanent women researchers, the cell would also need to ensure that the right funding support is made available to grow the diverse talent base at their respective organizations.

Figure 4.14: Share of labs/institutes with EDI Cells



While the organizations were found wanting in the area of establishing an EDI cell, it is noteworthy that over 90 percent of the organizations have differently abled facilities which is a positive step towards ensuring inclusivity. It would be important for the remaining 9 percent labs/institutes to also ensure that their facilities are upgraded to ensure they are differently abled friendly.

Figure 4.15: Share of labs/institutes with Differently Abled Facilities



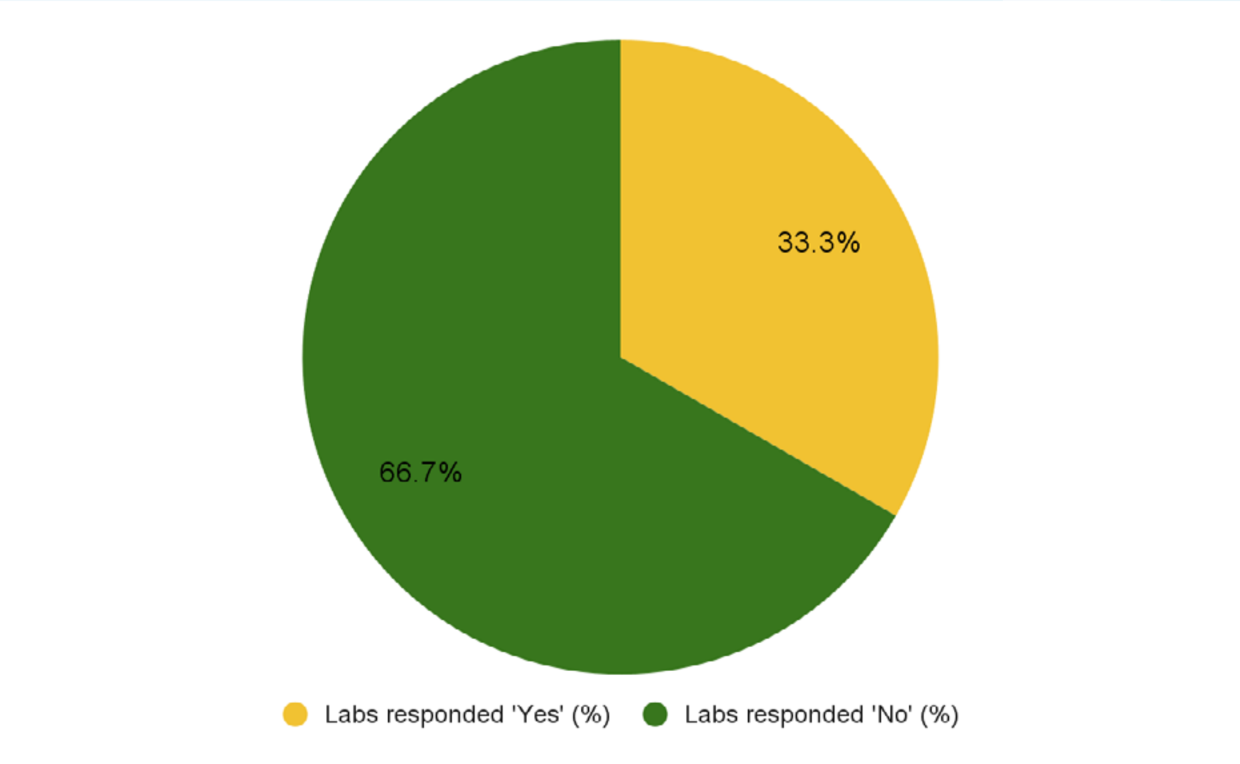
Some of the other best practices relate to having national and international accreditation for the organization's lab procedures, following the Government of India's security protocols for their respective websites and whether the organization's websites are differently-abled friendly. 59 percent of the organizations have national accreditation for their lab procedures while this number drops to just 33 percent of labs/institutes when it comes to international accreditation for their lab procedures. It would be important for all labs/institutes to get both the national and international accreditation done to be able to engage with industry in a meaningful way and also provide necessary testing and research consulting services to domestic and international startups and industry, apart from longer term research collaborations. Around 91 percent of the organizations said they followed government mandated security protocols. As we saw above, over 90 percent of the organizations said their facilities were differently abled friendly - however only 58 percent responded that their websites were differently abled friendly, something that would need to be addressed to ensure greater access to the work being done at these organizations.

Table 4.2: Share of labs/institutes with supporting accreditation for lab procedures, adoption of cybersecurity measures, website accessibility

Question	Share of labs/institutes that responded 'Yes' (%)
Does your organization have national accreditation/ certification for its lab procedure?	58.5
Does your organization have international accreditation/ certification for its lab procedure?	32.5
Does your organization's website follow all security protocols as mandated by the Government of India?	90.6
Is your organization's website differently-abled friendly?	51.7

Ensuring having their facilities and equipment made available to other researchers through a presence on the I-STEM portal is an important initiative of the Office of the Principal Scientific Advisor to the Government of India. Here too just 33 percent of the organizations had a presence on the I-STEM portal, suggesting significant scope for improvement on the part of organizations that are currently not on the portal to engage with the wider innovation ecosystem.

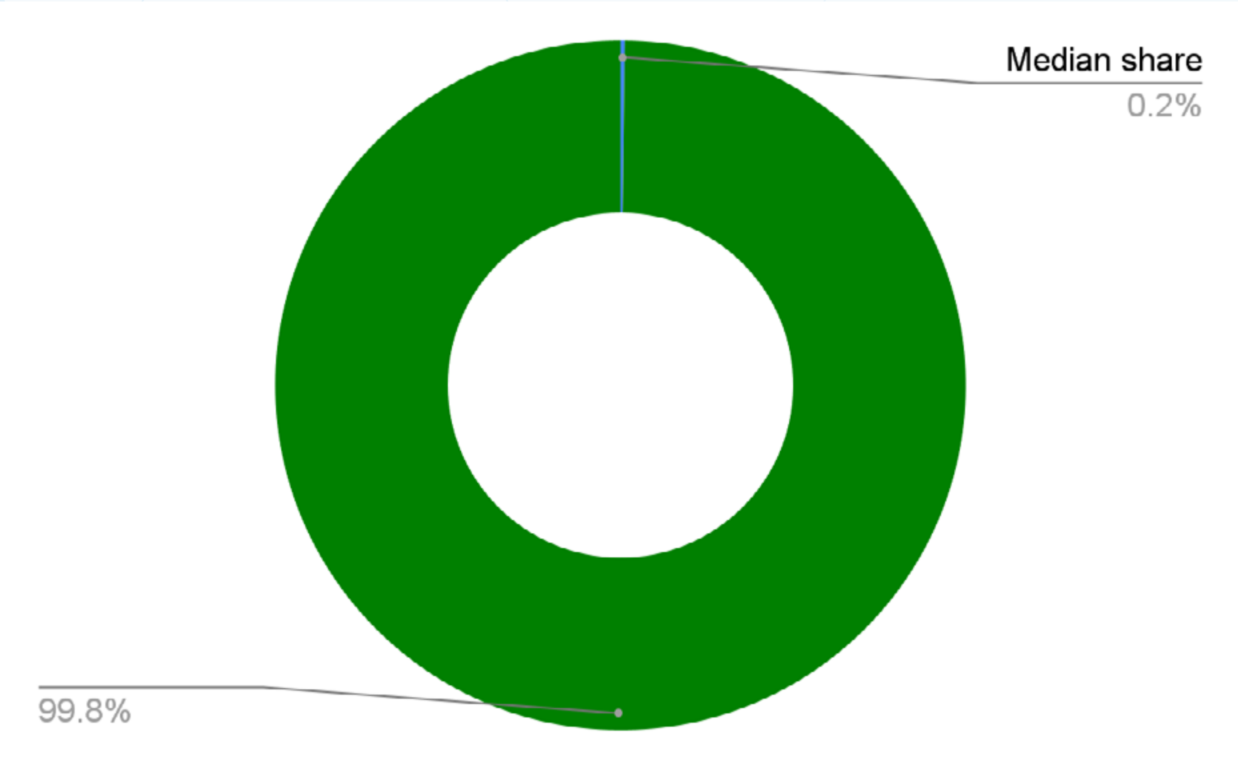
Figure 4.16: Share of labs/institutes on I-STEM



4.3.7 More spending on training needed

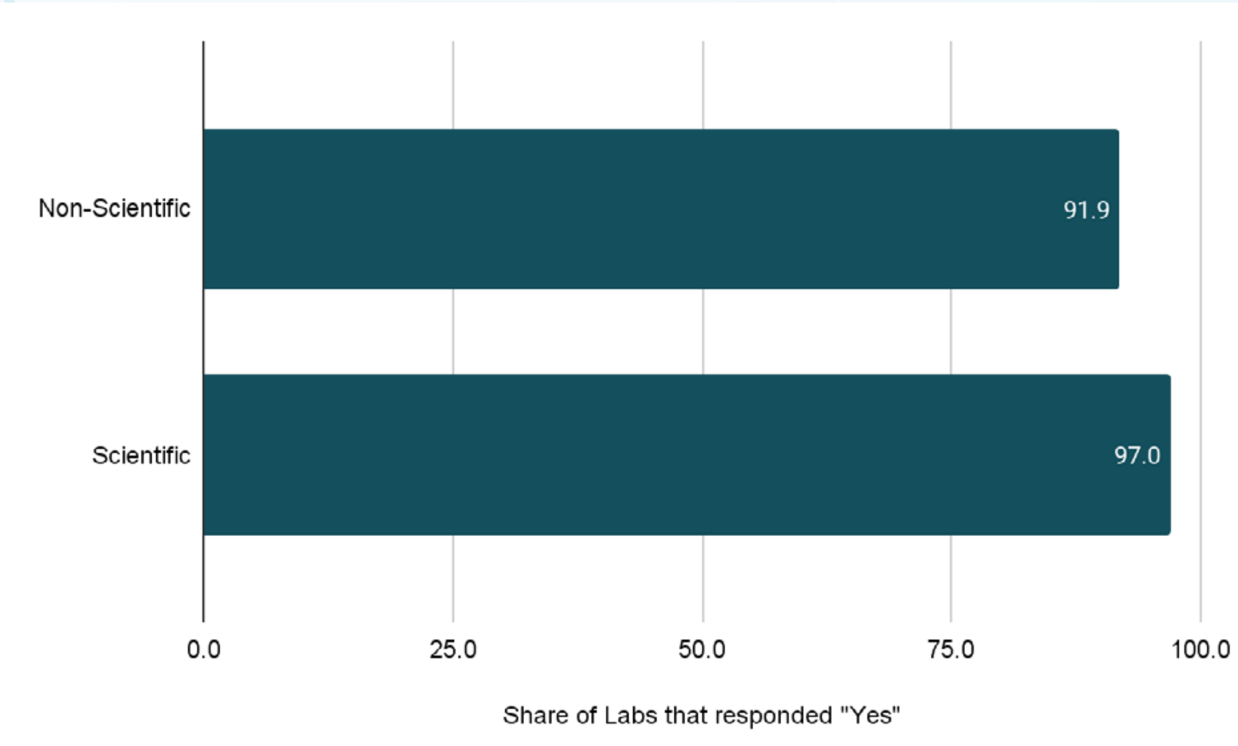
The median share of the budget spent on training by the participating organizations is very low at 0.2 percent, while around 67 percent of the organizations reported spending less than 1 percent of their budget on training. With the rapid pace of change in technology and research methodology as well as priority research areas given significant global challenges like climate change, there is a need for organizations to upgrade their skill sets and research tools to meet these global challenges. For this organizations would need to support their scientific staff for training as well as attending conferences.

Figure 4.17: Median Share of percentage of budget spent on training



The positive takeaway is that over 90 percent of organizations do have a structured career progression plan in place for their scientific and non-scientific technical staff.

Figure 4.18: Share of labs/institutes that responded 'Yes' to having a structured career progression plan for scientific and non scientific staff



In terms of career development programmes being organized by various stakeholders including the parent ministries, a significant number of organizations reported participating in programmes organized by their parent ministries. There were 136 organizations that reported attending programmes conducted or supported by their parent ministry in 2022-23 compared to the 124 in organizations in the previous year. There was also an increase in the number of organizations that benefited from programmes conducted or organized by the Capacity Building Commission from 25 organizations in 2021-22 to 38 organizations in 2022-23. Over 100 organizations reported participating in career development programmes organized by 'Other' institutions or agencies in both years. Labs/institutes from ICAR, and CSIR accounted for the largest proportion of labs/ institutes that reported participating in career development programmes organized by each stakeholder.

Figure 4.19: Number of labs/institutes that had scientists undergo a career development programme on an annual basis organized by various stakeholders

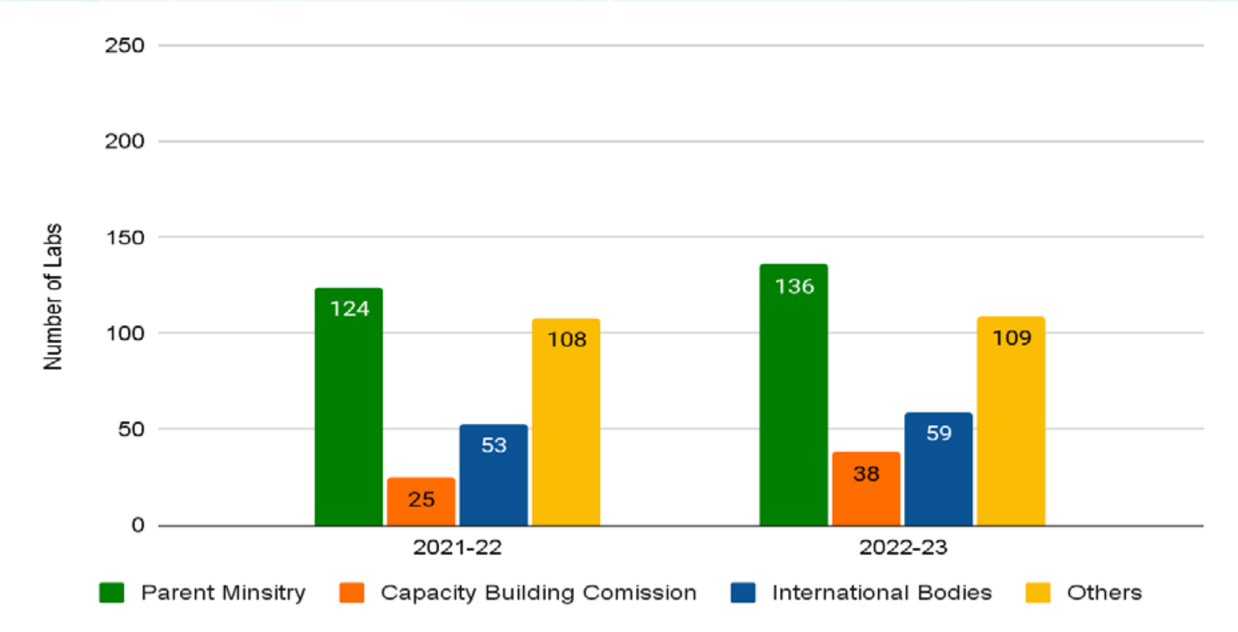
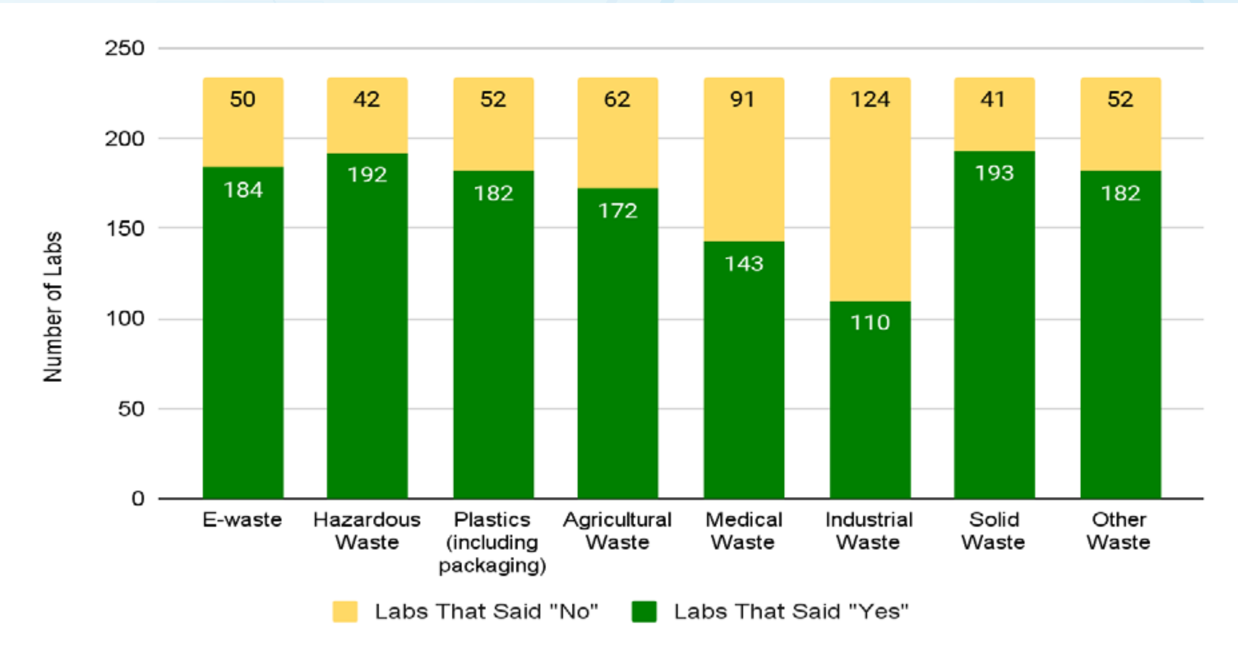


Figure 4.20: Number of labs/institutes with safe waste reclamation policies



4.4 Scientific Output and Innovation Outcomes of the Labs/Institutes

4.4.1 Over 75 percent of organizations have some collaborations with domestic industry

The number of labs/institutes by budget category can be found in Figure 4.21. Over 50 percent of the organizations have an annual budget of up to Rs. 50 crore, around 56 organizations are in the Rs. 50 - 100 crore range in terms of their budgets, while around 46 organizations have a budget of over Rs. 100 crore. One of the findings as can be seen in Table 5.3 is that when moving across the budget categories, from the Rs. 0 - 50 crore range to upwards of Rs. 100 crore, there is a doubling in the median number of scientific staff for the higher budget categories, but this is not seen in the median number of projects undertaken.

Figure 4.21: Distribution of labs/institutes by Budget Category

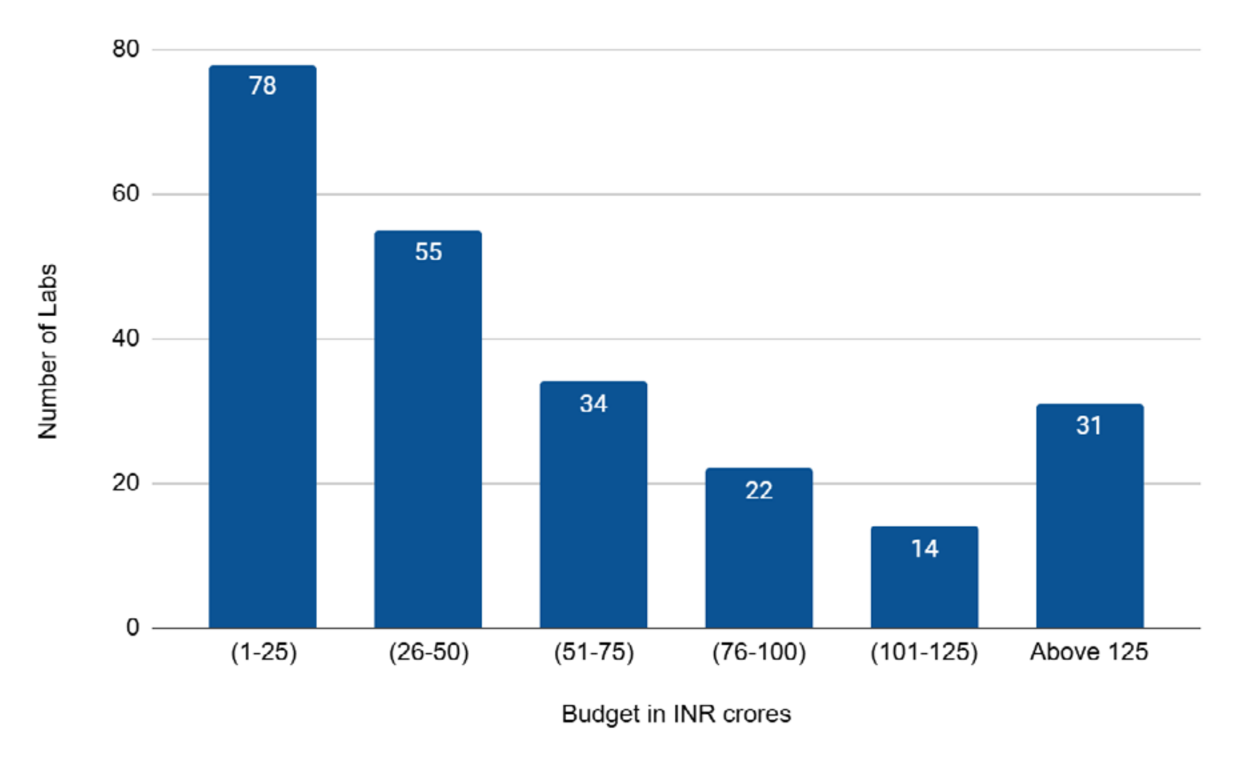


Table 4.3 Budget categories, number of labs/institutes and median number of projects executed

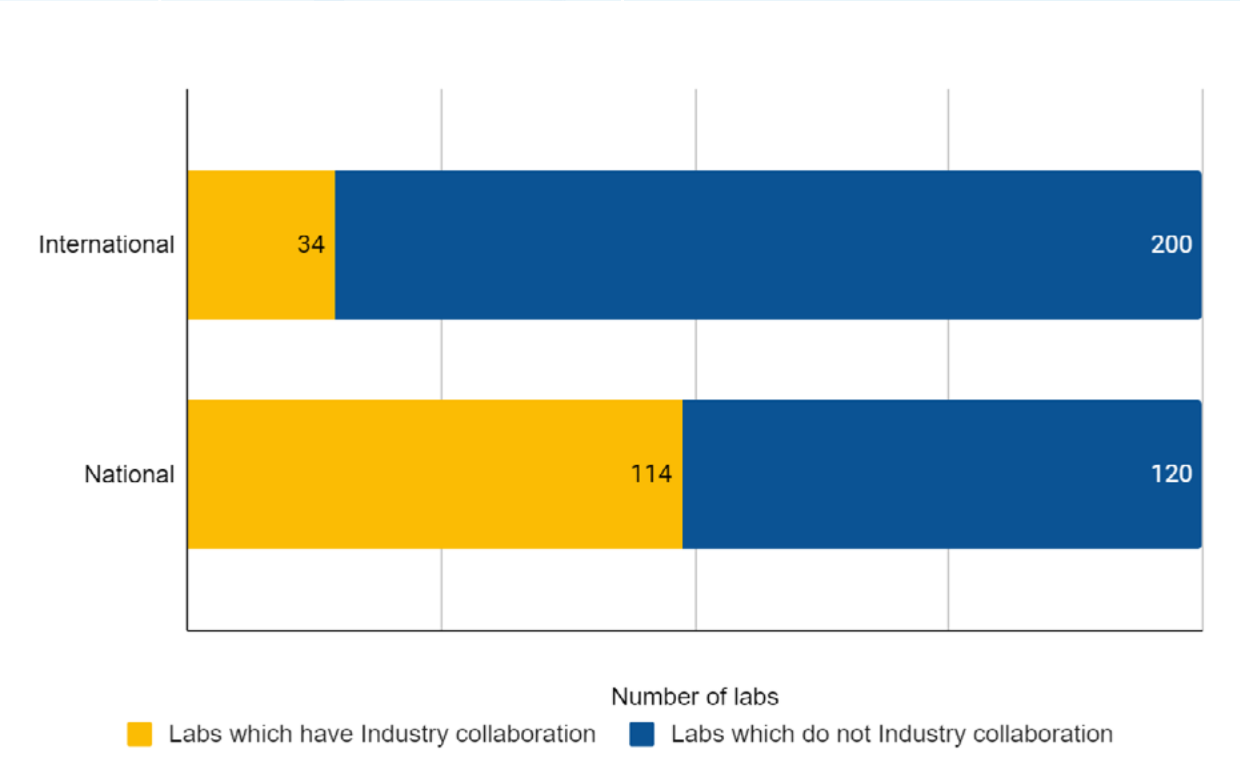
Budget of the labs/institutes (Rs Crores)	Number of labs/ institutes	Median number of projects executed	Median Scientific Staff
0-50	127	32	55
50-100	61	50	112
Above 100	46	74	214

Note: Analysis is done for 233 labs/institutes. One lab/institute was excluded as their response could not be verified.

For the projects undertaken, the organizations were required to report the number of collaborations they had with industry, academia/other public research organizations or jointly with industry and academia/other public research organizations. They were required to report this for both national as well as international collaborations.

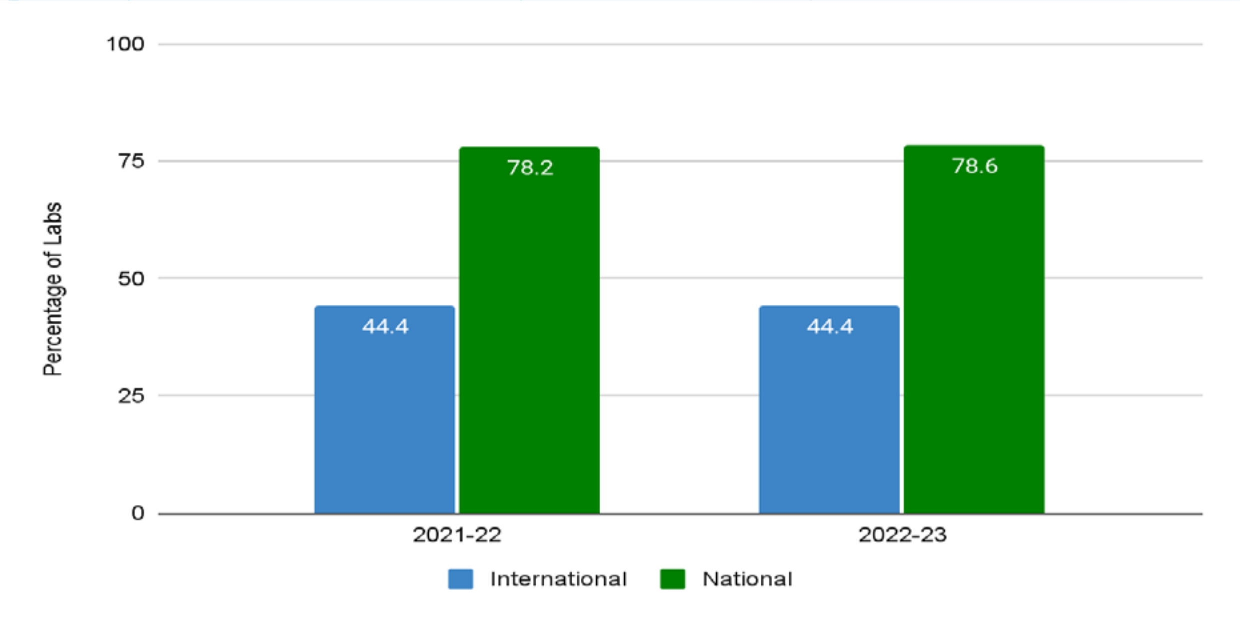
With respect to industry collaborations, there were 114 organizations that had collaborations with domestic industry i.e. 48 percent of the organizations while just 34 organizations or 15 percent of the participating organizations reported having collaborations with international industry. The share of the participating organizations that had collaborations with domestic as well as international academia/other public research organizations were much higher at 78 percent and 44 percent respectively. The total number of projects that were being undertaken by the reported 233 organizations were around 14,000 in 2022-23 compared to 13,000 in 2021-22.

Figure 4.22: Collaborative Projects with Industry



For the organizations that reported having collaborations with academic institutions and/or other public research organizations, the median share of projects in total projects was around 19 percent for domestic collaborations and around 5 percent for international collaborations.

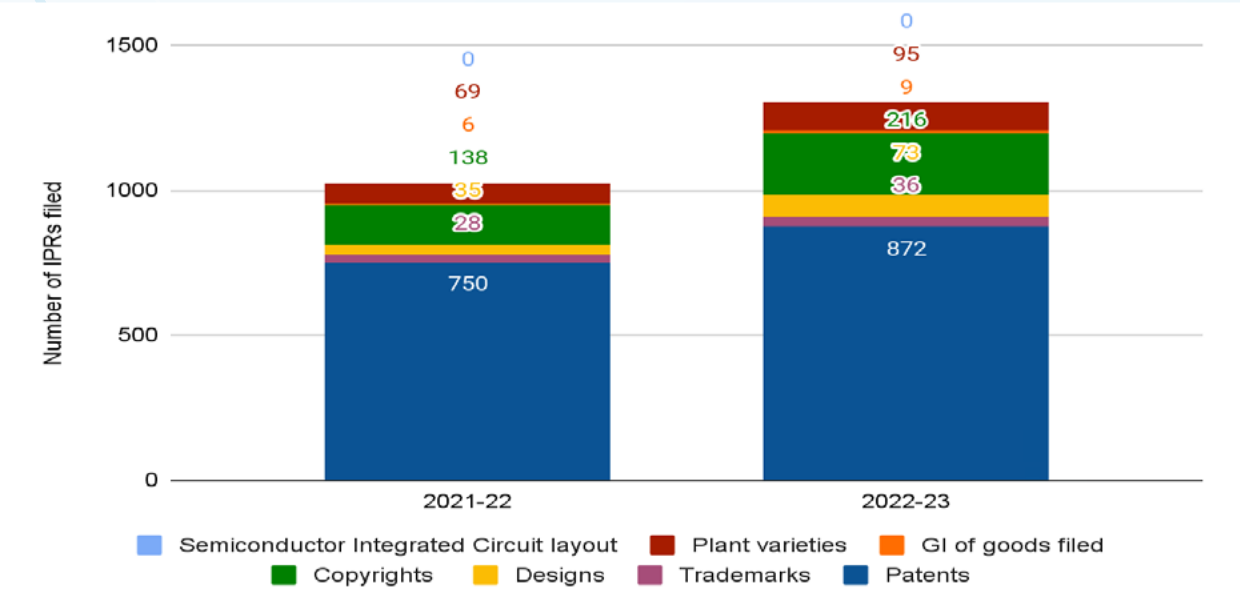
Figure 4.23: Share of labs/institutes with Collaborative Projects with Academic Institutions and Research labs/institutes



4.4.2 IPR Filings and Grants both saw an increase in 2022-23

The number of patents filed in 2022-23 by the 233 labs/institutes was 872 compared to 750 in the previous year. The patents filed by the labs/institutes accounted for 2 percent of the total patents filed within India and outside India by Indian residents.[4] There has been an increase in filings in 2022-23 across all the various categories of IPR as can be seen in Figure 4.24 except for filings of semiconductor integrated circuit layout. Copyrights filed were the second highest in terms of numbers at 216 filings in 2022-23 compared to 138 filed in 2021-22. CSIR, ICAR, DST, DBT, and MEITY showed the highest number of IPR filings.

Figure 4.24: IPR Filed

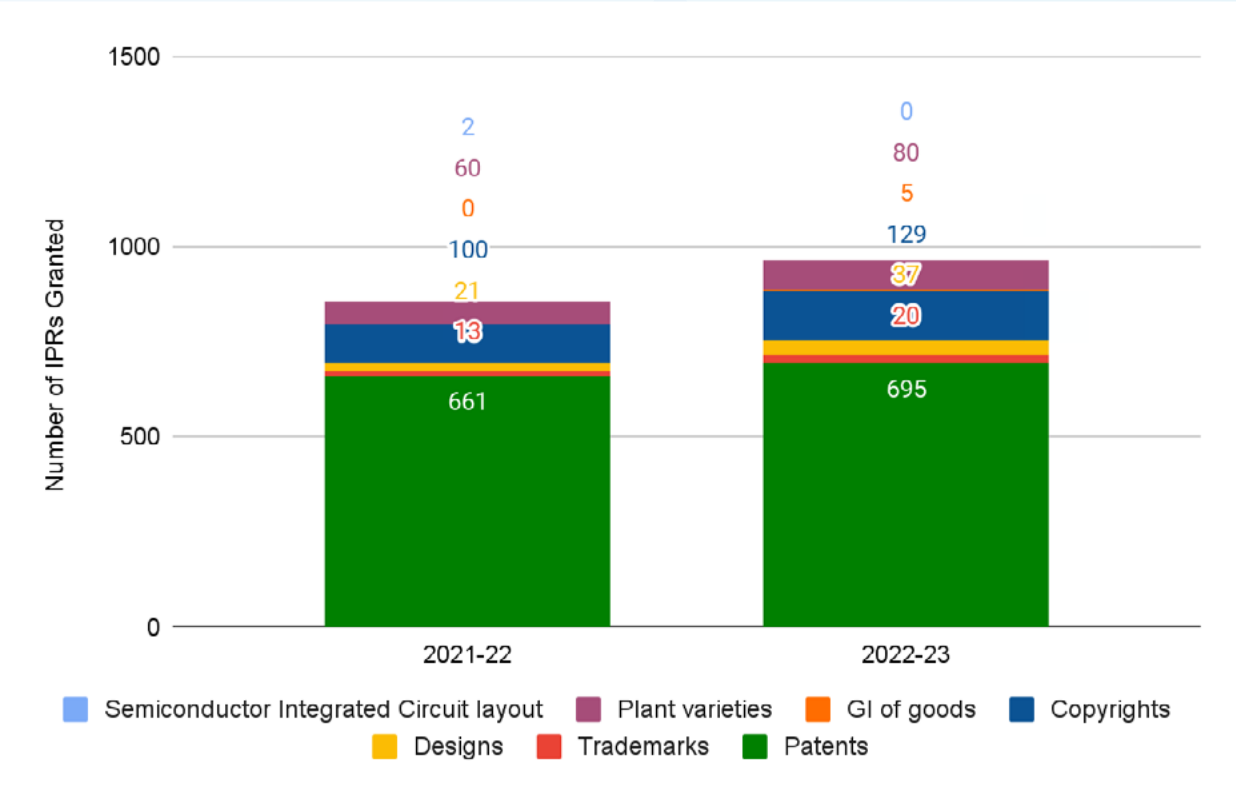


Note: Analysis is done for 233 labs/institutes. One lab/institute was excluded as their response could not be verified.

[4] *Number of patents filed within India and outside India by Indian residents based on estimates in CTIER Handbook 2023*

In terms of patents granted, the labs/institutes accounted for 5 percent of the total patents granted within India and outside India to residents in India.[5] There was an increase in the number of patents granted to 695 patents granted in 2022-23 compared to 661 patents granted in 2021-22. As can be seen in Figure 4.25, there was an increase in almost all the categories except for the semiconductor integrated circuit layout which saw nothing being granted in this category in 2022-23 compared to 2 that were granted in 2021-22. The ministries with the highest number of IPRs granted are CSIR, DST, ICAR, MEITY, and DBT.

Figure 4.25: IPR Granted sees an increase across nearly all categories



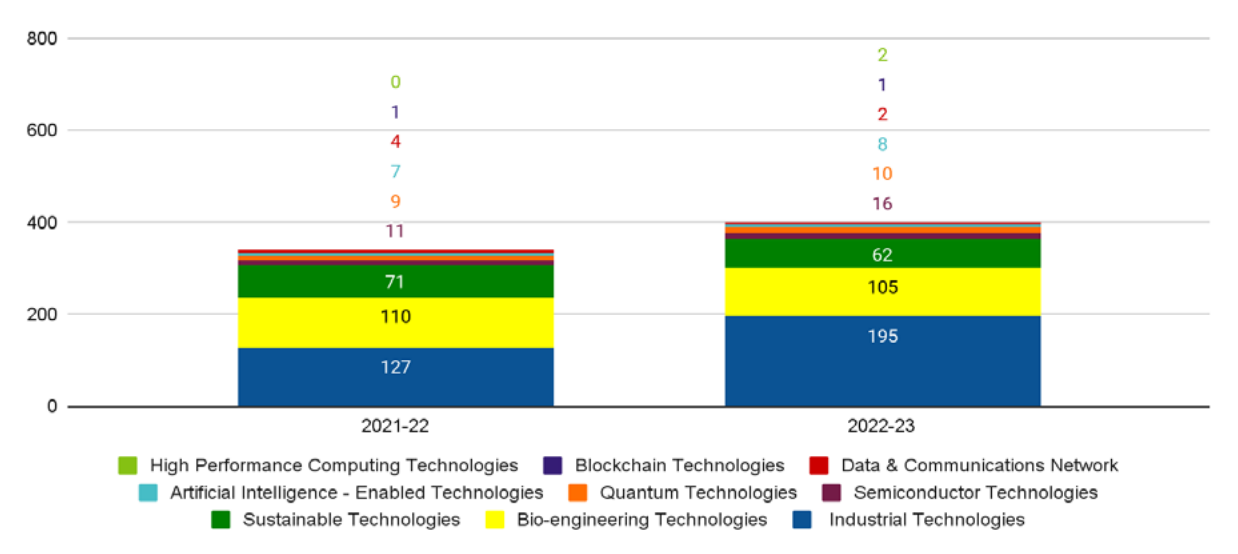
Note: Analysis is done for 232 labs/institutes. Two labs/institutes were excluded as their response could not be verified.

In this round of the evaluation of public funded organizations, a new indicator was introduced to capture the IPR granted in the areas of key emerging technologies. These key emerging technologies were classified based on the list prepared by the MEA and the O/o PSA under the Emerging Technologies Initiative[6]. The area of industrial technologies (for example, advanced manufacturing, 3D printing etc.) saw the highest number of patents being granted - this category received 195 grants in 2022-23 compared to 127 patents in 2021-22. As can be seen in Figure 4.26, bio-engineering technologies was the second highest category in terms of patents that were granted, which was followed by sustainable technologies. Both bio-engineering technologies and sustainable technologies saw a dip in the number of patents granted in 2022-23 compared to the previous year.

[5] *Number of patents granted within India and outside India to residents in India based on estimates in CTIER Handbook 2023*

[6] *https://thesciencepolicyforum.org/initiatives/eti/*

Figure 4.26: IPR Granted Emerging Technologies

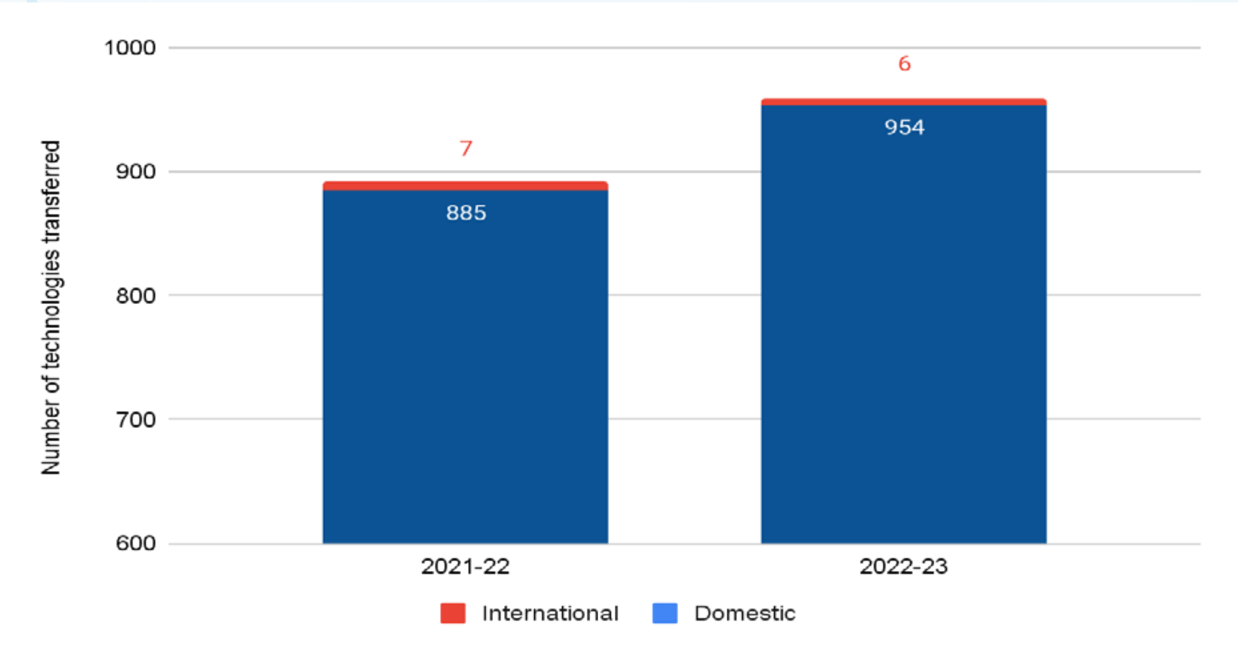


Note: Analysis is done for 232 labs/institutes. Two labs/institutes were excluded as their response could not be verified.

4.4.3 Number of technologies transferred domestically see an increase

There was an increase in the number of technologies transferred domestically over the two years under consideration. There were 954 technologies that were transferred domestically in 2022-23 compared to 885 technologies that had been transferred domestically in 2021-22. Very few technologies were transferred internationally by the participating organizations - the total number of technologies transferred was much lower than what had been reported in the previous round of this exercise. Greater participation through global partnerships should be encouraged and also greater international technology transfer should be encouraged as a source of revenue for the public funded organizations as well.

Figure 4.27: Technologies Transferred domestically and internationally

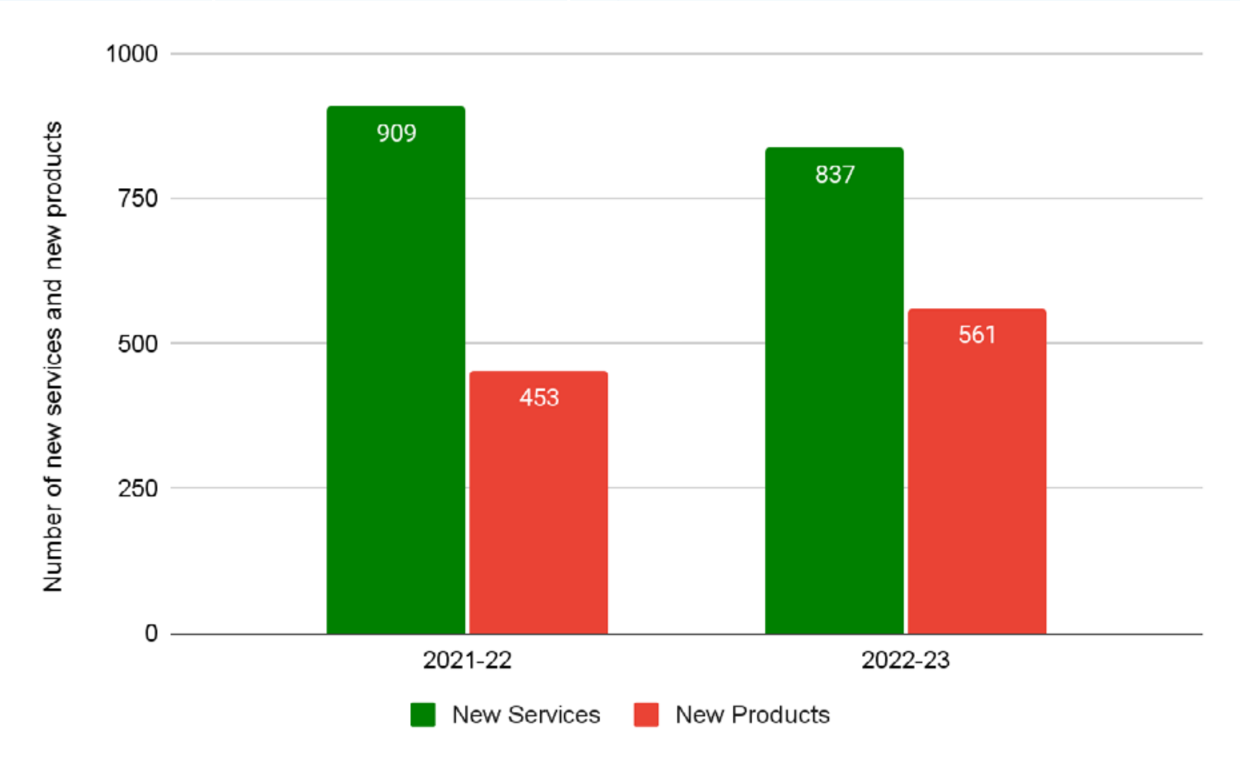


Note: Analysis is done for 233 labs/institutes. One lab/institute was excluded as their response could not be verified.

4.4.4 Introduction of new products see an increase while new services see a drop

Introduction of new products and services showcases the innovativeness of the organizations. The participating organizations were only required to report the number of new products and/or services they introduced, and were not required to report whether these were new to the organization, new to the market or new to the world. Over the two years under consideration, there were a total of 1,014 new products that were introduced and 1,746 new services that were introduced. While the number of new products introduced saw an increase in 2022-23 compared to the previous year, the number of new services introduced were lower in 2022-23 compared to the previous year.

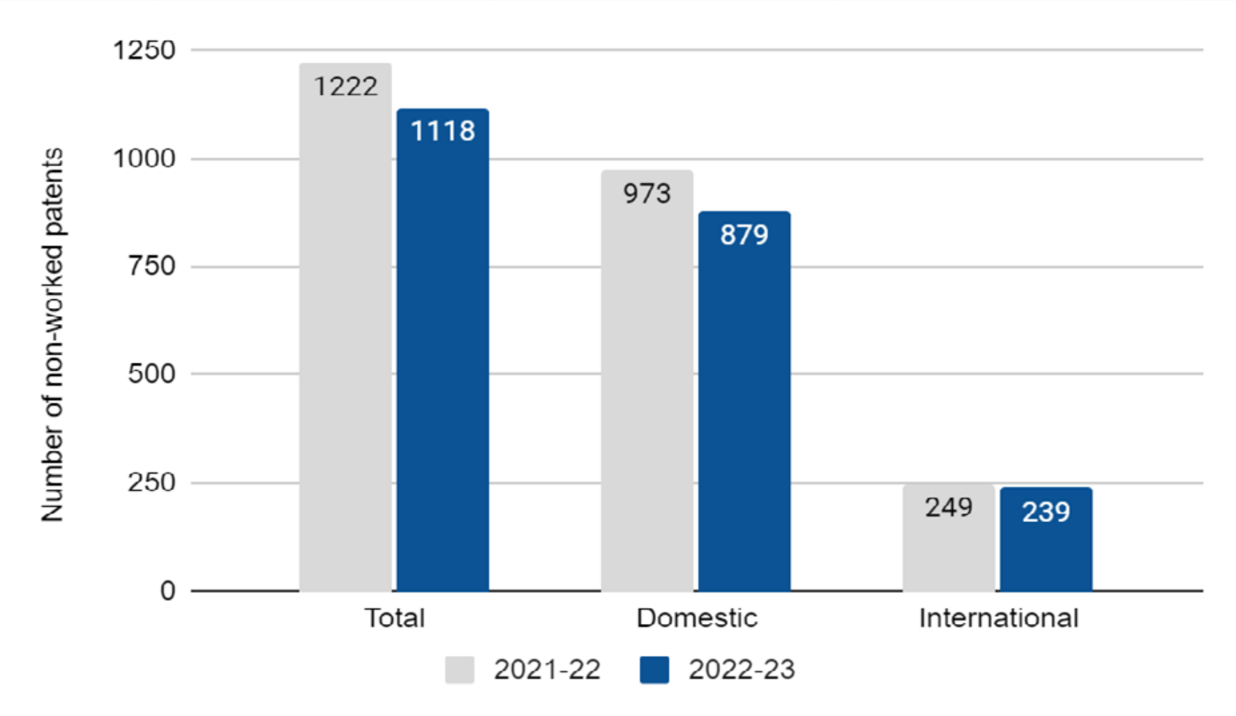
Figure 4.28: New Services and Products



4.4.5 Non Worked Patents reported see a drop in 2022-23

Non worked patents as indicators have been introduced in this round and are a new feature in this report. It was felt necessary to consider these patents to encourage organizations to seek opportunities for commercialization either through sale or even licensing deals, while appreciating that organizations may own or file for patents to ring fence some of their technologies or research being undertaken. There were 879 domestic patents that organizations reported as being non worked in 2022-23 compared to 973 patents that were reported as non-worked in 2021-22, while there were 239 international patents reported as non-worked in 2022-23 compared to 249 in the previous year.

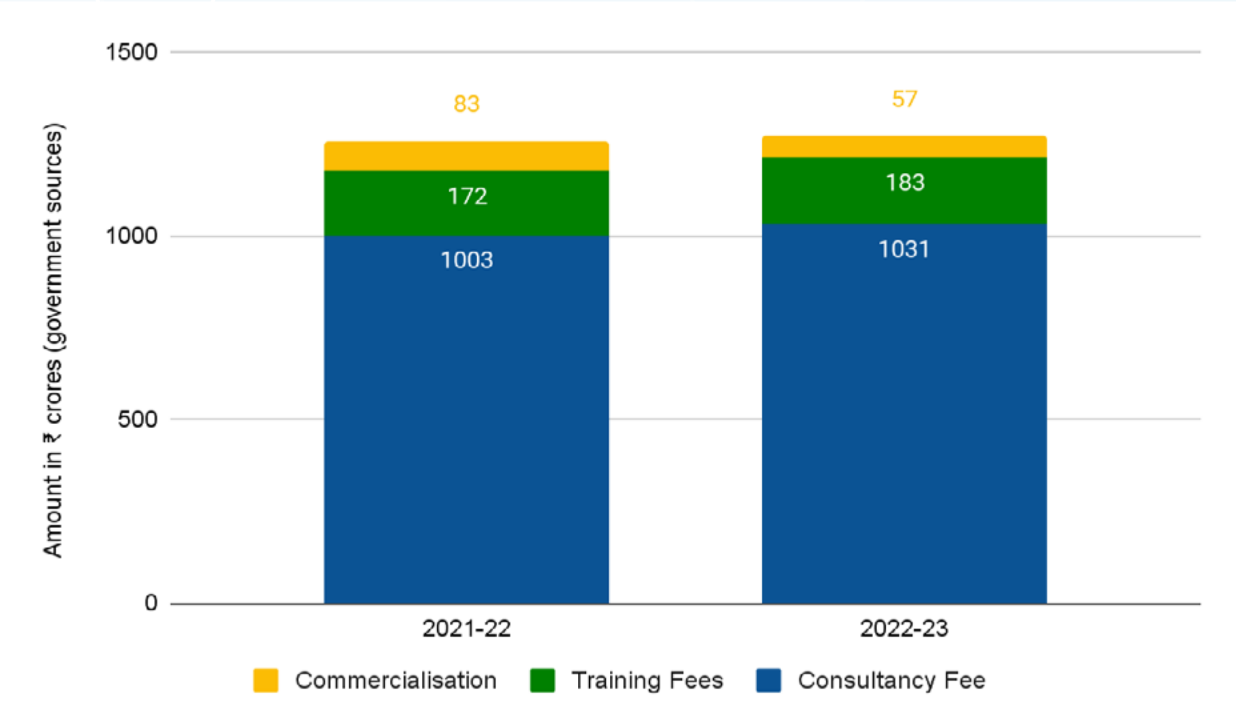
Figure 4.29: Non Worked Patents



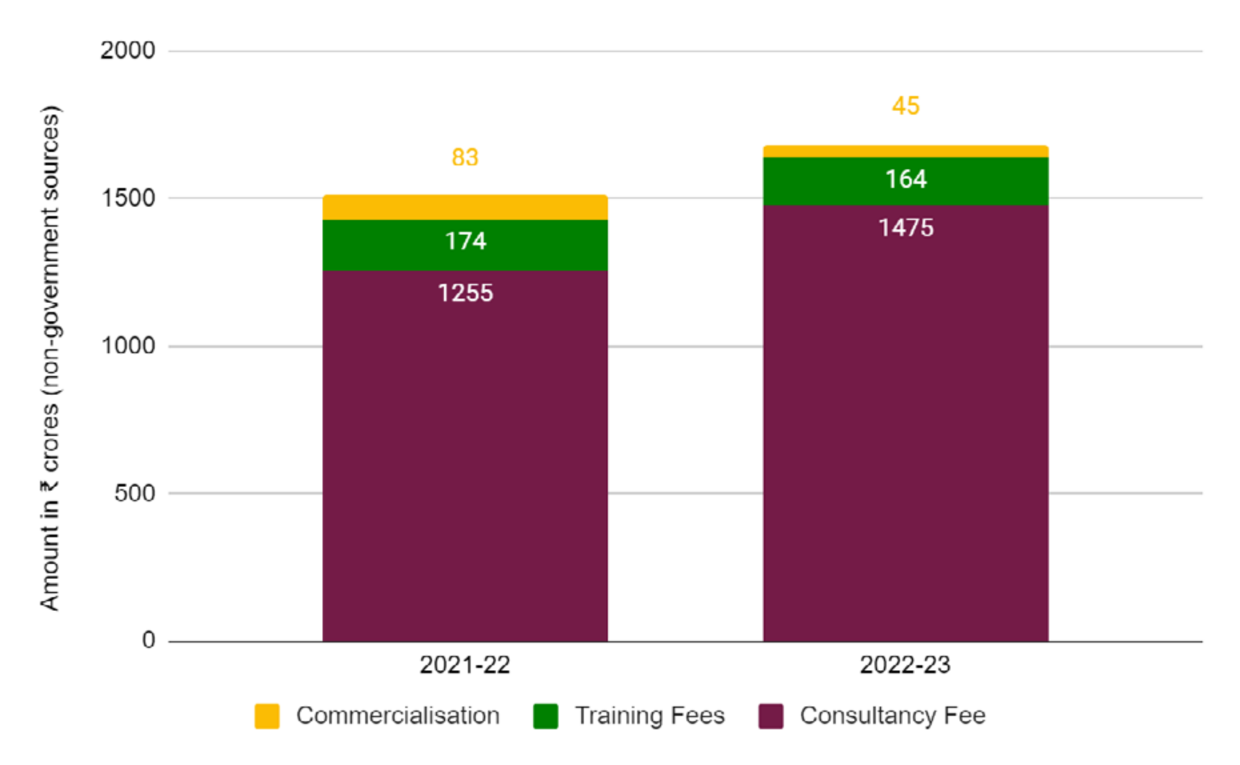
Note: Analysis is done for 233 labs/institutes. One lab/institute was excluded as their response could not be verified.

4.4.6 Total earnings higher from non-government sources while extramural funding higher from government sources

Figure 4.30: Earnings from commercialization see a drop in 2022-23 for both government and non-government sources



Note: Analysis is done for 233 labs/institutes. One lab/institute was excluded as their response could not be verified.

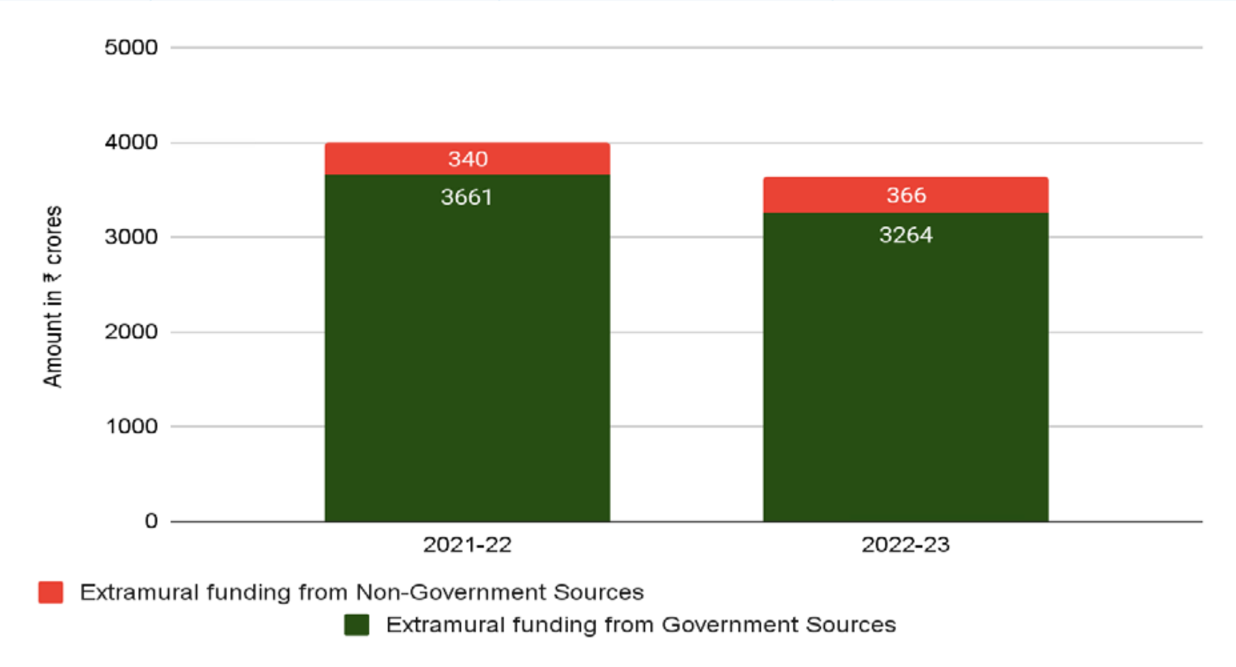


Note: Analysis is done for 233 labs/institutes. One lab/institute was excluded as their response could not be verified.

The overall earnings from non government sources in 2022-23 was higher at Rs. 1,684 crore compared to Rs. 1,271 crore that were received from government sources in 2022-23. The total earnings in 2022-23 from both sources was Rs. 2,955 crore compared to Rs. 2,770 crore in 2021-22. The earnings for both government and non government sources was largely driven by earnings through consultancy services. In 2022-2023, consultancy fees accounted for 80 percent of government earnings and over 85 percent of non government earnings. There was a drop in earnings from commercialization for both government as well as non government sources with earnings from commercialization dropping to Rs. 57 crore in 2022-23 from Rs. 83 crore in 2021-22 as part of earnings from government sources while there was a drop in earnings from commercialization to Rs. 45 crore in 2022-23 from Rs. 83 crore in 2021-22 as part of earnings from non government sources. There was a drop in overall earnings from commercialization at a time when the number of technologies transferred saw an increase. The total earnings from both government and non-government sources are highest for CSIR, MEITY, Ministry of Heavy Industries, DST, and Ministry of Power.

In terms of extramural funding, while the funding from government sources trump funding from non government sources, the total funding from government sources did see a drop in 2022-23 to Rs. 3,264 crore from Rs 3,661 crore in the previous year. While this may not necessarily represent a trend given possible increased spending during a pandemic year, it would be important to track this indicator closely.

Figure 4.31: Extramural Funding significantly higher from government sources



4.4.7 Total publication output rises but share in top 10 percent journals drops

The total publication output rose slightly from 18,367 in 2021 to 18,717 in 2022. Labs/institutes were asked to use either Web of Science or Scopus databases to provide publications related data and the director's sign off on the data signifies that such guidelines were adhered to. CSIR, ICAR, DST, ICMR, and DBT have the highest number of publications in quality peer reviewed journals.

Even though the total number of publications by labs/institutes increased slightly, the median value for share of publications in the top 10 percent journals saw a significant drop from around 8.1 percent in 2021 to 6.7 percent in 2022.

Figure 4.32 Total number of publications

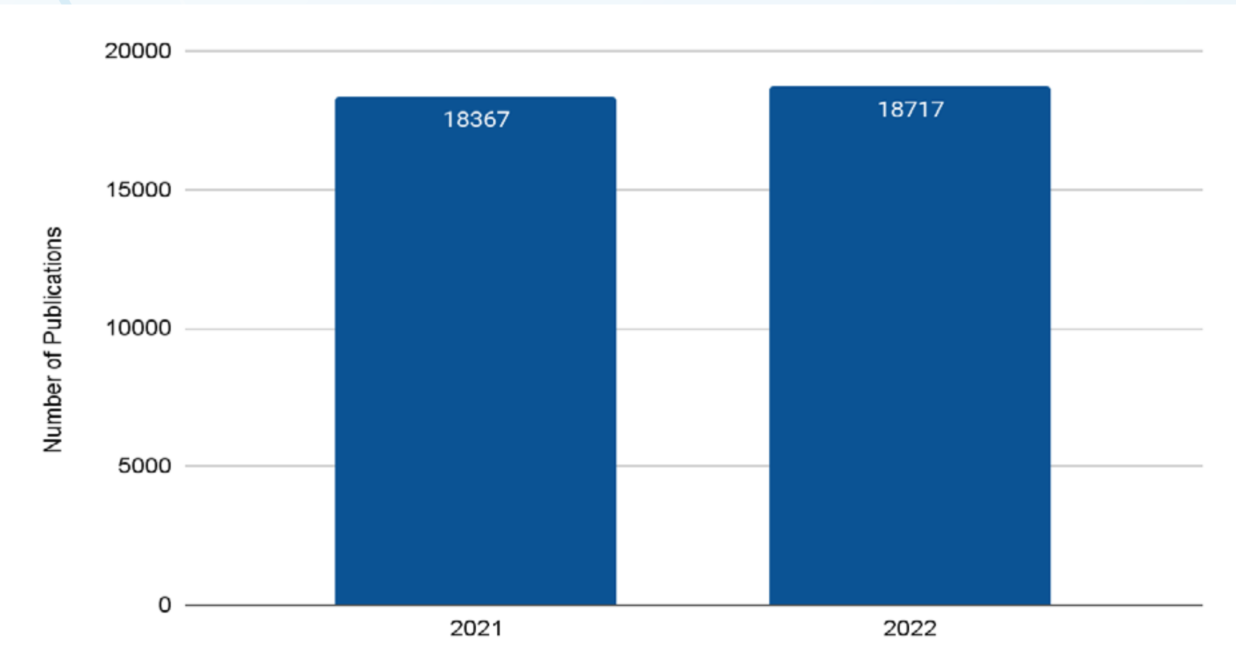
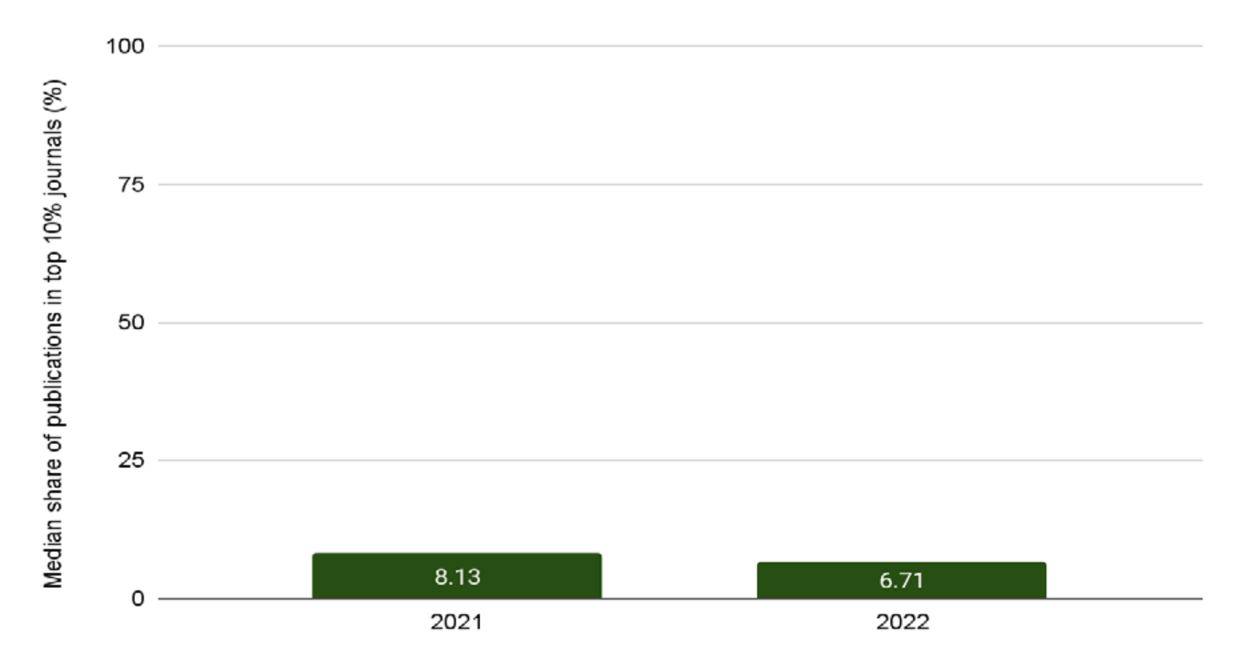


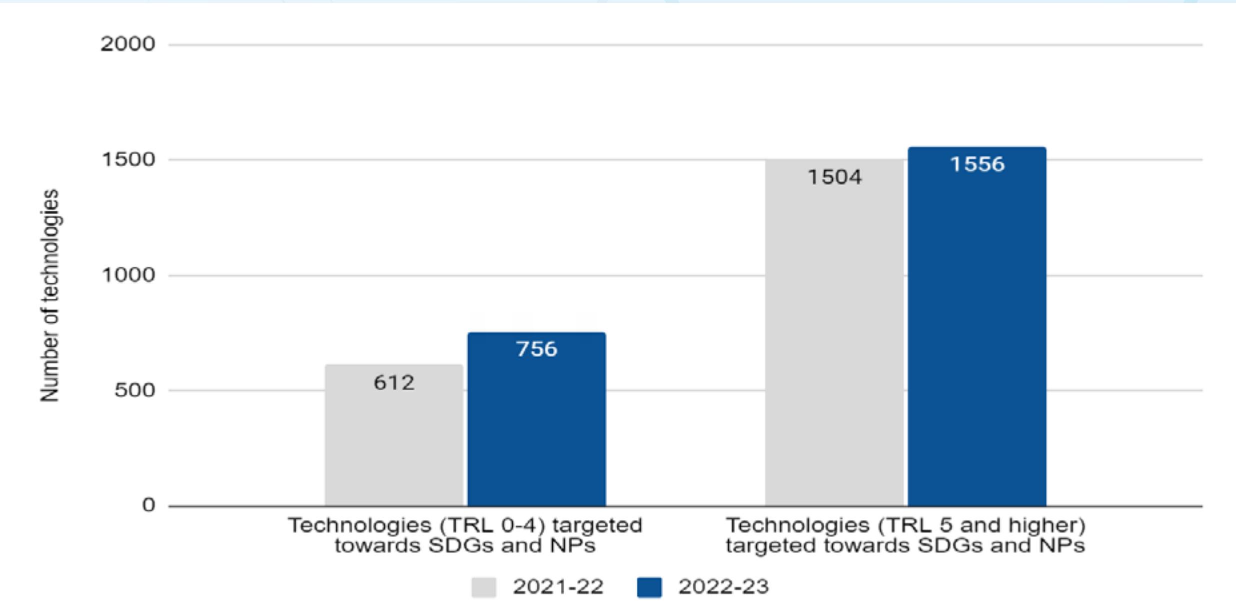
Figure 4.33 Share of publications in top 10 percent of journals



4.5 Contributions of Organizations to Socio-economic Development

The total number of technologies that were being or had been developed with TRL 0 to 4 and targeting SDGs or national programmes saw a significant increase of around 23% to 756 in 2022-23. This compared to an increase of only 3% for technologies with TRL 5 and higher to 1556 in 2022-23. Increased sensitization to SDG goals as well as to various national programmes targeted amongst participating organizations is underway - the focus on trying to target industry is evident in the choice of SDG goal 9 with nearly 50 percent of the participating organizations having chosen this goal. Targeting SDG goal 3, Good health and well-being is the most common SDG goal targeted while nearly 30 percent of the organizations said their technologies they were developing were targeted at goal 13 on climate action.

Figure 4.34: Total number of technologies targeting SDGs and national programmes



4.5.1 Technologies developed targeting SDGs and national programmes

Figure 4.35: Total number of technologies targeting SDGs and National Programs

Sustainable development goals (SDGs)	Number of labs/institutes
Goal 1: No poverty	46
Goal 2: Zero hunger	64
Goal 3: Good health and well-being	132
Goal 4: Quality education	38
Goal 5: Gender equality	24
Goal 6: Clean water and sanitation	36
Goal 7: Affordable and clean energy	38
Goal 8: Decent work and economic growth	45
Goal 9: Industry, innovation and infrastructure	115
Goal 10: Reduced inequalities	16
Goal 11: Sustainable cities and communities	37
Goal 12: Responsible consumption and production	56
Goal 13: Climate action	76
Goal 14: Life Below Water	16
Goal 15: Life on land	42
Goal 16: Peace, justice and strong institutions	6
Goal 17: Partnerships for the goals	33

With respect to national programmes, nearly 50 percent of the organizations were targeting the Make in India initiative as well as 'Other' national programmes currently not in the top national programmes list below. The Skill India Mission was being targeted by around 35 percent of the organizations through the technologies they were developing while around 30 percent of the organizations said they were targeting the Swachh Bharat Mission. Some of the more recent missions like the National Mission on Quantum Technologies & Applications, the National Mission for Artificial Intelligence or the National Green Hydrogen Mission are also seeing a take up by organizations, albeit just a handful given the specialized nature of these initiatives.

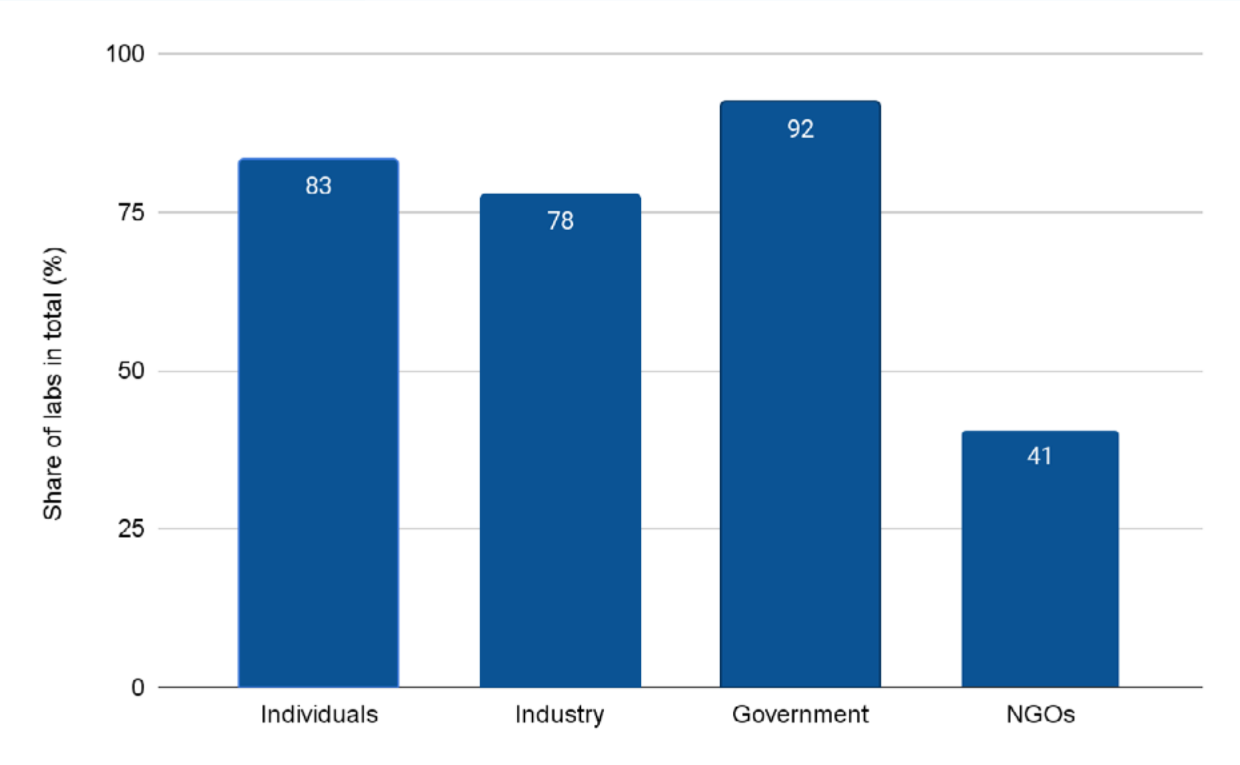
Figure 4.36: Total number of technologies targeting SDGs and National Programs

National Programmes	Number of labs/institutes
National Health Protection Scheme	50
Mid-day Meal Program	14
Swachh Bharat Mission	72
‘Housing for All by 2022’ Mission	2
National Rural Drinking Water Program	14
Jan Dhan Yojna	1
Skill India Mission	82
Make In India	110
Shramew Jayate Yojna	0
National Ayush Mission (NAM)	19
Hriday Scheme	1
Ujala Yojna	0
Atal Pension Yojna	0
Pradhan Mantri Swasthya Suraksha Yojana (PMSSY)	7
Smart Cities Mission	24
AMRUT	5
UDAY	18
Startup India	57
Gramoday se Bharat Uday	16
Pradhan Mantri Ujjwala Yojana (PMUY)	2
Namami Gange	10
National Supercomputing Mission	8
National Mission on Interdisciplinary Cyber-Physical Systems	8
National Mission on Quantum Technologies & Applications	9
National Mission for Artificial Intelligence	16
National Green Hydrogen Mission	12
Other	110

4.5.2 Largest beneficiary of research continues to be the Government

The organizations were required to respond as to who were the main beneficiaries of their research as well as the technologies they were developing. Around 90 percent of the organizations said the main beneficiary of their research was the government, while around 80 percent said it was individuals and also industry. Only 40 percent of the organizations said NGOs and civil society organizations were their targeted beneficiaries. Focusing on the NGO sector would help achieve a wider benefit to society at large. The engagement with industry appears to be through the consultancy route, although we did see that close to 80 percent of the organizations did have collaborations with industry when it came to research collaborations as well. There is scope for meaningful collaborations with industry, increasing the number of projects as well as deepening the connection through licensing their technologies to industry.

Figure 4.37: Distribution of labs/institutes Targeting Different Stakeholders



4.5.3 International and national programmes organized

The share of international conferences or programmes organized by the participating organizations was 8 percent of the total programmes organized, compared to 92 percent which were national conferences or programmes. Support for international conferences, stronger linkages with the global S&T ecosystem and organizing international conferences for sharing of domestic and global best practices should become a priority. Our organizations have just as much to offer as they have to learn about key developments, ranging from regulatory issues to key research areas for potential collaborations that will enable these organizations to tackle challenges both at the national as well as international level. The number of national S&T symposia and conferences organized was 2,417 in 2022-23 compared to 2,344 the previous year. Given the potential for a greater number of online conferences to be organized, every effort should be made to increase the share of international conferences and symposia.

Figure 4.38 Significantly larger share of national programs (S&T symposia, conferences) organized

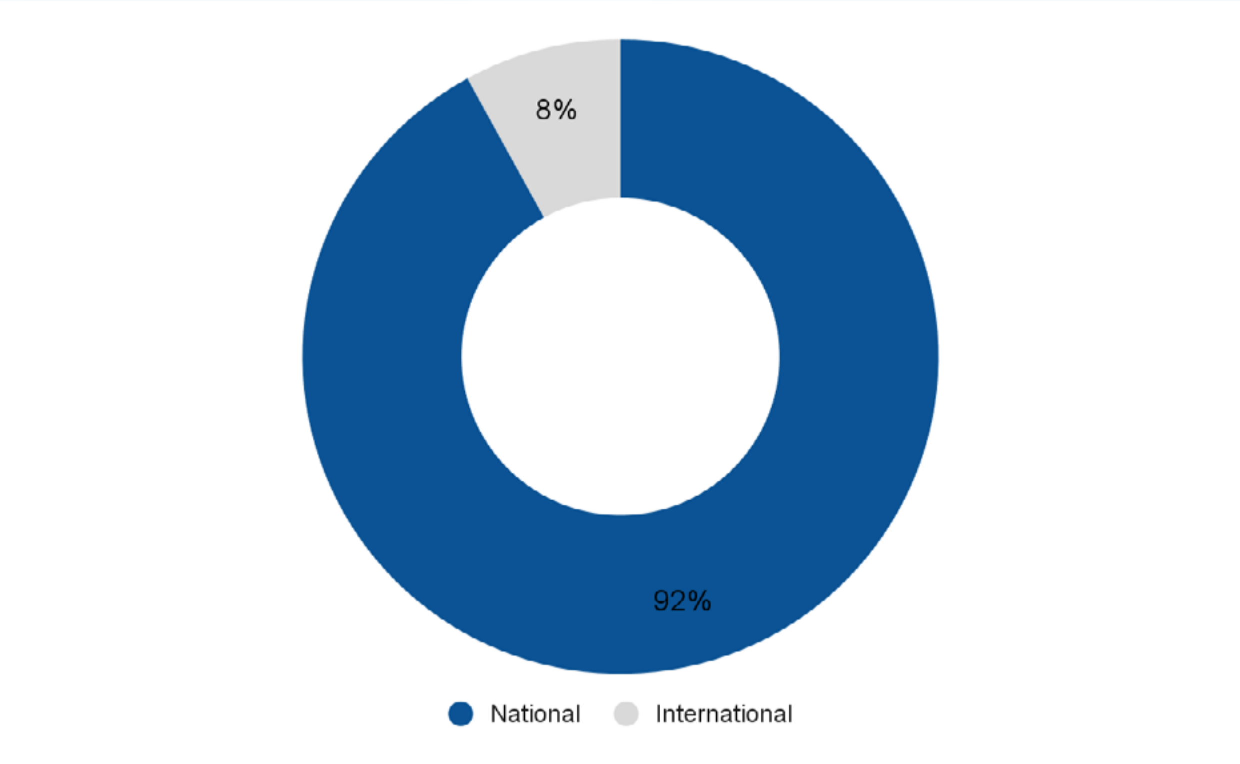
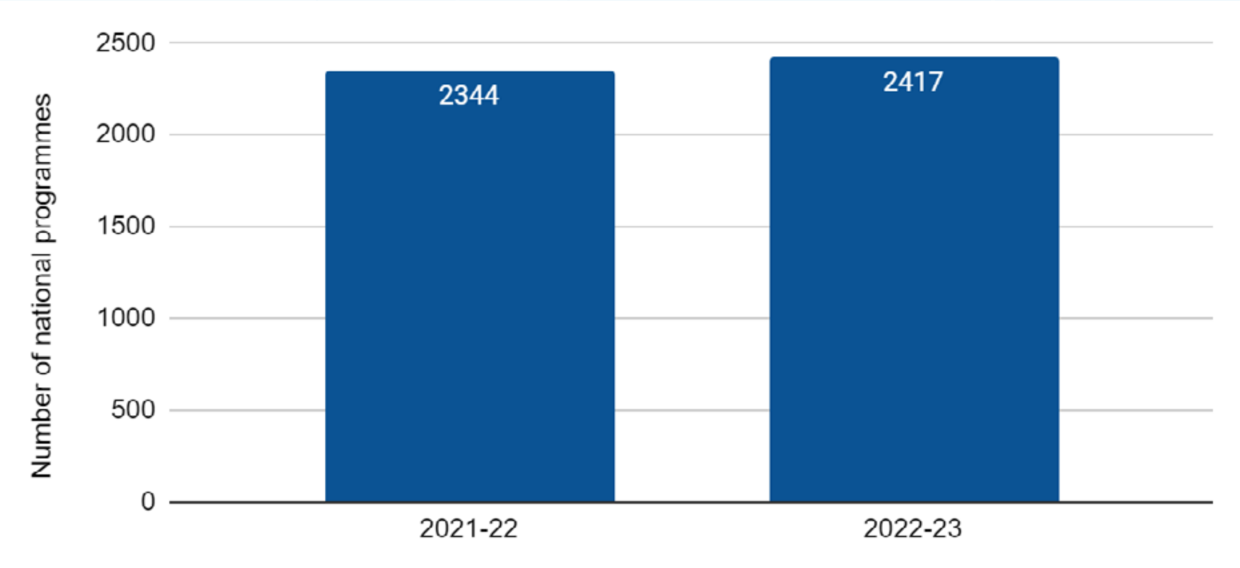


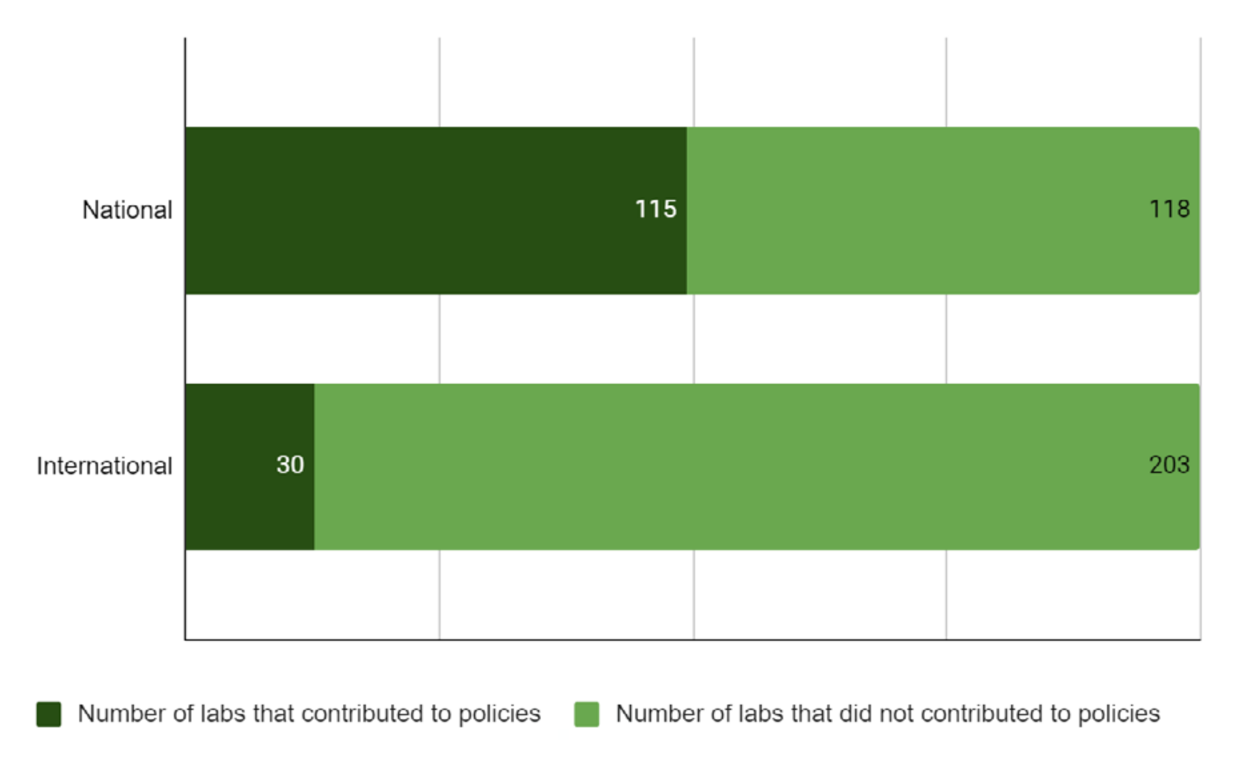
Figure 4.39 Number of national programs (S&T symposia, conferences) organized



4.5.4 Other activities - outreach and contribution to policy

The participating labs/institutes are engaged in a number of other activities that are contributing directly and indirectly to India's socio-economic development. Close to 50 percent of the organizations contributed to national policies and regulations while around 13 percent have engaged on the international policy front. Every effort must be made to engage more internationally as the organizations have much to offer in terms of sharing their experiences and ensuring that international policies pay heed to the research findings from one of the major countries of the Global South.

Figure 4.40: Contributions to policies, regulations and standards



Note: Analysis is done for 233 labs/institutes. One lab/institute was excluded as their response could not be verified.

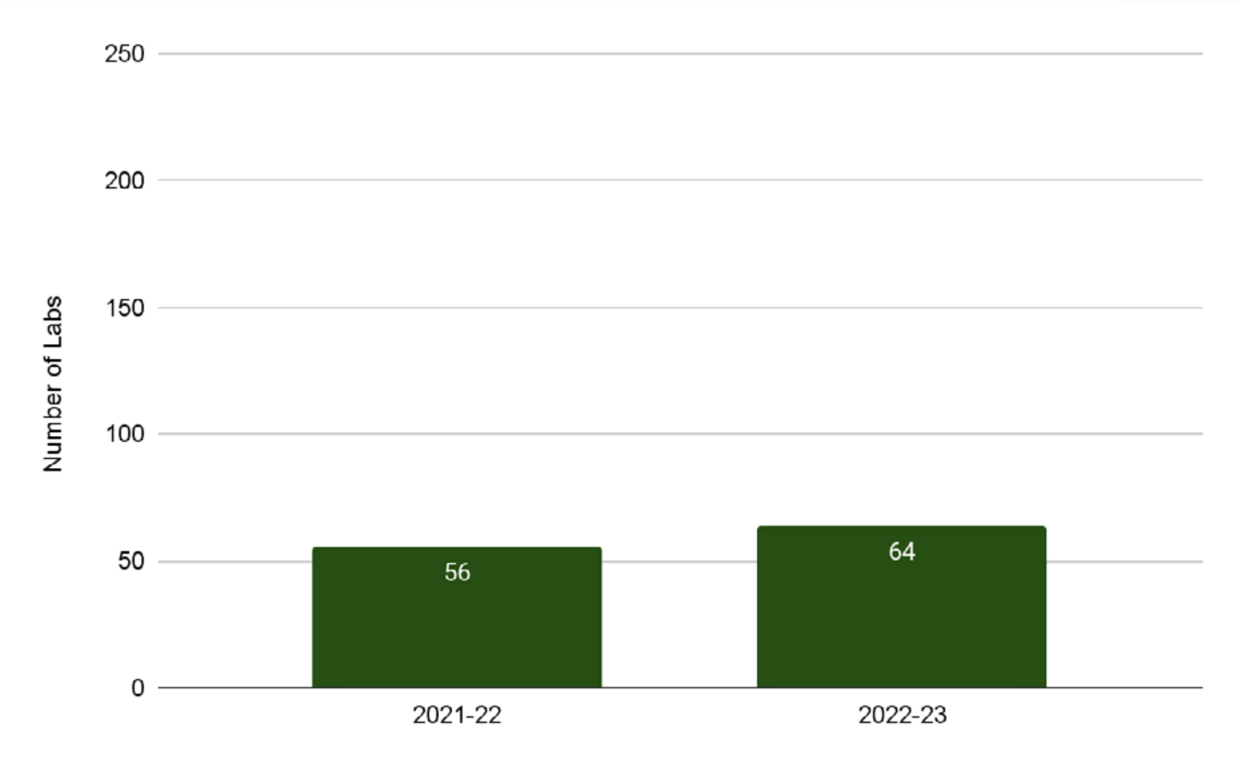
4.5.5 Contribution to India's entrepreneurial ecosystem

India's public funded organizations have the potential to contribute significantly to growing India's entrepreneurial ecosystem. Apart from the need to explore opportunities to incubate startups or license out their technologies or create spin outs which are touched upon in greater detail in the chapter on Startups, there are also opportunities to engage with the startup ecosystem through opening up their facilities or offering support through training, research support and even mentoring startups.

Currently of the 233 participating labs/institutes, just 64 labs/institutes reported that they were incubating startups. In 2022-23, In terms of support they were offering to engage with the ecosystem as can be seen in Figure 4.42, even if they did not physically or virtually incubate startups, there were 53 organizations that offered training to startups, 40 organizations that provided consulting services to startups, 50 organizations supported startups through research support, 53 organizations offered mentorship support while 47 said they offered other types of support. ICAR, CSIR, DBT, DST, and ICMR incubated the highest number of startups within their labs/institutes.

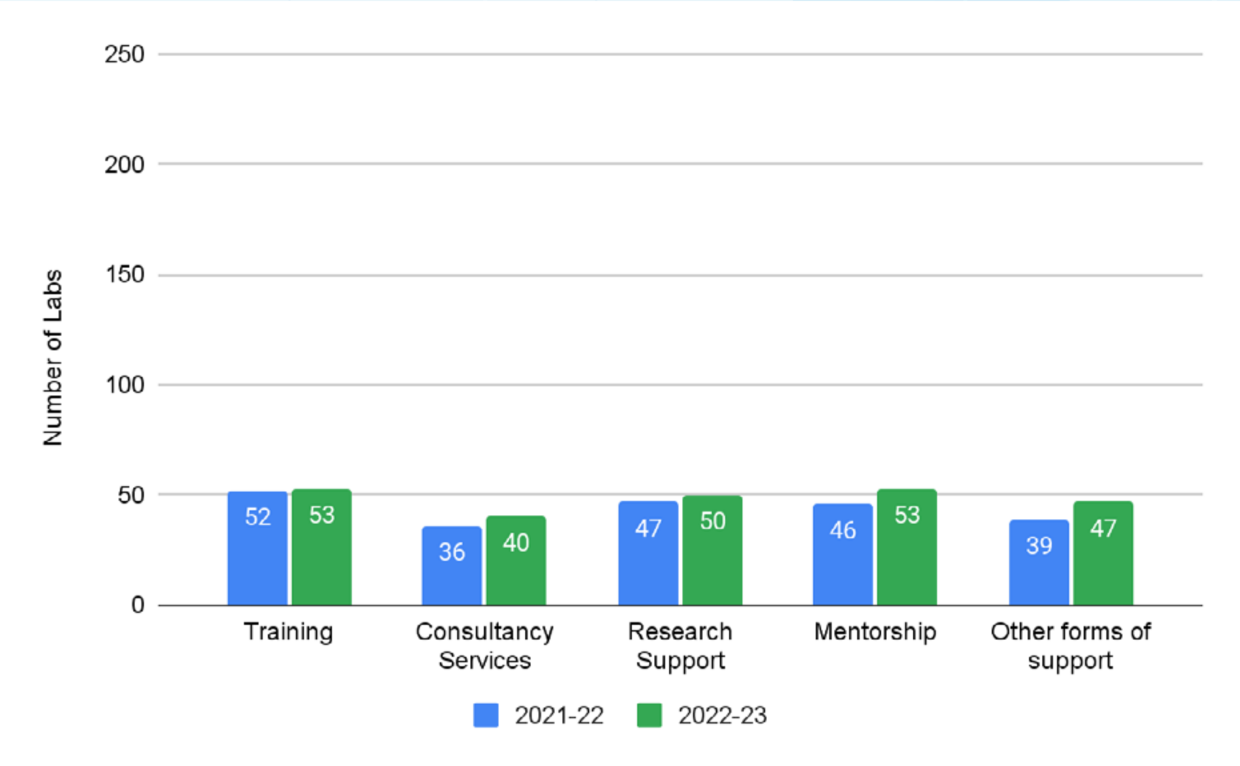
The engagement levels presently with the startup ecosystem remains limited and that too with a handful of organizations really contributing meaningfully in terms of the number of startups that they either incubate or provide some form of support to. This needs to be addressed immediately if one has to see a significant improvement in innovative deep-tech ideas emerging out of India.

Figure 4.41 Number of labs/institutes incubating startups

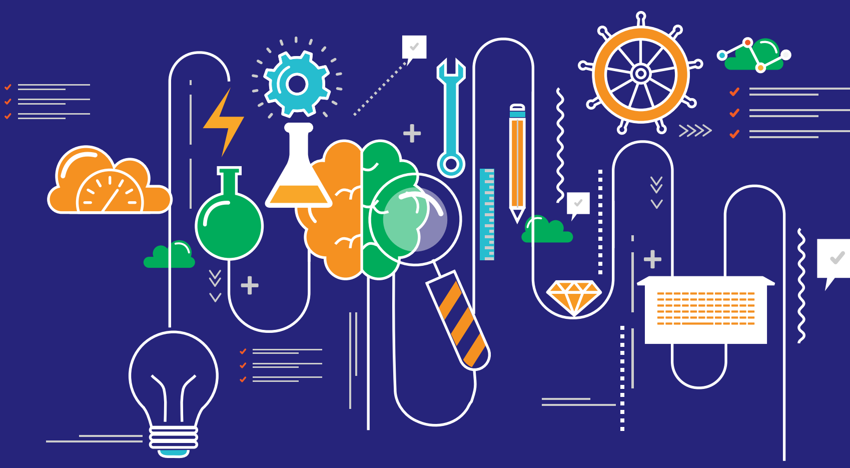


Note: Analysis is done for 233 labs/institutes. One lab/institute was excluded as their response could not be verified.

Figure 4.42 Number of labs/institutes supporting startups through training etc.



Note: Analysis is done for 232 labs/institutes. Two labs/institutes were excluded as their response could not be verified.



Chapter 5

Public R&D Labs/institutes and the Startup Ecosystem

Public R&D labs/institutes and the startup ecosystem are integral to fostering innovation and driving economic growth. India is home to the world's third largest startup ecosystem.[7] Public R&D labs/institutes and startups are essential drivers of this change, each playing a unique yet complementary role in fostering technological advancements and economic prosperity. However, the current linkages between public R&D labs/institutes and the startup ecosystem remain nascent and demand strategic nurturing to unlock their full potential. This chapter presents a comprehensive analysis of the existing collaborations between public R&D labs/institutes and startups, as reported by the labs/institutes.

5.1 Strengthening Linkages between Public R&D Labs/institutes and Startups

Public R&D labs/institutes often serve as a foundational platform for breakthroughs in various fields spanning from biotechnology, and clean energy, to digital and information technology. These labs/institutes provide the rigorous research and development necessary to validate new ideas and technologies. They offer invaluable resources, including advanced facilities and expert knowledge, which might be inaccessible to startups operating on limited budgets. By conducting foundational research, public R&D labs/institutes can lay the groundwork for innovations that startups can further develop and commercialize.

On the other hand, the startup ecosystem thrives on the transformative potential of these innovations. Startups, driven by entrepreneurial spirit, are adept at turning novel research into viable products and services. They bring agility, creativity, and market-oriented approaches that complement the scientific advancements made in public labs/institutes. Effective collaboration between public R&D labs/institutes and startups can accelerate the commercialization of new technologies, enhance the scalability of innovations, and bring cutting-edge solutions to market faster.

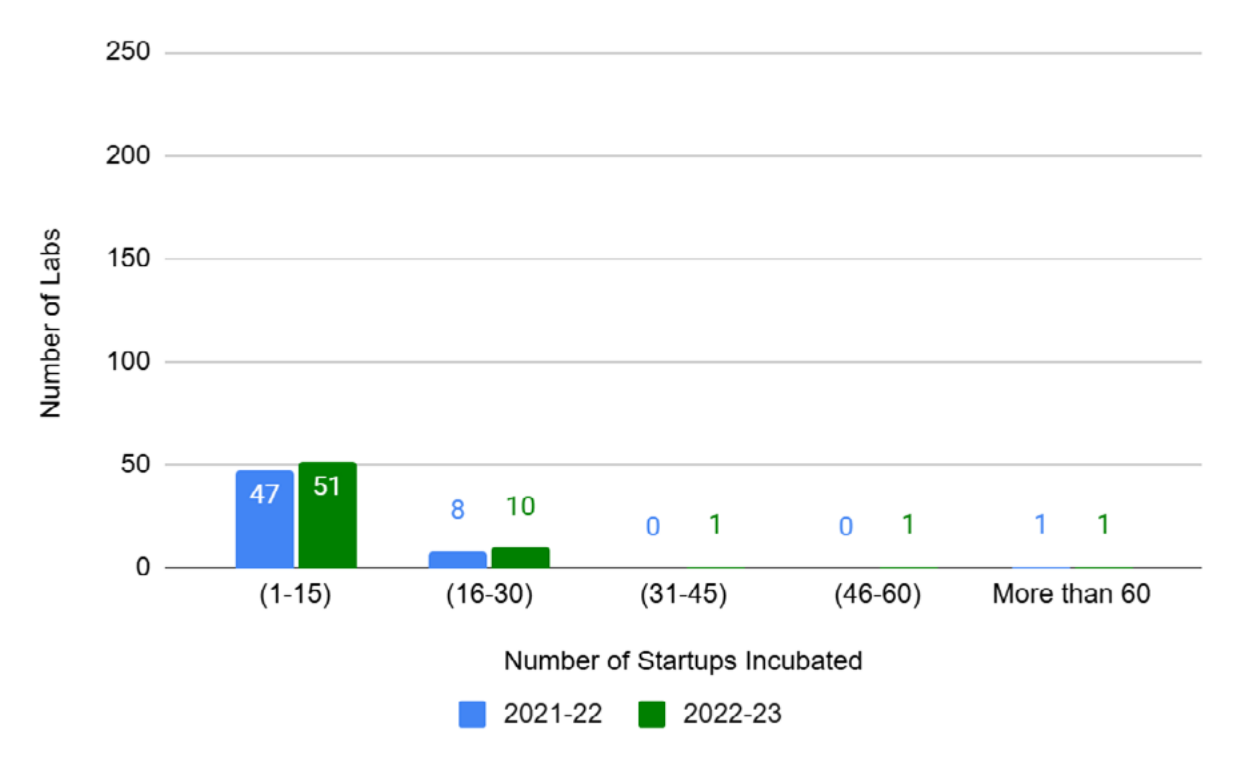
Furthermore, such collaboration fosters a vibrant innovation ecosystem where knowledge flows seamlessly between public institutions and private enterprises. This synergy not only drives technological progress but also generates economic opportunities, creates jobs, and strengthens global competitiveness. By bridging the gap between research and market application, public R&D labs/institutes and startups together play a pivotal role in driving sustainable economic development and addressing contemporary challenges.

[7] *https://www.startupindia.gov.in/content/sih/en/international/go-to-market-guide/indian-startup-ecosystem.html*

5.2 Incubation, Exits and Spinouts

Incubation, exits, and spinouts are fundamental outcomes of the startup incubation process, serving as key indicators of the success and impact of innovation. The Government of India has been making concerted efforts to increase incubation opportunities at different government institutions through initiatives like Startup India, Nidhi-Prayas, the TIDE scheme by MeitY, PRISM by CSIR, and others.[8] Overall, the number of labs/institutes engaging in the incubation process remains on the lower side.

Figure 5.1: Distribution of labs/institutes by number of startups incubated

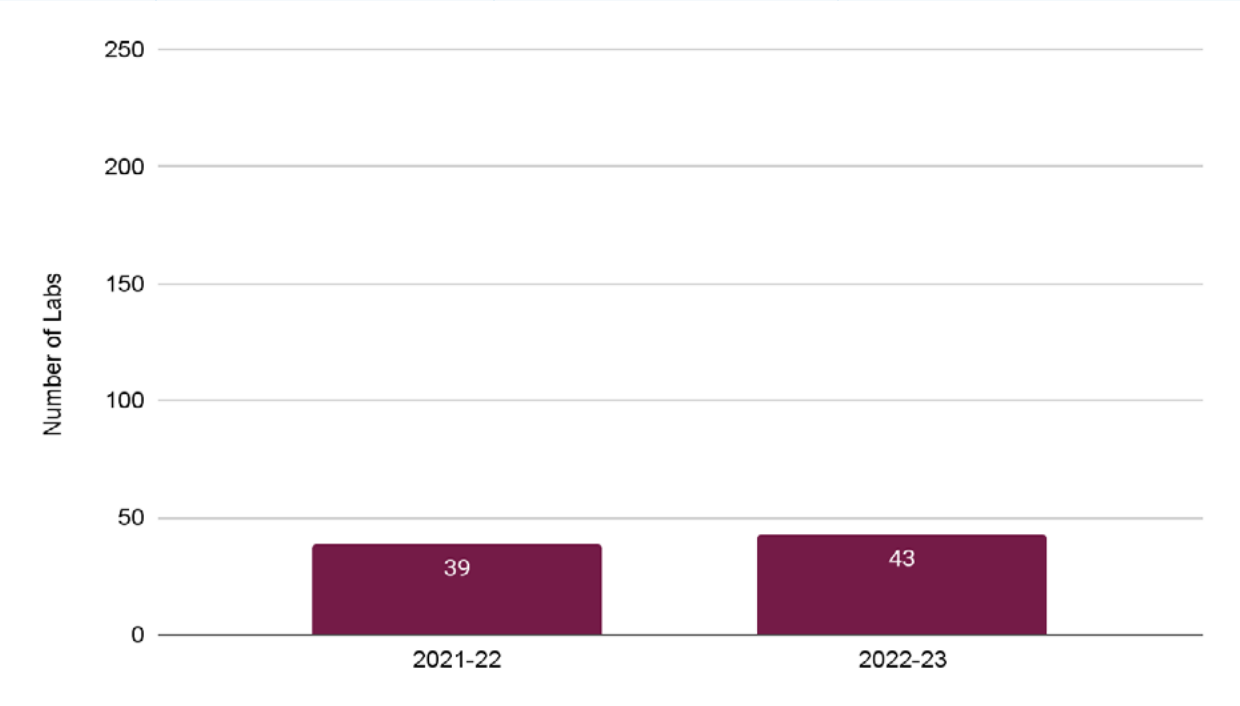


Note: Analysis is done for 233 labs/institutes. One lab/institute was excluded as their response could not be verified.

Of the 64 labs/institutes that incubated startups, the majority of the labs/institutes incubated up to 15 startups. This majority incubated a total of 242 startups with a median of 4 startups in 2022-23. There is a stark difference between the number of labs/institutes that incubated up to 15 startups and the number of labs/institutes that incubated between 15-30 startups. The number of labs/institutes incubating startups drops even lower as the number of startups incubated increases. Only one lab incubated more than 60 startups in both reporting years. A considerable number of labs/institutes continue not foraying into incubating startups, representing a missed opportunity to enhance linkages between public R&D labs/institutes and the startup ecosystem. Expanding engagement in startup incubation could significantly strengthen these connections and foster greater innovation and collaboration.

[8] *https://www.indiascienceandtechnology.gov.in/funding-opportunities/startups*

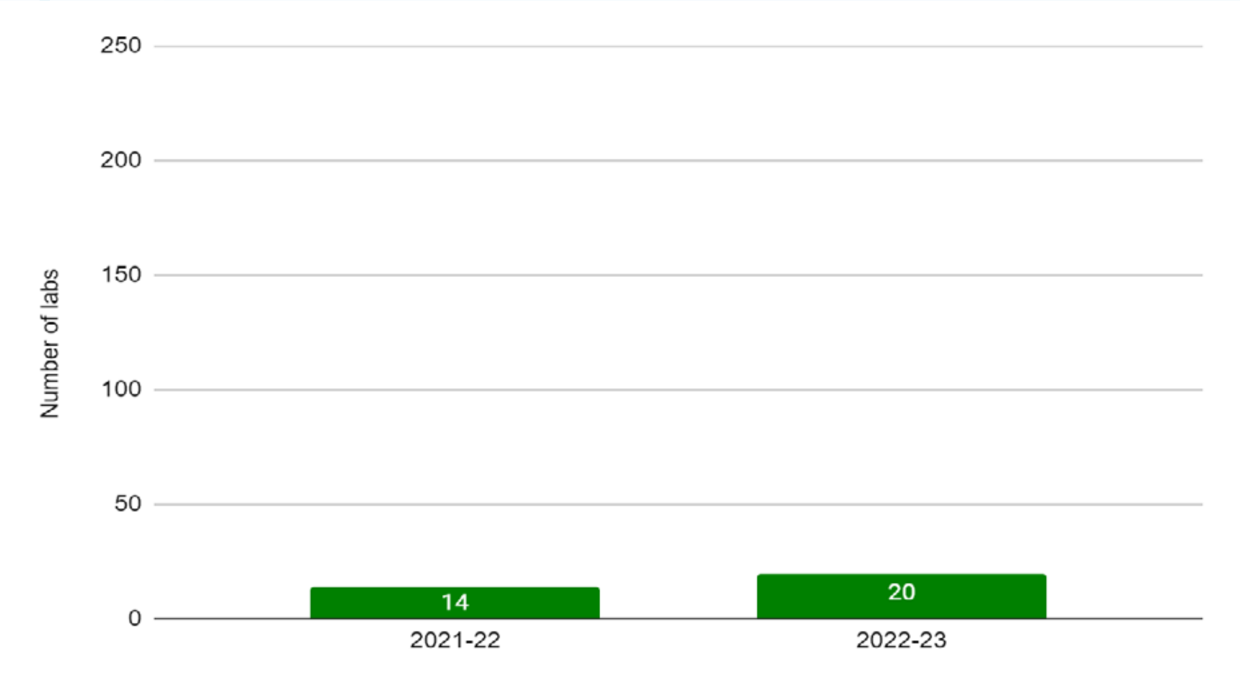
Figure 5.2: Number of labs/institutes That Successfully Exited Startups



Note: Analysis is done for 232 labs/institutes. Two labs/institutes were excluded as their response could not be verified.

Successful exited startups are startups that have successfully graduated from the incubation program of the organization under the organization's policy and does not include those who were compulsorily retired/ removed/ terminated. For both years under review, approximately 40 organizations reported successful exits. The median number of startups exited by these labs/ institutes was 3 for both years with only 1 lab reporting more than 20 successful exits in 2022-23.

Figure 5.3 Number of labs/institutes that Generated Spinouts



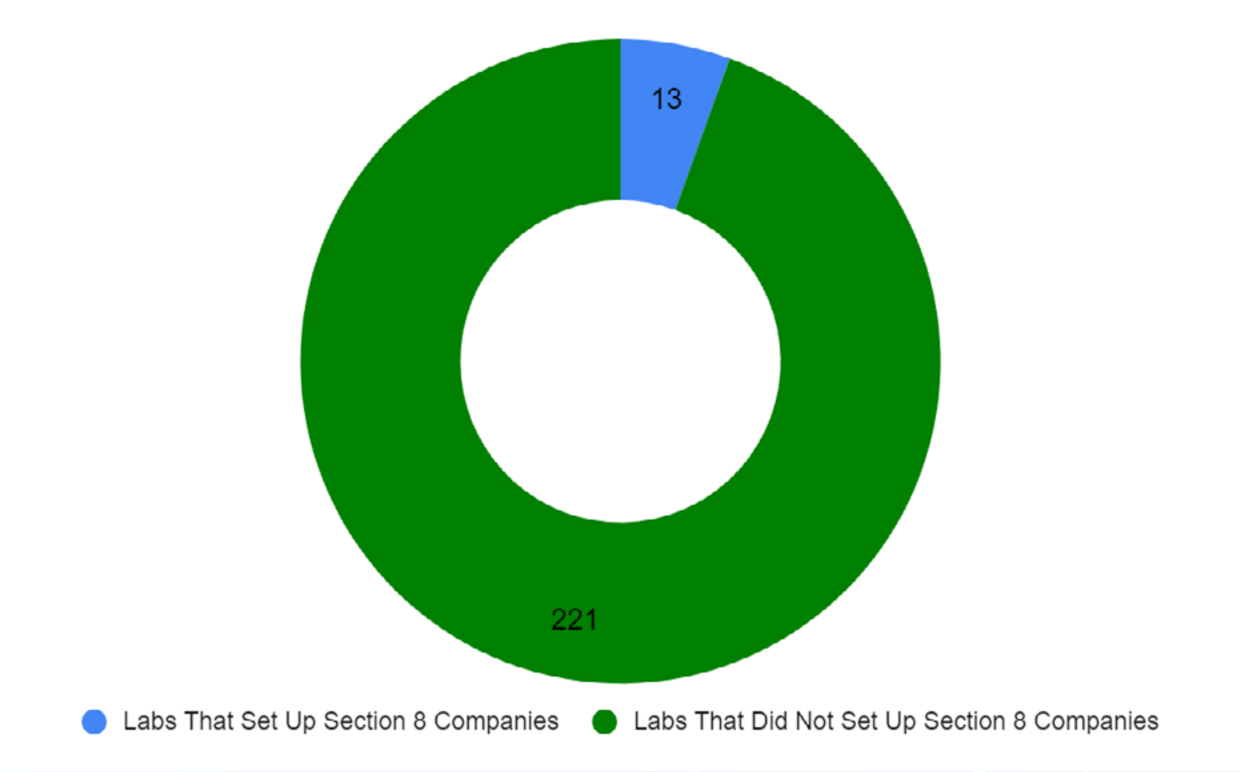
A spinout company is a startup that is created based on intellectual property (IP) generated through the lab's research. Spinouts represent a key pathway for the commercialization of new technologies and innovations. In the fiscal year 2021-22 there were 14 labs/institutes reported creation of spinouts which increased to 20 in 2022-23. Enabling and facilitating labs/institutes to generate more spinouts will not only propel the startup ecosystem in India but also generate external revenue for labs/institutes to advance further research. This can lead to a self-perpetuating cycle of generation of deep tech startups that aspire to solve the national challenges through research and technology. This cycle can further be strengthened by setting up section 8 companies and exploring other forms of support to startups.

5.3 Mechanisms to Support Startups

While incubation remains the most commonly employed method to support startups, forming Section 8 companies is another valuable mechanism used by labs/institutes. This approach offers unique advantages, such as attracting external funding, deepening collaborations, and expanding market opportunities. Public R&D labs/institutes also support startups through a variety of other mechanisms, including mentorship, consulting services, training, research support, and more.

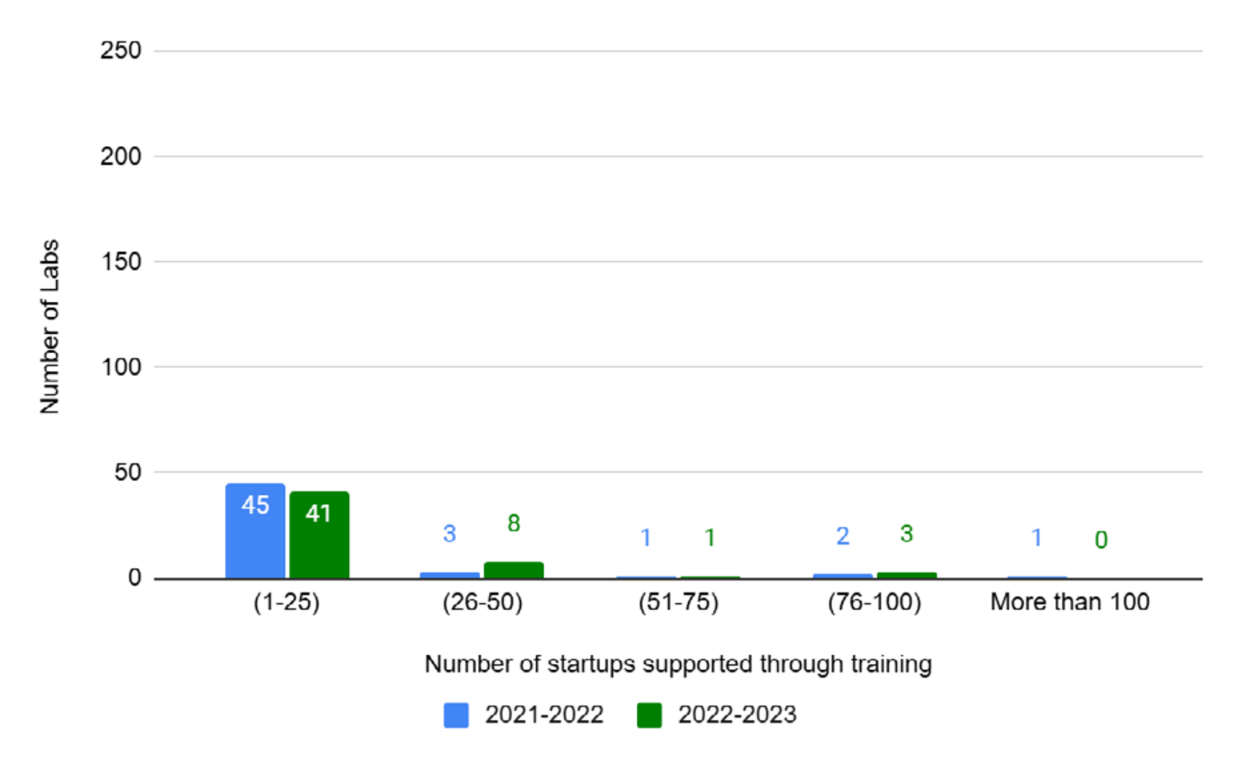
In our analysis, we've also looked at the number of labs/institutes that have opened their testing and research facilities to startups, further enabling innovation and development. The majority of these support mechanisms were provided by labs/institutes under ICAR, CSIR, and DST, reflecting a strong commitment to fostering the startup ecosystem across these institutions.

Figure 5.4: Number of labs/institutes That Set Up Section 8 Companies to Support Startups



A Section 8 company[9], under the Companies Act, can offer different forms of support such as access to infrastructure, resources, legal support, IP counsel, and networks. Housing IPR expertise in the Section 8 company can have positive spillovers for public R&D labs/institutes. Only 13 labs/ institutes in this round have reported setting up a Section 8 company.

Figure 5.5: Distribution of labs/institutes supporting startups through training

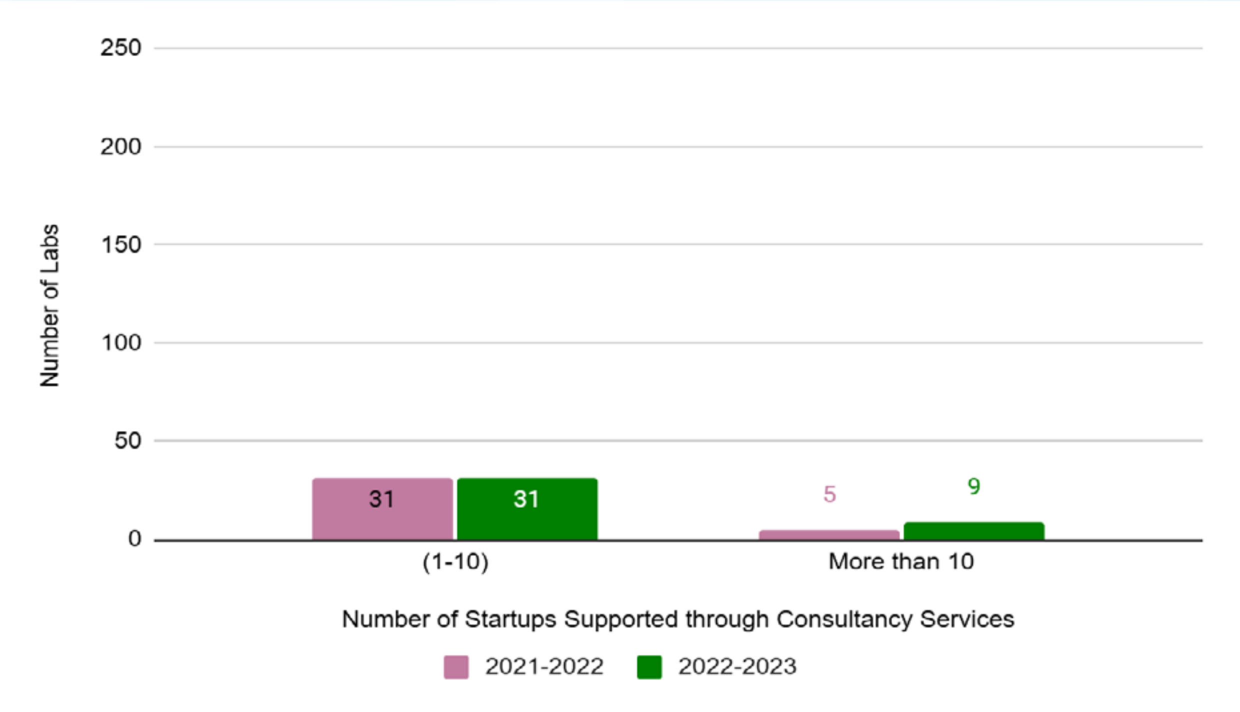


Note: Analysis is done for 232 labs/institutes. Two labs/institutes were excluded as their response could not be verified.

Of the 53 labs/institutes that reported providing training for startups, the majority of the labs/ institutes provided training to up to 25 startups. These labs/institutes provided training to a total of 274 startups with a median of 5 startups in 2022-23. While a healthy number of labs/institutes provided training support to up to 25 startups, the number of labs/institutes that provided training to more startups decreases as the number of startups increase. As can be seen in figure 6.2, the number of labs/institutes that reported providing training for 25-50 startups was 3 and 8 for 2021-22 and 2022-23 respectively, 1 lab reported providing training for 50-75 startups, and 2 labs/institutes in 2021-22 and 3 labs/institutes in 2022-23 provided training to 75-100 startups. One lab provided training to more than 100 startups in 2021-22. The labs/institutes that supported either between 75 and 100 startups or more than 100 startups came primarily from CSIR with one lab being an ICAR lab.

[9] According to the Companies Act 2013, a Section 8 company is defined as an organization whose objectives are to promote arts, commerce, science, research, education, sports, charity, social welfare, religion, environmental protection, or other similar activities goals. These entities utilize their profits to achieve their mission and do not distribute dividends to their shareholders.

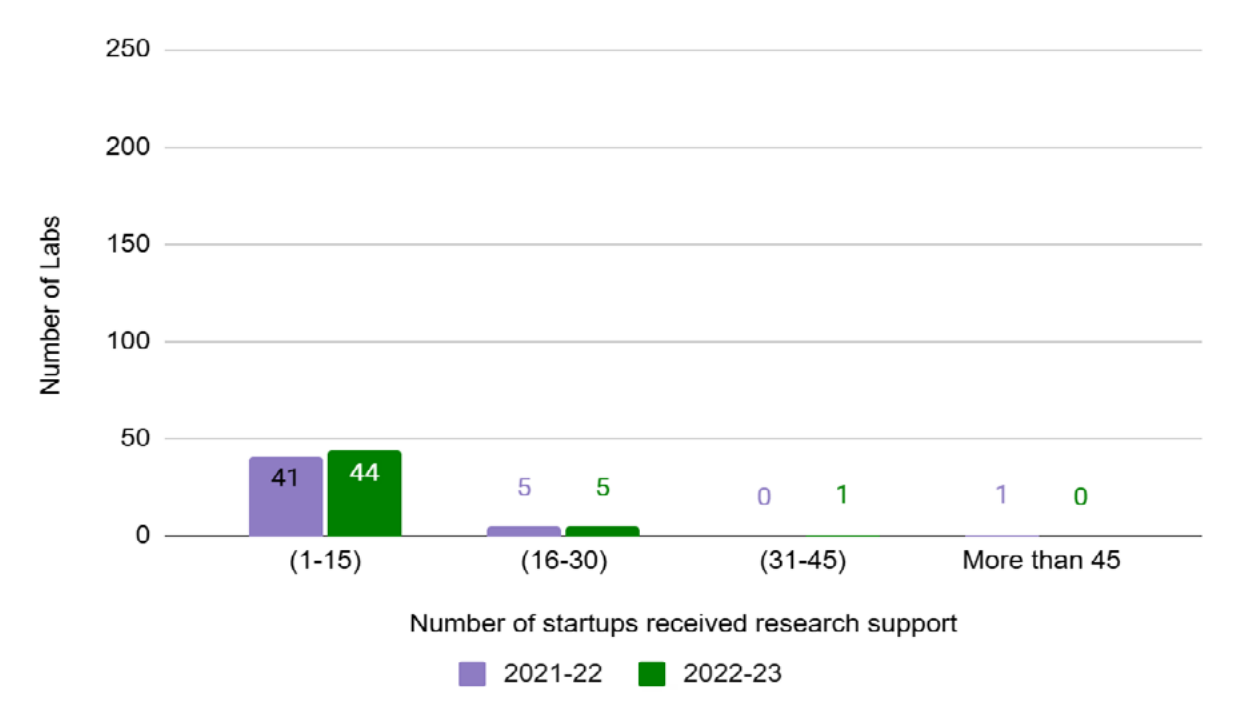
Figure 5.6: Distribution of labs/institutes supporting startups through consultancy services



Note: Analysis is done for 232 labs/institutes. Two labs/institutes were excluded as their response could not be verified.

Consulting Services are an avenue for a lab to provide research expertise and technical services to startups. 31 labs/institutes provided consulting services for up to 10 startups. However, the median number of startups supported through consultancy services by these 31 labs/institutes was only 2.

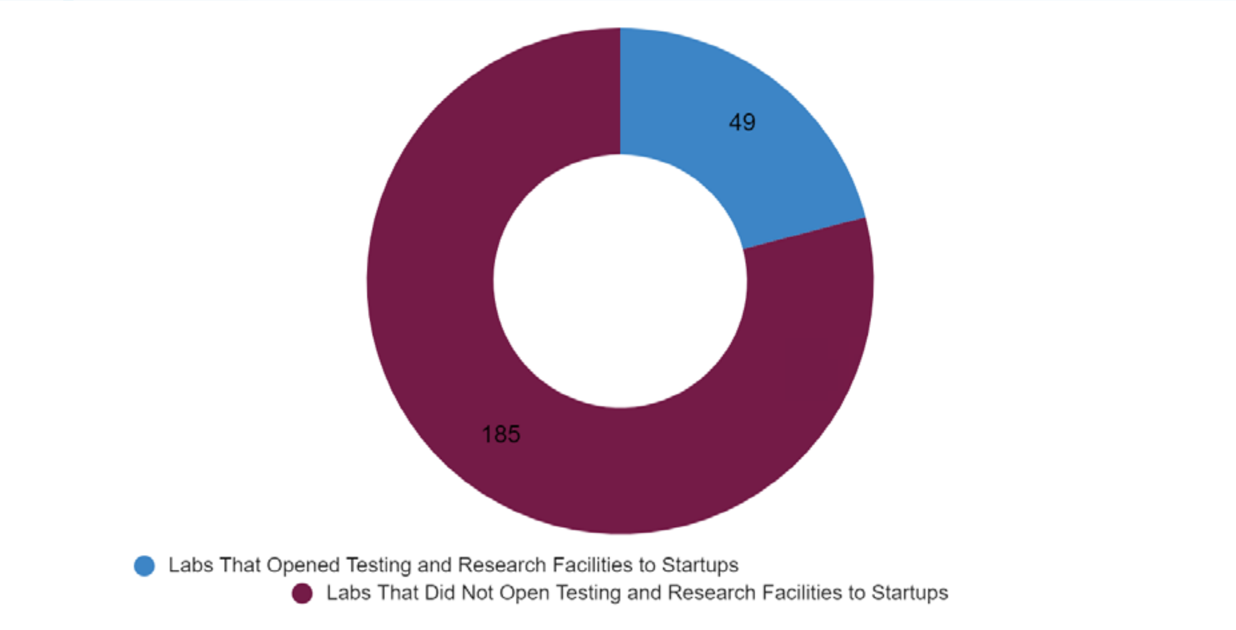
Figure 5.7: Distribution of labs/institutes providing research support to startups



Note: Analysis is done for 232 labs/institutes. Two labs/institutes were excluded as their response could not be verified.

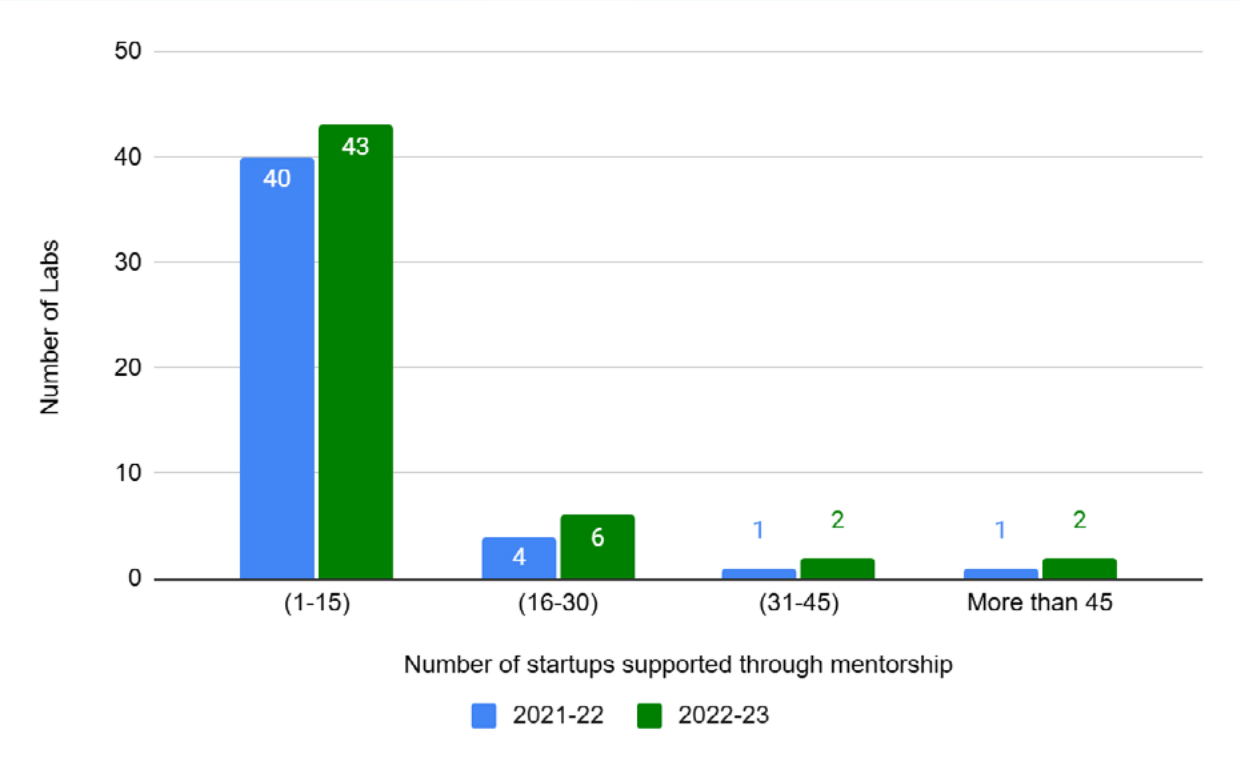
The number of labs/institutes that provide research support to up to 15 startups was more than 40 in both the reporting years. The median number of startups supported by these 40+ labs/institutes was 2. Research support can take on many forms such as guidance from lab researchers on experiments or collaborative projects undertaken with startups. Notably, the 6 labs/institutes that extended research support to more than 15 startups were affiliated with six distinct ministries or departments: CSIR, DST, ICAR, MoEFCC, Ministry of Textiles, and Ministry of Heavy Industries.

Figure 5.8: Number of labs/institutes that Opened Testing and Research Facilities to Startups



Only one in five labs/institutes reported opening testing and research facilities to startups. Startups, which are often constrained by limited resources can significantly benefit from using research and testing facilities already available. It can contribute to faster commercialization and better products. The Union Budget 2023 underscored the importance of opening of the high quality testing and research facilities of public R&D labs/institutes is crucial when it specifically mandates ICMR labs/ institutes to open their facilities to startups among others. However, only 1 ICMR lab reported opening its facilities to startups in 2022-23. Strengthening the implementation of such policies will support India's startup ambitions.

Figure 5.9: Distribution of labs/institutes supporting startups through mentorship



Note: Analysis is done for 232 labs/institutes. Two labs/institutes were excluded as their response could not be verified.

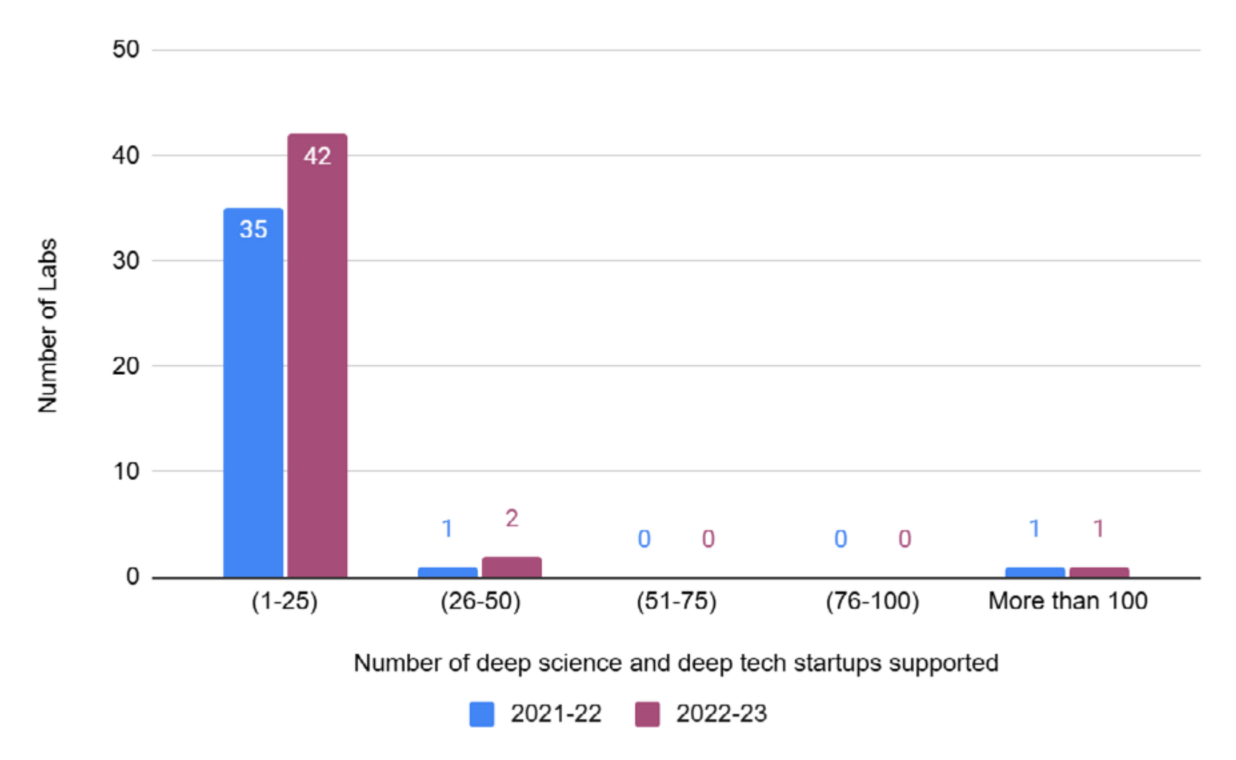
Mentorship can be crucial to startups, especially those trying to break new ground and explore uncharted territories. Experienced scientists from public R&D labs/institutes, with their extensive research backgrounds, can offer valuable guidance to startups, facilitating their navigation through challenging phases and aiding in overcoming significant barriers. Approximately 25% of the labs/institutes included in this exercise reported providing mentorship to startups in 2022-23. Most of these provided support to up to 15 startups. A median of 5 startups were supported through mentorship by labs/institutes with only 2 labs/institutes providing mentorship to more than 45 startups in 2022-23.

5.4 Spotlight on Deep Tech Startups

Currently there is no common repository of deep tech startups in India. However, there is growing policy recognition on the pivotal role that deep tech can play in realizing the vision of 'Viksit Bharat'. The draft National Deep Tech Startup Policy[10] highlights the significance of deep tech in driving innovation, economic growth, societal development and national security. It recognizes that increased investment must be made into basic R&D to expand the emerging science base for deep tech startups and the critical base of trained scientific human resources.

[10] *https://psa.gov.in/CMS/web/sites/default/files/process/NDTSP.pdf*

Figure 5.10: Distribution of labs/institutes supporting deep science and deep tech startups



Only around 40 of the 234 labs/institutes have reported supporting deep science and deep tech startups. Noteworthy among these is the lab supporting more than a 100 deep tech startups. Figure 5.10 shows the yawning gap between the performance of this lab compared to the rest of the labs/ institutes. Most labs/institutes supported up to 25 deep tech startups with a median of only 3 deep tech startups supported.

Key Takeaways:

- Public R&D labs/institutes and startups together play a critical role in the innovation landscape of India
- Close to 80% of the labs/institutes that incubated startups, incubated a median of 4 startups in 2022-23. Only one lab incubated more than 60 startups in a year.
- 18% of all labs/institutes reported successfully exiting a startup in 2022-23 with the median of 3 startups exited. Only one lab reported exiting more than 20 startups.
- 20 labs/institutes capitalized on their intellectual property by generating spin outs
- 5% of labs/institutes reported setting up a section 8 company to support startups. These section 8 companies can also house the IPR of the lab and generate opportunities for positive spillover effects.
- labs/institutes under CSIR, ICAR, and DST provided support through different mechanisms to the most number of startups

Key Takeaways:

- 53 labs/institutes reported providing training support to startups in 2022-23 with the majority of labs/institutes providing support to a median of 5 startups
- 40 labs/institutes reported providing consultancy services to startups in 2022-23 with the majority of labs/institutes providing such services to a median of 2 startups
- 50 labs/institutes reported providing research support to startups in 2022-23 with the majority of labs/institutes providing such support to a median of 2 startups
- Only one in five labs/institutes reported opening testing and research facilities to startups
- 53 labs/institutes reported providing mentorship to startups in 2022-23 with a median of 5 startups supported
- 40 labs/institutes supported deep science and deep tech startups with one lab supporting more than 100 deep tech startups in both years

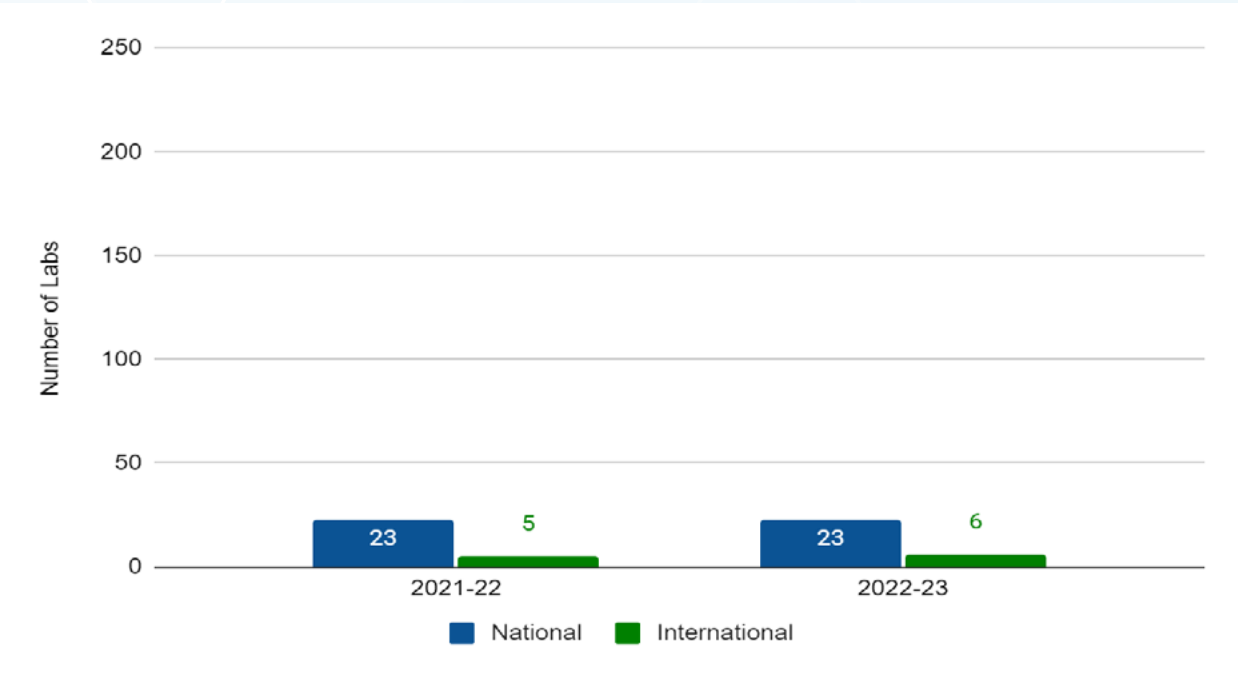
Chapter 6

Public R&D Labs/institutes and Sustainable Practices

India has placed 'green growth' at the heart of her economic agenda, wherein it is envisioned that green growth will usher in green industrial and economic transition, environmentally friendly agriculture and sustainable energy in the country.[11] Public R&D has a leading role to play in driving innovation to minimize environmental impacts and adopting sustainable practices. They can take a lead creating policies and regulations that incentivize the development of green technologies and R&D investments in this space. In this chapter, we present a synthesis of data related to sustainable practices provided by labs/institutes.

6.1 Contribution to Policy Frameworks

Figure 6.1 Number of labs/institutes that contributed to policies, regulations and standards focusing on green technologies



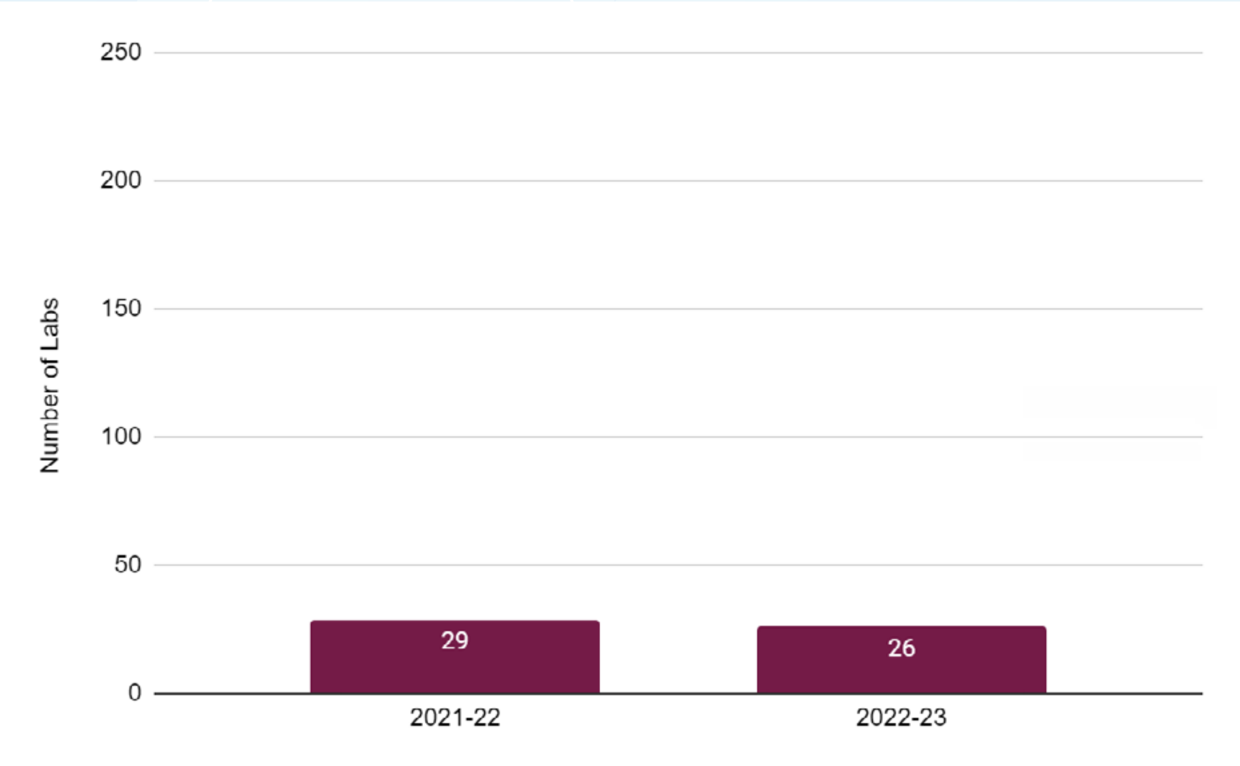
Note: Analysis is done for 233 labs/institutes. One lab/institute was excluded as their response could not be verified.

[11] *https://pib.gov.in/PressReleasePage.aspx?PRID=1901622*

All Public R&D labs/institutes were requested to provide data on their contributions to the development of national and international policies, regulations, and standards specifically focused on green technologies. While the number of labs/institutes contributing to international policies is relatively small (5 for 2021-22 and 6 for 2022-23), it is a positive sign that public R&D labs/institutes are contributing on the international stage. A good number of labs/institutes contributed to national policies, with CSIR and ICAR emerging as the primary contributors.

6.2 Development of Sustainable Technologies

Figure 6.2: Number of labs/institutes that were granted a patent related to sustainable technologies



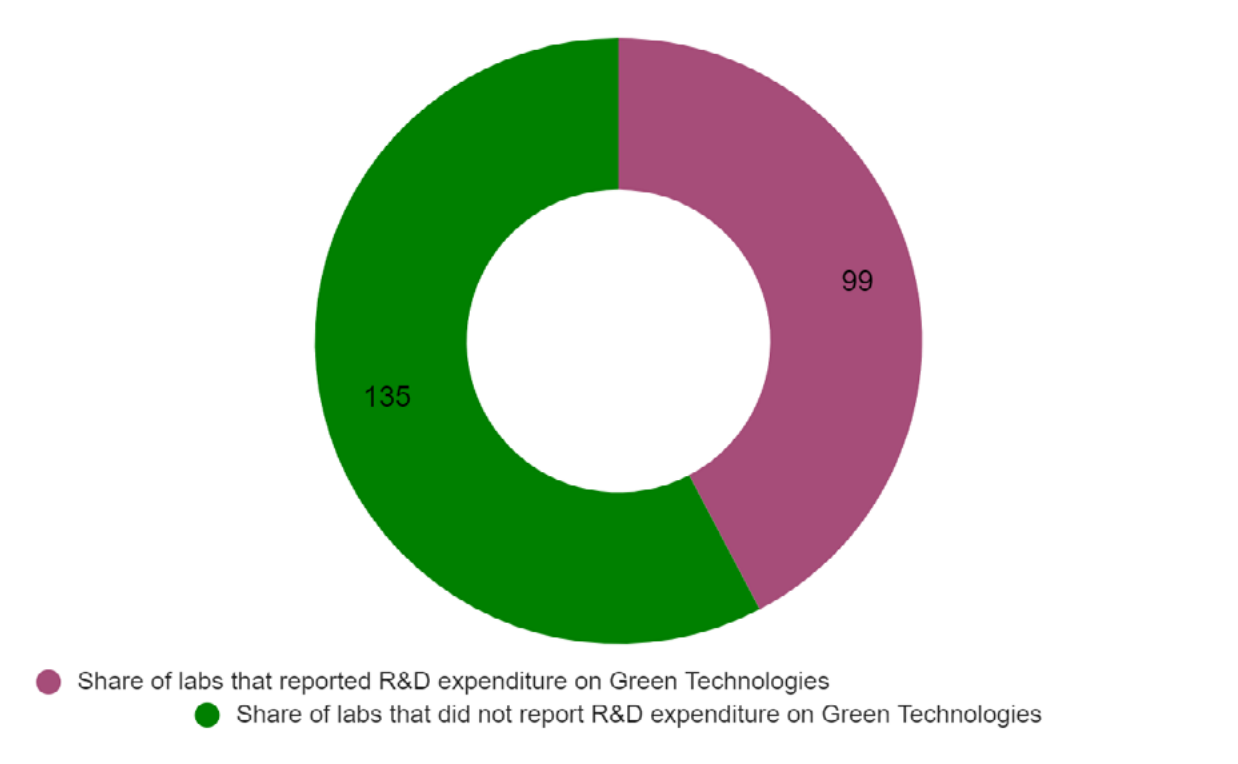
Note: Analysis is done for 232 labs/institutes. Two labs/institutes were excluded as their response could not be verified.

Public R&D institutions are pivotal in the development and advancement of sustainable technologies. While many labs/institutes are actively engaged in projects and publications in this domain, this analysis prioritizes the generation of patents specifically related to sustainable technologies. 29 labs/institutes out of the 232 reported being granted a patent related to sustainable technologies. The total number of patents granted to these labs/institutes is 71 and 62 for 2021-22 and 2022-23 respectively.

6.3 Going Green - Snapshot of Green Practices undertaken by Labs/ institutes

In this section, we focus on the performance of public R&D labs/institutes in relation to the green practices that have been adopted internally and resources dedicated towards green practices.

Figure 6.3: labs/institutes reporting R&D expenditure on green technologies



There were 99 labs/institutes which reported R&D expenditure on green technologies. Of these 99 labs/institutes, ICAR and CSIR accounted for more than 50 percent of the labs/institutes.

Figure 6.4: Ministry-wise distribution of labs/institutes reporting R&D expenditure on green technologies

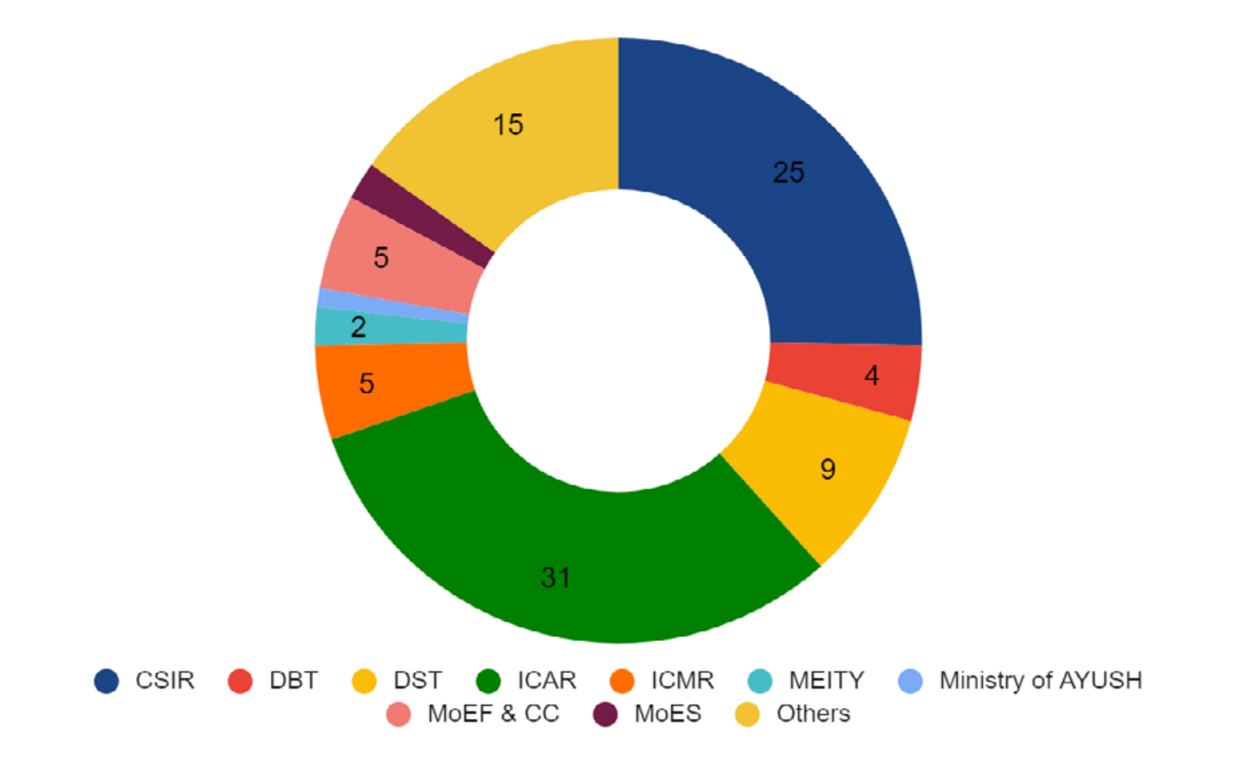
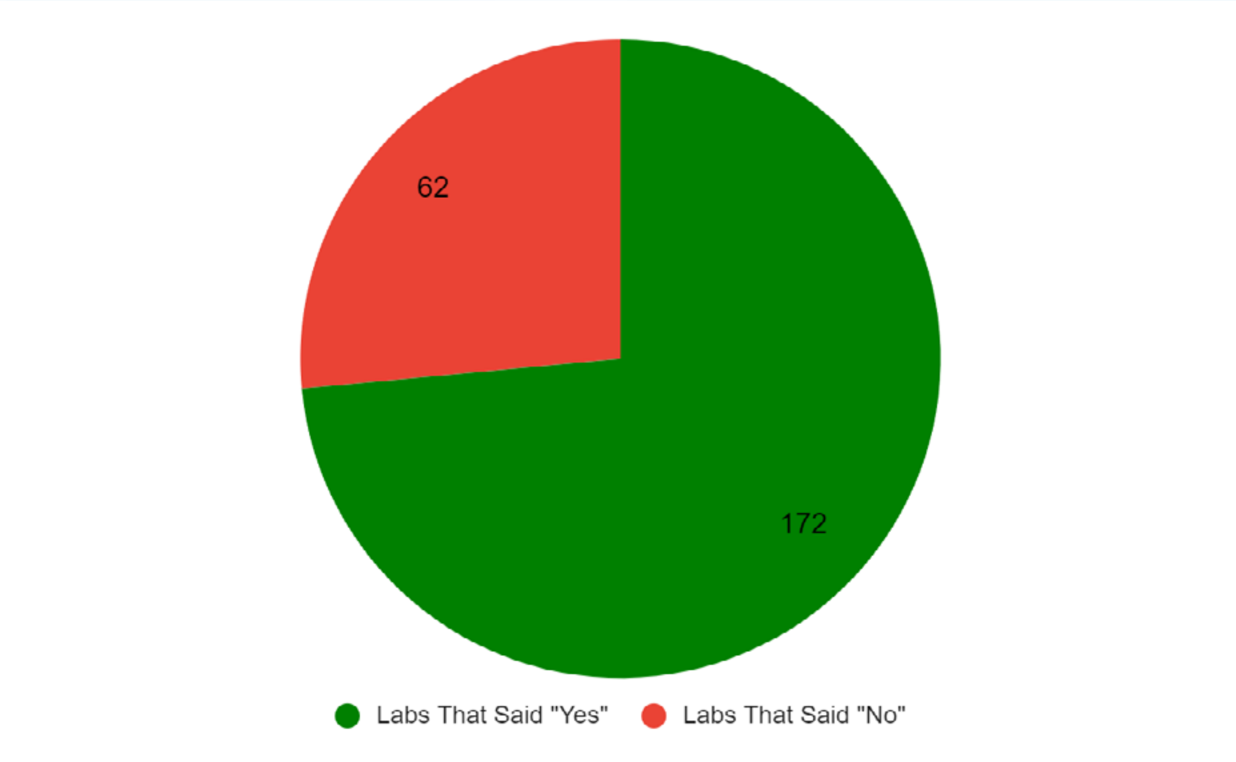
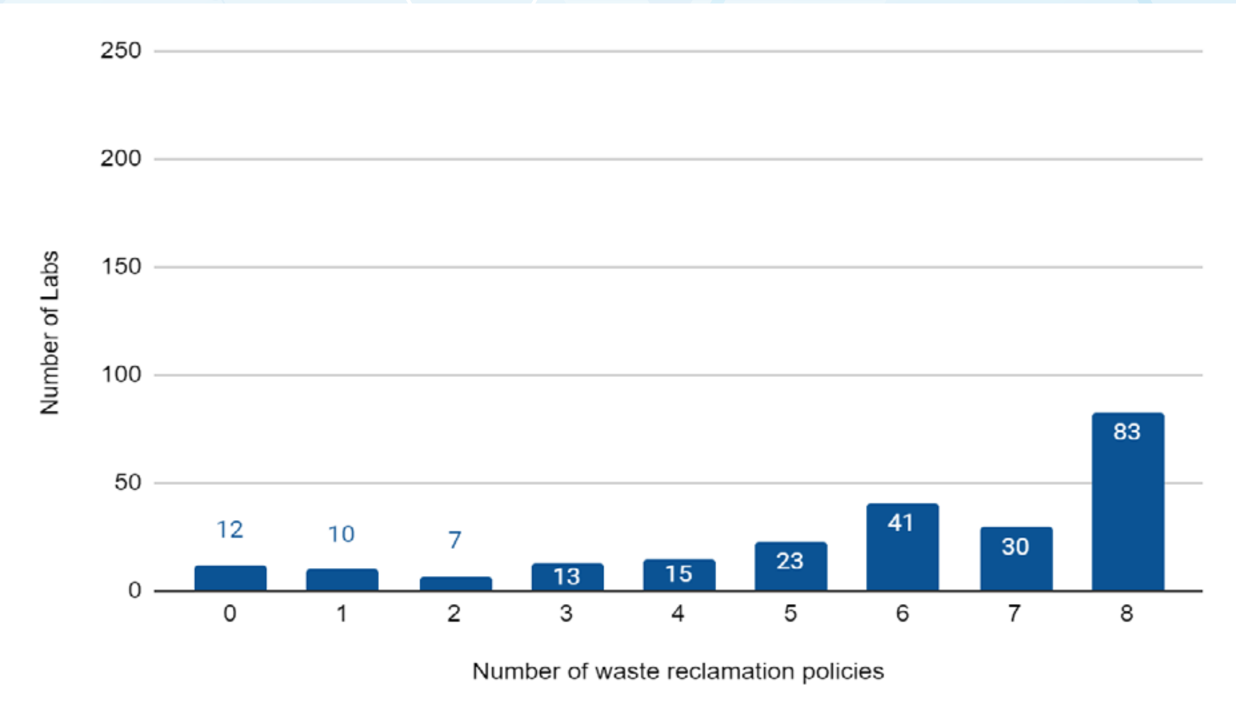


Figure 6.5 Sustainable sourcing of materials



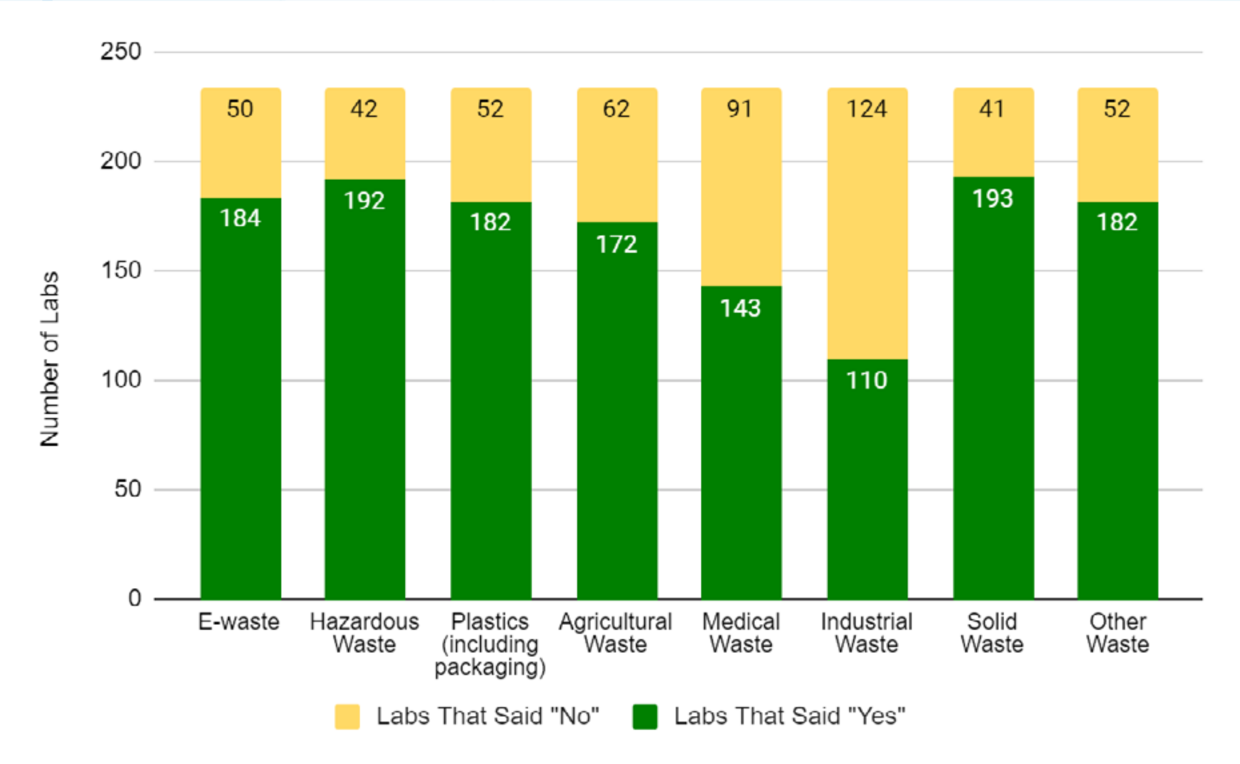
A total of 172 labs/institutes reported engaging in the sustainable sourcing of materials, reflecting a significant commitment to environmentally responsible practices. However, there remains considerable room for improvement, as 62 labs/institutes have yet to adopt sustainable sourcing measures. Addressing environmental concerns and overcoming resource constraints will be critical for these labs/institutes to enhance their sustainability efforts.

Figure 6.6 labs/institutes with policies in place for safe waste reclamation



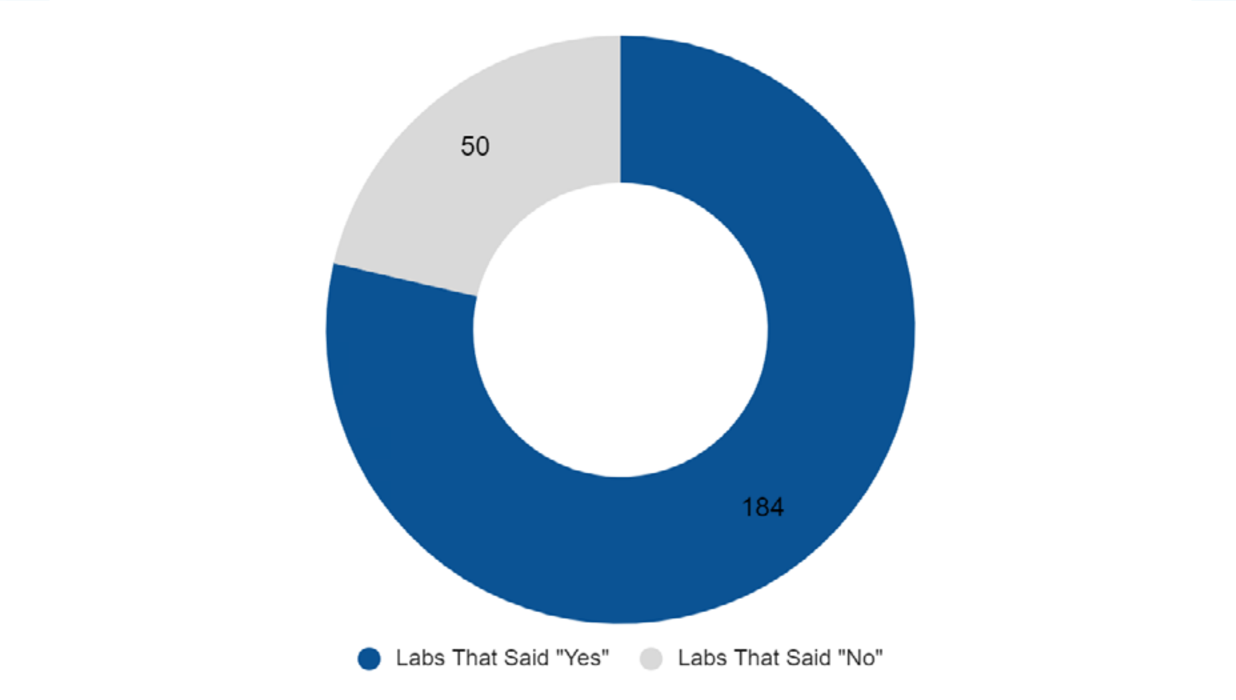
According to the new Business Responsibility and Sustainability Reporting (BRSR), introduced as mandatory disclosures for private entities, reclaiming refers to collecting products & their packaging materials at the end of their useful lives. This process is essential for facilitating reuse, recycling, or ensuring their safe disposal, aligning with broader sustainability and environmental responsibility goals. Reclaimed items can include products & their packaging materials that are collected by or on behalf of the organization, by a third-party contractor.[12] This indicator has been introduced with the intent that over time standardized data can be used to look at sustainability practices within Public R&D labs/institutes and private firms. Safe waste reclamation is crucial for conserving resources. The policies related to safe waste reclamation include E-waste, Hazardous Waste, Plastics (including packaging), Agricultural Waste, Medical Waste, Industrial Waste, Solid Waste, and Other Waste. A majority of the labs/institutes have reported that they have all the policies recommended under BRSR for safe waste reclamation. Of the 234 labs/institutes that have responded,12 labs/ institutes have no safe waste reclamation policy whereas 154 labs/institutes have at least 6 safe waste reclamation policies. 83 labs/institutes reported having all 8 waste reclamation policies listed in the questionnaire.

Figure 6.7 Number of labs/institutes with safe waste reclamation policies



[12] *https://nsearchives.nseindia.com/s3fs-public/inline-files/BRSR_Guide_IF.4_Waste%20Management_0.pdf*

Figure 6.8 Labs/institutes with E-waste reclamation policy



A United Nations report highlights that India is among the largest producers of e-waste globally, generating approximately 2 million tons of e-waste annually.[13] Given this, and how omnipresent e-waste is, it is imperative that all labs/institutes should have an e-waste reclamation policy.

Key Takeaways:

- Public R&D labs/institutes can play a leading role in driving India's green growth
- 6 labs/institutes contributed to international policies, regulations, or standards focusing on green technologies
- 23 labs/institutes contributed to national policies, regulations or standards focusing on green technologies with CSIR and ICAR labs/institutes as primary contributors
- 62 patents on sustainable technologies were granted to a total 26 labs/institutes in 2022-23
- 42% of labs/institutes reported R&D expenditure on green technologies with a majority of these labs/institutes coming from CSIR and ICAR labs/institutes
- 172 labs/institutes reported engaging in the sustainable sourcing of materials
- 12 labs/institutes reported not having any safe waste reclamation policies and 83 labs/ institutes reported having waste reclamation policies for all 8 types of waste covered in this report
- 50 labs/institutes reported not having safe waste reclamation policies for e-waste. The ubiquity of e-waste makes it imperative for all labs/institutes to have waste reclamation of e-waste.

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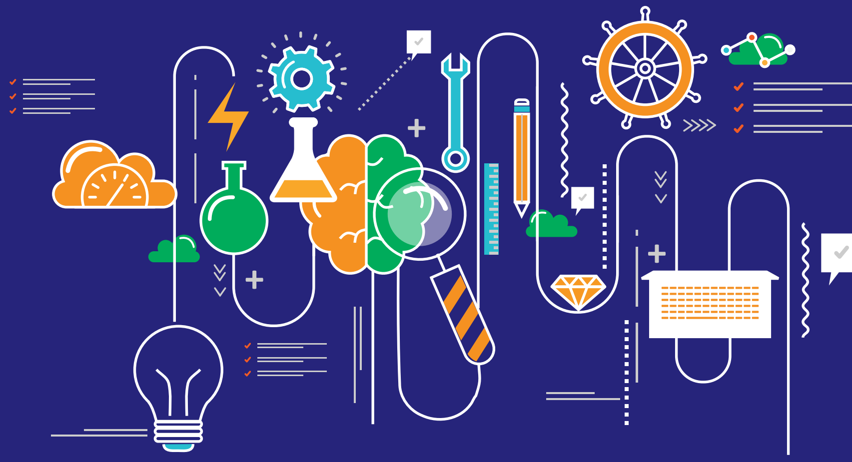
[13] *https://www.investindia.gov.in/waste-to-wealth*



Chapter 7

The North East: A Strategic Frontier for Innovation and R&D

The North East region is a cornerstone of India's R&D ecosystem, significantly enriching its diversity and fostering innovation. Endowed with abundant natural resources and exceptional biodiversity, the North East provides a distinctive setting for research across various disciplines, including biotechnology, environmental science, agriculture, and more. The region's indigenous knowledge systems, coupled with its varied flora and fauna, offer unparalleled opportunities for scientific exploration and innovation, particularly in areas like sustainable development and traditional medicine.

The North East is also a hub for educational and research institutions which foster an environment of academic excellence. These institutions are pivotal in driving forward cutting-edge research and innovation, thereby playing a significant role in advancing the nation's scientific and technological frontiers.

Moreover, the region's strategic location, sharing borders with multiple Southeast Asian countries, amplifies its importance in transnational research collaborations. This geographical advantage allows the North East to serve as a gateway for scientific cooperation and knowledge exchange between India and its neighbors, fostering a more cohesive and integrated R&D ecosystem.

Investing in the R&D potential of the North East is crucial for India's overall growth, as it not only supports national innovation goals but also addresses region-specific challenges, thereby contributing to balanced and inclusive development across the country.

7.1 Top Research Areas Focused on Societal Impact

Research organizations in Northeast India are making impactful strides across various fields, addressing environmental sustainability, agricultural productivity, and public health concerns with innovative solutions. These initiatives reflect a commitment to leveraging local resources and traditional knowledge to solve contemporary problems.

One notable development is the manufacturing of compostable bioplastic bags made from cassava starch or more commonly known as tapioca. This use of tapioca not only helps in reducing plastic waste but also promotes the utilization of local agricultural products, supporting both environmental sustainability and regional economies.

The focus on the environment also extends to the reclamation of coal-mined lands. The development of a comprehensive package of practices to restore degraded coal-mined areas using seed ball technology and integrated biological approaches is a step towards the reforestation of degraded lands and the promotion of native plant growth. Further, to ensure energy security in the north east, graphene supercapacitors were also developed.

In the realm of livestock management,labs have combined traditional practices with modern techniques to develop a semi-intensive rearing method of mithuns to improve animal health and productivity. This approach enhances economic returns for farmers, boosts food security, and promotes sustainable forest resource use. Complementing this, value-added mithun meat products are also being developed to increase marketability and generate employment.

Similar advancements in the rearing of pigs, using low-cost balanced rations have improved growth rates. The development of artificial insemination methods and diagnostic kits for common pig diseases are ensuring increased quality and spurring economic activity through startups focusing on pork processing.

Mirroring India's national health priorities, the labs in the north east have made significant efforts to document and scientifically validate traditional healing practices and folk medicine. This includes developing agro-techniques for cultivating endemic medicinal plants and employing network pharmacology to investigate multi-molecular interactions of herbal drugs to improve drug repurposing and develop personalized medicine. Additionally, efforts are being made to develop alternative drugs to tackle growing concerns around antimicrobial resistant strains of bacteria. Technological advancements were also made in ensuring clean drinking water to communities and the easy detection of contaminants like arsenic in the water supply.

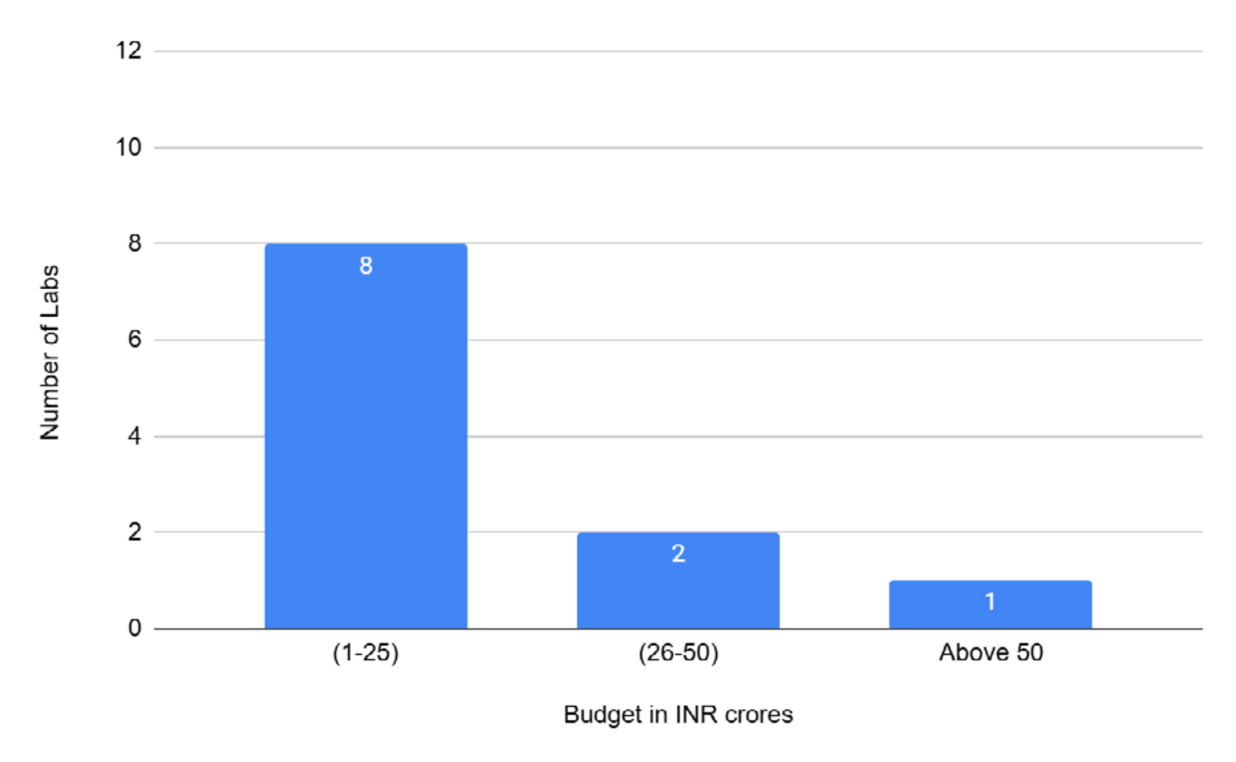
The following sections provide a glimpse into the performance of the labs/institutes in the north east on innovation indicators. While the impact of these labs/institutes has clearly been shown in the previous section, the data below also shows the areas of improvement to ensure the growth of the R&D ecosystem in the region and improved outcomes for the communities in the region.

7.2 Institutional Capabilities and Practices

7.2.1 Labs/institutes in the north east have smaller budgets

The 11 labs/institutes in the northeast region reported a total average budget of Rs. 299 crore for the period under consideration. This represents 1.7% of the total budget of the 234 labs/institutes included in this exercise. As seen in figure 7.1, most labs/institutes had budgets between Rs. 0 and 50 crore, with the median budget being Rs. 20.2 crore. Only 2 labs/institutes in the north east had a budget higher than the national median of Rs. 41 crore.

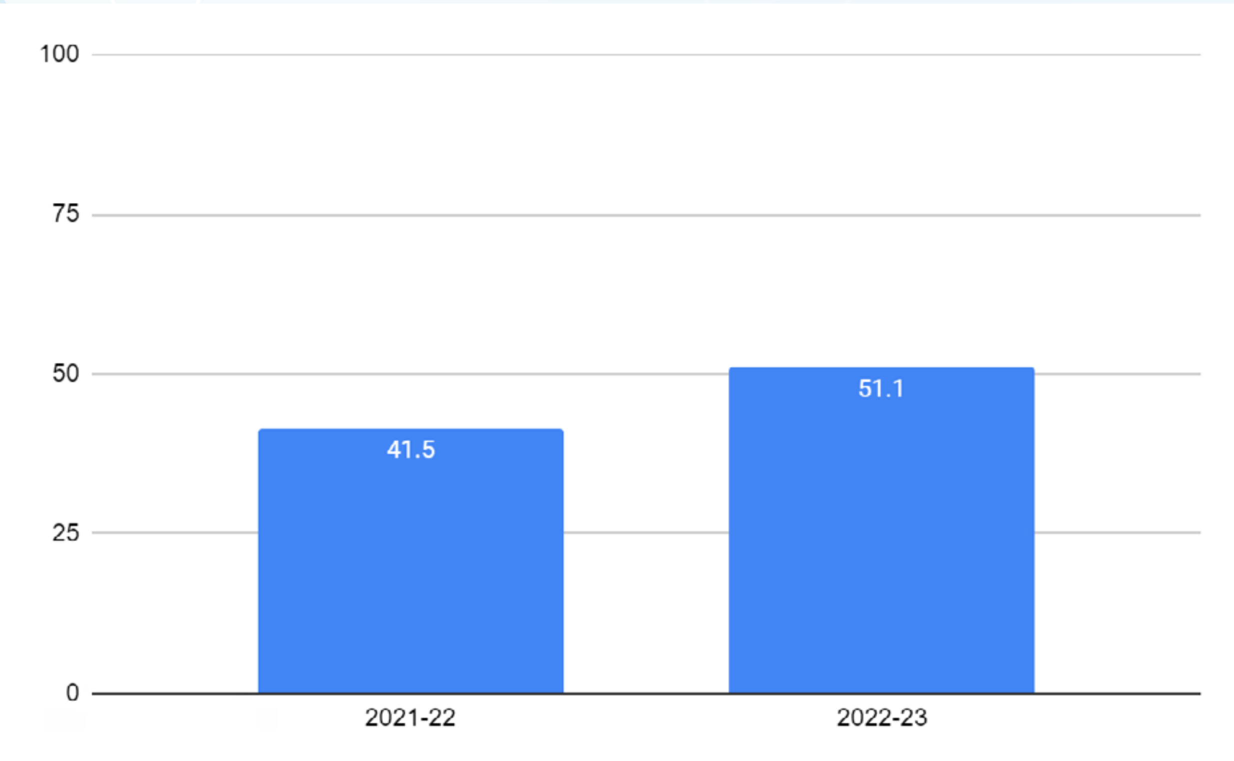
Figure 7.1: Distribution of North East labs/institutes by Budget



Despite the smaller budgets, the median share of budget used for R&D and S&T activities by these 11 labs/institutes was 61.2% which was higher than the national average.

7.2.2 Higher Share of Women in STEM in the North East

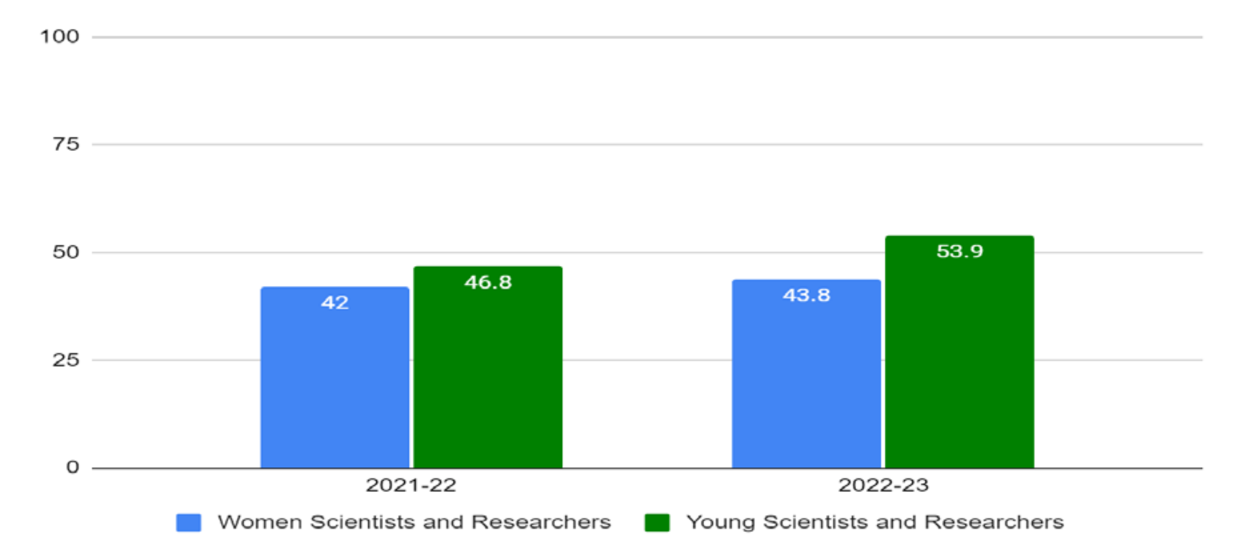
Figure 7.2: Median share of scientific staff



The median share of the scientific staff in these labs/institutes increased between the 2021-22 and 2022-23 to 51.1%. The scientific staff at these labs/institutes is dominated by contractual researchers, with 881 researchers or 78.7 percent of the 1,120 scientists and researchers in 2022-23 being contractual researchers. This largely follows the national patterns. It should be noted that the increase in the scientific staff was due to an increase in the number of permanent scientists rather than contractual researchers, bucking the national trend.

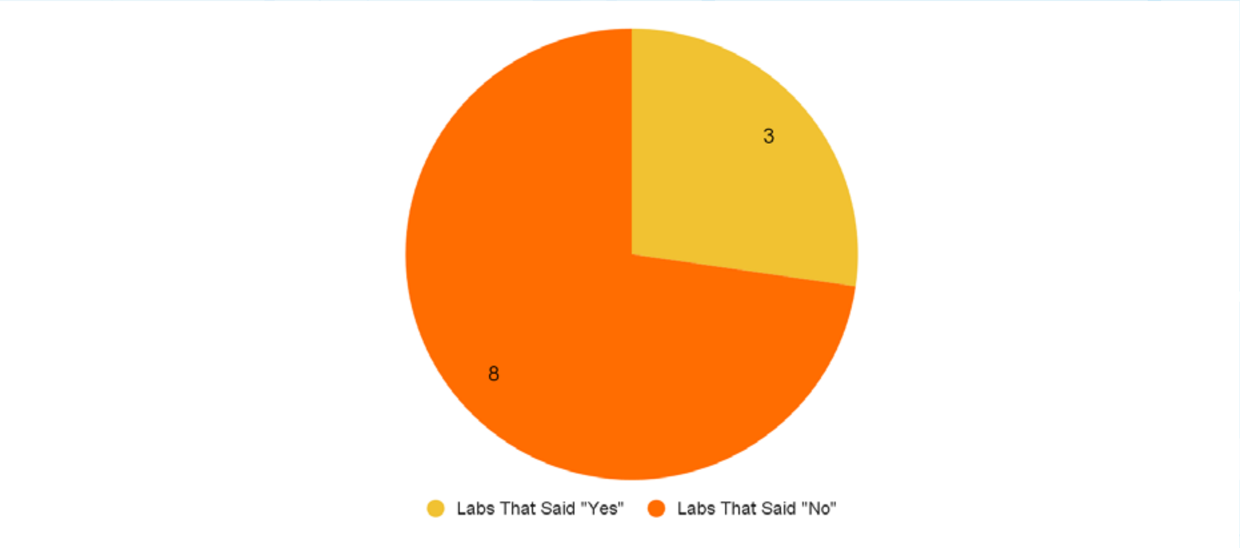
Further, labs/institutes in the north east show a significantly higher share of women researchers in the scientific staff. The share of young scientists and researchers was similar to the national average.

Figure 7.3: Median Share of Women Scientists and Young Researchers



However, only 6 of the 11 labs/institutes supported women researchers and young researchers for training, conferences, sabbaticals, etc. This is similar to the national numbers with only 16.2% of the women in scientific staff being supported and only 34.6% of young researchers being supported. This follows the poor national trend and highlights the need for establishment of EDI cells in all labs/ institutes. Only 3 labs/institutes reported having an Equity, Diversity, and Inclusion cell.

Figure 7.4: Labs/institutes with an EDI Cell

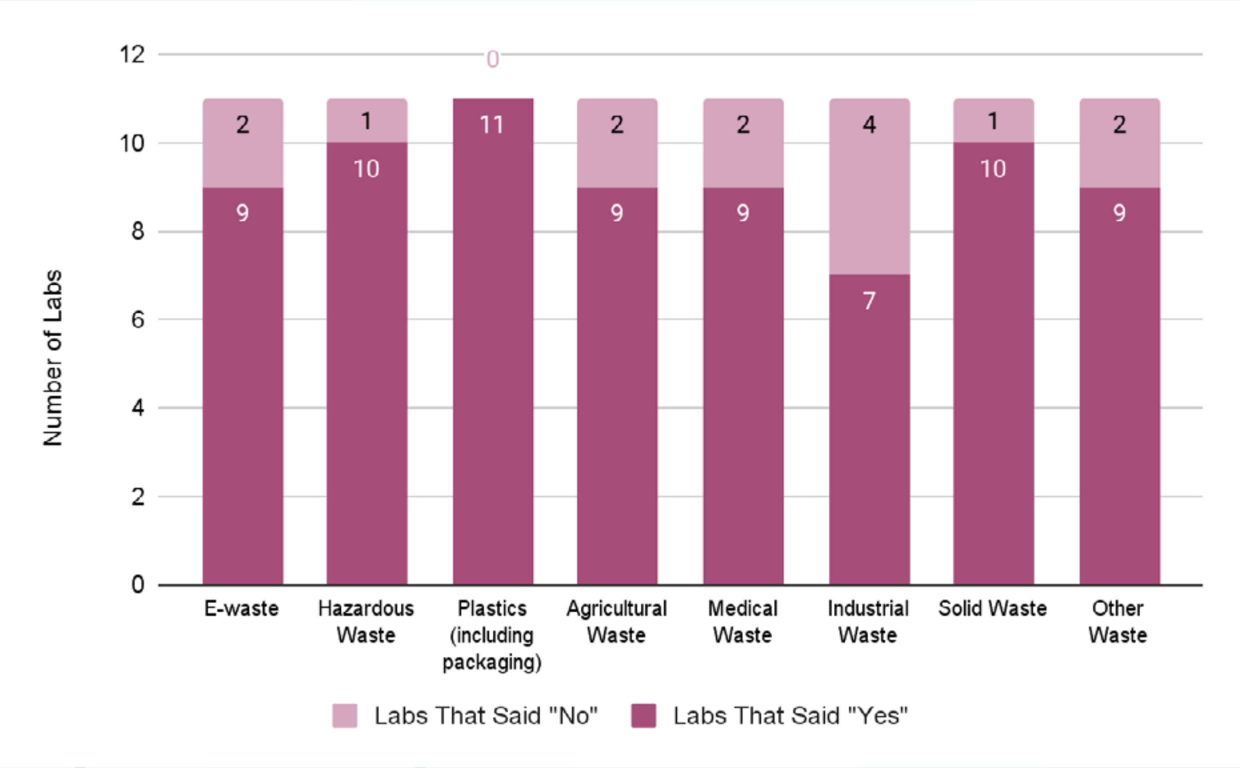


The need for the establishment of an EDI cell in all labs/institutes is also highlighted by the fact that the median share of expenditure on training was 2% of total budget. This share is ideal and is slightly higher than industry standards[14]. With high spending on training, but low number of women and young researchers being supported, it is clear that labs/institutes must reorient their efforts and the establishment of the mandated EDI cells in these labs/institutes would be beneficial in ensuring a more equitable distribution of support along with retention and enhancement of important talent.

7.2.3 All labs/institutes in the north east have plastic waste reclamation policies

The focus on sustainability by the labs/institutes in the north east, as shown by their top research areas is reflected in the number of labs/institutes with waste reclamation policies. As was seen in the top research area, special focus was placed on reducing plastic waste. Here too, we see that all labs/institutes in the north east had a waste reclamation policy for plastic waste.

Figure 7.5: labs/institutes with Waste Reclamation Policies



10 of the 11 labs/institutes in the north east had at least 5 of the 8 waste reclamation policies included in this exercise. While this is a welcome sign and much higher than the national average, not all labs/institutes in the north east have a waste reclamation policy for e-waste, which is ubiquitous. E-waste should be focused on especially due to its economic and strategic potential and its inclusion in the Waste to Wealth Mission.[15]

7.3 Scientific Output and Innovation Outcomes

7.3.1 Labs/institutes in the North East Received Patents on Sustainable Technologies

In line with the focus on sustainability, labs/institutes in the north east were granted 6 patents in sustainable technologies in 2021-22. This represents close to 40% of all patents granted in emerging technologies to these labs/institutes in 2021-22. However, there is a significant drop in the

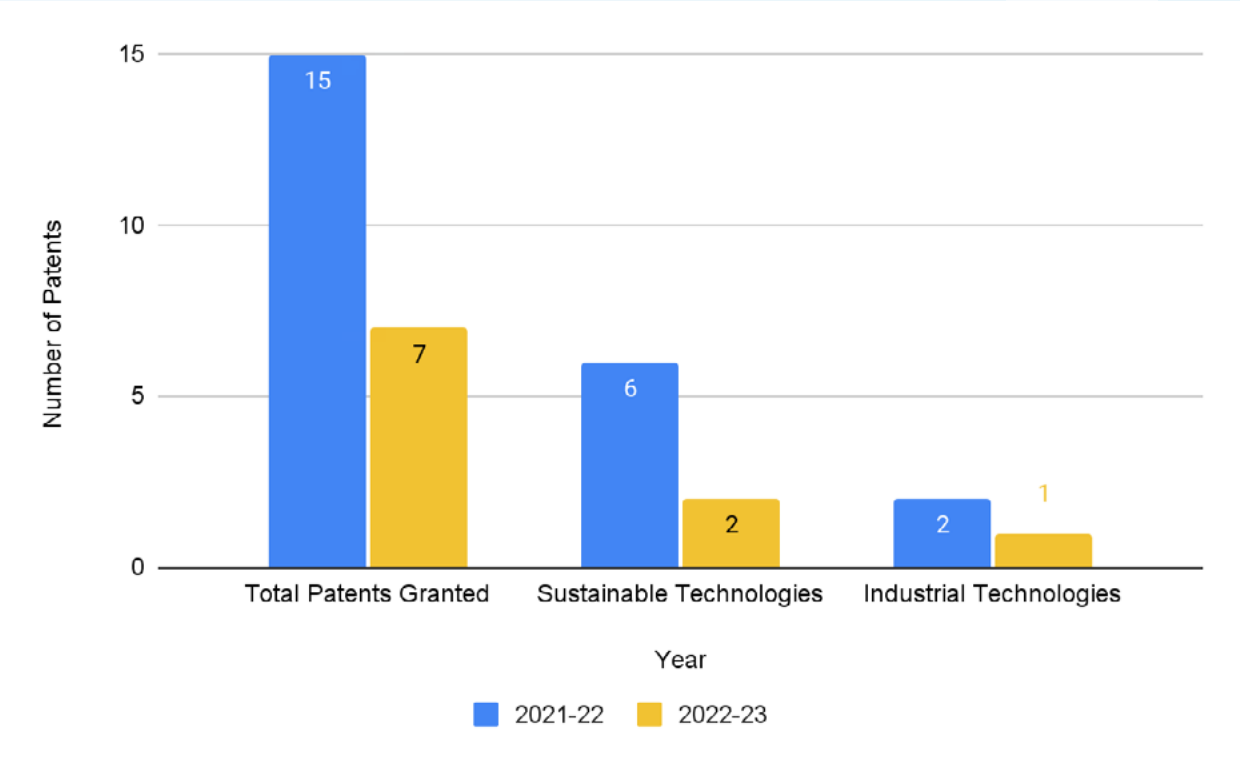
[14] *https://www.bcg.com/publications/2023/your-strategy-is-only-as-good-as-your-skills*

[15] *https://www.investindia.gov.in/waste-to-wealth*

number of patents granted to these labs/institutes between the two years with total patents granted dropping by around 50% to 7 in 2022-23.

Apart from patents, labs/institutes were also granted designs and copyrights. Importantly, of all the IPR granted to labs/institutes in 2022-23, majority were copyrights. This is a big departure from both the composition in 2021-22 and the national trend.

Figure 7.6: Patents Granted in Emerging Areas



Note: Analysis is done for 10 labs/institutes. One lab/institute was excluded as their response could not be verified.

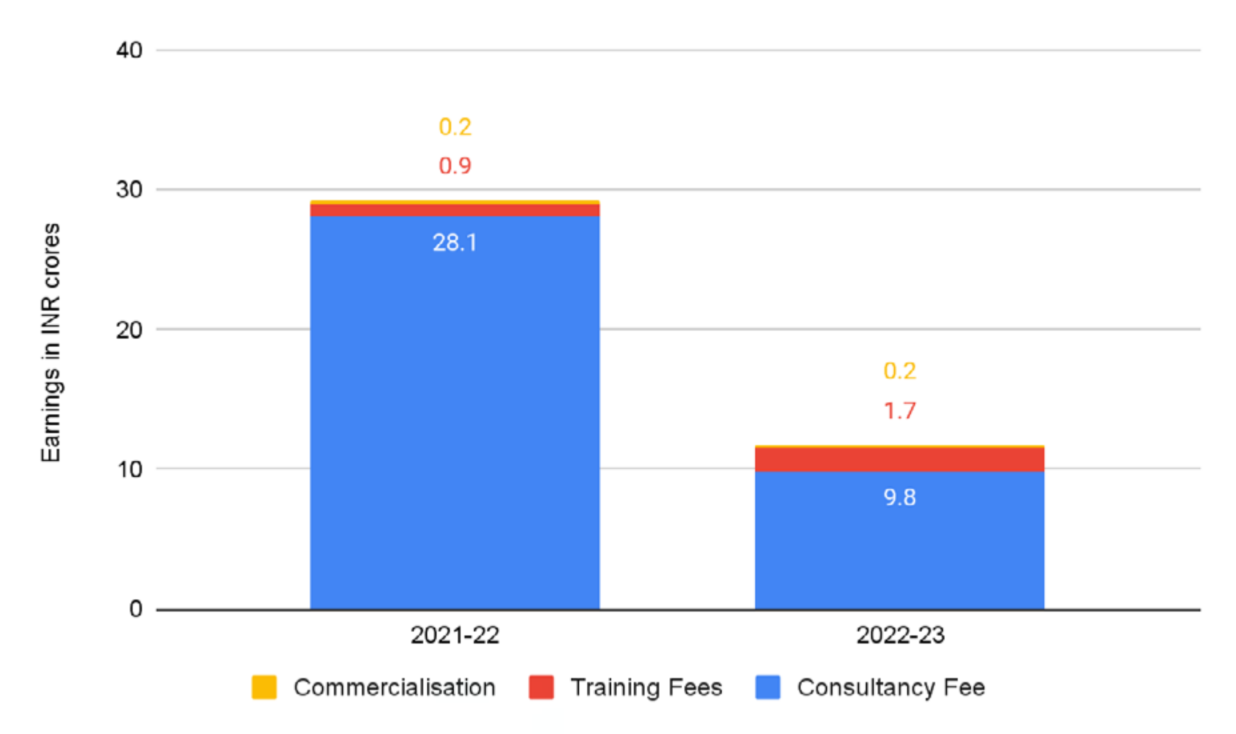
7.3.2 Labs/institutes in the North East Earned More From Government Sources

Earnings from consultancies, training, and commercialization can be a great source of revenue for labs/institutes, providing them the ability to spend more on research and development and can boost the lab's competitiveness.

The earnings from government sources of the labs/institutes in the north east accounted for around 2% of the total earnings from government sources nationally in 2021-22. This is close to the share of the budget of these labs/institutes to the national total. While the earnings from government sources saw a small increase between the two years, it was largely due to one lab, while most other labs/institutes saw a dip in earnings.

Similarly, labs/institutes in the north east saw a drastic decrease in earnings from government sources between the two years. Interestingly, while national earnings from non-government sources were higher than those from government sources, labs/institutes in the north east had much lower earnings from non-government sources. Labs/institutes in the north east only Rs. 1.2 crore and Rs. 0.4 crore for the year 2021-22 and 2022-23 respectively from domestic non-government sources.

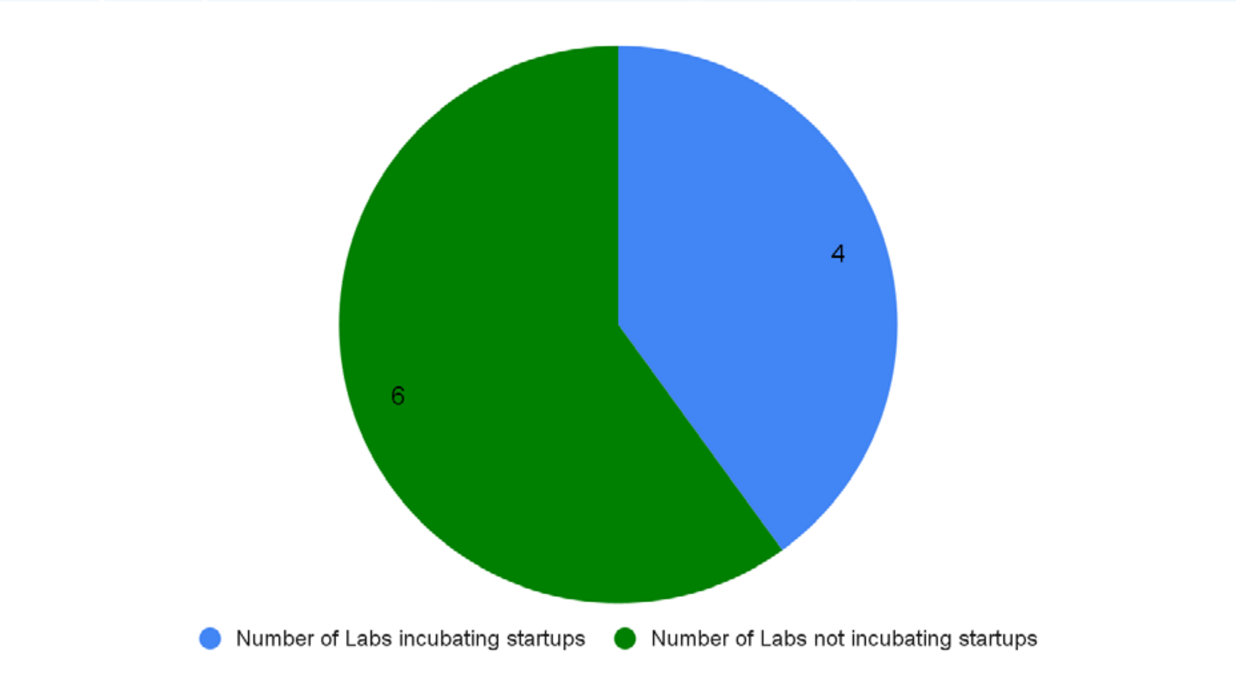
Figure 7.7: Earnings from Government Sources dropped to Rs 9.8 Cr in 2022-23



7.4 Contributions of Labs/institutes to Socioeconomic Development

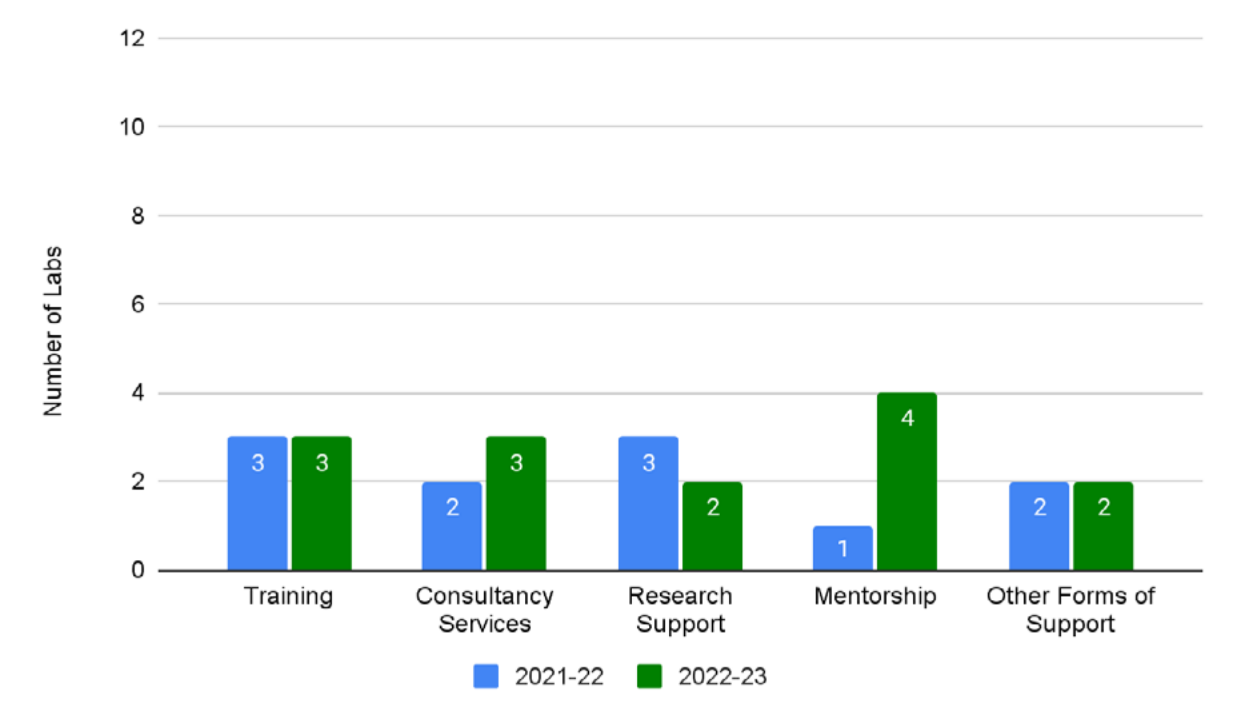
7.4.1 Startup Ecosystem linkages developing

Figure 7.8: Share of labs/institutes incubating startups



Note: Analysis is done for 10 labs/institutes. One lab/institute was excluded as their response could not be verified.

Figure 7.9: Number of labs/institutes supporting startups



Note: Analysis is done for 10 labs/institutes. One lab/institute was excluded as their response could not be verified.

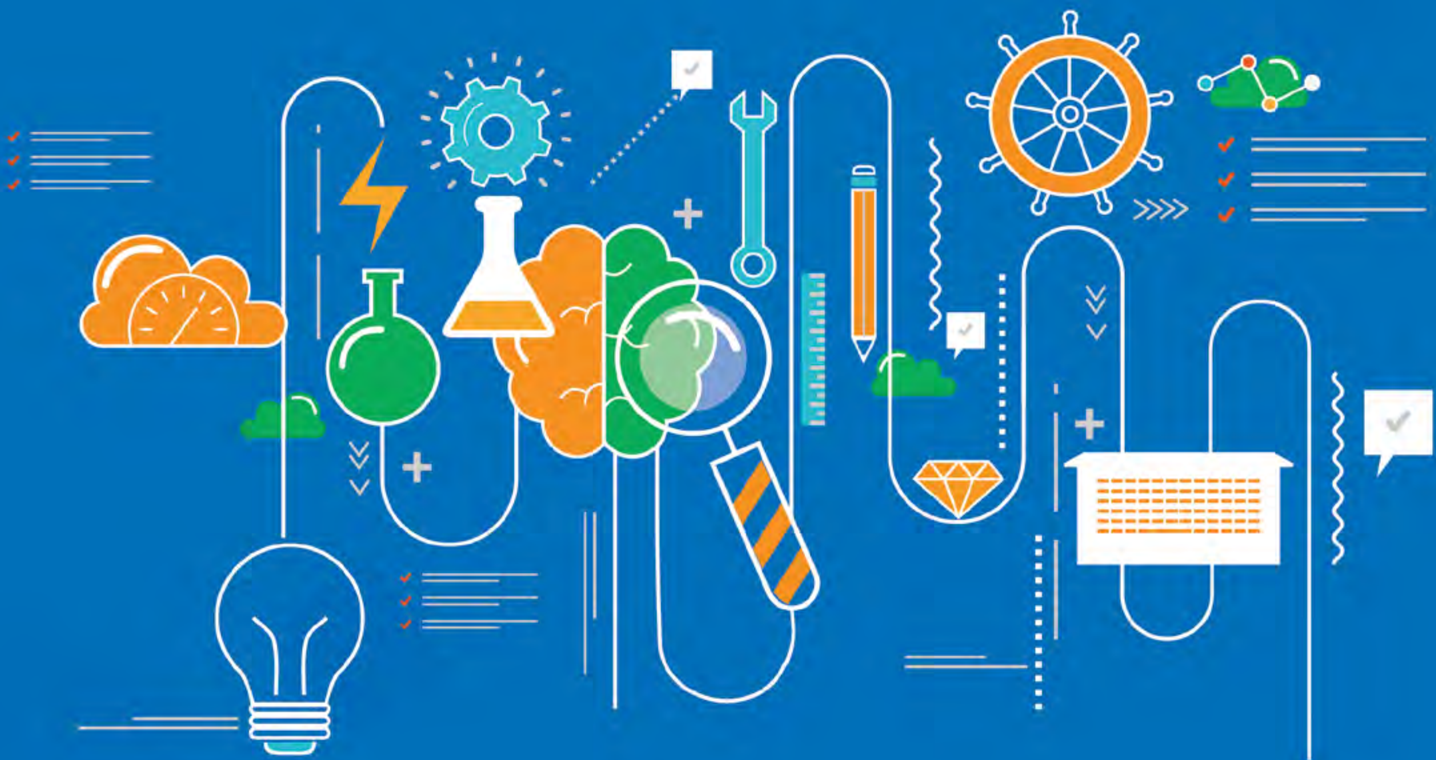
The linkages of the labs/institutes in the north east with the startup ecosystem are still developing. 4 labs/institutes have reported incubating startups (see Figure 7.8). Given their location and expertise, the labs/institutes in the north east can play a crucial role in building up the startup ecosystem in the north east by fostering more collaboration and leveraging domain expertise. Apart from incubation, the labs/institutes in the north east are also providing other kinds of support to startups as seen in Figure 7.9. The labs/institutes are engaging in training, mentoring, offering research support and consulting services.

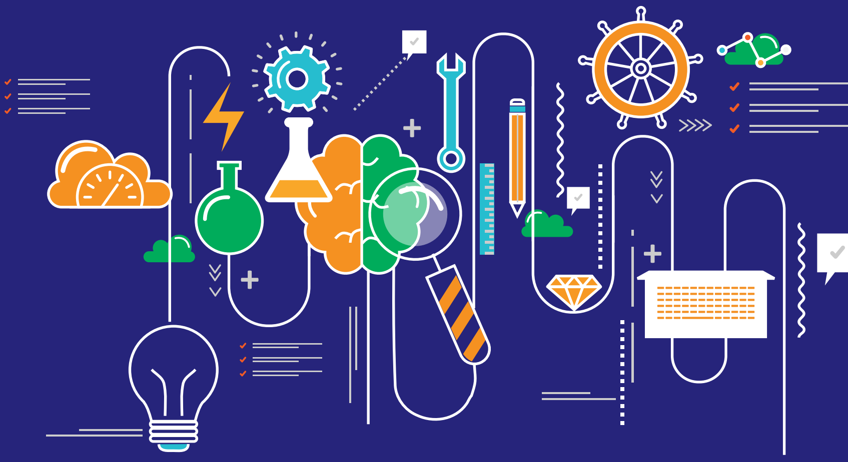
Key Takeaways:

- Labs/institutes in the north east made strides addressing sustainability, agriculture and animal husbandry, and public health concerns
- Labs/institutes in the north east had a higher median share of women researchers in scientific staff of 43.8%
- Only 6 of the 11 labs/institutes supported women researchers for sabbaticals, training, conference, etc.
- Median share of expenditure on training was 2% which is close to industry standards
- All labs/institutes in the north east had waste reclamation policies for plastic waste
- Labs/institutes in the north east were granted 15 patents in emerging technologies of which 40% were granted in sustainable technologies
- Earnings from government sources saw a significant decrease of Rs. 9.8 crore in 2022-23 for these labs/institutes
- Only 4 of the 10 labs/institutes in the north east reported incubating startups

SECTION 3

Findings - Innovation Excellence Indicators





Chapter 8

Basic R&D Labs/institutes

Basic research by definition is experimental or theoretical work that is undertaken primarily to acquire new frontiers of knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. The TRL levels of the technologies developed by these labs/institutes were between 0 and 4. The present chapter analyzes the responses of 129 labs/institutes that chose to categorize themselves under Basic R&D labs/institutes.

Chapter Summary

- There were 20 labs/institutes that had developed more than 15 technologies(targeting SDGs and/or national programmes) per 100 scientific staff
- Of the reported labs/institutes there were 18 labs/institutes that had undertaken more than 90 projects per 100 scientific staff.
- The primary beneficiaries of the output from the basic labs/institutes are government departments followed by individuals.
- There were 37 labs/institutes incubated startups of which 11 labs/institutes that incubated startups were performing only basic R&D.
- There were 31 labs/institutes that support deep science and deep tech startups while only 5 labs/institutes supported startups through support mechanisms like training, consultancy services, research support, mentorship, and other forms of support.
- Of the 129 labs/institutes 105 labs/institutes awarded PhD degrees whereas 50 percent of the labs/institutes awarded less than 10 educational degrees (combined PhDs, Master's and undergraduate degrees).
- While there were around 68 labs/institutes that took on up to 60 interns per 100 scientific staff trained in cutting edge areas, 12 labs/institutes had more than 60 interns trained per 100 scientific staff.

- A majority of the labs/institutes were seen to be engaging in filing patents and a majority were also granted patents, however only around a third of them are seen to be licensing out their patents.
- There were 57 labs/institutes that obtained patents in the emerging areas of technology. Higher number of patents were granted in bio-engineering technologies followed by industrial technologies and sustainable technologies.
- 25 labs/institutes introduced more than 2 new products and/or services per Rs.10 crore of budgetary support.
- Majority of the basic R&D labs/institutes received extramural funding from government sources while there were around 23 labs/institutes that received more than Rs. 4 crore through extramural funding for every Rs. 10 crore of budget spent.
- Most of the labs/institutes that did receive any extramural funding from non-government sources received up to Rs.1 crore for every Rs.10 crore of budgetary support.
- There were just 21 labs/institutes that had ongoing international industry collaborations while 73 labs/institutes had ongoing national industry collaborations whereas 55 labs/institutes had absolutely no national or international collaboration with industry.
- Compared to industry collaborations, there were a lot more labs/institutes engaged in project collaborations with both international and national academic institutions and/or research labs/ institutes. There were 69 labs/institutes that had international and 108 labs/institutes that had national collaborations with academic institutions and/or research labs/institutes.
- There were 56 labs/institutes that introduced 3 new research fields/ innovations/ services in each year for the period under consideration, while 34 labs/institutes introduced at least 2 new fields/ innovations/services in each year.
- For 74 labs/institutes, the share of permanent scientists and project based (contractual) researchers in total staff is over 50 percent whereas for 19 labs/institutes the share of permanent scientists and project based (contractual) researchers was less than 25 percent.
- There were only 41 labs/institutes that said they had EDI cells while 47 labs/institutes have up to 25 percent of women scientists in their total scientific and research staff.
- 101 labs/institutes that spend between 0 and 2 percent of their budget towards training or on opportunities for skill upgradation of their staff of these close to 88 labs/institutes spend less than 1 percent of their budget on training.
- Efforts should be made to support many more young and women researchers for conferences, training, sabbaticals, etc as 16 percent of the labs/institutes supported between 25 to 50 young scientists per 100 scientific staff while only 4 percent of the 129 labs/institutes supported between 25 to 50 women scientific staff.

Basic R&D Labs

129 **Labs** or close to **55%** self identified as basic R&D labs

18,693 **Total Scientific Staff**

33% Median Share of Women in Scientific Staff

59% Median Share of Young Researchers in Scientific Staff

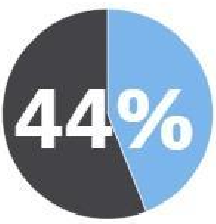
45% Median Expenditure on R&D and S&T Activities as a Share of Budget

756 **Technologies** Primarily Targeting **Good Health SDG** and **Make in India**

568 IPR Granted

₹ 17 cr of budget spent per IPR Granted

₹ 24 **Lakhs** in **Extramural Funding** Received for Every 1 Cr of Budget

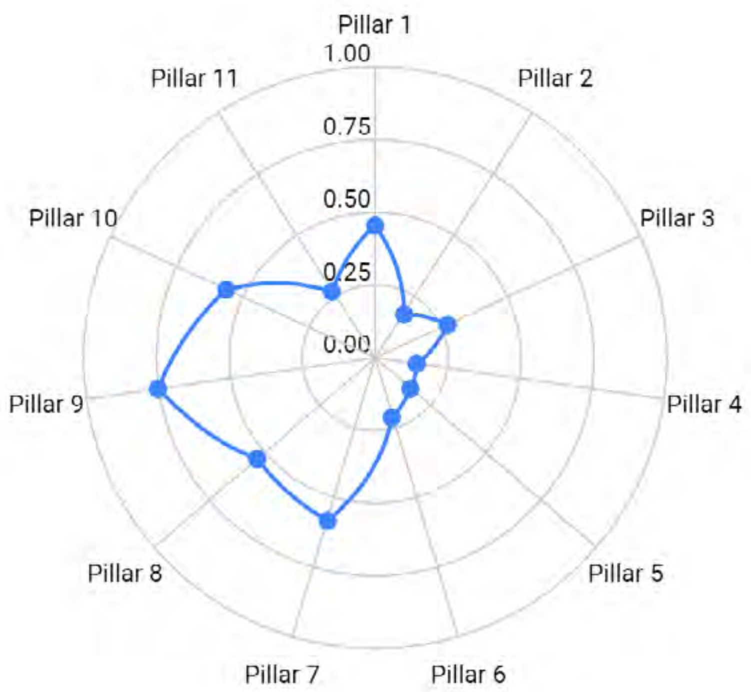


Labs had International Collaborations with Academia

There were 129 labs/institutes that categorized themselves as Basic R&D labs/institutes, of which there were 43 labs/institutes that were undertaking pure basic R&D while the remaining 86 were hybrid in nature signifying that they were also undertaking applied and/or services R&D.

Labs/institutes from CSIR and ICAR accounted for nearly 40 percent of the 129 R&D labs/ institutes (pure basic + hybrid basic). When one considers the sample of R&D labs/institutes that were only engaged in basic R&D, the largest numbers of labs/institutes came from CSIR, followed by ICAR, DST and ICMR. The average budget for the overall sample of 129 basic research labs/ institutes was around Rs. 72 crore, while it was around Rs. 66 crore for the 43 labs/institutes that were engaged in only basic R&D. With respect to scientific staff, the average number of scientific staff per labs/institutes for the overall sample of 129 labs/institutes was around 141, with this number dropping to around 114 scientific staff per labs/institutes for the labs/institutes engaged in only basic R&D. There is a significant variation in terms of budgetary outlay as well as by the number of scientific staff across the category of Basic R&D labs/institutes. There were around 4 or 5 labs/institutes that reported a high number of project based research staff, which contributed to the variation in the numbers of total scientific staff reported by these 129 labs/institutes. The labs/institutes with a high number of project based research staff included labs/institutes from key scientific ministries as well as the institutions engaged in educational activities.

Figure 8.1: Sub-pillar wise Average Scores



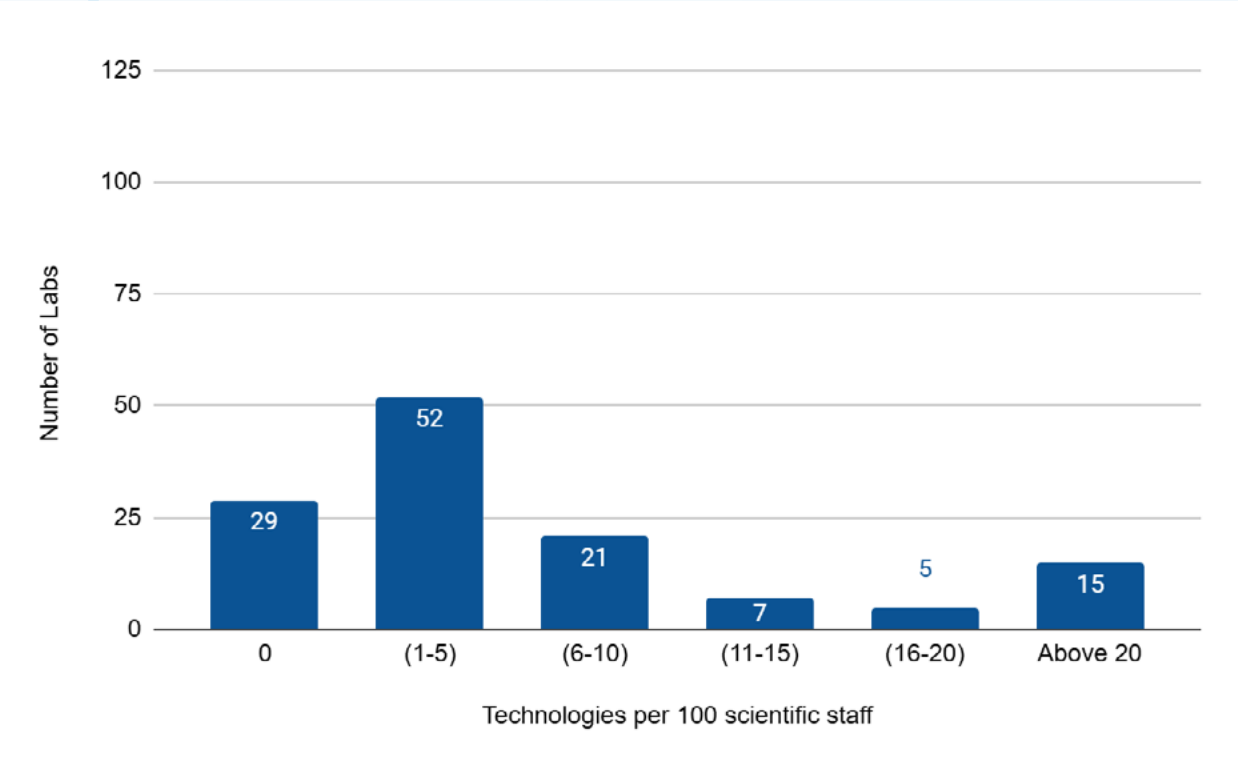
8.1 Pillar 1: Socio-economic Impact

The indicators in the pillar on socio-economic impact that have been captured below include the number of technologies (with TRL levels between 0 and 4) targeted towards SDGs or national programmes, the number of projects being undertaken by the labs/institutes, the targeted beneficiaries of the labs/institutes programmes, number of degrees (PhDs, master's, undergraduate) awarded and the number of interns trained at the labs/institutes. The data presented in the charts below are based on an average of the two years under consideration, namely 2021-22 and 2022-23.

- The data shows that a majority of the labs/institutes are developing up to 10 technologies (targeting SDGs and/or national programmes) per hundred scientific staff. There were 20 labs/institutes that had developed more than 15 technologies per 100 scientific staff.
- Over 30 percent of the labs/institutes are engaged in more than 60 projects per hundred scientific staff. There were 18 labs/institutes that had undertaken more than 90 projects per 100 scientific staff.
- The primary beneficiaries of the output from the basic labs/institutes are government departments followed by individuals.
- Close to 50 percent of the labs/institutes award less than 10 educational degrees (combined PhDs, Master's and undergraduate degrees).
- More than 50 percent of the labs/institutes train up to 60 interns each year per hundred scientific staff.

8.1.1 Sub-pillar 1: Contribution to SDGs and national programmes

Figure 8.2: Technologies targeted towards SDGs & National Programmes

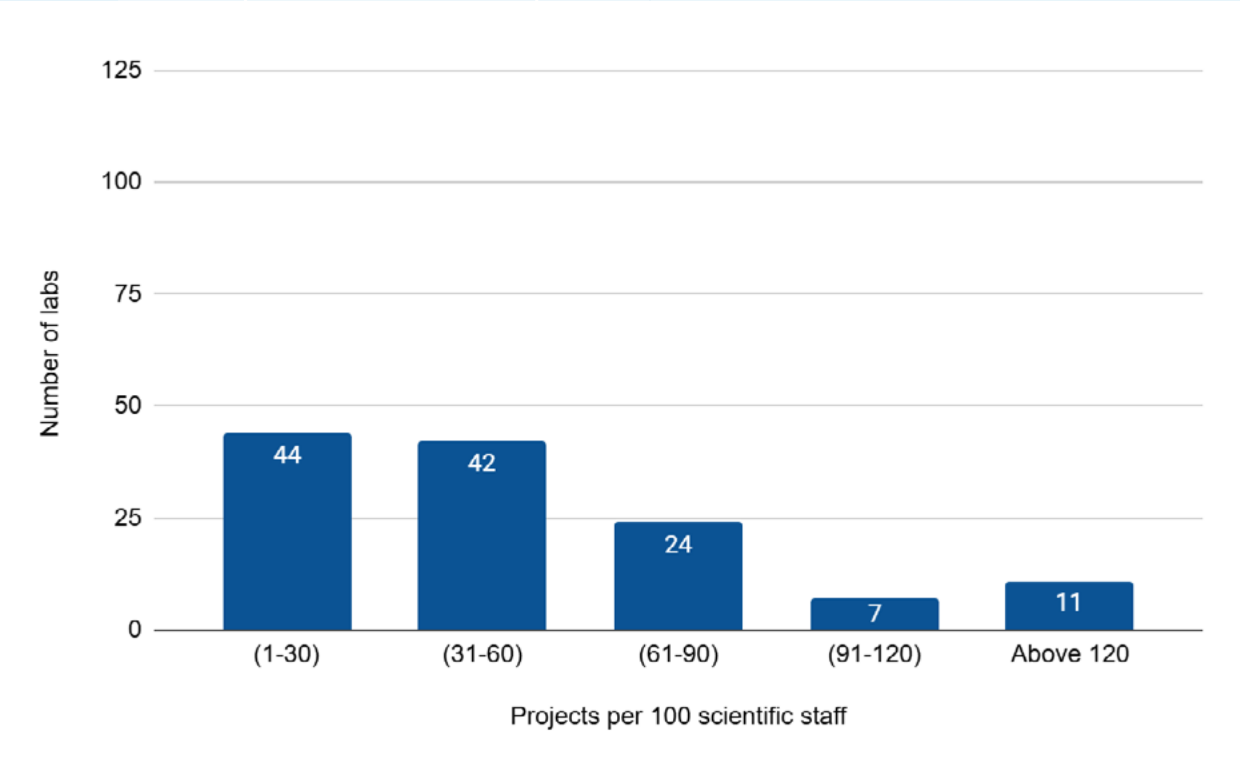


There were 29 labs/institutes that did not report any technologies with TRL between 0 and 4 targeted towards SDGs and national programmes that had been developed during the period under consideration, while 27 labs/institutes reported having developed more than 10 technologies per 100 scientific staff. Over 40 percent of the labs/institutes had developed up to 5 technologies per 100 scientific staff. Given that around 86 basic R&D labs/institutes were hybrid, it is likely that many of them may have also developed technologies with TRL 5 and above, which would not be reflected here.

The 27 labs/institutes that had developed more than 10 technologies per 100 scientific staff included 13 labs/institutes from ICAR, 5 labs/institutes from Ministry of textiles, 2 labs/institutes each from ICMR and DST and one from CSIR. The remaining labs/institutes in this set of 27 were from other central government ministries, and also comprised educational and training institutions.

Of the 128 basic labs/institutes, there were 86 labs/institutes that were undertaking up to 60 projects per 100 scientific staff. The remaining 43 labs/institutes were engaged in more than 60 projects per 100 scientific staff, of which 18 were engaged in more than 90 projects per 100 scientific staff.

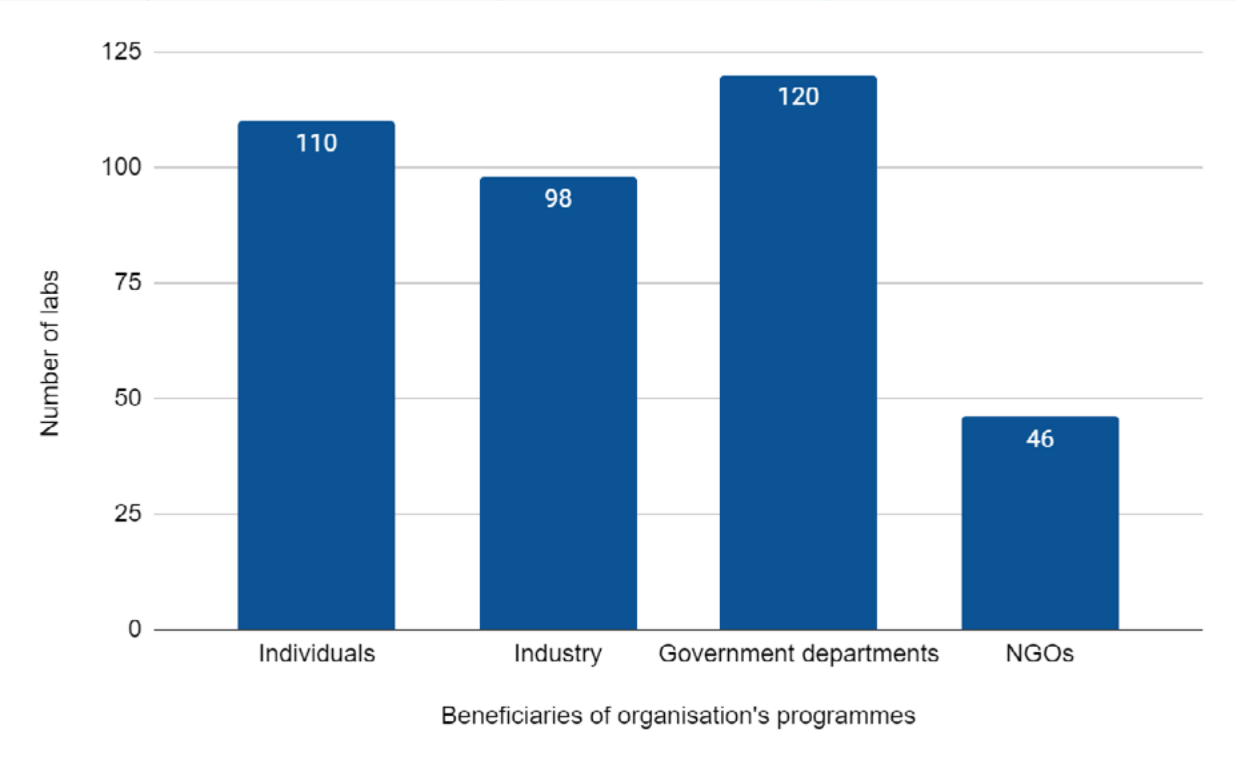
Figure 8.3: Project executed per 100 scientific staff



Note: Analysis is done for 128 labs/institutes. One lab/institute was excluded as their response could not be verified.

The 18 labs/institutes that were engaged in more than 90 projects per 100 scientific staff included 7 labs/institutes from ICAR, 3 labs/institutes each from CSIR and ICMR, one lab each from DST and DBT, with the remaining 3 labs/institutes coming from other central government ministries. Apart from a few labs/institutes that were in common for the most part, the labs/institutes that were engaged in a higher number of projects per 100 scientific staff differed from those that had developed a higher number of technologies per 100 scientific staff.

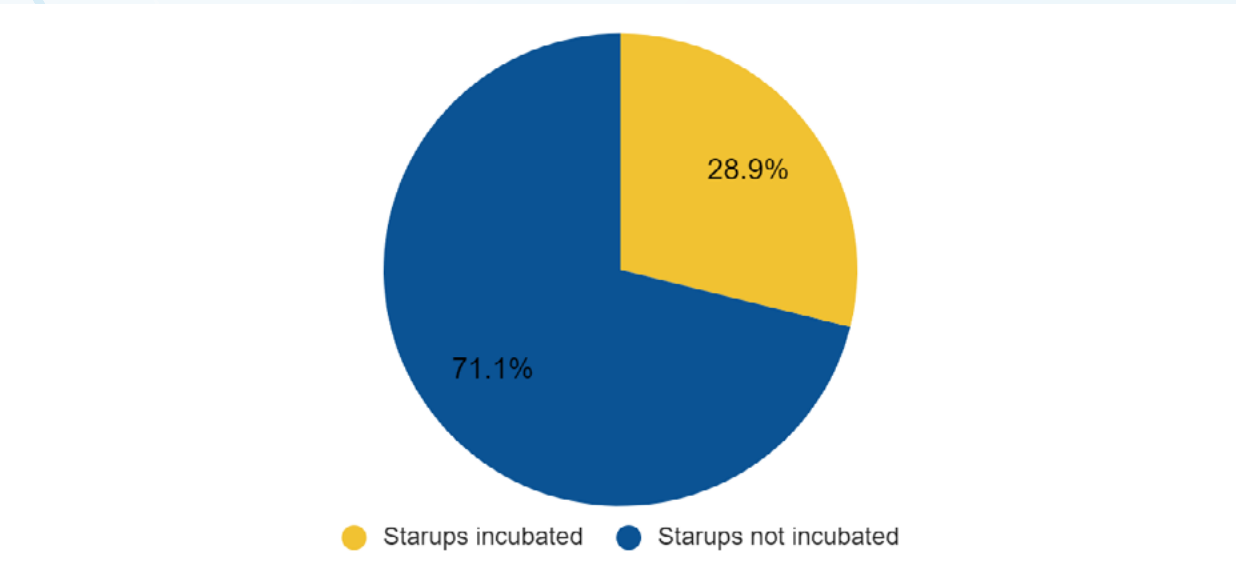
Figure 8.4: Beneficiaries of organization's programmes



The beneficiaries of each lab's programmes and research were mainly government departments followed by individuals and then industry. Only around 36 percent of the labs/institutes had NGOs who were beneficiaries of their programmes.

8.1.2 Sub-pillar 2: Employment generation and human resource development

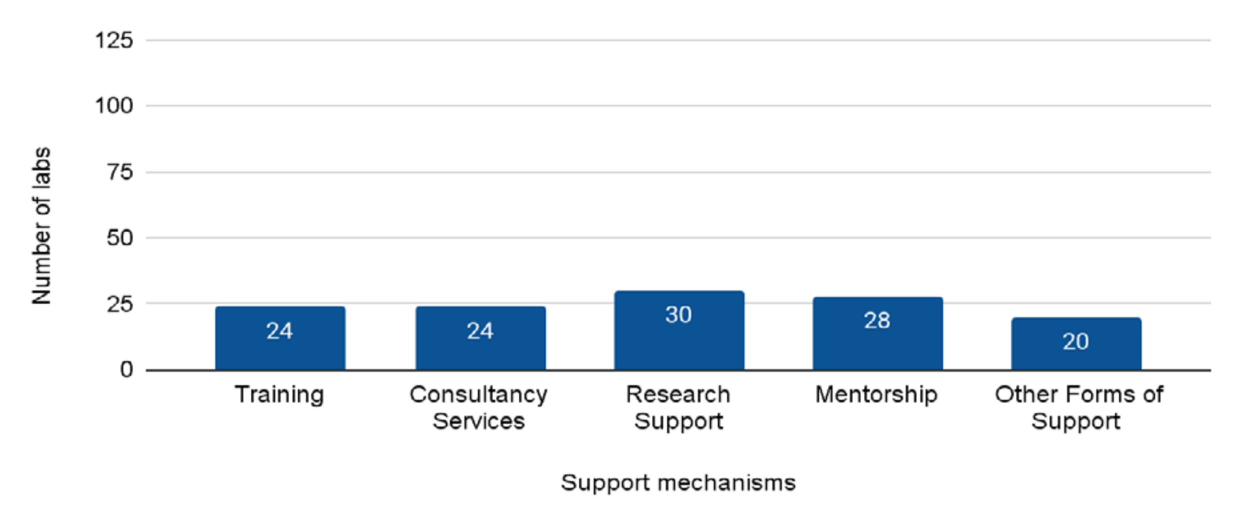
Figure 8.5: Labs/institutes incubated startups



Note: Analysis is done for 128 labs/institutes. One lab/institute was excluded as their response could not be verified.

There were 37 labs/institutes that incubated startups of which 11 labs/institutes that incubated startups were performing only basic R&D. There were 13 labs/institutes from ICAR that incubated startups, 8 from CSIR, 6 from DST, 5 from DBT, 1 from ICMR, 1 from Ministry of AYUSH, and the remaining 3 labs/institutes were from other central government ministries.

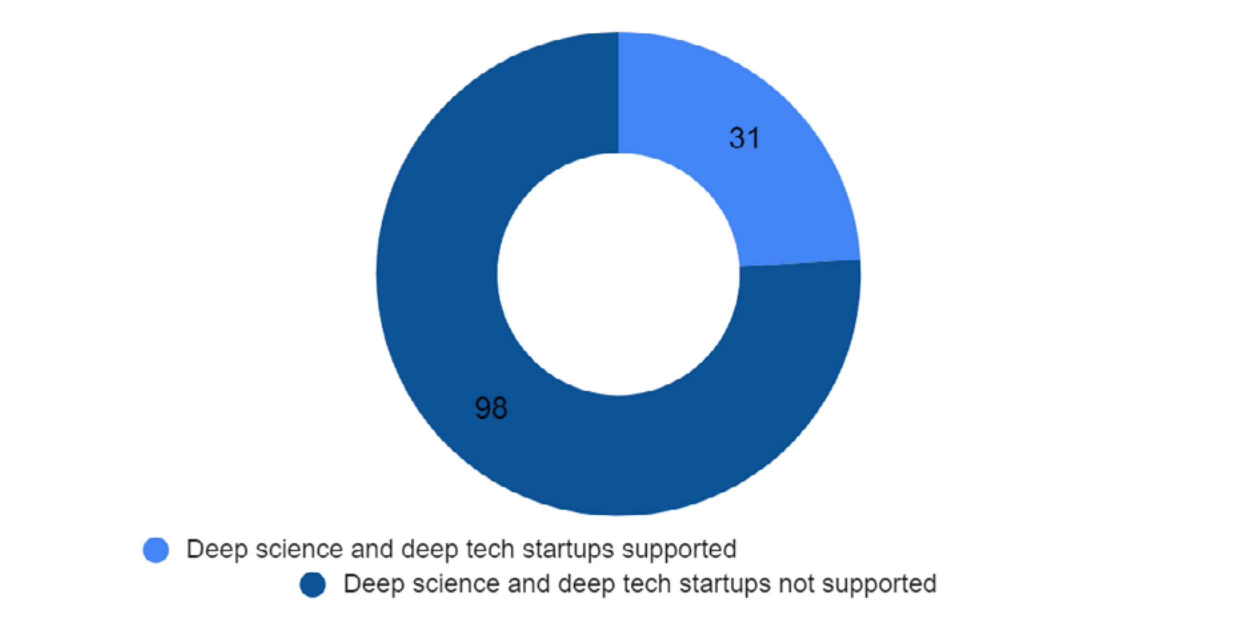
Figure 8.6: Startups supported through different support mechanisms



Note: Analysis is done for 127 labs/institutes. Two labs/institutes were excluded as their response could not be verified.

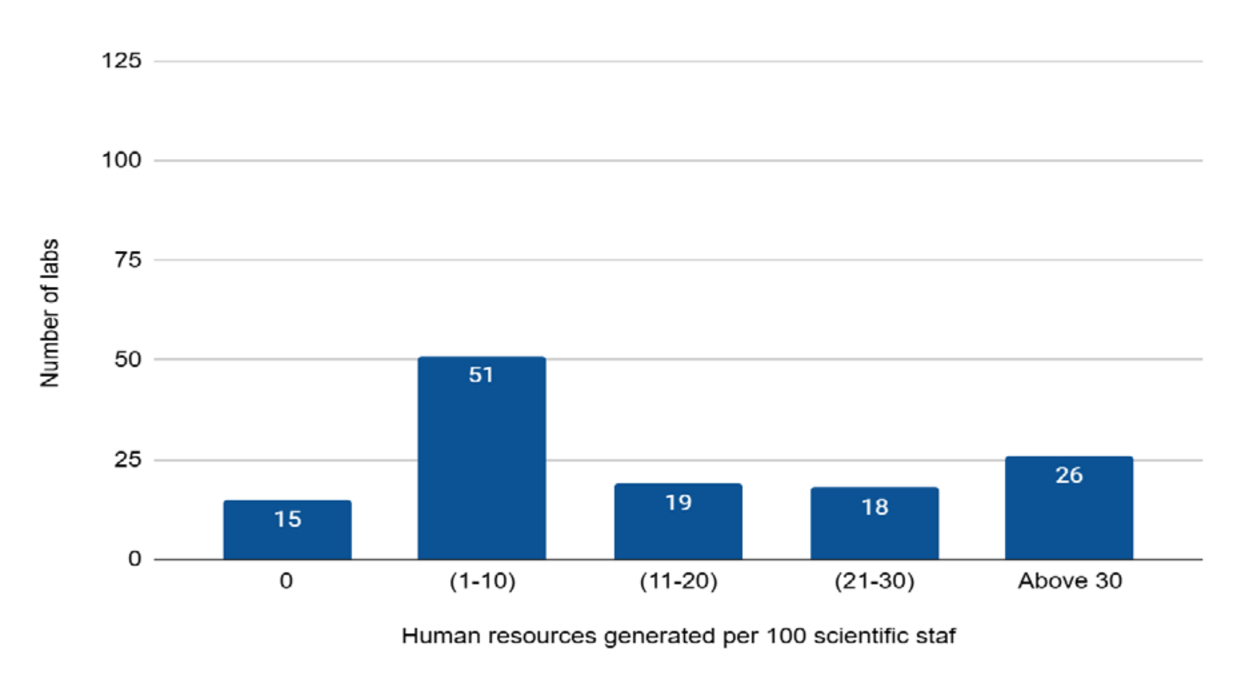
As can be seen in the accompanying chart, there were 30 labs/institutes that supported startups through research support, 28 labs/institutes provided mentorship whereas 24 each labs/institutes provided training and consultancy services while 20 labs/institutes supported them through other forms of support. Among all these labs/institutes that provided support to startups only 5 labs/ institutes supported them through all support mechanisms. Of these 5 labs/institutes 3 were from ICAR and 1 each lab were from CSIR and DST.

Figure 8.7: Deep science and deep tech startups supported



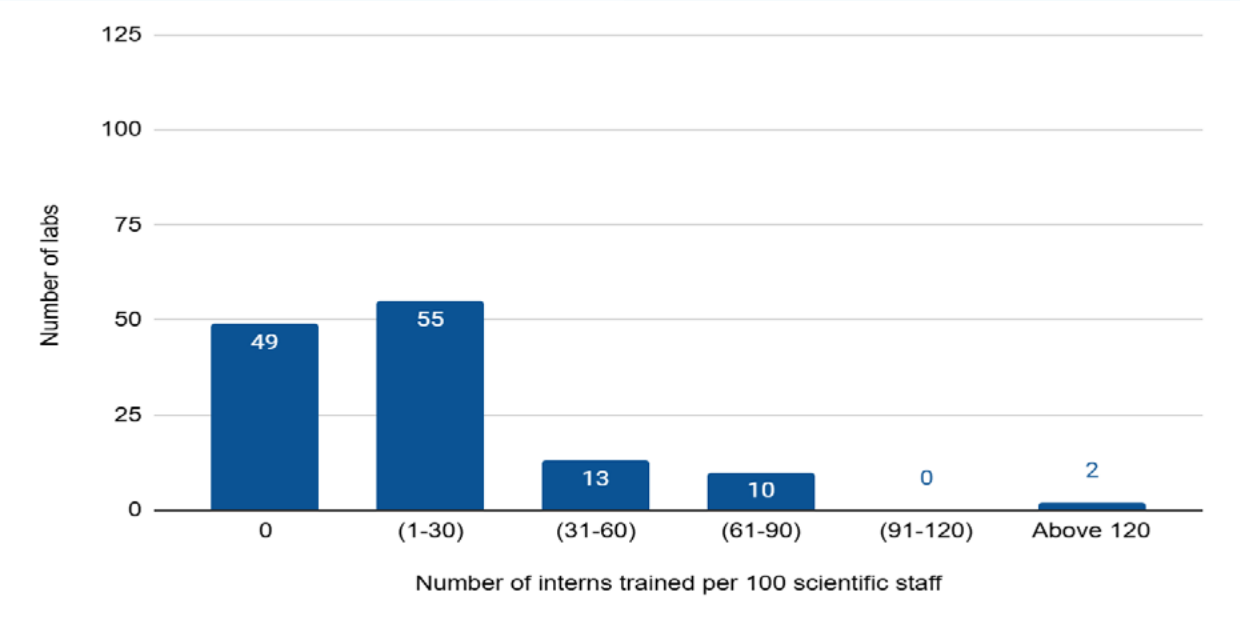
Of the 129 labs/institutes there were 98 labs/institutes that did not support any deep science and deep tech startups. Of the 31 labs/institutes that did support deep science and deep tech startups there were 8 labs/institutes each from ICAR and CSIR, 6 labs/institutes from DST, 4 labs/institutes from DBT, 1 lab each from ICMR and Ministry of Ayush, and the remaining 3 labs/institutes were from other central government ministries.

Figure 8.8: PhD, Masters and Graduate degree awarded per 100 scientific staff



The highest share of labs/institutes fall into the bracket of having awarded up to 10 degrees per 100 scientific staff. The degrees awarded are a combination of PhDs, Masters and undergraduate degrees. There were 15 labs/institutes that did not award any degrees during the period under consideration, while there were 26 labs/institutes that offered more than 30 degrees per 10 scientific staff. These 26 labs/institutes comprised 17 labs/institutes that were from key scientific ministries while the remaining 9 labs/institutes were institutions that also had a focus on education and training. While 112 labs/institutes out of the 129 did not offer any graduate degrees and 70 labs/institutes did not offer any master's degrees, there were only 24 labs/institutes that did not offer any PhD degrees.

Figure 8.9: Number of interns trained per 100 scientific staff



There were 49 labs/institutes that did not take on any interns during the periods under consideration. While there were around 68 labs/institutes that took on up to 60 interns per 100 scientific staff and trained them in cutting edge areas such as quantum technologies, bio-engineering, green hydrogen, artificial intelligence, renewable technologies, blockchain, smart manufacturing, semiconductor technologies, high performance computing, and advanced wireless networks. There were 12 labs/institutes that had more than 60 interns per 100 scientific staff attached to them whereas there were only 2 labs/institutes that had more than 120 interns per 100 scientific staff, with one belonging to ICMR while the other belonged to DST.

Key Takeaways:

- There were 20 labs/institutes that had developed more than 15 technologies per 100 scientific staff. For projects executed, 18 labs/institutes had undertaken more than 90 projects per 100 scientific staff. However, there was very little overlap between these labs/institutes that had developed a higher number of technologies and had undertaken a higher number of projects. The 29 labs/institutes that were observed to have not developed any technologies were predominantly from among the major scientific agencies.
- While the major beneficiaries of the lab's programmes are government departments, the labs/institutes may wish to engage with NGOs for greater socio-economic impact.
- There were 37 labs/institutes incubated startups of which 11 labs/institutes that incubated startups were performing only basic R&D. Labs/institutes were found to be supporting startups through different support mechanisms like research support, mentorship, training, consultancy services and other forms while only 5 labs/institutes supported them through all support mechanisms.
- There were 31 labs/institutes that supported deep science and deep tech startups.
- Close to 50 percent of the labs/institutes awarded less than 10 educational degrees. The infrastructure and resources within the labs/institutes of the key scientific ministries should be made more accessible to the higher education system to benefit students pursuing science and engineering degrees.

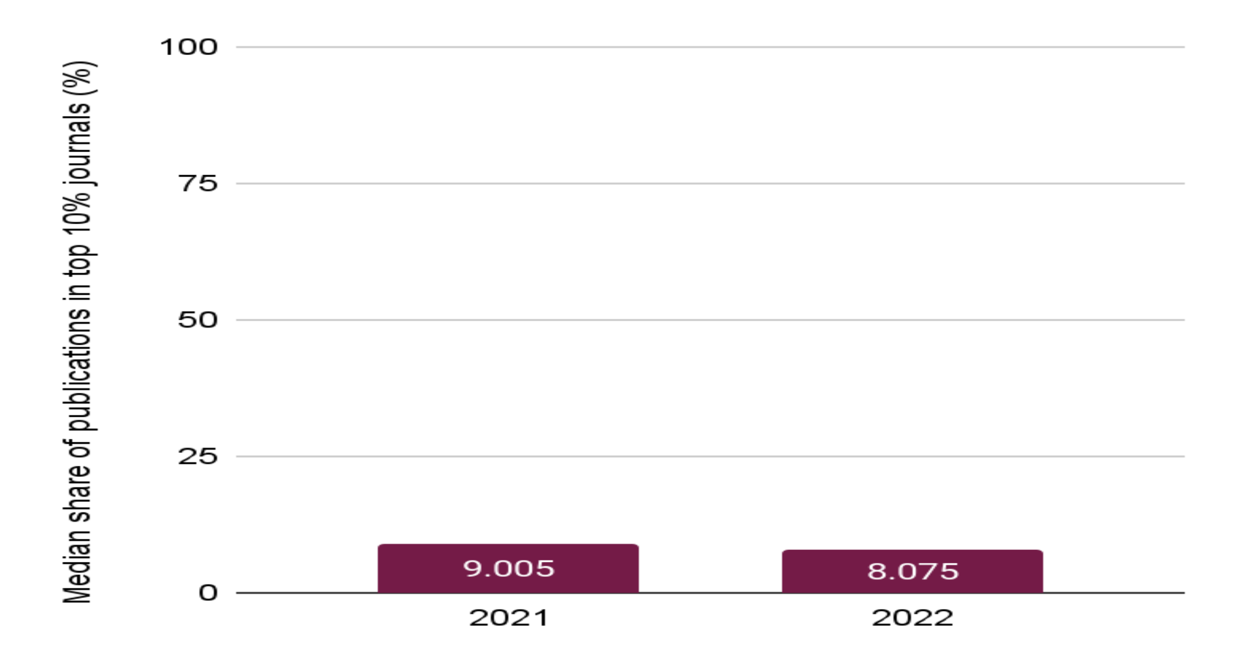
- There were around 68 labs/institutes that took on up to 60 interns per 100 scientific staff and 49 labs/institutes did not train any interns. It is pertinent to mention that labs/institutes where possible should look to increase the number of internships provided per year to inculcate 'scientific temper' among the youth of the country.

8.2 Pillar 2: Science, Technology and Innovation Excellence

- A majority of the labs/institutes were seen to be engaging in filing patents and a majority were also granted patents, however only around a third of them are seen to be licensing out their patents.
- There were 71 labs/institutes that did not obtain any patents in any emerging areas of technology. Higher number of patents were granted in bio-engineering technologies followed by industrial technologies and sustainable technologies.
- Close to thirty eight percent of the labs/institutes did not introduce a single new product or service in the years under consideration.
- The main source of external funding for the labs/institutes has been government funding, while for nearly three quarters of the labs/institutes the amount received through external funding is less than Rs. 2 crore for every Rs. 10 crore of their budget spent.
- There were just 21 labs/institutes that had ongoing international industry collaborations while 73 labs/institutes had ongoing national industry collaborations.
- Compared to industry collaborations, there were a lot more labs/institutes engaged in project collaborations with both international and national academic institutions and/or research labs/institutes.

8.2.1 Sub-pillar 3: Scholarly research, development output and quality

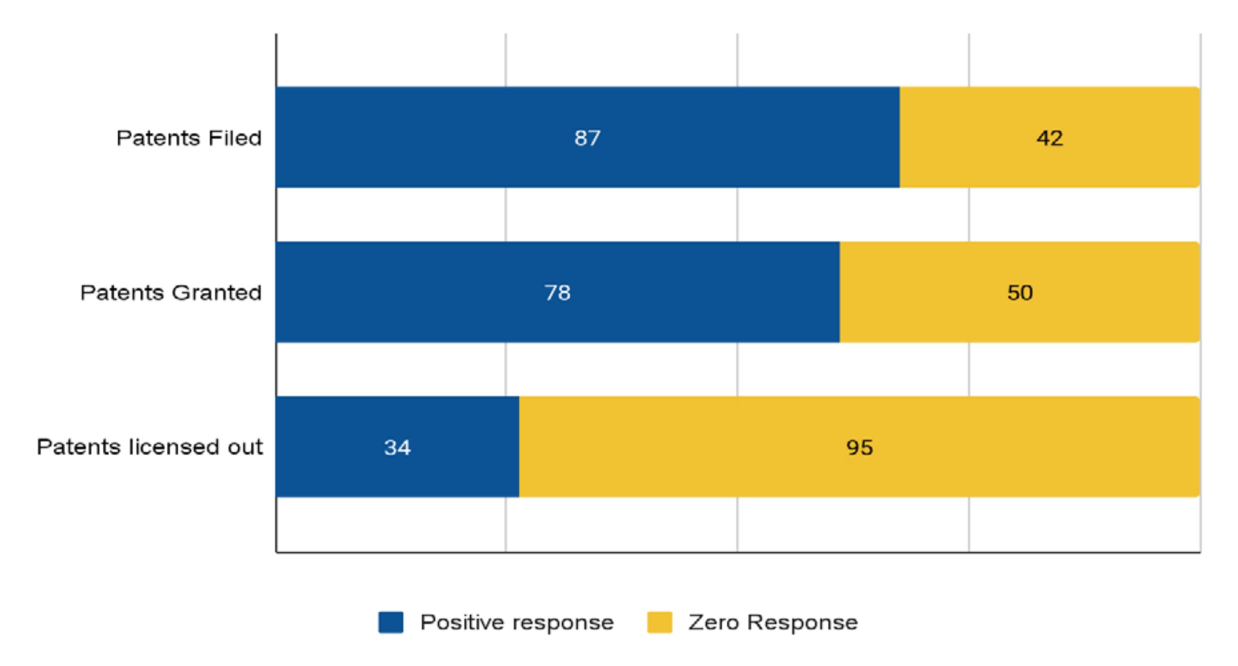
Figure 8.10: Median share of publications in top 10 percent journals



The median share of publications in the top 10 percent journals was just around 9 percent for both years. There is a need for labs/institutes to focus publishing in high quality peer-reviewed journals.

8.2.2 Sub-pillar 4: Development and innovation output and quality

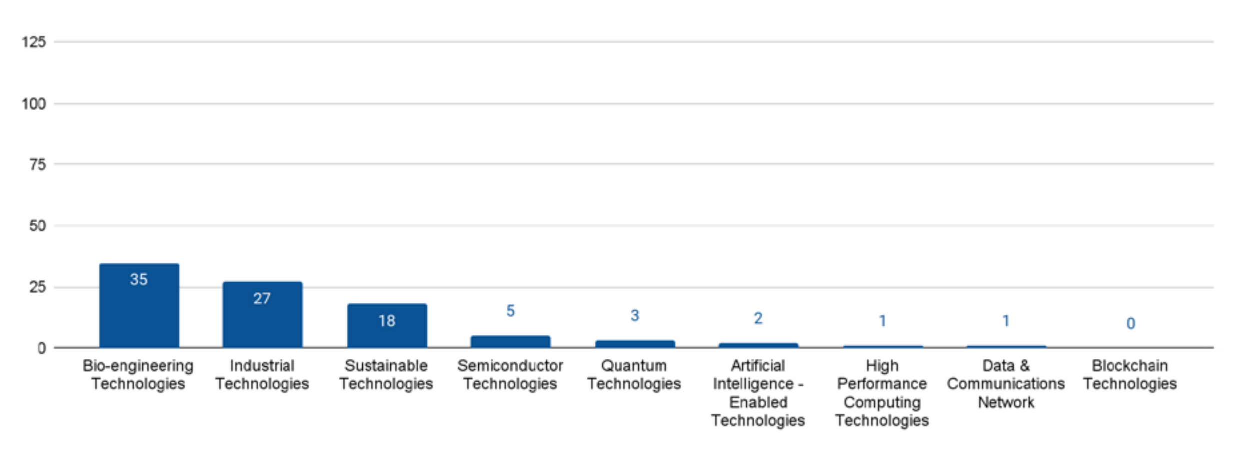
Figure 8.11: Patents filed, granted and licensed out



Note: Analysis is done for 128 labs/institutes for patents granted data. One lab/institute was excluded as their response could not be verified.

When it came to patents filed and patents granted, the data above shows that 70 percent of the labs/institutes filed patents in the period under consideration, while around 60 percent of the labs/ institutes also obtained patents during this period. However when it came to licensing out patents, the share of labs/institutes dropped to nearly a third. Although a large number of labs/institutes are filing patents and obtaining patents, the total number of patents filed or granted per 100 scientific staff or even per Rs. 10 crore of budget spent is very low in general.

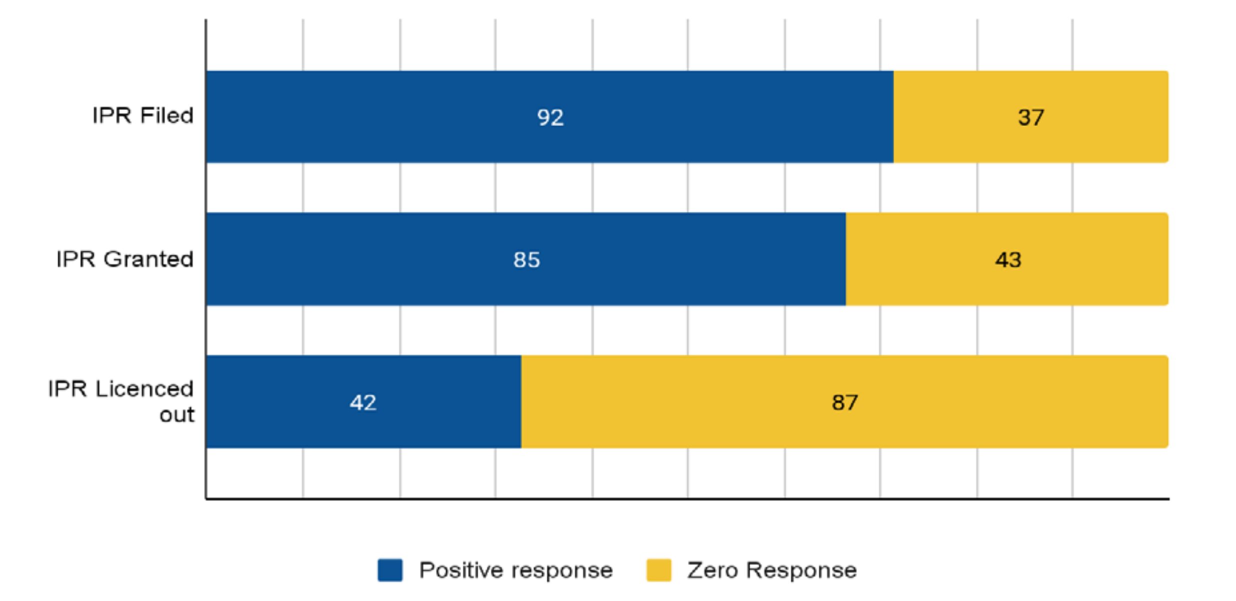
Figure 8.12: Patents granted in emerging areas of technology



Note: Analysis is done for 128 labs/institutes. One lab/institute was excluded as their response could not be verified.

There were 57 labs/institutes that obtained patents in the emerging areas of technology while there were 71 labs/institutes that did not obtain any patents in any emerging areas of technology. As can be seen in the above chart, a higher number of patents were granted to these 57 labs/institutes in bio-engineering technologies followed by industrial technologies and sustainable technologies. Of these 57 labs/institutes 22 labs/institutes were from CSIR, 13 labs/institutes were from ICAR, 8 labs/institutes from DST, 7 labs/institutes from DBT, 4 labs/institutes from ICMR, 1 lab each from MoEFCC and MoES, and the remaining 1 labs/institutes was from other central government ministries.

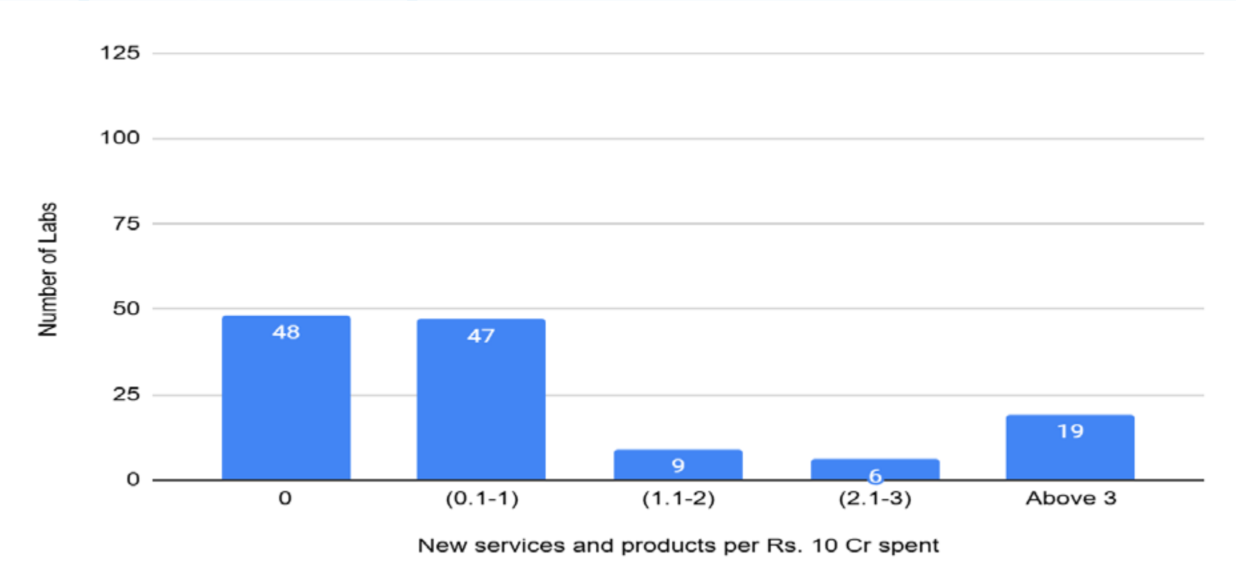
Figure 8.13: Intellectual Property Rights filed, granted and licensed out



Note: Analysis is done for 128 labs/institutes for IPR granted data. One lab/institute was excluded as their response could not be verified.

The chart captures the data on how many labs/institutes are filing, being granted and have licensed out any IP (patents, trademarks, copyrights, plant variety) etc. The pattern observed is similar. Patents form the largest category of the IPR as can be seen when the two charts are compared.

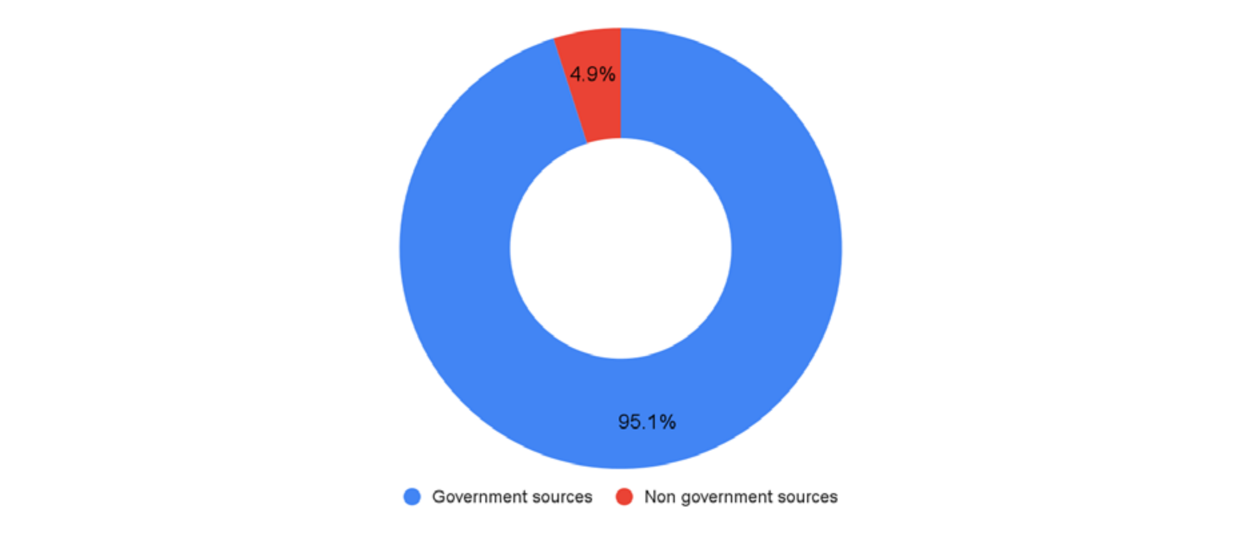
Figure 8.14: New services and/or products introduced per Rs.10 crore spent



There were 48 labs/institutes, or nearly 38 percent of the labs/institutes, that did not introduce a single new product or service in the period under consideration. There were 56 labs/institutes that introduced up to 2 new products and/or services per Rs.10 crore of budgetary support while 25 labs/institutes introduced more than 2 new products and/or services per Rs. 10 crore of budgetary support. The 25 labs/institutes that introduced more than 2 new products and/or services per Rs. 10 crore of budgetary support were dominated by labs/institutes from ICAR.

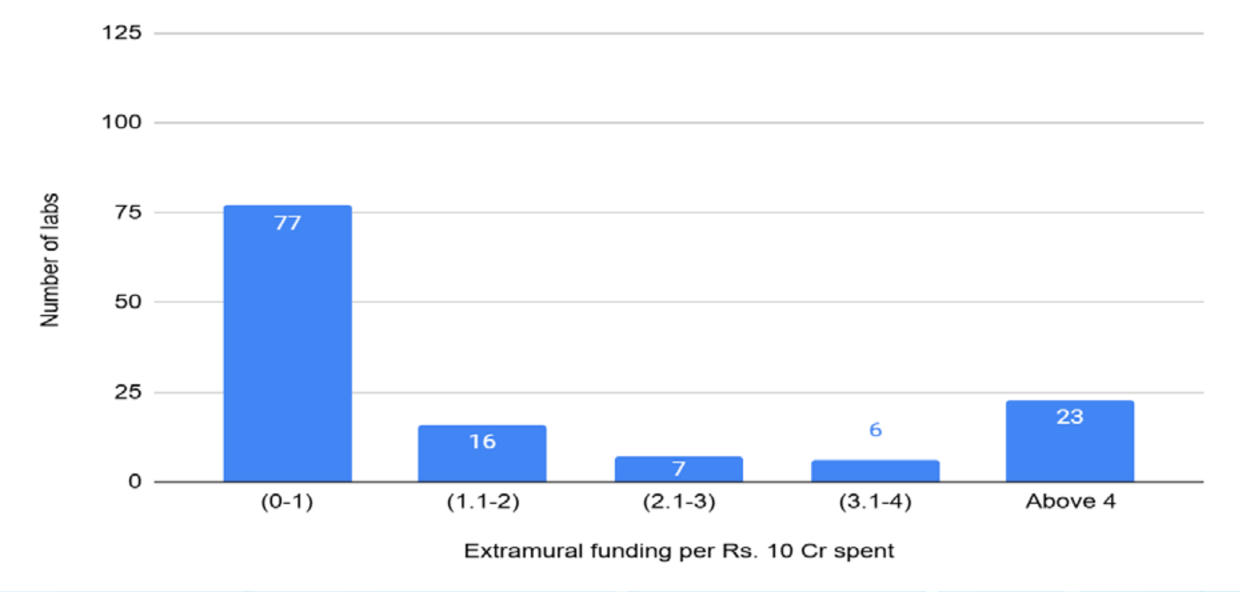
8.2.3 Sub-pillar 5: Commercialisation of technologies and revenue generation

Figure 8.15: Extramural funding from government and non-government sources (%)



The pie-chart here clearly illustrates that the bulk of extramural funding received by the labs/ institutes is from government sources. Looking at the extramural funding received from government sources, there are 93 labs/institutes that received less than Rs. 2 crore of extramural funding for every Rs. 10 crore of budget spent. There were around 23 labs/institutes that received more than Rs. 4 crore through extramural funding for every Rs. 10 crore of budget spent. Of these 23 labs/ institutes, there were 7 ICAR labs/institutes, 5 DBT labs/institutes, 4 ICMR labs/institutes, 1 DST, 1 MEITY lab and the balance from other central government ministries.

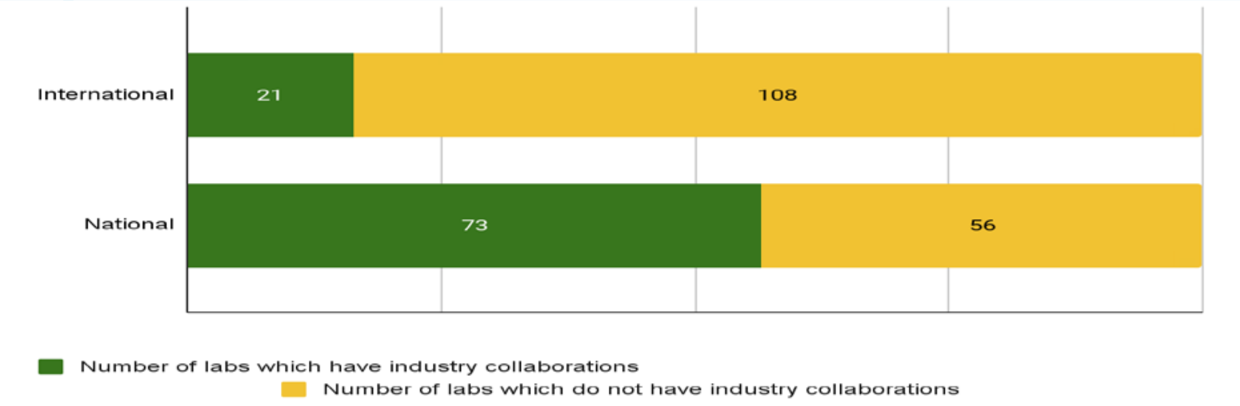
Figure 8.16: Extramural funding received from government per Rs 10 crore spent



Around 48 percent of the labs/institutes did not receive any extramural funding from non-government sources. There was one lab that received more than Rs. 4 crore through extramural funding for every Rs. 10 crore of budget spent. This lab was from DBT. Most of the labs/institutes that did receive any extramural funding from non-government sources received up to Rs. 1 crore for every Rs. 10 crore of budgetary support.

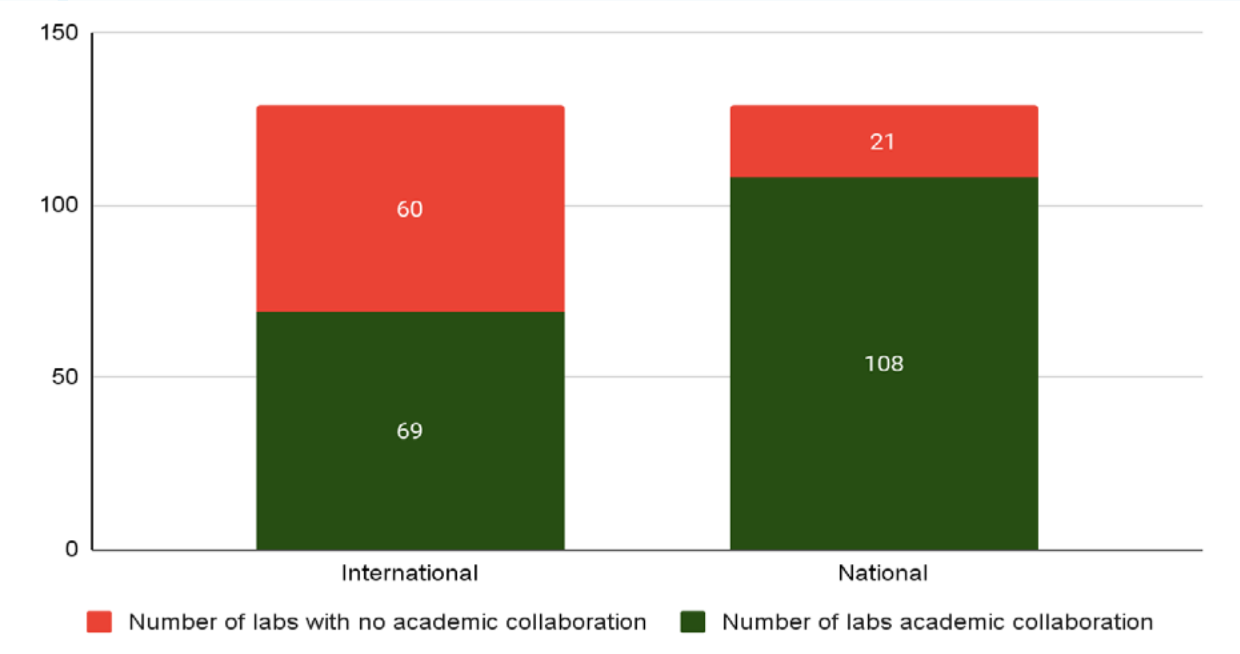
8.2.4 Sub-pillar 6: Collaborative research

Figure 8.17: International and National industry project collaborations



When it came to project collaborations, there were just 21 labs/institutes that had ongoing international industry collaborations while 73 labs/institutes had ongoing national industry collaborations. There were 55 labs/institutes that had absolutely no national or international collaboration with industry. There were a lot more labs/institutes that had project collaborations ongoing with both international and national academic and/or other research institutions. There were 65 labs/institutes engaged in international collaborations and 80 labs/institutes engaged in national collaborations when it came to projects. There were 10 labs/institutes that had no international or national project related collaborations. As can be seen in the chart above, for a majority of the labs/ institutes the share of international or national collaborations in their projects was up to 20 percent.

Figure 8.18: Collaborations with academic institutions and/ or research labs/institutes



Compared to industry collaborations, there were a lot more labs/institutes engaged in project collaborations with both international and national academic institutions and/or research labs/ institutes. There were 69 labs/institutes that had international and 108 labs/institutes that had national collaborations with academic institutions and/or research labs/institutes. Of the 69 international collaborations, there were 53 labs/institutes which had up to 5 collaborations per 100 scientific staff while there were 16 labs/institutes which had more than 5 international collaborations per 100 scientific staff. Of these 20 labs/institutes which had more than 5 international collaborations, there were 5 labs/institutes each from DST and DBT, 3 labs/institutes from ICMR, 1 lab from CSIR and the remaining 2 labs/institutes were from other central government ministries.

Of the 108 labs/institutes that had national collaborations with academic institutions and/or research labs/institutes, there were 32 labs/institutes which had up to 5 collaborations per 100 scientific staff while 39 labs/institutes had between 5 to 20 collaborations per 100 scientific staff. On the higher end there were 37 labs/institutes which had more than 20 collaborations per 100 scientific staff. Of these 37 labs/institutes there were 9 labs/institutes each from ICAR and ICMR, 6 labs/institutes from DBT, 4 labs/institutes from DST, 3 labs/institutes from MoEFCC, 1 lab each from CSIR and Ministry of AYUSH and the remaining 4 labs/institutes were from other central government ministries.

Key Takeaways:

- Of the 44 percent labs/institutes that had obtain patents in emerging areas of technology higher numbers were from bio-engineering technologies, industrial technologies and sustainable technologies however the basic R&D labs/institutes could obtain more patents in other emerging areas like semiconductor, quantum, artificial Intelligence, high performance computing, data & communications network, and blockchain.
- Many labs/institutes are not currently engaged in licensing out their patents. This is one area where labs/institutes could be provided assistance by their respective departments/ ministries or industry associations in facilitating a wider access to the technologies being developed by the labs/institutes.
- Around 38 percent of the labs/institutes did not introduce a single new product or service in the three years under consideration. There were 25 labs/institutes that introduced more than 2 new products and/or services per Rs. 10 crore of budgetary support and were dominated by labs/institutes from ICAR.
- There is significant scope for increased project collaborations not just with industry but also with other academic and/or research institutions. This will also possibly contribute to diversifying the sources of extramural funding away from mainly government sources, and through international projects also allow for greater international funding.

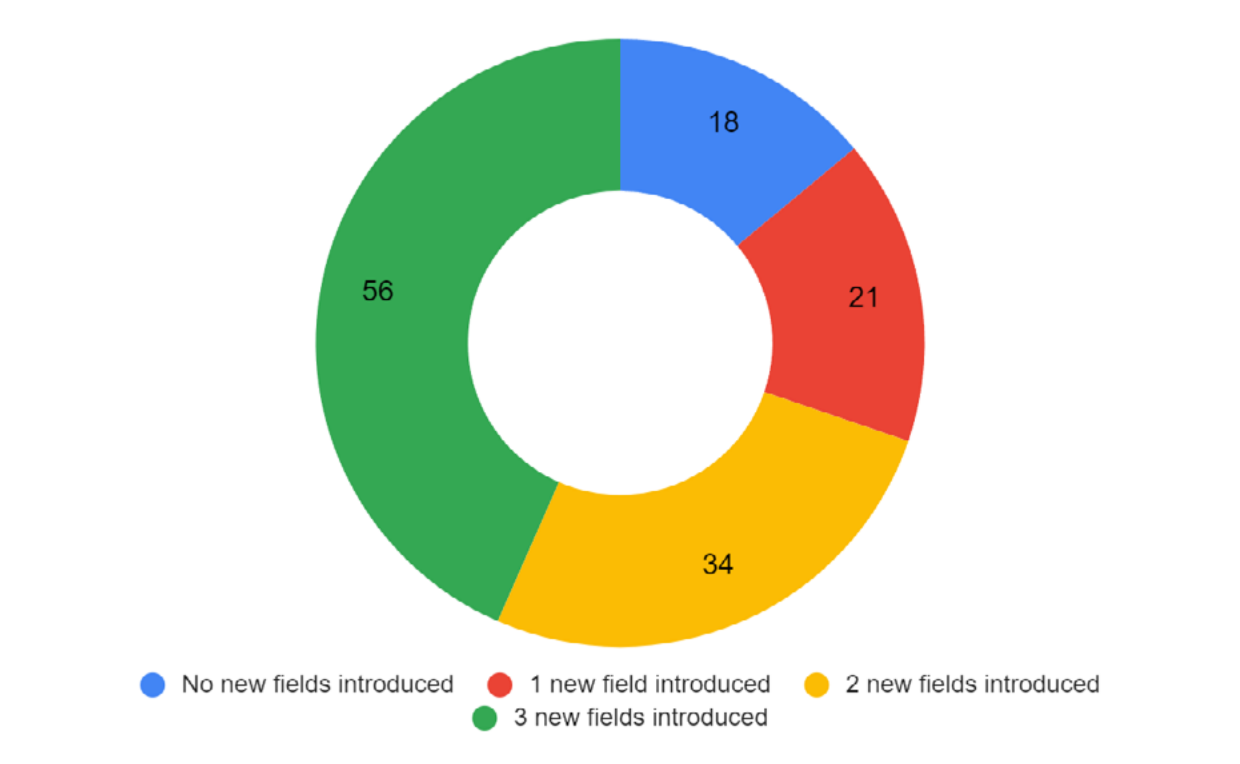
8.3 Pillar 3: Organizational Effectiveness

The indicators considered here look at the number of new research fields/ innovations/ services that have been introduced by a lab in each year under consideration, the share of scientists and project based (contractual) researchers in the overall staff, indicators on governance that include for example whether the labs/institutes have ethics guidelines and policies in place, a sexual harassment mitigation cell, indicators on EDI and lastly the amount spent towards internal capacity building of the staff.

- There were 111 labs/institutes that introduced at least one new research field/ innovation/ service on average every year for the period under consideration, of which 56 labs/ institutes introduced 3 new research fields/innovations/services each year.
- Around 74 labs/institutes had a share of permanent scientists and project based (contractual) researchers in total staff that was greater than 50 percent. The median share of the budget spent in R&D was around 45 percent for the Basic R&D labs/ institutes.
- There were 90 labs/institutes that had procedures in place for sustainable sourcing of material. There were 51 labs/institutes that adhered to all 8 types of the waste reclamation procedures whereas 23 labs/institutes followed at least 6 of these.
- In terms of governance, the labs/institutes were following an effective management system for nearly all the parameters.
- A majority of labs/institutes were also found wanting when it came to having an EDI cell, while the share of women in research staff was between 25 percent to 50 percent for around 54 labs/institutes. There were 74 labs/institutes for whom more than 50 percent of their staff consisted of young researchers (below the age of 40).
- Out of the 129 labs/institutes, 88 labs/institutes spend less than 1 percent of their budget on training and skill upgradation of their staff.

8.3.1 Sub-pillar 7: Mandate alignment

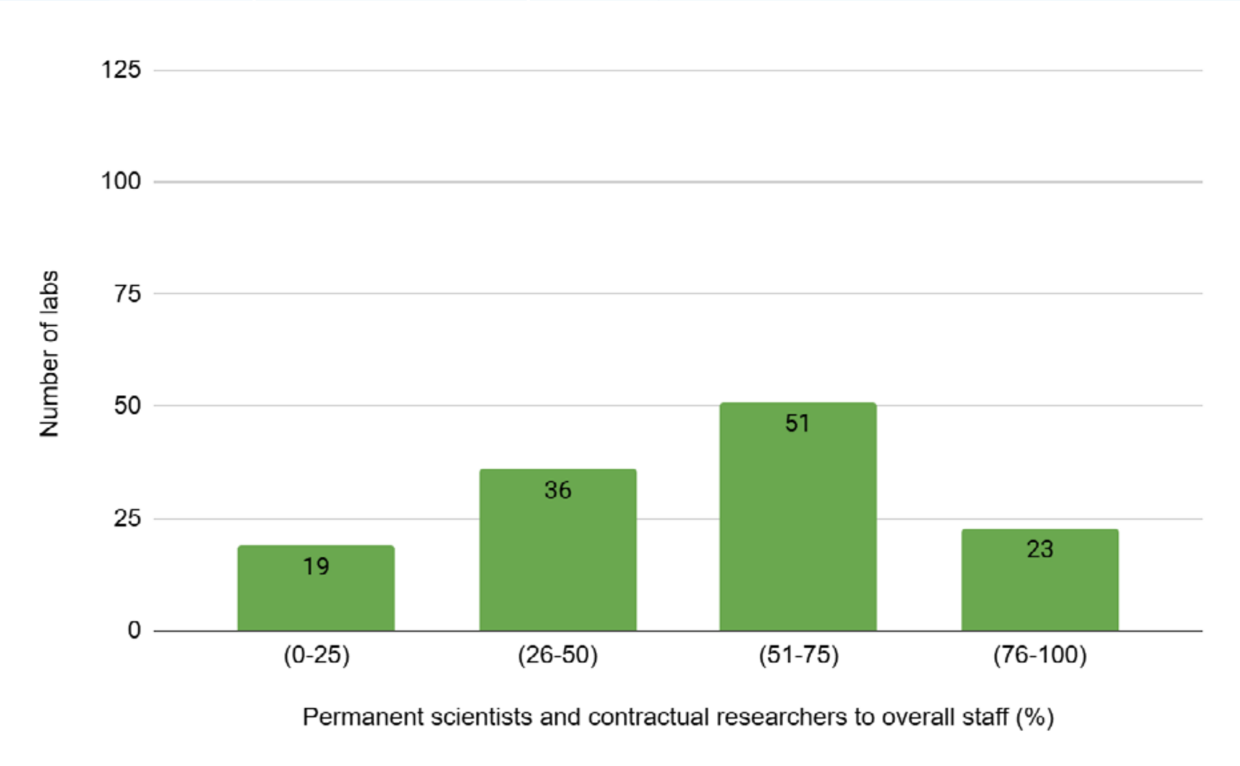
Figure 8.19: New research fields/innovations/services introduced by the labs/institutes (up to 3)



As can be seen in the chart, there were 56 labs/institutes that introduced 3 new research fields/ innovations/ services in each year for the period under consideration, while 34 labs/institutes introduced at least 2 new fields/ innovations/services in each year. While the labs/institutes have provided the necessary details of the fields or innovations or services introduced, it would require domain experts to evaluate the impact of these new fields/ innovations/ services introduced.

8.3.2 Sub-pillar 8: Resource management

Figure 8.20: Share of permanent scientists and contractual researchers to overall staff

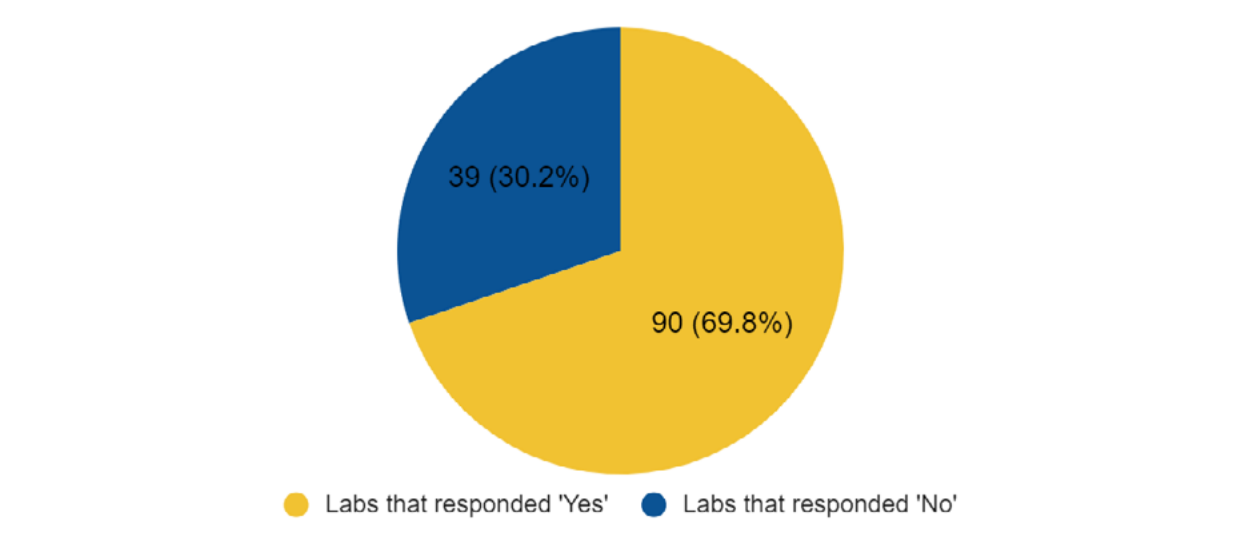


Note: Analysis is done for 128 labs/institutes. One lab/institute was excluded as their response could not be verified.

For 74 labs/institutes, the share of permanent scientists and project based (contractual) researchers in total staff is over 50 percent. There were 19 labs/institutes for whom the share of permanent scientists and project based (contractual) researchers was less than 25 percent. The median value for R&D and S&T expenditure as a share of a lab's overall budget was close to 45 percent for the 129 basic labs/institutes. The R&D and S&T related expenditure was meant to include all research related expenditure including salaries paid to the researchers and travel costs related to research etc. and was required to exclude administrative and other running costs. There is a possibility of under-reporting by labs/institutes when it comes to R&D and S&T expenditure from a computational standpoint. Less than a quarter of labs/institutes reported their R&D and S&T related expenditure as a share of the overall budget to be in excess of 75 percent.

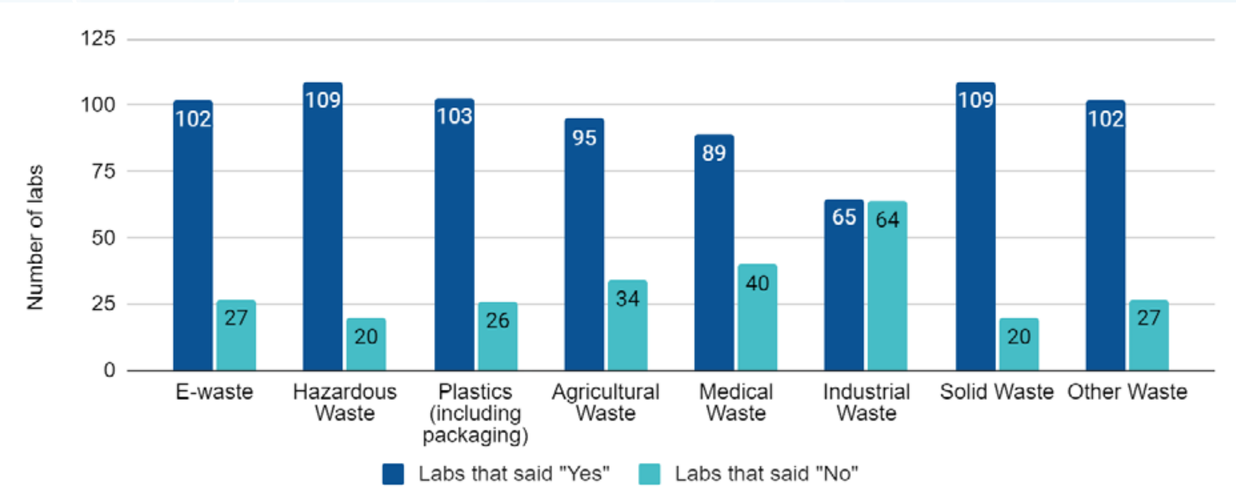
8.3.3 Sub-pillar 9: Governance

Figure 8.21: Sustainable sourcing of materials



There were 90 labs/institutes that had procedures in place for sustainable sourcing of material. Of these 90 labs/institutes there were 20 labs/institutes each from ICAR and CSIR, 11 labs/institutes from DST, 9 labs/institutes from DBT, 7 labs/institutes from Ministry of Ayush, 6 labs/institutes from ICMR, 4 labs/institutes from MoEFCC, 2 labs/institutes from MoES, 1 lab from MeitY, and the remaining 10 labs/institutes were from other central government ministries.

Figure 8.22: Number of labs/institutes with safe waste reclamation policies



The policies related to safe waste reclamation under the new Business Responsibility and Sustainability Reporting (BRSR) include e-waste, hazardous waste, plastics (including packaging), agricultural waste, medical waste, industrial waste, solid waste, and other types of waste. There were 51 labs/institutes that adhered to all of the waste reclamation procedures whereas 23 labs/institutes followed at least 6 of these procedures. There were 102 labs/institutes that had procedures in place for safe reclamation of e-waste, whereas 29 labs/institutes had yet to incorporate these procedures.

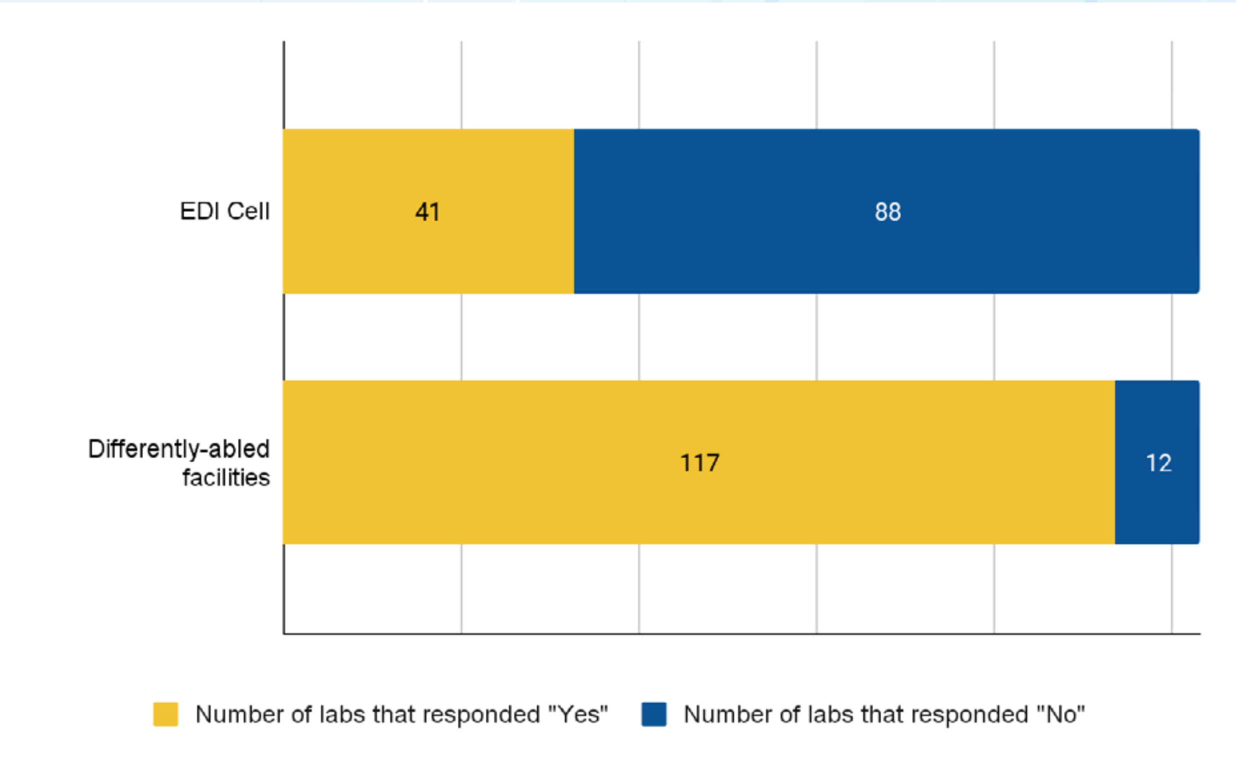
Table 8.1: Effectiveness of Management System

Question	Share of labs/institutes that responded 'Yes' (%)
Are there initiatives in place to promote intra-organisational collaborations?	99
Has your organization adopted any digital technologies that would enhance R&D activities?	82
Does your organization have necessary ethics guidelines and policies in place?	98
Does your organisation have a sexual harassment mitigation cell with requisite policies and procedures?	99
Does your organization have a public grievance redressal cell?	98

As can be seen in the table above, nearly all labs/institutes have incorporated effective management system in terms of promoting collaborations within the organization, having the necessary ethics guidelines in place, have established a sexual harassment mitigation cell with necessary policies and also have a public grievance redressal cell. Over 80 percent of the labs/ institutes have adopted digital technologies to enhance their R&D activities.

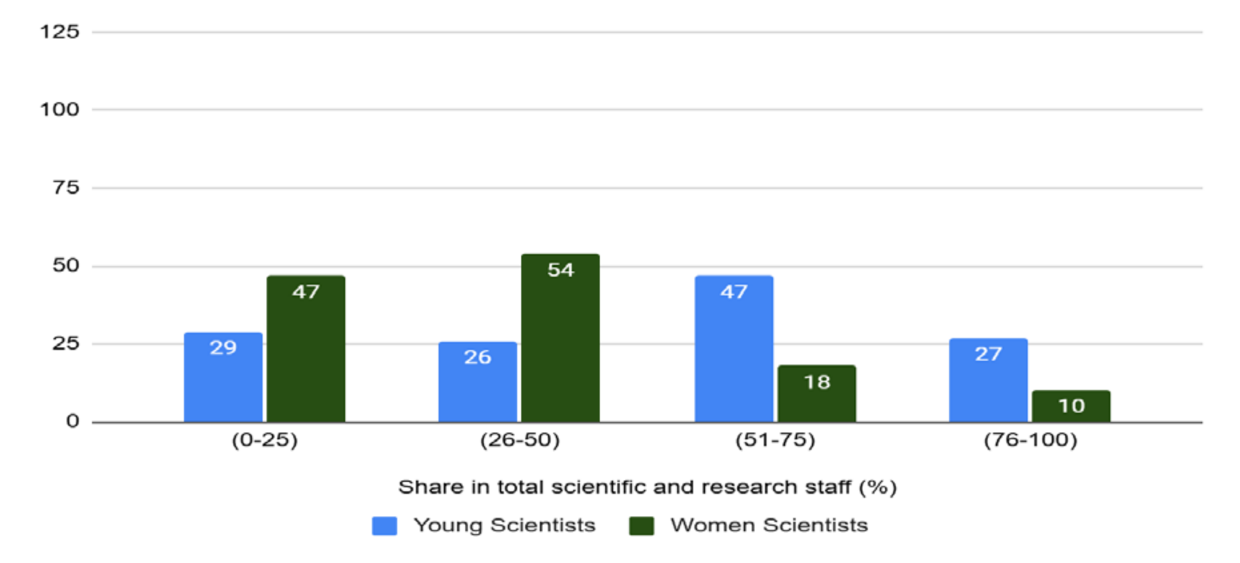
8.3.4 Sub-pillar 10: Equity, diversity, and inclusion

Figure 8.23: Provision of EDI cell and differently-abled friendly facilities



Despite the growing awareness and importance of equity, diversity and inclusion, there were only 41 labs/institutes that said they had EDI cells. It would be important for all labs/institutes to continue to strive towards adopting objectives of promoting equity, diversity and inclusion at the workplace, and also establishing the necessary mechanism in the form of a cell or committee that could address any issues that may arise.

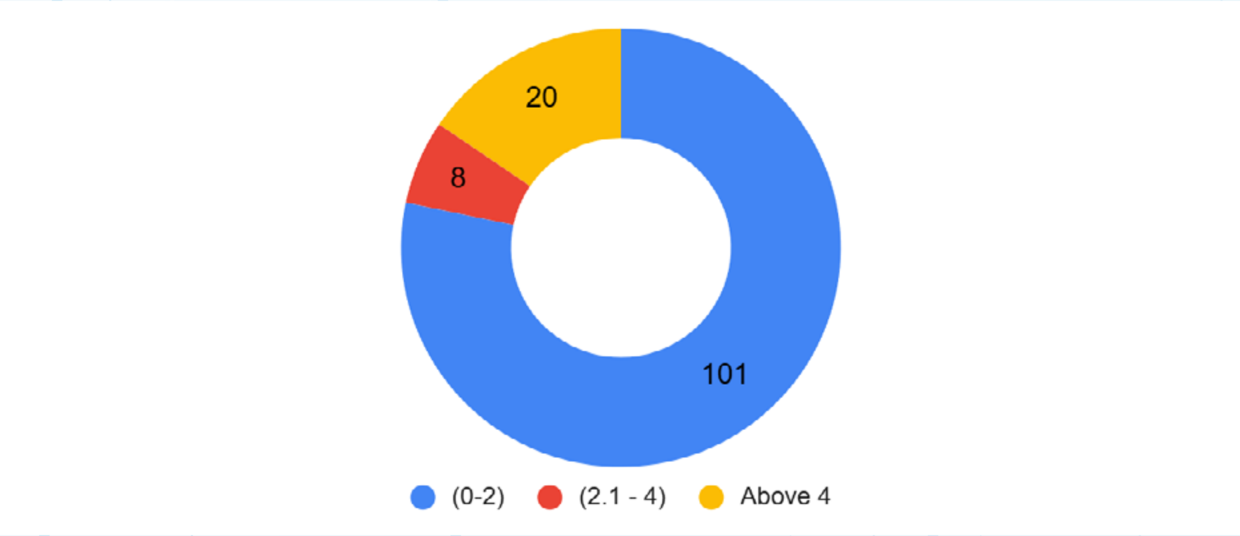
Figure 8.24: Share of young scientists and women scientists to the total scientific and research staff



With respect to women scientists as a share of the total scientific and research staff, there were 54 labs/institutes whose share of women scientists was between 25 and 50 percent while 18 labs/ institutes had a share between 50 to 75 percent. There is scope for 47 labs/institutes to increase the share of women scientists in their scientific and research staff. These 47 labs/institutes include 9 labs/institutes from CSIR, 8 labs/institutes each from ICAR and ICMR, 6 labs/institutes from Ministry of AYUSH, 4 labs/institutes from DST, 2 labs/institutes from MoEFCC, 1 lab each from DBT and MOES and the remaining labs/institutes from other central government ministries. In addition, there were 74 labs/institutes for whom more than 50 percent of their scientific and research staff were young researchers (below the age of 40).

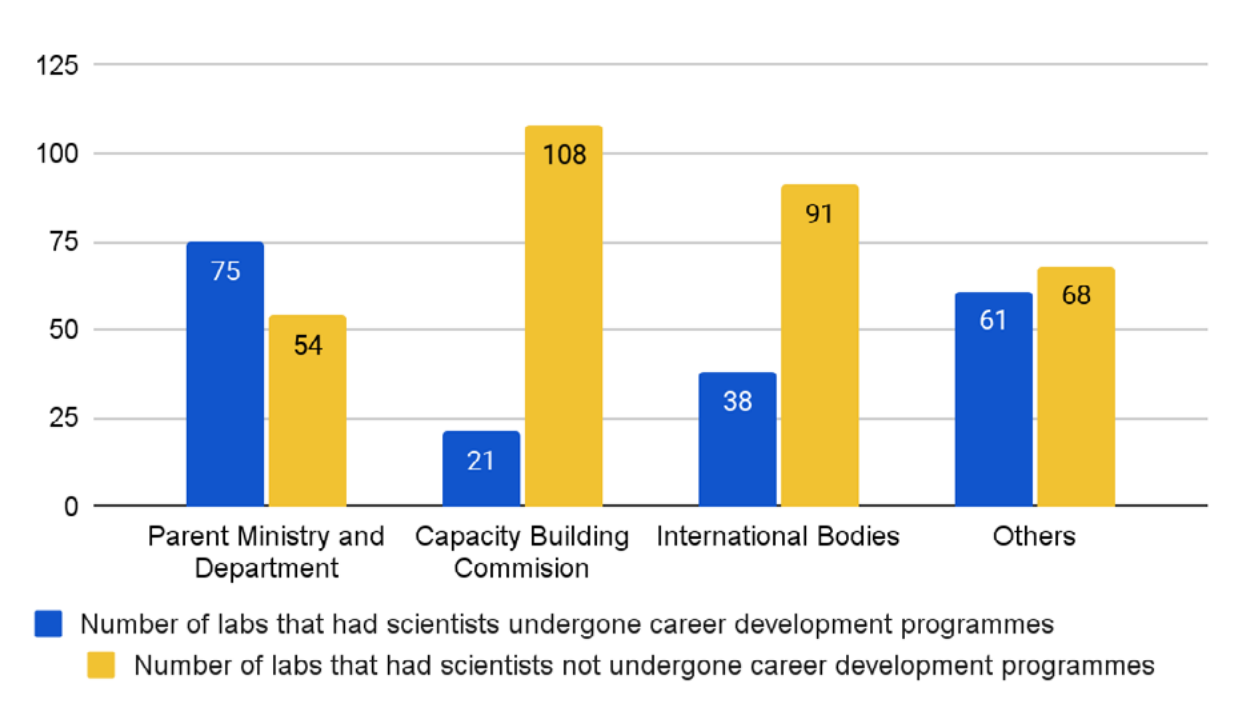
8.3.5 Sub-pillar 11: Internal capacity building

Figure 8.25: Share of the total budget spent on training and skill up-gradation of the staff (%)



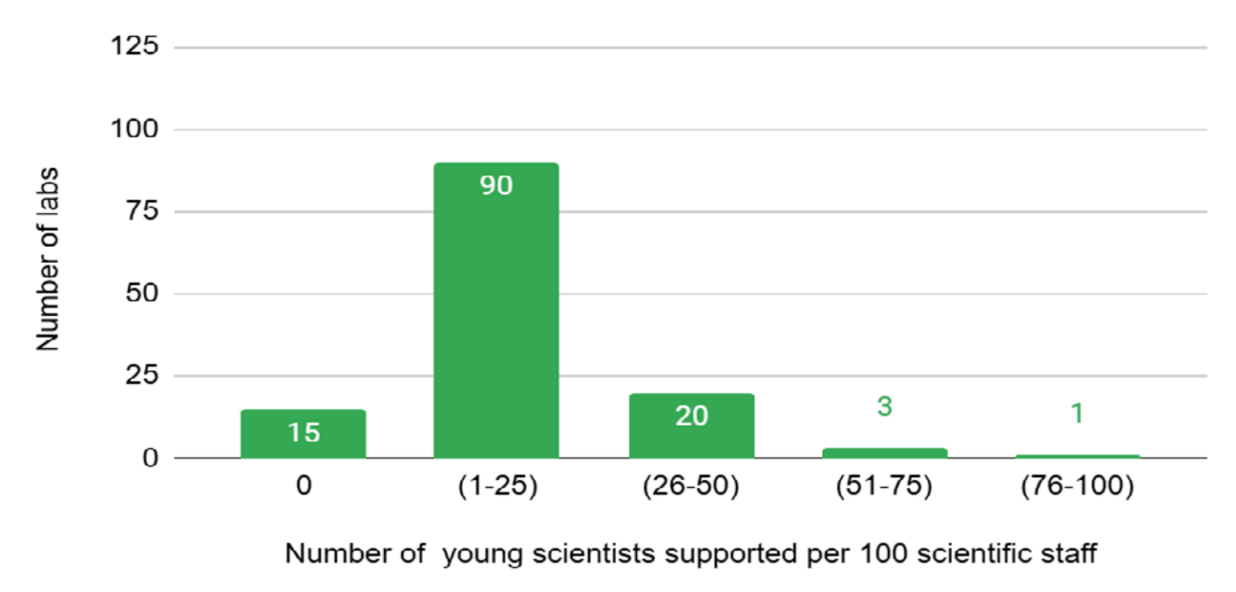
The expenditure being captured here includes training for the administrative staff as well as the scientific and research staff. Most labs/institutes have allocated very little of their budget towards training their staff. Of the 129 basic labs/institutes, there are 101 labs/institutes that spend between 0 and 2 percent of their budget towards training or on opportunities for skill upgradation of their staff. In fact, of these 101 labs/institutes, there are close to 88 labs/institutes that spend less than 1 percent of their budget on training. Increased expenditure on training and skill upgradation would be important to complement the R&D and other activities of the labs/institutes. We have already seen the median spend on R&D and S&T as a share of the overall budget being quite low at 45 percent. Thus a majority of labs/institutes may need to take a holistic approach towards their R&D and S&T expenditure that also sees increased allocation towards training of their staff. Training of the administrative staff to support the scientific and research staff would also be very important.

Figure 8.26: Number of labs/institutes that had scientists undergo a career development programmes



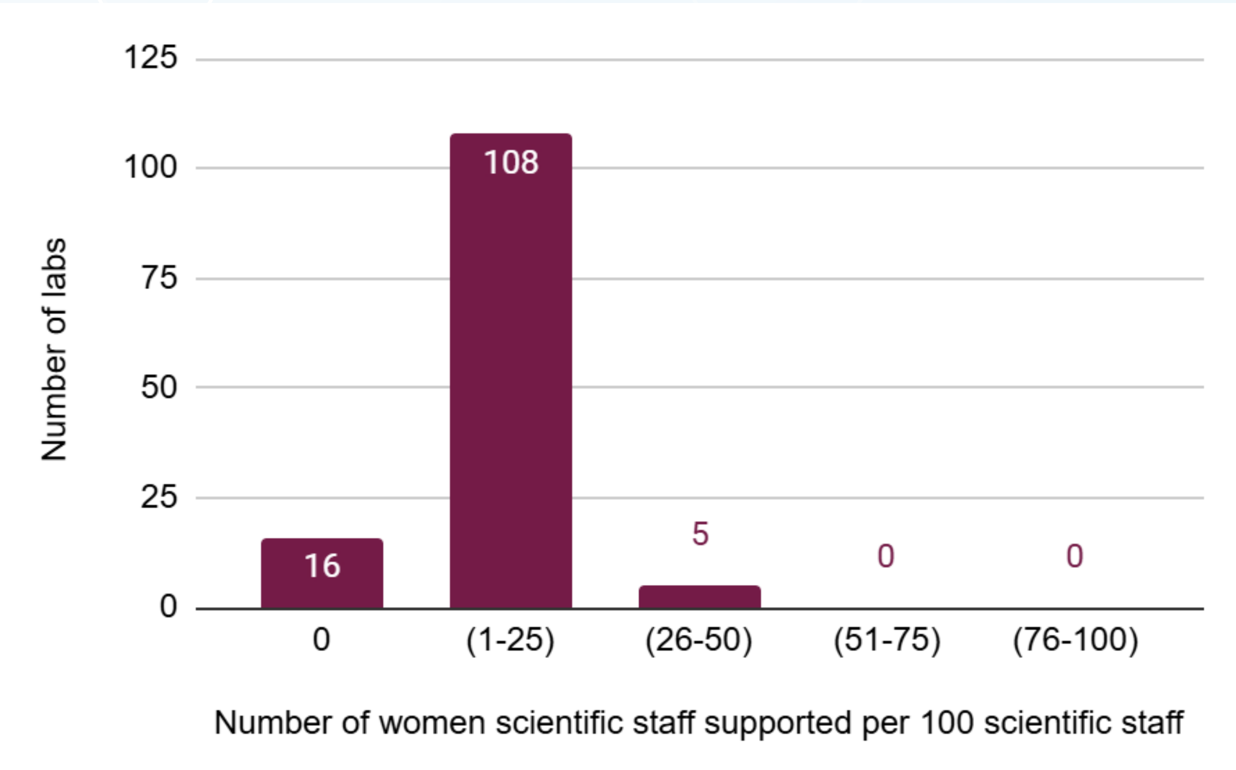
As can be seen in the accompanying chart, the majority of the labs/institutes had scientists participating in career development programmes within their parent ministry and departments and other departments. While 38 labs/institutes had scientists involved in career development programmes organized by international bodies, only 21 labs/institutes had scientists who participated in career development programmes organized by capacity building commissions.

Figure 8.27: Distribution of labs/institutes by number of young scientists supported



Of the 129 labs/institutes there were 114 labs/institutes that supported young scientists through conferences, training, sabbaticals, etc. As can be seen in the above chart there were 90 labs/institutes that supported up to 25 young scientists per 100 scientific staff whereas 20 labs/institutes supported between 25 to 50 young scientists per 100 scientific staff. On the higher end of young scientists being supported, there were only 3 labs/institutes that supported between 50 to 75 young scientists while only one lab from DBT supported between 75 to 100 young scientists. Of the 3 labs/institutes that supported between 50 to 75 young scientists, 1 lab each was from CSIR, DBT, and MoEFCC.

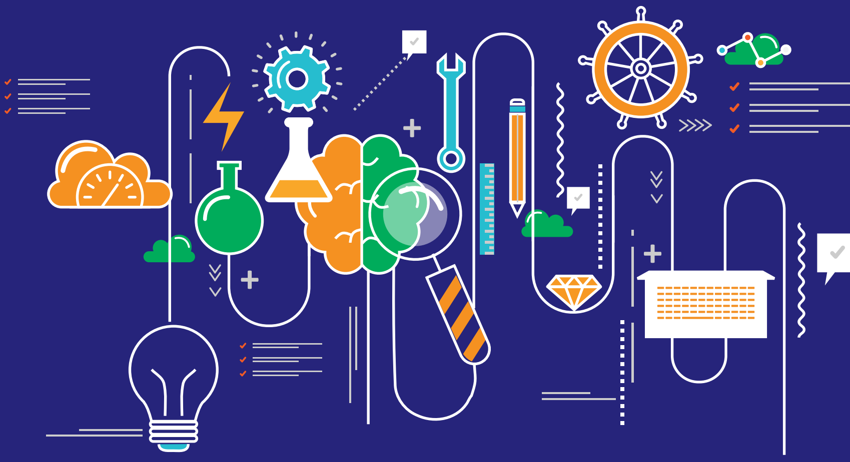
Figure 8.28: Distribution of labs/institutes by number of women scientific staff supported



Of the 129 basic R&D labs/institutes, 113 labs/institutes supported women scientific staff through conferences, training, sabbaticals, etc. There were 108 labs/institutes that supported up to 25 women scientific staff through conferences, training, sabbaticals, etc whereas only 5 labs/institutes supported between 25 to 50 women scientific staff. There were no labs/institutes that provided conferences, training, sabbaticals, etc to more than 50 women scientific staff per 100 scientific staff. Of the 5 labs/institutes that supported between 25 to 50 women scientific staff 1 lab each were from DBT, ICAR, ICMR, and the Ministry of Ayush and the remaining 1 lab was from other central government ministries.

Key Takeaways:

- There were 56 labs/institutes that introduced 3 new research fields/ innovations/ services in each year for the period under consideration, while 34 labs/institutes introduced at least 2 new fields/ innovations/services in each year.
- There were 19 labs/institutes for whom the share of permanent scientists and project based (contractual) researchers was less than 25 percent. There is scope for many labs/ institutes to increase the share of permanent and contract researchers in their total staff.
- 88 labs/institutes do not have an EDI cell, establishing an EDI cell and increasing the share of women researchers in their total scientific staff would be important for labs/institutes to work towards for several labs/institutes.
- labs/institutes would also need to invest in upgrading the skills of their research as well as administrative staff to complement the other research activities being undertaken. Currently there are 101 labs/institutes that spend between 0 and 2 percent of their budget towards training or on opportunities for skill upgradation of their staff. Of these 101 close to 88 labs/ institutes spend less than 1 percent of their budget on training.
- 20 labs/institutes supported between 25 to 50 young scientists per 100 scientific staff while only 5 labs/institutes supported between 25 to 50 women scientific staff. Efforts should be made to support many more young and women researchers for conferences, training, sabbaticals, etc.



Chapter 9

Applied R&D Labs/institutes

Applied research by definition is an original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim or objective. The TRL levels of the technologies developed by these labs/institutes were 5 or higher. There were 175 labs/institutes that categorized themselves as Applied R&D labs/institutes. This chapter analyzes the responses of labs/institutes that chose to categorize themselves as doing Applied R&D.

Chapter Summary

- Around 88 labs/institutes had developed up to 10 technologies (targeting SDGs and/or national programmes) and 41 labs/institutes that had developed more than 15 technologies per hundred scientific staff
- There were 46 labs/institutes or around 26 percent of the labs/institutes that executed more than 80 projects per hundred scientific staff
- The primary beneficiaries of the output from the applied labs/institutes are government departments followed by individuals.
- Around 53 labs/institutes were incubating startups whereas only 11 labs/institutes were found to be supporting startups through all support mechanisms like training, consultancy services, research support, mentorship, and other forms. In the case of labs/institutes supporting deep science and deep tech startups of the 175 labs/institutes there were only 35 labs/institutes that supported deep science and deep tech startups.
- There were 126 labs/institutes that offered PhD degrees while 73 labs/institutes awarded Masters degrees.
- The majority of labs/institutes were filing and obtaining patents, but only about a third were licensing them out. 75 labs/institutes obtained patents in emerging areas of technologies, while 99 labs/institutes did not obtain any.
- The main source of external funding for the labs/institutes was from government sources, while sources of earnings are primarily from consultancies followed by training.

- While 97 labs/institutes had ongoing national industry collaborations, only 34 labs/institutes were involved in international industry collaborations. There were 142 labs/institutes that had collaborations with national academic institutions and/or research labs/institutes, compared to 87 labs/institutes with international collaborations.
- There were 84 labs/institutes that introduced 3 new research fields/innovations/services each year
- Around 93 labs/institutes had over 50 percent of their staff as permanent scientists and contractual researchers
- There were 134 labs/institutes that had procedures in place for sustainable sourcing of material while there were 66 labs/institutes that adhered to all of the 8 waste reclamation procedures, 28 labs/institutes followed at least 6 of these procedures.
- 106 labs/institutes allowed outside researchers and students to access their facilities, while 80 labs/institutes opened their facilities to startups and firms.
- 118 labs/institutes had no EDI cell while 59 labs/institutes had women representing 25 percent to 50 percent of their research staff.
- Over 57 percent of the labs/institutes spend less than 1 percent of their budget on training of their scientific and administrative staff whereas only 27 labs/institutes spend over 4 percent of their budget on skills upgradation of their staff.
- Majority of the labs/institutes had scientists participating in career development programs within their parent ministries and other departments. Compared to 54 labs/institutes that had scientists involved in career development programmes organized by international bodies, only 33 labs/institutes had scientists participating in capacity-building commission programs.
- 145 labs/institutes supported up to 25 women scientific staff for conferences, training, sabbaticals, etc, while 116 labs/institutes supported up to 25 young scientists per 100 scientific staff for conferences, training, sabbaticals, etc.

Applied R&D Labs

175 **Labs** or close to **75%** self identified as applied R&D labs

25,773 **Total Scientific Staff**

32% Median Share of Women in Scientific Staff

57% Median Share of Young Researchers in Scientific Staff

9 Number of **New Products/ Services** Introduced **per 100 cr of Budget**

904 **Technologies Transferred** Domestically & Internationally

350 Patents Granted in Emerging Tech primarily in Industrial Technology

₹ 39 cr of budget spent per patent granted

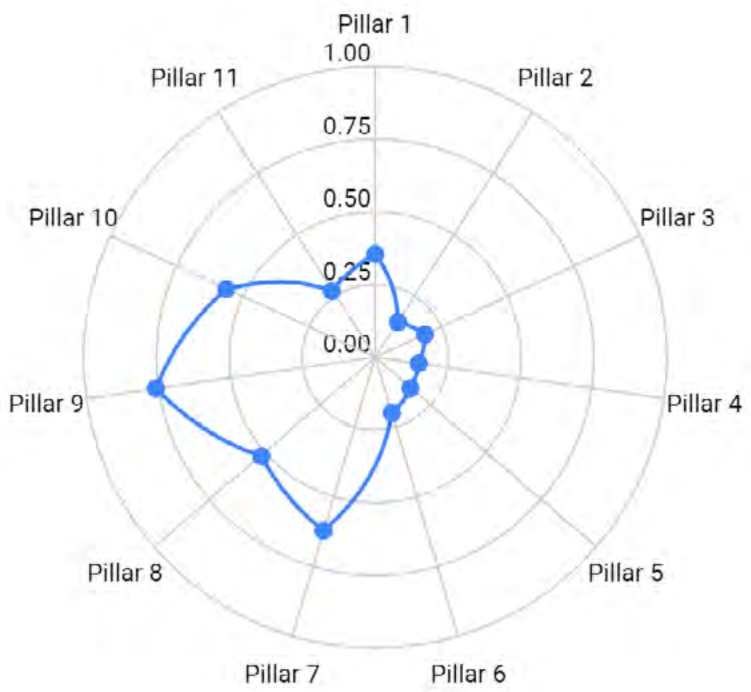
₹ 0.72 **Lakh** in **Earnings from Technology Transfer** Received for Every 1 Cr of Budget

51% Labs had National Collaborations with Industry

There were 175 labs/institutes that categorized themselves as Applied R&D labs/institutes, of which there were 71 labs/institutes that were undertaking pure applied R&D while the remaining 104 labs/ institutes were hybrid in nature i.e. they were also undertaking basic, services and/or applied R&D.

Labs/institutes from CSIR and ICAR accounted for nearly 52 percent of the 175 applied R&D labs/ institutes. When one considers the sample of R&D labs/institutes that were only engaged in applied R&D, the largest numbers of labs/institutes came from ICAR, followed by CSIR, ICMR, and the Ministry of Earth Sciences. The average budget for the overall sample of 175 applied research labs/ institutes was around Rs. 76 crore, while it was around Rs. 77 crore for the 71 labs/institutes that were engaged in only applied R&D. With respect to scientific staff, the average number of scientific staff per labs/institutes for the overall sample of 175 labs/institutes was around 141, with this number dropping to around 132 scientific staff per labs/institutes for the labs/institutes engaged in only applied R&D.

Figure 9.1: Sub-pillar wise Average Scores



9.1 Pillar 1: Socio-economic Impact

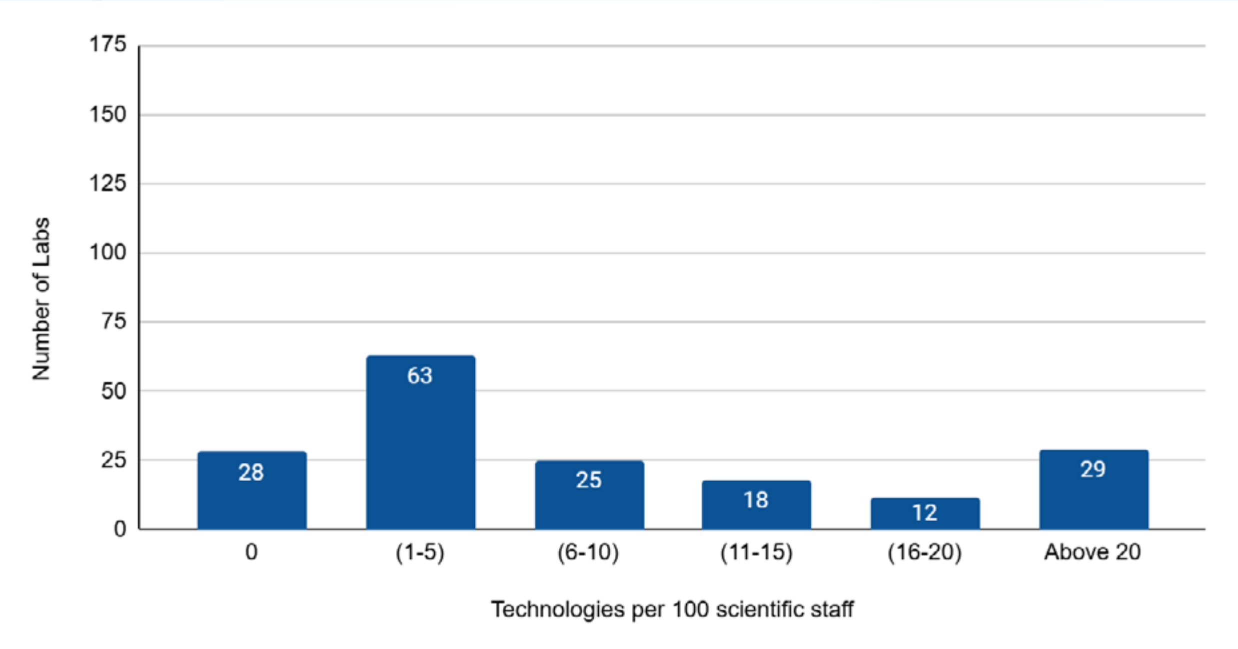
The key indicators in the pillar on socio-economic impact that have been captured below include the number of technologies (with TRL levels 5 and higher) targeted towards SDGs or national programmes, the number of projects being undertaken by the labs/institutes, the targeted beneficiaries of the labs/institutes programmes, startups incubated, and the number of degrees (PhDs, masters, undergraduate) awarded by the labs/institutes. The data presented in the charts below are based on an average of the two years under consideration, namely 2021-22 and 2022-23.

- There were 28 labs/institutes that had not developed any technologies. Around 88 labs/institutes had developed up to 10 technologies (targeting SDGs and/or national programmes) and 41 labs/institutes that had developed more than 15 technologies per hundred scientific staff.

- Around 46 percent of the labs/institutes are engaged in more than 60 projects per hundred scientific staff. On the higher end, there were 46 labs/institutes or around 26 percent of the labs/institutes that executed more than 80 projects per hundred scientific staff.
- The primary beneficiaries of the output from the applied labs/institutes are government departments followed by individuals.
- Around 30 percent of the labs/institutes were incubating startups whereas only 11 labs/institutes were found to be supporting startups through all support mechanisms like training, consultancy services, research support, mentorship, and other forms.
- Around 38 percent of the labs/institutes awarded up to 10 educational degrees (combined PhDs, Masters and undergraduate degrees). There were 126 labs/institutes that offered PhD degrees while 73 labs/institutes awarded Masters degrees.

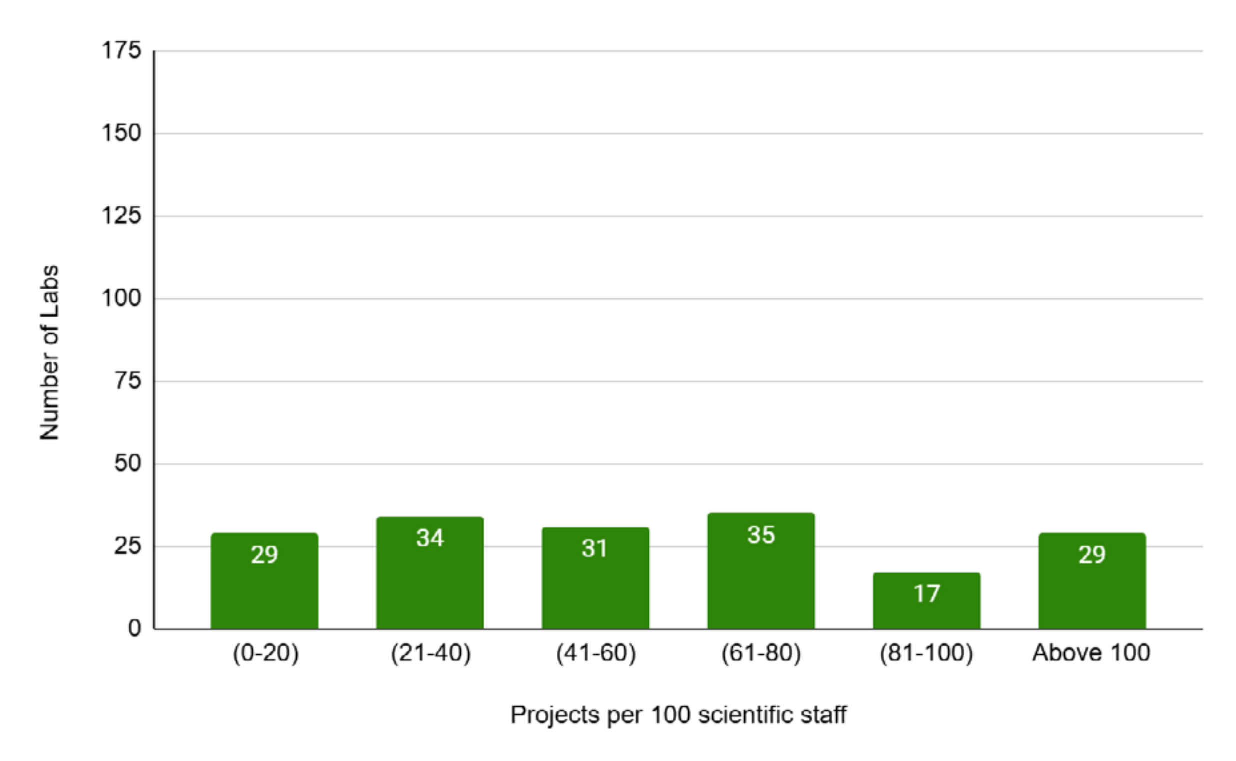
9.1.1 Sub-pillar 1: Contribution to SDGs and national programmes

Figure 9.2: Technologies targeted towards SDGs & National Programmes (TRL 5 or higher)



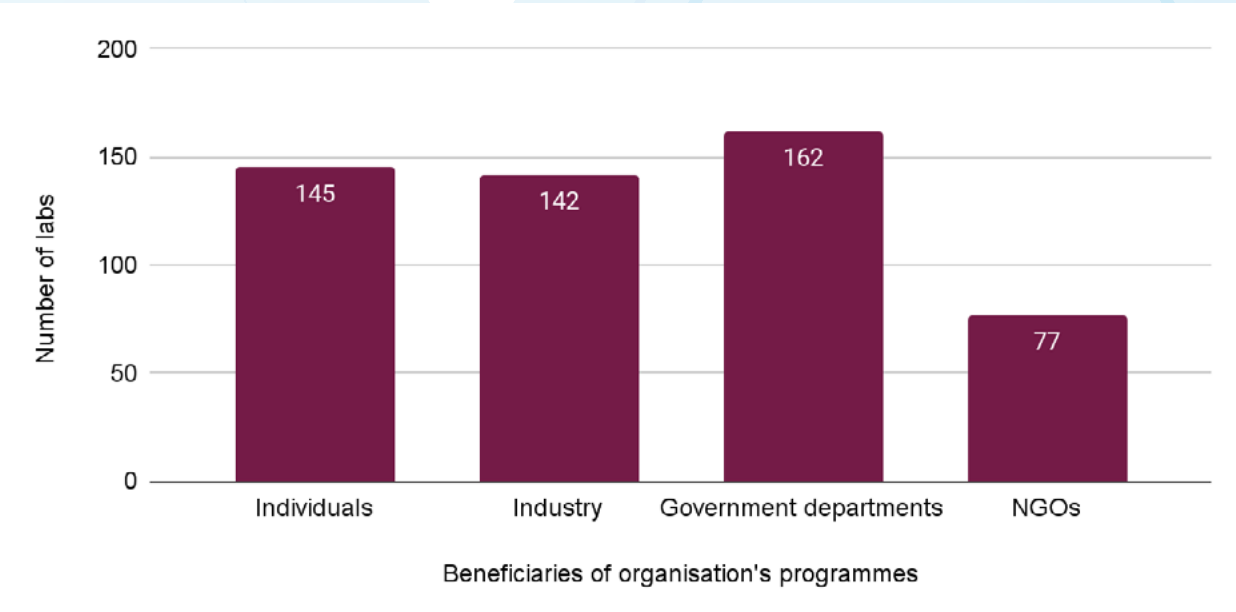
Of the 128 labs/institutes, there were 28 labs/institutes that had not developed any technologies with TRL 5 and higher (targeting SDGs and/ or national programmes). There were 88 labs/institutes that had developed up to 10 technologies per 100 scientific staff while 29 labs/institutes had developed more than 20 technologies per 100 scientific staff with TRL 5 and higher. The 29 labs/institutes with 20 or more technologies per hundred scientific staff included 17 labs/institutes from ICAR, 3 labs/institutes fromICMR, 2 labs/institutes from CSIR and 1 lab from the Ministry of Ayush. The remaining 6 labs/institutes were from other central government ministries.

Figure 9.3: Projects executed per 100 scientific staff



There were 94 labs/institutes that were undertaking up to 60 projects per 100 scientific staff, while the remaining 81 labs/institutes were engaged in more than 60 projects per 100 scientific staff. Of these 81 labs/institutes, 29 labs/institutes were engaged in more than 100 projects per 100 scientific staff. Of the 29 labs/institutes that were engaged in more than 100 projects per 100 scientific staff, there were 13 labs/institutes from ICAR, 6 labs/institutes from CSIR, 4 labs/institutes from ICMR, 1 lab from DST, and 5 labs/institutes from other central government ministries.

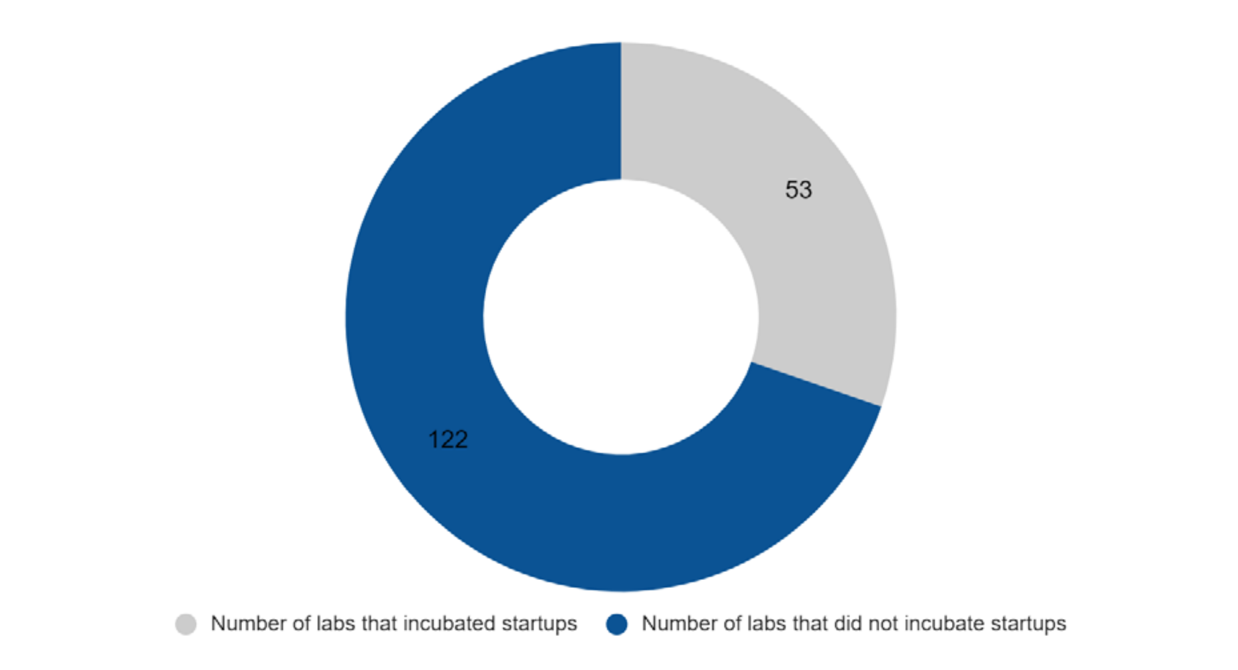
Figure 9.4: Beneficiaries of organization's programmes



Nearly all the applied labs/institutes were targeting government departments through their research and programmes. Individuals were targeted by close to 83 percent of the labs/institutes while around 81 percent of the labs/institutes were also targeting industry through their programmes. Over 44 percent of the labs/institutes were targeting NGOs through their work.

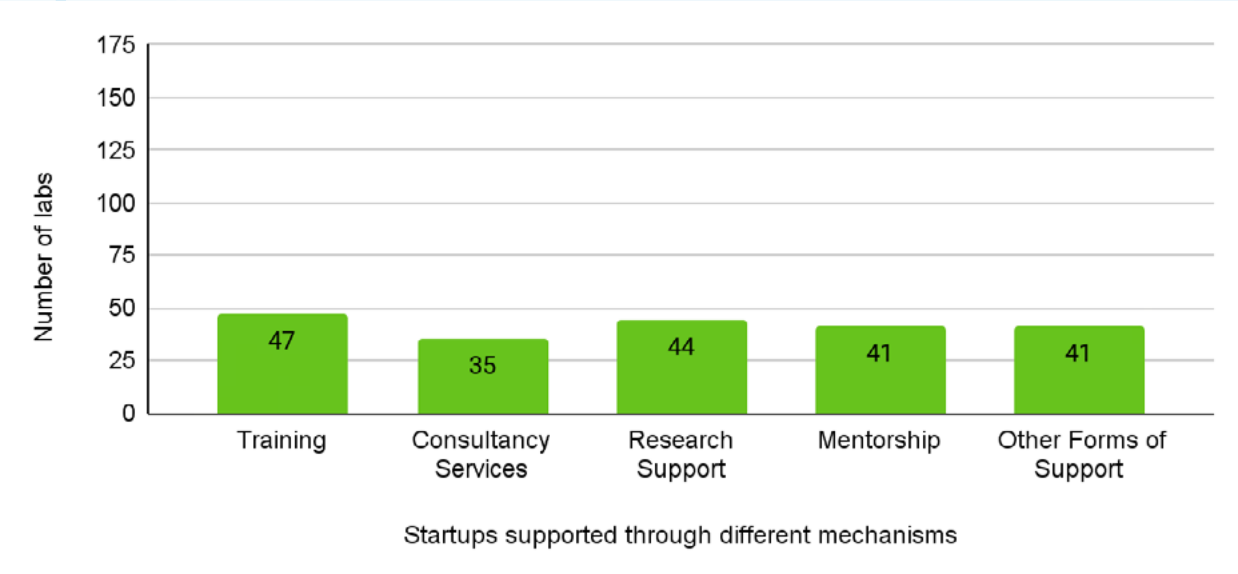
9.1.2 Sub-pillar 2: Employment generation and human resource development

Figure 9.5: Incubation of startups



There were 53 labs/institutes undertaking applied R&D that were incubating startups while 122 labs/ institutes did not provide any incubation support to startups.

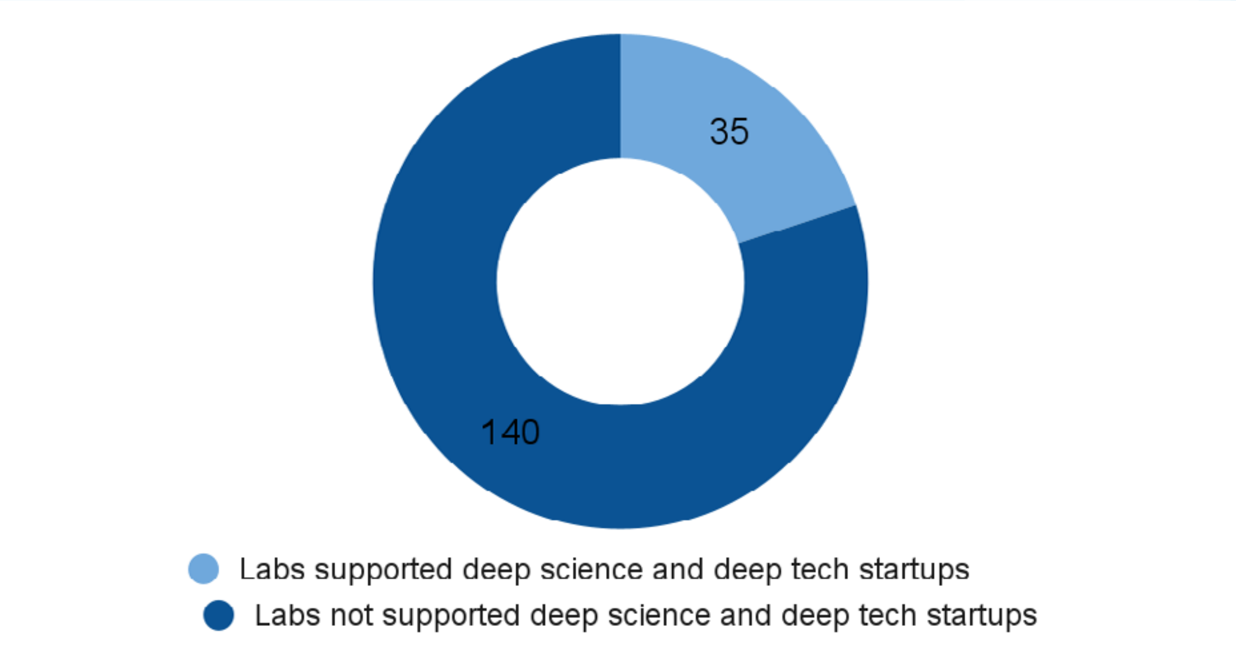
Figure 9.6: Startups supported through different support mechanisms



Note: Analysis is done for 174 labs/institutes. One lab/institute was excluded as their response could not be verified.

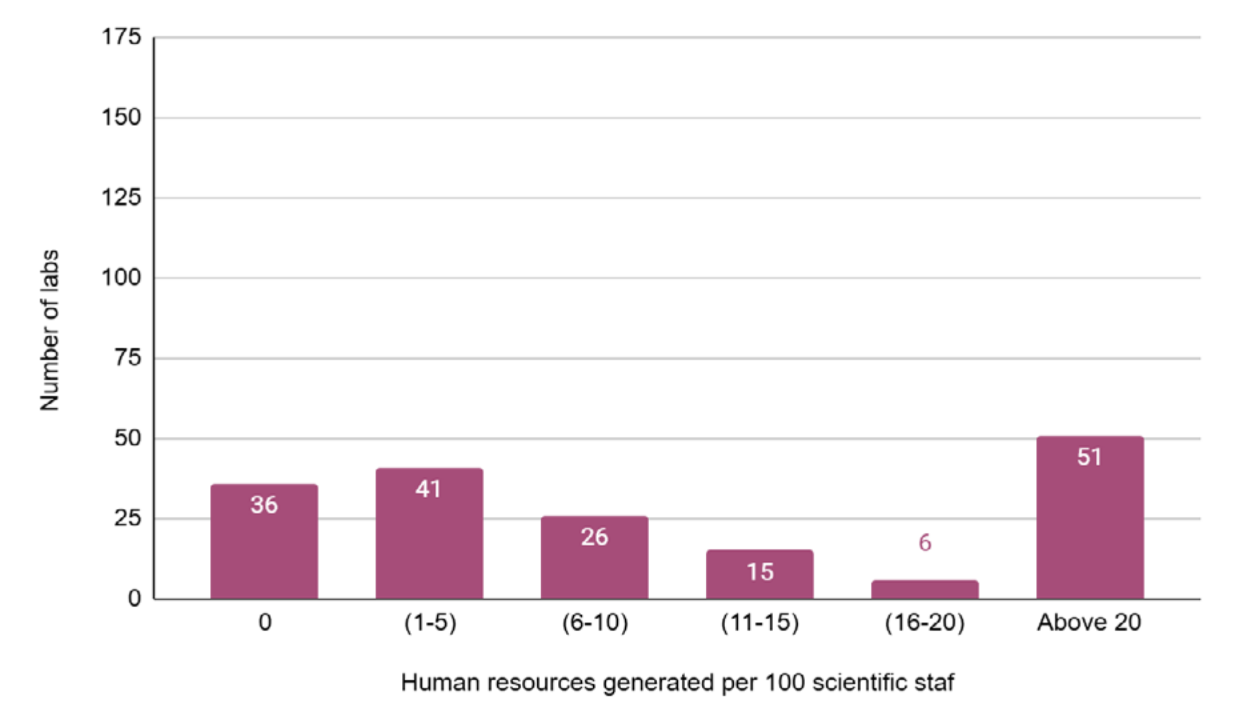
There were 47 labs/institutes that supported startups through training, 44 labs/institutes provided research support, 41 labs/institutes were supported through mentorship and 41 labs/institutes were supported through other forms. Around 35 labs/institutes supported startups through consultancy services.

Figure 9.7: Deep science and deep tech startups supported



Of the 175 labs/institutes there were 140 labs/institutes that did not support any deep science and deep tech startups. Of the 35 labs/institutes that did support deep science and deep tech startups there were 15 labs/institutes from ICAR, 8 from CSIR, 5 from DST, 2 from MeitY, 1 from ICMR and remaining 4 labs/institutes were from other central government ministries.

Figure 9.8: PhDs, Masters and Graduate degrees awarded per 100 scientific staff



There were 36 labs/institutes performing applied R&D that did not offer or award any degree in the period under consideration. Around 67 labs/institutes offered up to 10 degrees per 100 scientific staff while the remaining 72 labs/institutes offered more than 10 degrees per 100 scientific staff. The degrees awarded are a combination of PhDs, Masters, and undergraduate degrees. There were 51 labs/institutes that awarded more than 20 degrees per 100 scientific staff. Of these 51 labs/institutes, there were 20 labs/institutes from ICAR, 7 labs/institutes from ICMR, 6 labs/institutes from CSIR, 5 labs/institutes from DST, 2 labs/institutes from Ministry of Ayush, 1 lab from DBT and the remaining 10 labs/institutes were from other central government ministries. Of the 36 labs/institutes that did not award any degree, a majority of the labs/institutes were from ICAR.

There were 147 labs/institutes out of the 175 that did not offer any graduate degrees while 102 labs/institutes did not offer any master's degree.

Key Takeaways:

- There were 28 labs/institutes that had not developed any technologies. Of these, 26 were from major scientific agencies.
- While 41 labs/institutes that had developed more than 15 technologies per hundred scientific staff and 46 labs/institutes that executed more than 80 projects per hundred scientific staff, there were 17 labs/institutes among these which developed a higher number of technologies as well as executed a higher number of projects.
- The primary beneficiaries of the output from the applied labs/institutes are government departments. Labs/institutes may wish to start engaging with NGOs for increased socioeconomic impact of their work.
- More labs/institutes could consider incubating startups or providing support through their resources to startups, both in terms of research support as well as access to their infrastructure. Many of the labs/institutes are engaged in developing technologies having TRL levels between 5 and higher and should be incentivised to engage more with the start-up ecosystem to become a provider of a wider source of technology for industry.
- There were only 10 labs/institutes that had set up section 8 companies. There is significant potential for more labs/institutes to establish section 8 companies to foster the startup ecosystem.
- There were more labs/institutes offering PhD degrees compared to Masters or undergraduate degrees. Closer tie ups with the higher educational institutions would allow for easier access to the infrastructure and resources of the labs/institutes for students pursuing science and engineering degrees.

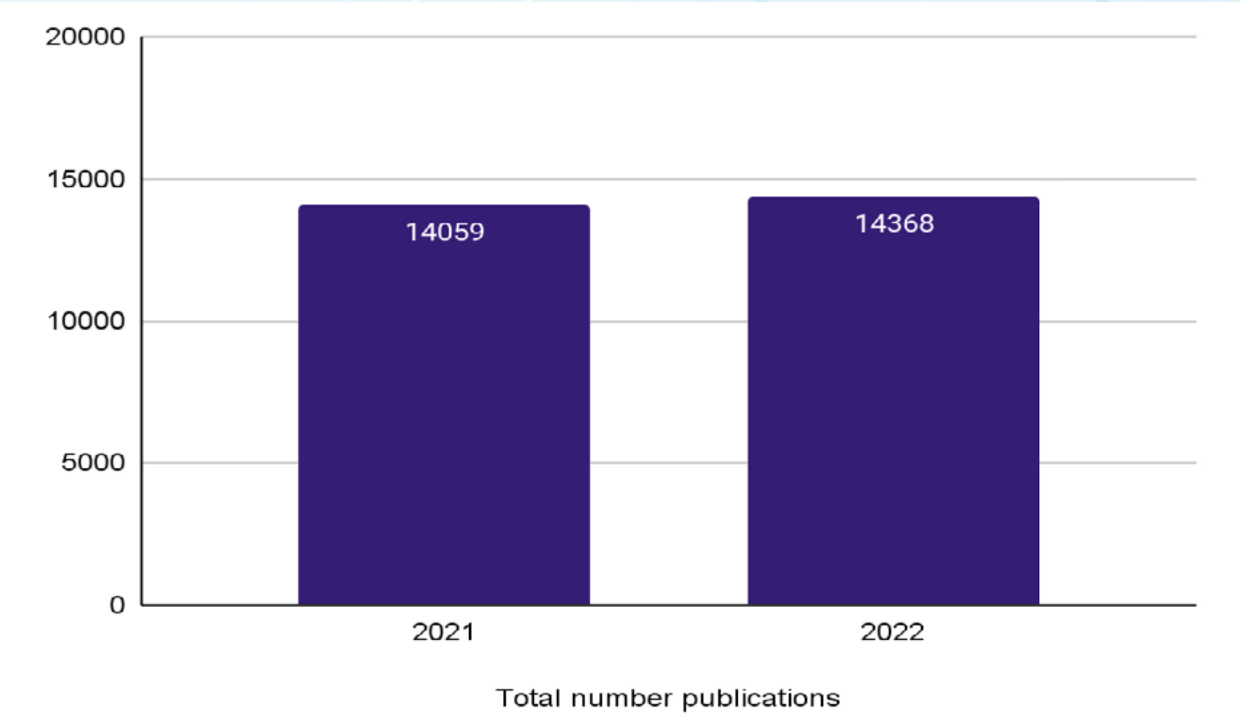
9.2 Pillar 2: Science, Technology and Innovation Excellence

The indicators considered below pertain to publication output, commissioned technical reports, citations received for the publications, the share of publications in top 10 percent journals, IPR filed, granted and licensed out, domestic and international technology transfer, new services and/or products introduced, earnings from government and non-government sources, external funding received by the labs/institutes and collaborations on projects as well as publications.

- There were 97 labs/institutes that had not prepared any commissioned technical reports while only 46 labs/institutes had prepared more than 4 commissioned technical reports per 100 scientific staff.
- A majority of the labs/institutes were seen to be engaging in filing patents and a majority had also obtained patents, however only around a third of them are seen to be licensing out their patents. 66 percent of the labs/institutes had transferred technologies developed by them domestically and very few labs/institutes had transferred any technologies internationally.
- There were 99 labs/institutes that did not obtain any patents in any emerging areas of technology whereas 75 labs/institutes that did had more patents in industrial technologies, followed by bio-engineering and sustainable technologies.
- There were 63 labs/institutes that had not introduced a single new product or service in the two years under consideration, while 37 labs/institutes that introduced more than 2 new products and/or services per Rs. 10 crore of budget spent over the same period.
- The main source of external funding for the labs/institutes was from government sources, while sources of earnings are mainly through consultancies followed by training.
- Several labs/institutes are not collaborating with industry on projects. Only 19 percent of the labs/institutes have international collaborations with the industry whereas around 50 percent of the labs/institutes are engaged in international collaborations with academic institutions and research labs/institutes.

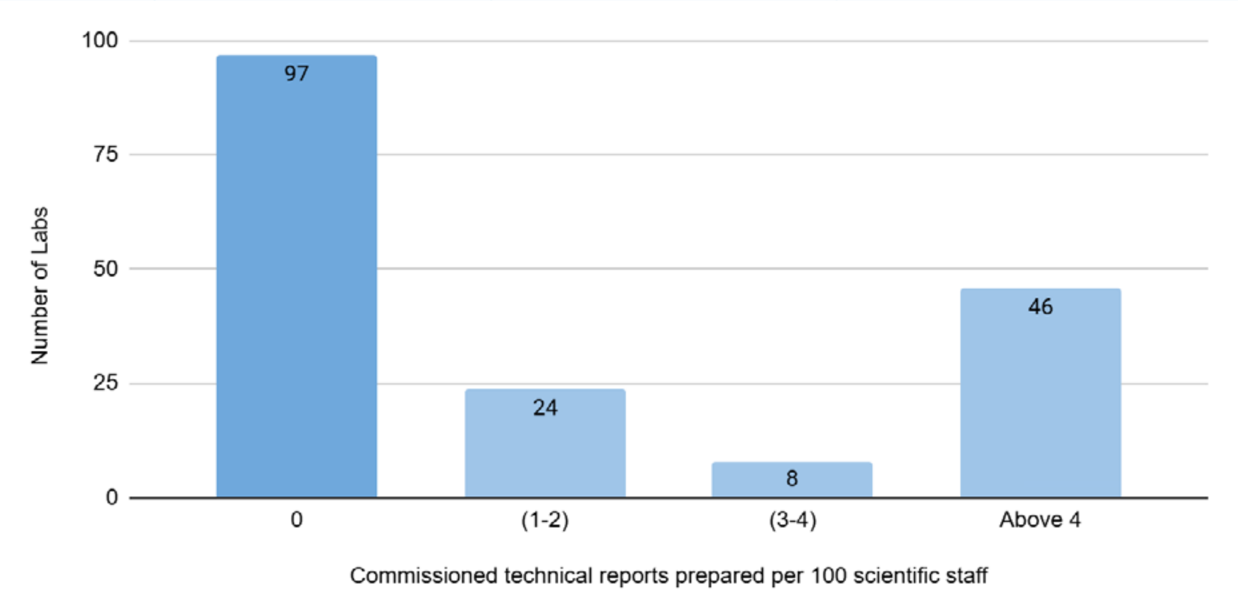
9.2.1 Sub-pillar 3: Scholarly research, development output and quality

Figure 9.9: Total number publications



The total publication output was 14,368 in 2022 compared to 14,059 in 2021.

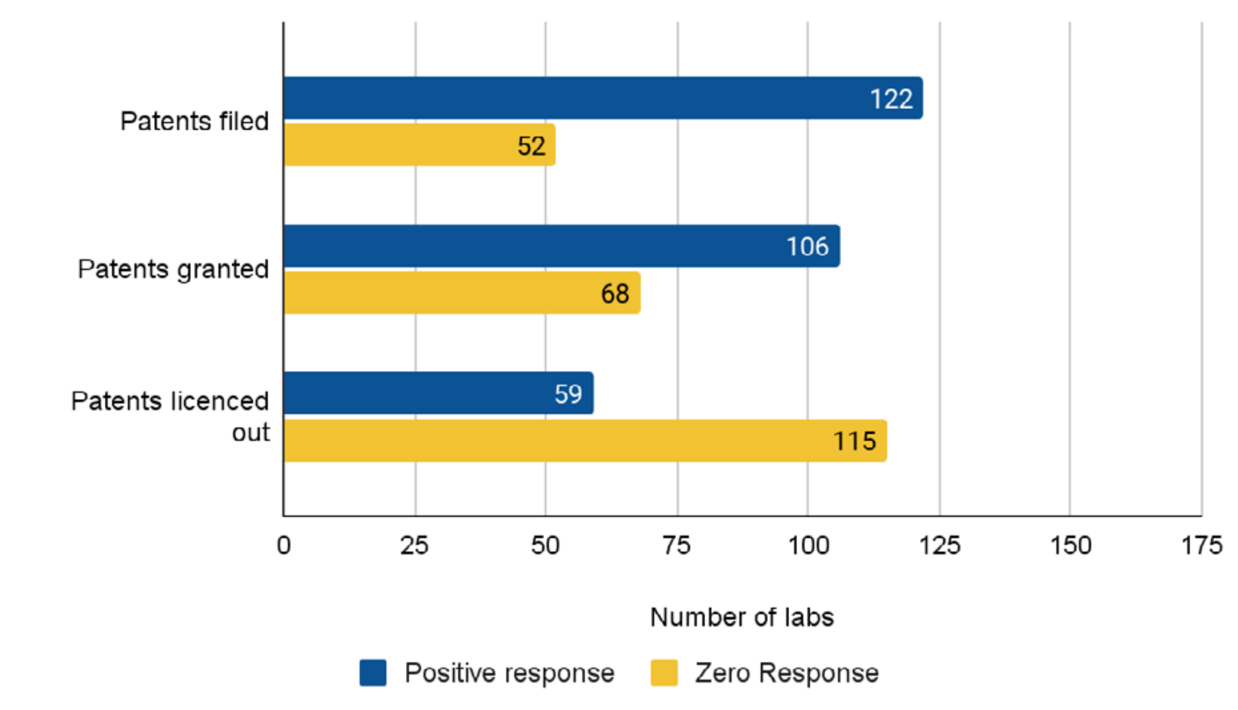
Figure 9.10: Commissioned technical reports per 100 scientific staff



As can be seen in the accompanying chart, there were 97 labs/institutes that were performing applied R&D but did not produce any commissioned technical reports. There were around 32 labs/ institutes that produced up to 4 commissioned technical reports per 100 scientific staff while there were 46 labs/institutes that produced more than 4 commission technical reports per 100 scientific staff.

9.2.2 Sub-pillar 4: Development and innovation output and quality

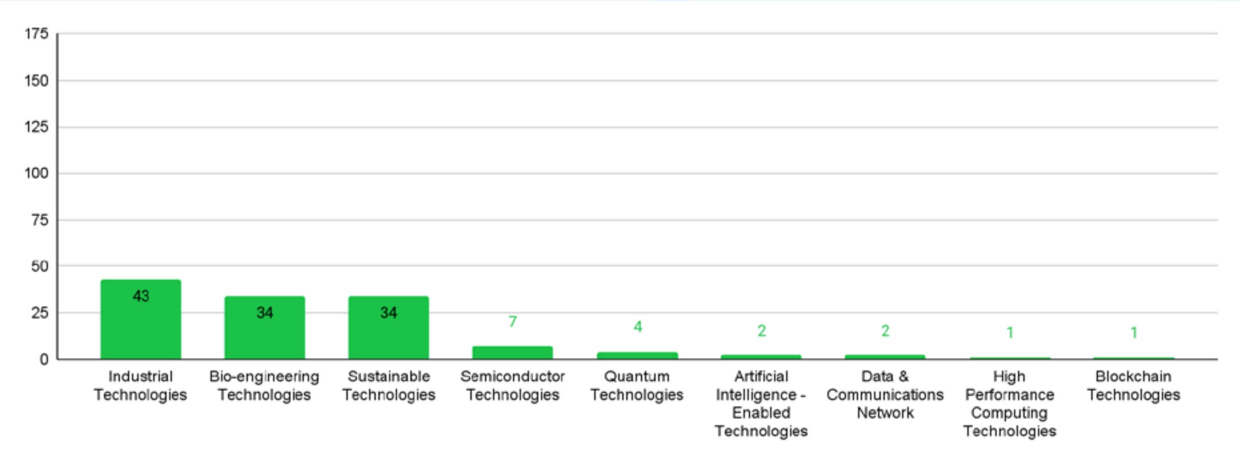
Figure 9.11: Patents filed, granted and licensed out



Note: Analysis is done for 174 labs/institutes. One lab/institute was excluded as their response could not be verified.

For the Applied R&D labs/institutes, 70 percent of the labs/institutes had filed patent applications while 61 percent of the labs/institutes had obtained patents in the period under consideration. When it came to licensing out patents, just 34 percent of labs/institutes were licensing out their patents. When one considers all IPRs (patents, trademarks, copyrights, plant variety etc.), there were 134 labs/institutes or 77 percent of the labs/institutes that filed IPRs while there were 121 labs/institutes or 70 percent that were granted an IPR in the period under consideration. However just 71 labs/ institutes or 41 percent of the labs/institutes licensed out their IPR.

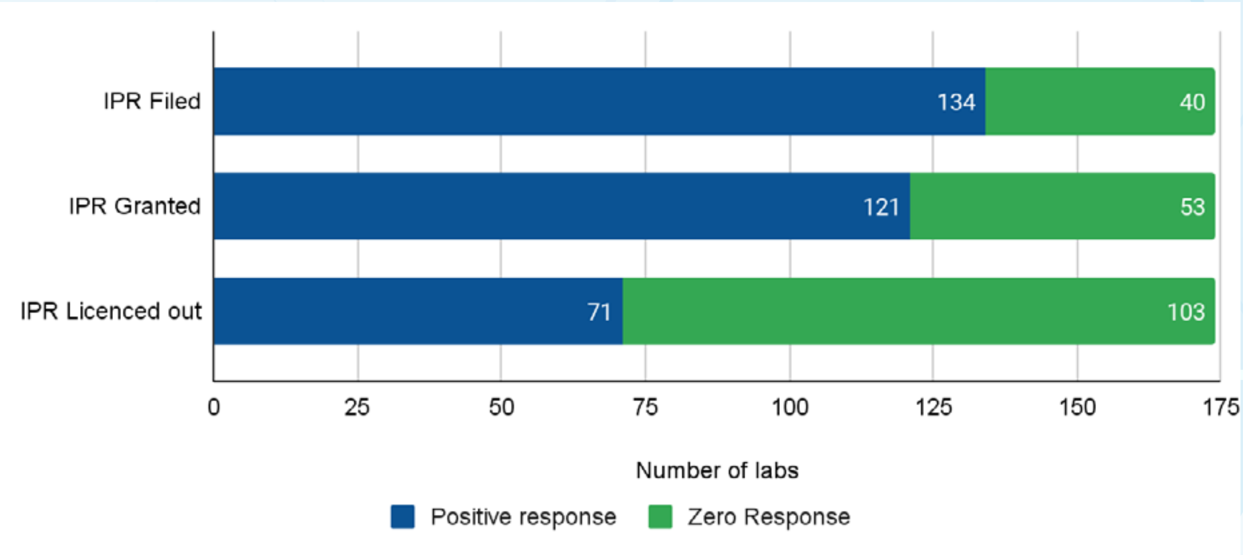
Figure 9.12: Patents granted in emerging areas of technology



Note: Analysis is done for 174 labs/institutes. One lab/institute was excluded as their response could not be verified.

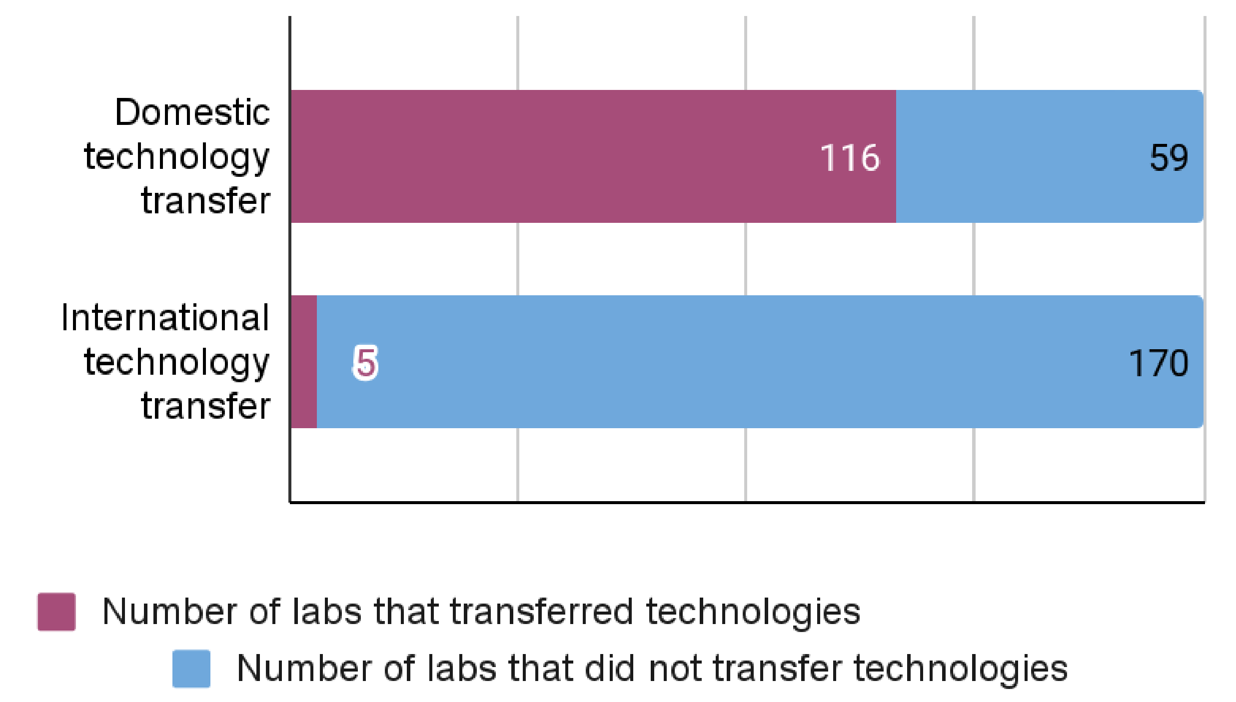
There were 75 labs/institutes that obtained patents in the emerging areas of technology while 99 labs/institutes that did not obtain any patents in any emerging areas of technology. As can be seen in the above figure, more patents were granted to these 75 labs/institutes in industrial technologies followed by bio-engineering technologies and sustainable technologies. Of these 75 labs/institutes 25 labs/institutes were from ICAR, 24 labs/institutes were from CSIR, 5 from DST, 4 labs/institutes each from DBT and ICMR, 2 labs/institutes each from MeitY and MoEFCC, and the remaining 9 labs/institutes were from other central government ministries.

Figure 9.13: Intellectual Property Rights filed, granted and licensed out



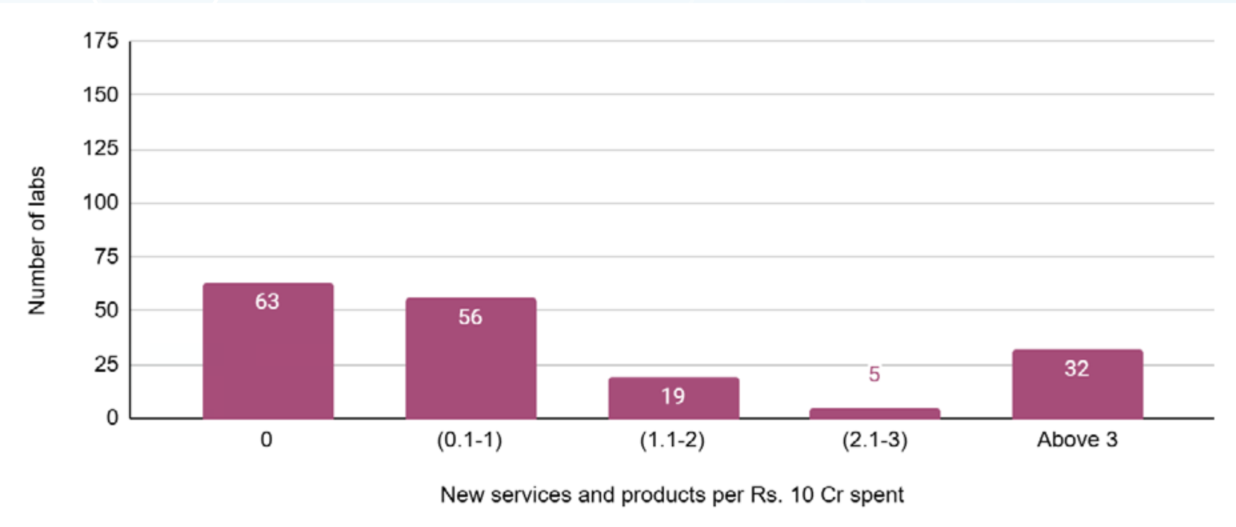
Note: Analysis is done for 174 labs/institutes. One lab/institute was excluded as their response could not be verified.

Figure 9.14: Domestic and international technology transfer



Of the 175 labs/institutes, 116 labs/institutes said they had transferred technologies domestically. Very few labs/institutes had transferred any technologies overseas. The 5 labs/institutes that did transfer technologies overseas had also transferred technologies domestically and included 2 labs/institutes from ICAR, 1 lab each from ICMR and DBT whereas 1 lab was from other central government ministry.

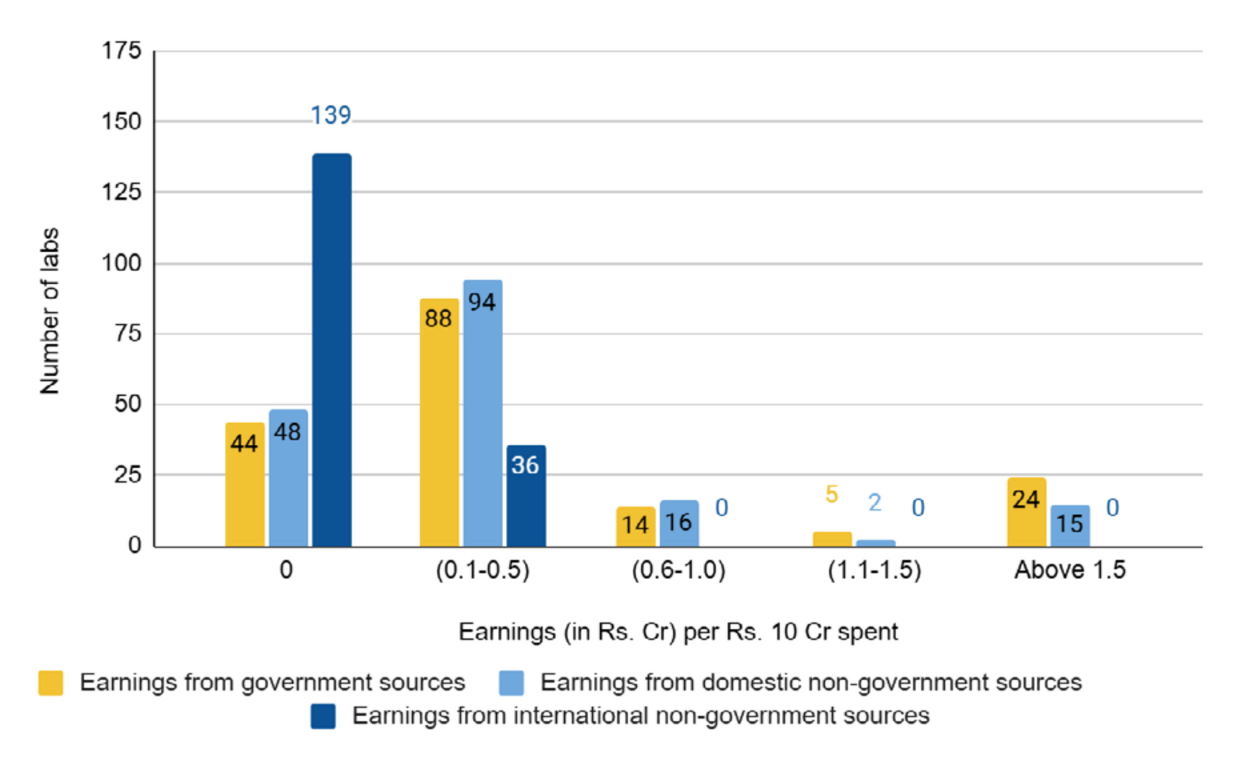
Figure 9.15: New services and/or products introduced per Rs. 10 crore spent



There were 63 labs/institutes that did not introduce a single new product or service in the period under consideration. There were 75 labs/institutes that introduced up to 2 new products and/ or services per Rs.10 crore of budgetary support while 37 labs/institutes introduced more than 2 new products and/ or services per Rs.10 crore of budgetary support. The 37 labs/institutes that introduced more than 2 new products and/or services per Rs. 10 crore of budgetary support were dominated by labs/institutes from ICAR.

9.2.3 Sub-pillar 5: commercialisation of technologies and revenue generation

Figure 9.16: Earnings from government, domestic non- government and international non-government sources



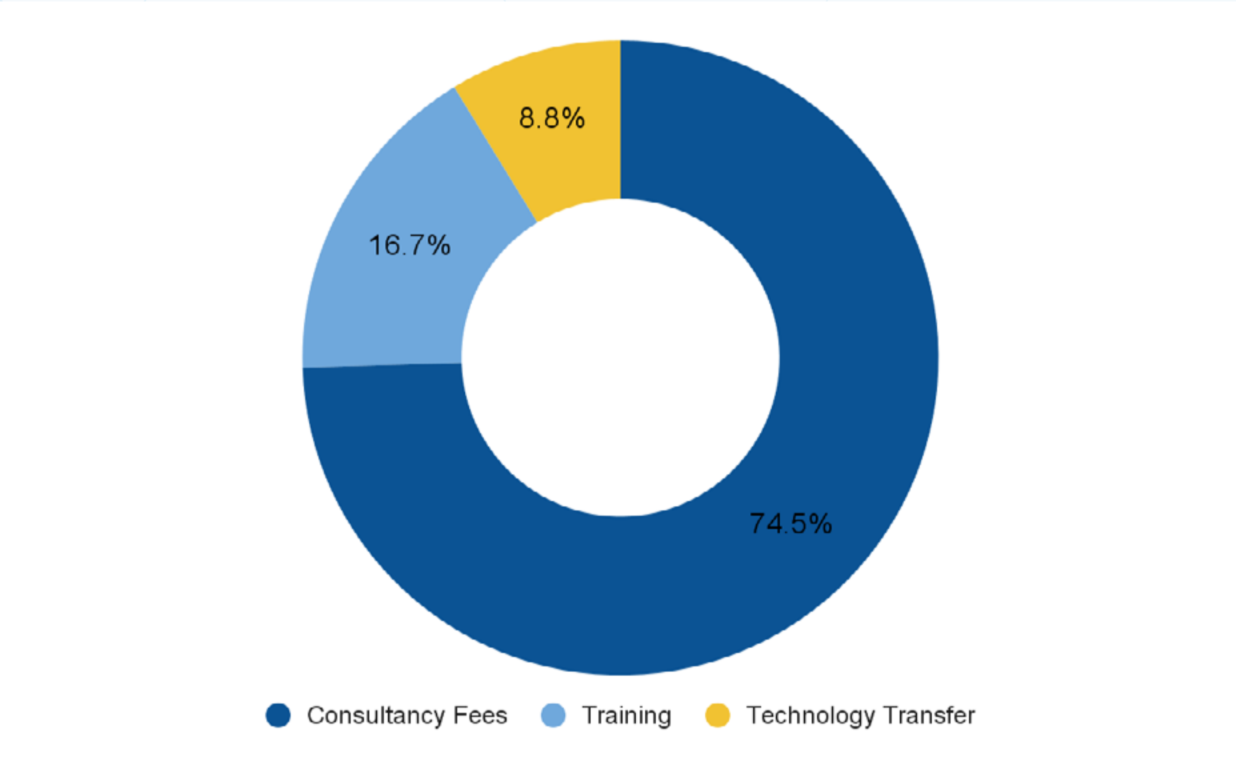
Note: Analysis is done for 174 labs/institutes. One lab/institute was excluded as their response could not be verified.

A majority of the earnings for the labs/institutes is coming by way of consultancies, followed by training and least by way of technology transfer as can be seen in the pie chart below. This holds true for earnings from government, domestic non- government as well as international non-government sources.

Of the reported labs/institutes, there were 48 labs/institutes that did not have any earnings from domestic non- government sources while 44 labs/institutes did not have any earnings from government sources. Majority of the labs/institutes did not have any earnings from international non-government sources while there were only 36 labs/institutes that had earnings from international non- government sources. There were 14 labs/institutes that had no earnings from any of the government sources, domestic non-government sources or international non-government sources with 6 of these labs/institutes coming from ICMR. There were 112 labs/institutes that said they had earned up to Rs. 1.5 crore per Rs. 10 crore of budget spent from domestic non-government sources and 107 labs/institutes that had earned the same amount from government sources.

At the higher end of the earnings, there were 24 labs/institutes that had earnings of more than Rs. 1.5 crore per Rs. 10 crore of budget spent from government sources and 15 labs/institutes that had these earnings from domestic non-government sources. Of these labs/institutes at the higher end, there were 8 labs/institutes that had earnings from both government and domestic non-government sources that were greater than Rs. 1.5 crore per Rs. 10 crore of budget spent. While 3 of these labs/institutes were from CSIR, 2 labs/institutes were from ICAR, 1 lab from DST and the remaining 2 labs/institutes were from other central government ministries.

Figure 9.17: Sources of earnings



Note: Analysis is done for 174 labs/institutes. One lab/institute was excluded as their response could not be verified.

Figure 9.18: Extramural funding received from government per 10 crore of rupee spent

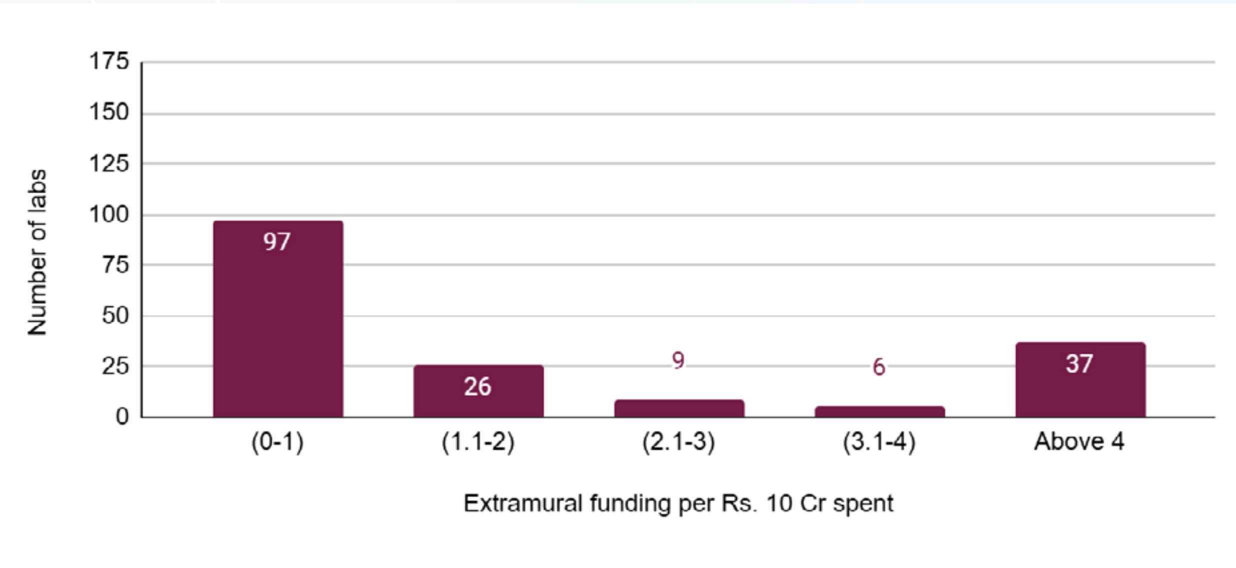
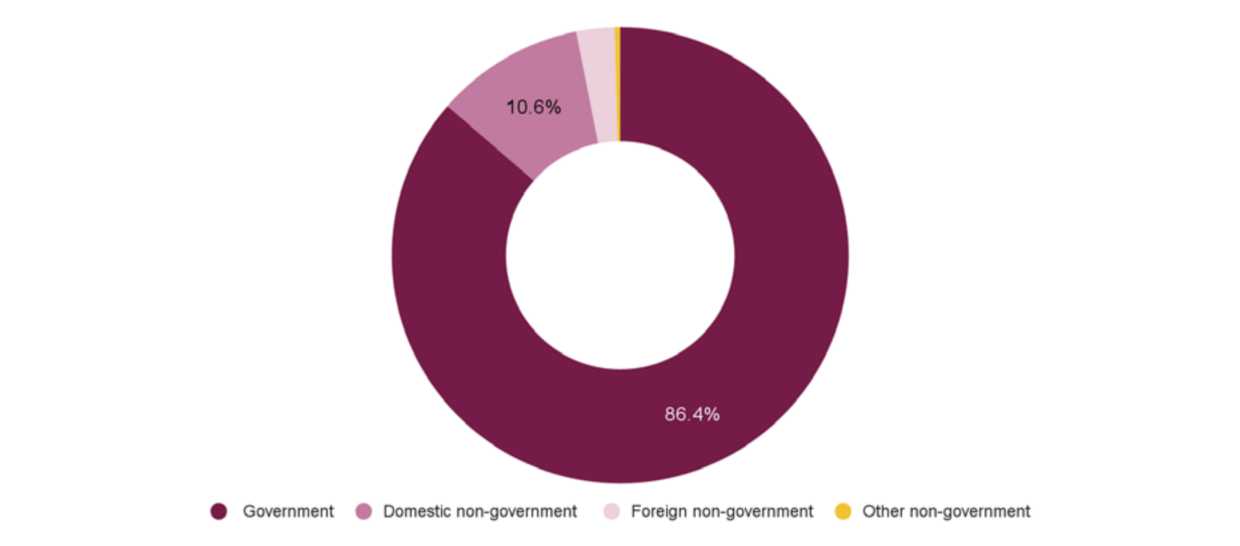


Figure 9.19: Extramural funding from government and non-government sources

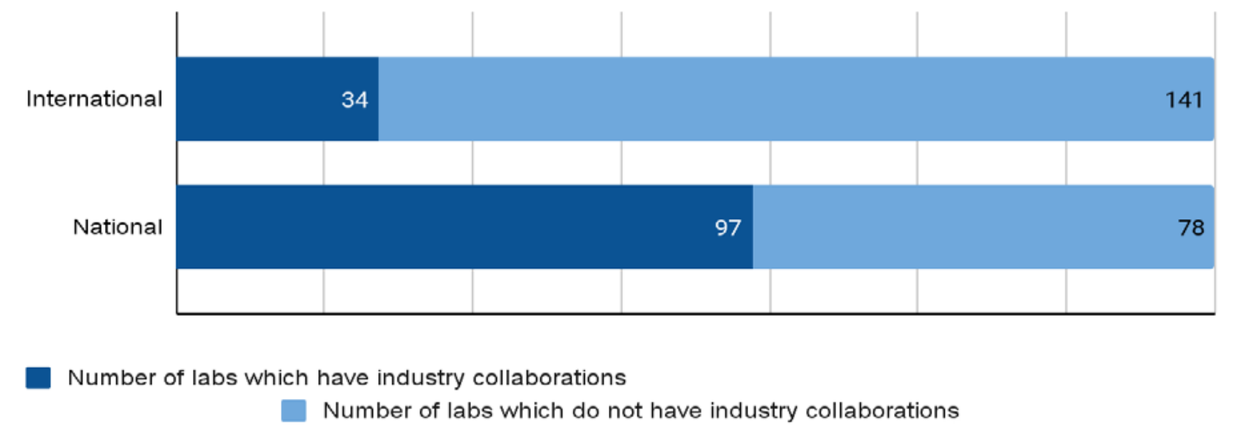


Over 86 percent of the extramural funding that the Applied R&D labs/institutes received during the period under consideration was from government sources, 10.6 percent from domestic non-government sources, around 3 percent from foreign non-government sources, and around 0.39 percent from other non-government sources. Looking at the extramural funding received from government sources, there were 123 labs/institutes that received up to Rs. 2 crore of extramural funding for every Rs. 10 crore of budget spent. There were around 37 labs/institutes that received more than Rs. 4 crore through extramural funding for every Rs. 10 crore of budget spent. Of these 37 labs/institutes, there were 14 ICAR labs/institutes, 5 labs/institutes each from ICMR and CSIR, 3 labs/institutes each from DBT and MEITY, 2 labs/institutes each from DST and MoEFCC, and 3 labs/institutes from other central government ministries.

Around 42 percent of the labs/institutes did not receive any extramural funding from non-government sources which include domestic non-government, foreign non-government and other non-government sources. There were 4 labs/institutes that received more than Rs. 4 crore through extramural funding from domestic non-government sources for every Rs. 10 crore of budget spent. Of these 3 labs/institutes were from ICAR and 1 lab was from MeitY whereas there was only one lab from DBT that received more than Rs. 4 crore of extramural funding from foreign non-government sources. Most of the labs/institutes that did receive any extramural funding from non- government sources received up to Rs. 1 crore for every Rs. 10 crore of budgetary support.

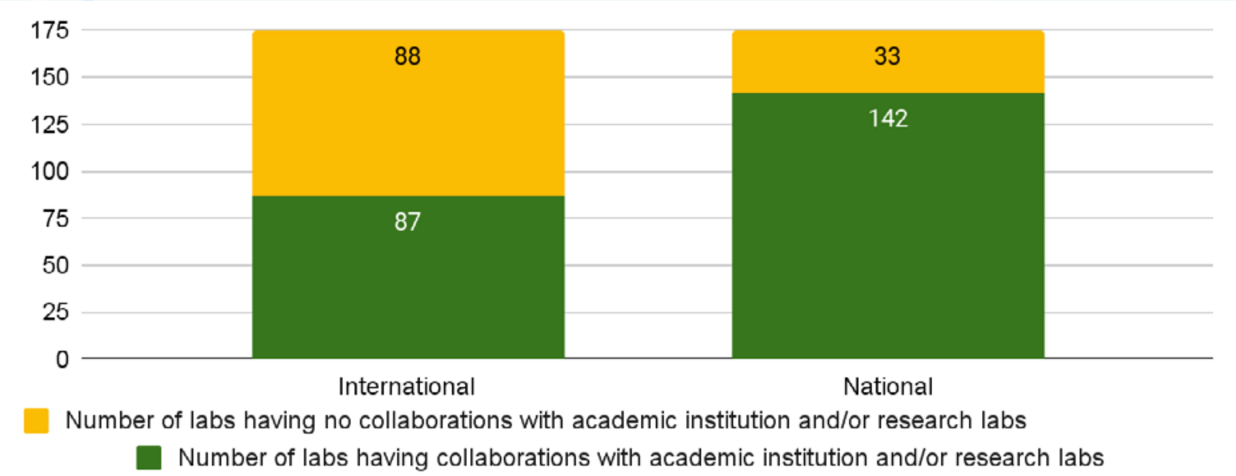
9.2.4 Sub-pillar 6: Collaborative research

Figure 9.20: International and National industry project collaborations



With respect to project collaborations, there were just 34 labs/institutes that had ongoing international industry collaborations while 97 labs/institutes had ongoing national industry collaborations. There were 72 labs/institutes that had absolutely no national or international collaboration with industry.

Figure 9.21: Collaborations with academic institutions and/ or research labs/institutes



Compared to industry collaborations, there were a lot more labs/institutes engaged in project collaborations with both international and national academic institutions and/or research labs/ institutes. There were 87 labs/institutes that had international and 142 labs/institutes that had national collaborations with academic institutions and/or research labs/institutes. Of the 87 international collaborations, there were 67 labs/institutes which had up to 5 collaborations per 100 scientific staff while there were 20 labs/institutes which had more than 5 international collaborations per 100 scientific staff. Of these 20 labs/institutes which had more than 5 international collaborations, there were 5 labs/institutes from ICMR, 4 labs/institutes from ICAR, 3 labs/institutes from DBT, 2 labs/institutes each from CSIR and DST, 1 lab from the Ministry of Earth Sciences and the remaining 3 labs/institutes were from other central government ministries.

Of the 142 labs/institutes that had national collaborations with academic institutions and/or research labs/institutes, there were 37 labs/institutes which had up to 5 collaborations per 100 scientific staff while 63 labs/institutes had between 5 to 20 collaborations per 100 scientific staff. On the higher end there were 42 labs/institutes which had more than 20 collaborations per 100 scientific staff. Of these 42 labs/institutes 15 labs/institutes were from ICAR, 10 labs/institutes from ICMR, 5 labs/ institutes from MoEFCC, 2 labs/institutes each from CSIR, DBT and DST, 1 lab from the Ministry of Earth Sciences and the remaining 5 labs/institutes were from other central government ministries.

Key Takeaways:

- By nature of the research being undertaken, many more labs/institutes should be engaged in producing commissioned technical reports. This would require a greater understanding from industry about the potential of these labs/institutes. Labs/institutes would also need to make a greater effort in showcasing their capabilities to industry.
- Several labs/institutes are not currently engaged in licensing out their patents. This is one area where labs/institutes could be provided assistance by their respective departments/ ministries or industry associations in enabling wider access to the technologies being developed by the labs/institutes.

- There were 37 labs/institutes that introduced more than 2 new products and/or services per Rs. 10 crore of budgetary support. These were dominated by labs/institutes from ICAR.
- There is significant scope for increased collaborations not just with industry but also with other academic and/or research labs/institutes. This would contribute towards possibly diversifying the sources of extramural funding away from mainly government sources.
- Increased collaborations on projects with academic institutions will also allow for use of the lab's facilities for students and researchers from the higher education sector.

9.3 Pillar 3: Organizational Effectiveness

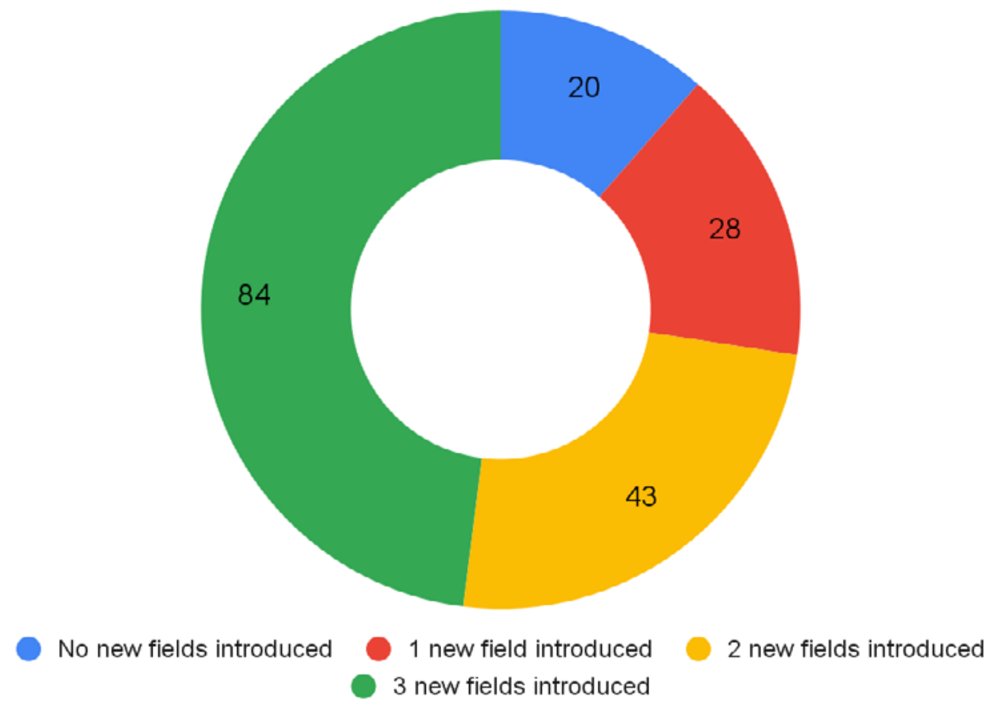
The indicators considered here look at the number of new research fields/innovations/services that have been introduced by a lab in each year under consideration, the share of permanent scientists and contractual researchers in the overall staff, indicators on governance that include whether the labs/institutes have ethics guidelines and policies in place, a sexual harassment mitigation cell etc., outside researchers supported, indicators on EDI and lastly the amount spent towards building internal capabilities of the staff.

- There were 155 labs/institutes that introduced at least one new research field/innovation/service on average every year for the period under consideration, of which 84 labs/institutes introduced 3 new research fields/innovations/services each year.
- Around 93 labs/institutes had a share of permanent scientists and contractual researchers in total staff that was greater than 50 percent.
- In terms of governance, 134 labs/institutes had procedures in place for sustainable sourcing of material while 66 labs/institutes adhered to all waste reclamation procedures, and 28 labs/institutes followed at least 6 of these procedures.
- The labs/institutes have the necessary effective management systems in place for nearly all the parameters, except when it came to adoption of any digital technologies that would enhance R&D activities where 86 percent of the labs/institutes had done so.
- There were 61 labs/institutes having R&D facilities available on the I-STEM national portal while there were 106 lab labs/institutes that opened their testing and research facility to outside researchers and students. Whereas there were 80 labs/institutes that opened its testing and research facility to startups and firms.
- Around 64 percent of the total Applied R&D labs/institutes had a national accreditation and 36 percent of the total Applied R&D labs/institutes had an international accreditation of their lab procedures.
- There were 118 labs/institutes that did not have an EDI cell, while the share of women in research staff was between 25 percent to 50 percent for around 59 labs/institutes.
- There were 100 labs/institutes that spend less than 1 percent of their budget on training and skill upgradation of their staff.

- 54 labs/institutes had scientists involved in career development programmes organized by international bodies.
- Around 83 percent of the labs/institutes supported up to 25 women scientific staff through conferences, training, sabbaticals, etc while around 66 percent of the labs/institutes supported up to 25 young scientists per 100 scientific staff for conferences, training, sabbaticals, etc.

9.3.1 Sub-pillar 7: Mandate alignment

Figure 9.22: New research fields/innovations/services introduced by the labs/institutes

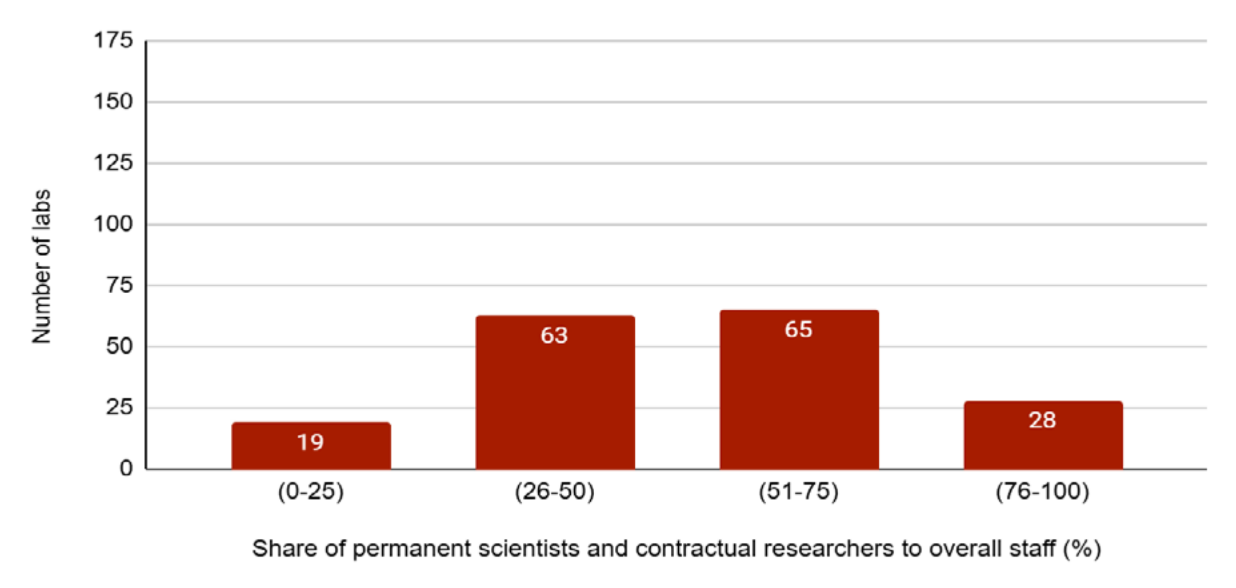


All labs/institutes have a scientific strategy in place to work towards their mandate. Nearly all the labs/institutes as part of their mandate have defined existing problems related to the social and economic situation of the nation and have been working towards solving these problems. Many of the labs/institutes have also seen the mission and vision for their research evolve over the past five years.

During the period under consideration, there were 84 labs/institutes that introduced 3 new research fields/innovations/ services in each year for the period under consideration, while 43 labs/institutes introduced at least 2 new fields/ innovations/services on average each year. There were 28 labs/ institutes that introduced one new field/innovation/service on average each year. The impact of these new fields/ innovations/ services introduced would need to be evaluated separately by domain experts.

9.3.2 Sub-pillar 8: Resource management

Figure 9.23: Share of permanent scientists and contractual researchers to overall staff (%)



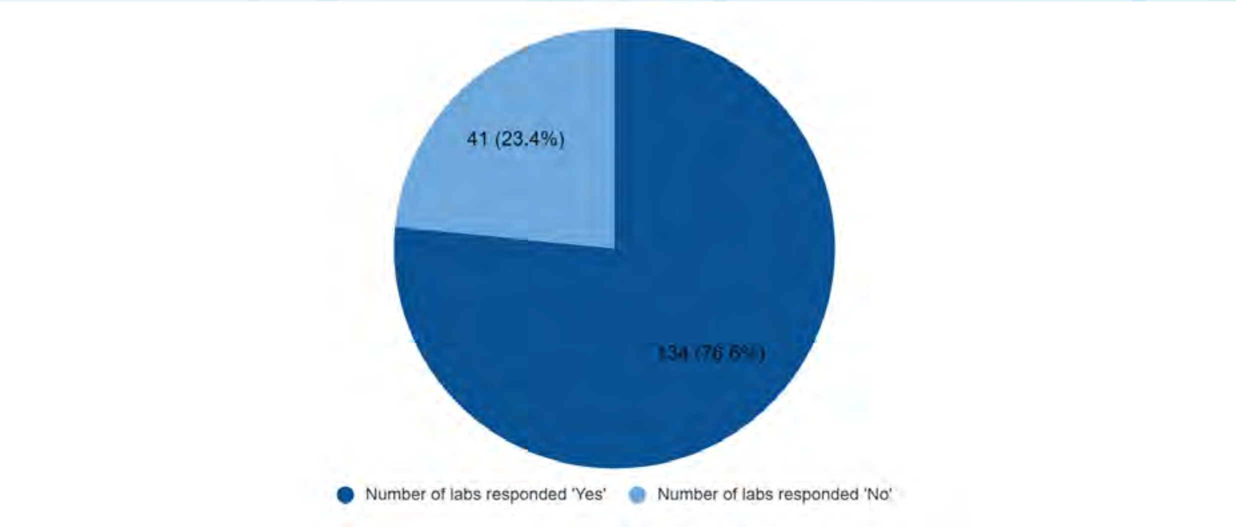
Note: Analysis is done for 174 labs/institutes. One lab/institute was excluded as their response could not be verified.

Of the reported labs/institutes, there were 93 labs/institutes for whom the share of permanent scientists and contractual researchers in total staff was over 50 percent. There were 19 labs/ institutes for whom the share of permanent scientists and contractual researchers was up to 25 percent.

For the 175 Applied R&D labs/institutes, the median value for R&D and S&T expenditure as a share of a lab's overall budget was close to 46 percent. The R&D and S&T related expenditure captures all research related expenditure including salaries paid to the researchers and travel costs related to research etc. and excludes administrative and other running costs. Less than a third of labs/ institutes that did report their R&D and S&T related expenditure as a share of the overall budget to be in excess of 75 percent.

9.3.3 Sub-pillar 9: Governance

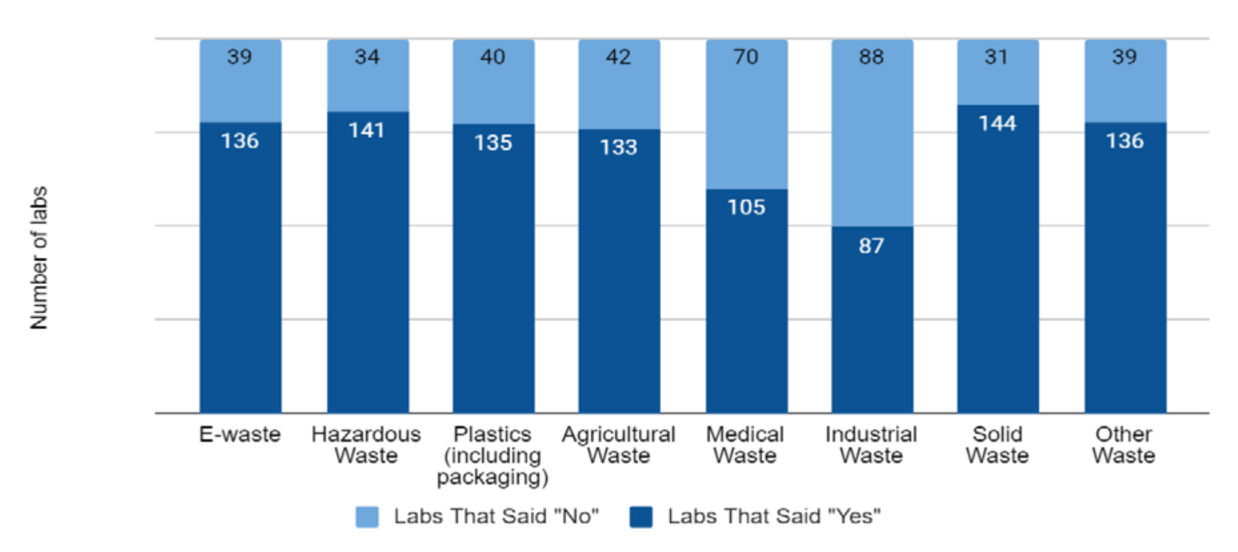
Figure 9.24: Sustainable sourcing of materials



There were 134 labs/institutes that had procedures in place for sustainable sourcing of material. Of these 134 labs/institutes 50 labs/institutes were from ICAR, 25 labs/institutes from CSIR, 14 labs/institutes from ICMR, 8 labs/institutes from MoEFCC, 6 labs/institutes each from DBT and DST, 4 labs/institutes from MeitY, 3 from Ministry of Ayush, 2 from MoES, and the remaining 16 labs/institutes were from other central government ministries.

As broadly discussed in the chapter 6 of this report; Public R&D labs/institutes and Sustainable Practices, the policies related to safe waste reclamation under the new Business Responsibility and Sustainability Reporting (BRSR) include e-waste, hazardous waste, plastics (including packaging), agricultural waste, medical waste, industrial waste, solid waste, and other types of waste. As can be seen in the Figure 9.25 of the 175 labs/institutes there were 66 labs/institutes that adhered to all of the waste reclamation procedures whereas 28 labs/institutes followed at least 6 of these procedures. There were 136 labs/institutes that had procedures in place for safe reclamation of e-waste, whereas 39 labs/institutes had yet to incorporate these procedures.

Figure 9.25: Number of labs/institutes with safe waste reclamation policies



A. Effectiveness of Management System

Table 9.1: Effectiveness of Management System

Question	Share of labs/institutes that responded 'Yes' (%)
Does your organization have initiatives in place to promote intra-organisational collaborations?	99
Has your organization adopted any digital technologies that would enhance R&D activities?	86
Does your organization have necessary ethics guidelines and policies in place?	98
Does your organisation have a sexual harassment mitigation cell with requisite policies and procedures?	100
Does your organization have a public grievance redressal cell?	99

Nearly all labs/institutes have the necessary effective management systems in place, such as guidelines for its processes, initiatives to promote intra-organisational collaborations, necessary ethics guidelines and policies, a sexual harassment mitigation policy as well as a public grievance redressal cell. However, one area that labs/institutes could improve on is adopting digital technologies to enhance R&D activities. Currently 86 percent of the Applied R&D labs/institutes had adopted digital technologies to enhance R&D activities.

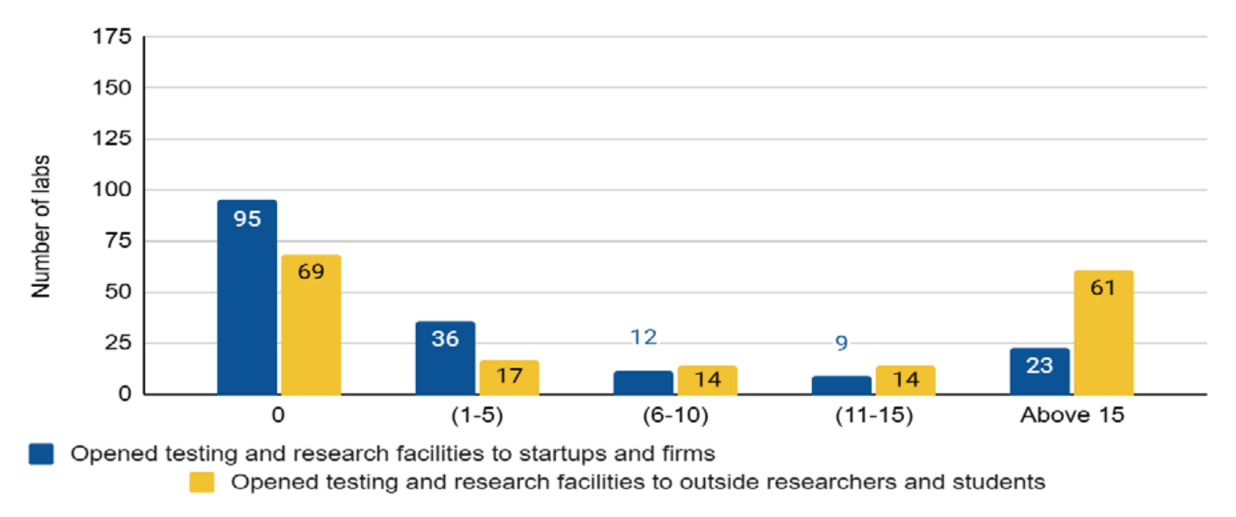
B. Adherence to governance best practices

Table 9.2: Adherence to governance best practices

Question	Share of labs/institutes that responded 'Yes' (%)
Does your organization have national accreditation/ certification for its lab procedure?	64
Does your organization have international accreditation/ certification for its lab procedure?	36
Are your organization's R&D facilities available on the I-STEM national portal?	35
Does your organization's website follow all security protocols as mandated by the Government of India?	93
Is your organization's website differently-abled friendly?	54

With respect to governance related matters such as a website that follows all security protocols as mandated by the Government of India. However, when it comes to having a national and international certification of its lab procedure, only 64 percent of the labs/institutes said they had national certification while only 36 percent of the labs/institutes had international certification. Only 35 percent or 61 labs/institutes were having R&D facilities available on the I-STEM national portal of which 28 labs/institutes were from CSIR, 15 were from ICAR, 5 from DBT, 4 from DST, while 3 each labs/institutes were from ICMR and MeitY, remaining 3 were from other central government ministries.

Figure 9.26: Opened testing and research facilities per 100 scientific staff



Of the 175 Applied R&D labs/institutes, there were 106 lab labs/institutes that opened their testing and research facility to outside researchers and students. Whereas there were 80 labs/institutes that opened its testing and research facility to startups and firms.

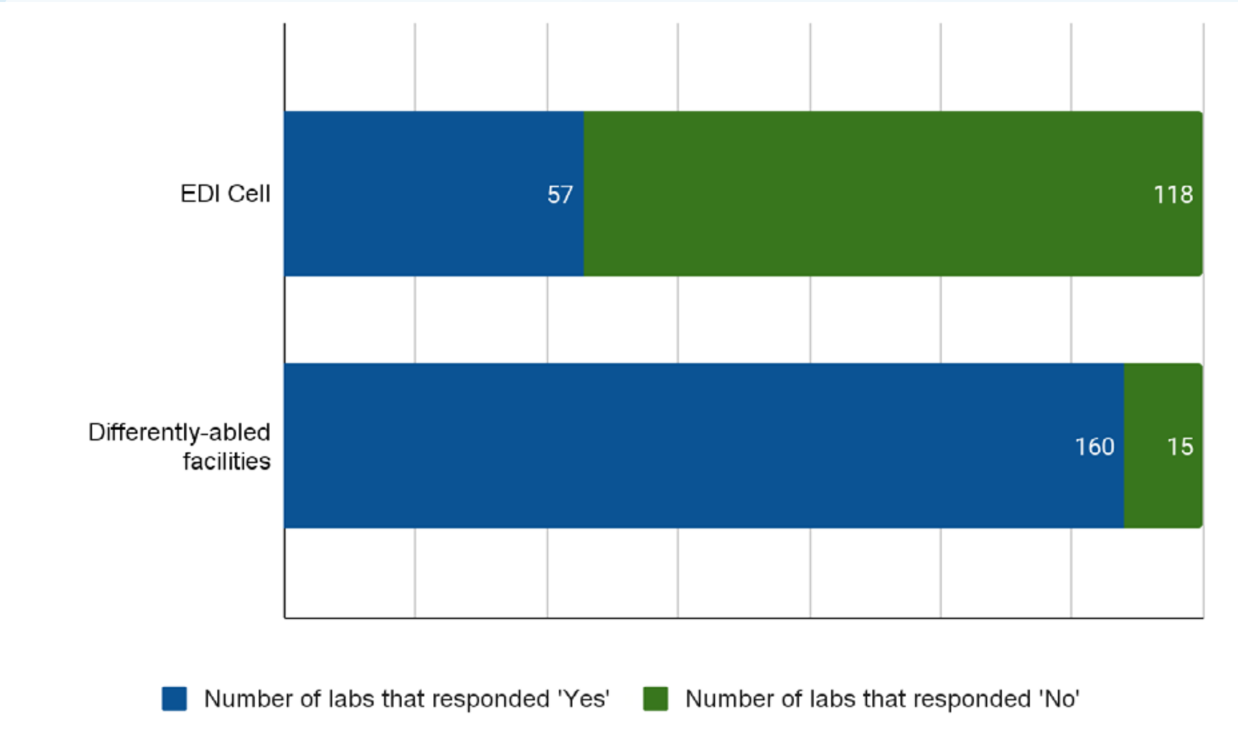
Around 31 of these labs/institutes had up to 10 outside researchers and students per 100 scientific staff that were able to access the labs/institutes' facilities. As can be seen in the accompanying chart, there were 69 labs/institutes that did not have outside researchers and students accessing their facilities while 17 labs/institutes opened its testing and research facility to up to 5 outside researchers and students per 100 scientific staff. There were 61 labs/institutes that opened its testing and research facility to more than 15 outside researchers and students per 100 scientific staff.

When it comes to startups and firms there were around 48 of these labs/institutes that had up to 10 startups and firms per 100 scientific staff that were able to access the labs/institutes' facilities. There were 95 labs/institutes that did not have startups and firms accessing their facilities while 36 labs/institutes opened its testing and research facility to up to 5 startups and firms per 100 scientific staff. There were 23 labs/institutes that opened its testing and research facility to more than 15 outside researchers per 100 scientific staff.

Of the 23 labs/institutes who opened its testing and research facility to more than 15 startups and firms and of the 61 labs/institutes that opened its testing and research facility to more than 15 outside researchers and students, there were 16 labs/institutes who supported both.

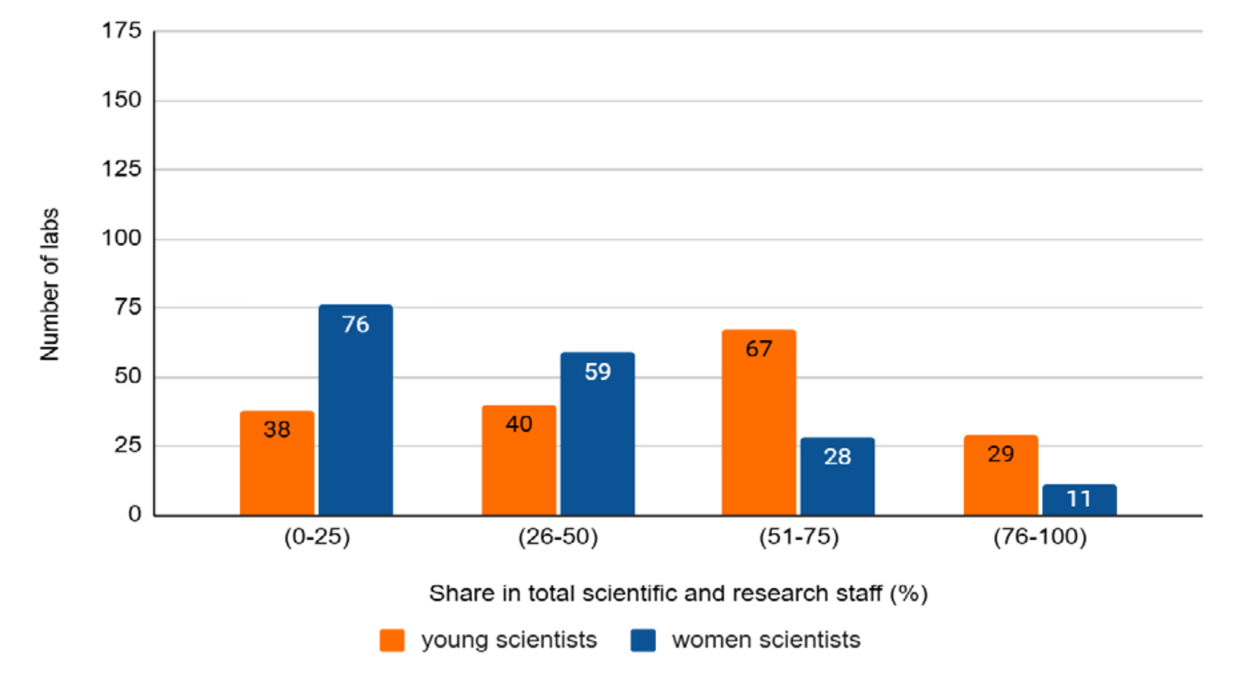
9.3.4 Sub-pillar 10: Equity, diversity, and inclusion

Figure 9.27: Provision of EDI cell and differently-abled friendly facilities



Just 57 of the 175 labs/institutes had an EDI cell while 160 labs/institutes had facilities that were differently-abled friendly. A majority of the labs/institutes would need to focus on improving their focus on EDI related matters by establishing a cell or committee dedicated to addressing any EDI related concerns.

Figure 9.28: Share of young scientists and women scientists to the total scientific and research staff (%)

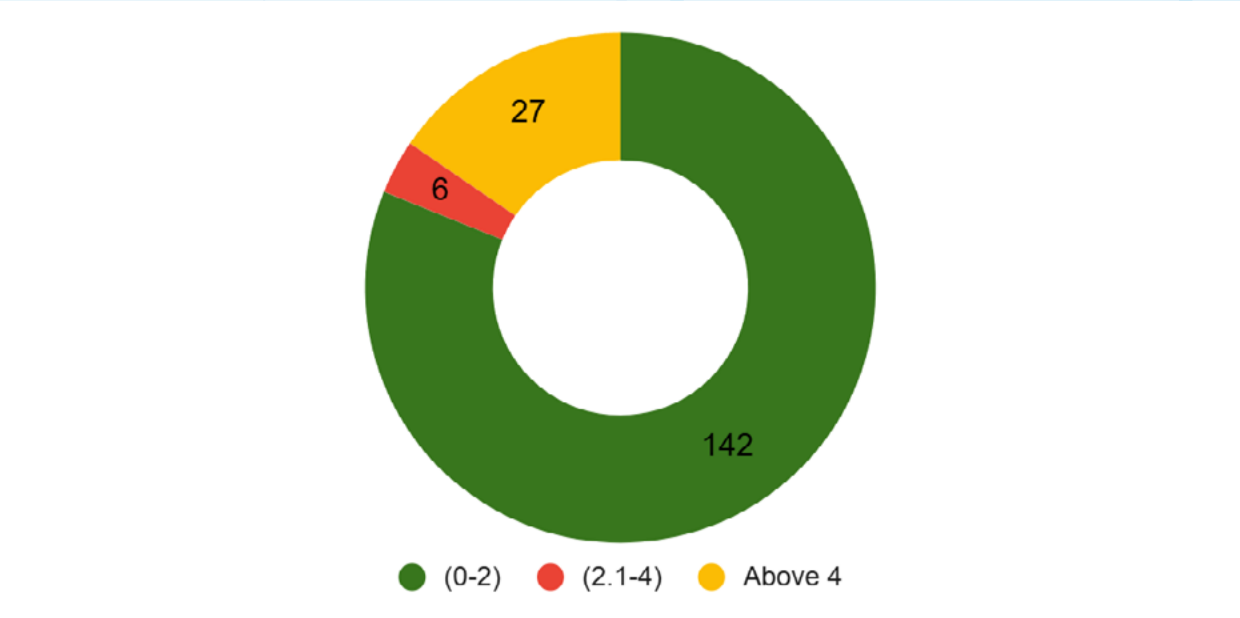


Note: Analysis is done for 174 labs/institutes. One lab/institute was excluded as their response could not be verified.

There were 59 labs/institutes for whom the share of women scientists as a share of total scientific and research staff was between 25 to 50 percent while 28 labs/institutes had a share between 50 to 75 percent. The 76 labs/institutes for whom the share of women scientists in total scientific and research staff was between 0 to 25 percent have scope to push for greater gender diversity among their research staff. With respect to young researchers (below the age of 40), 96 labs/institutes had a share of young researchers in total scientific and research staff that was greater than 50 percent.

9.3.5 Sub-pillar 11: Internal capacity building

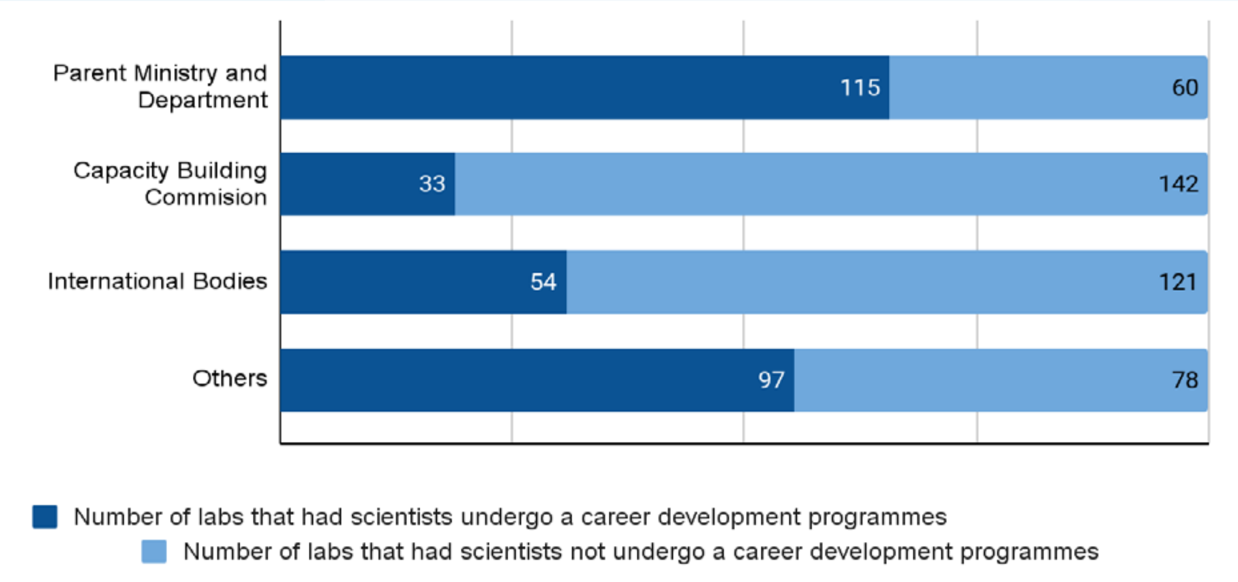
Figure 9.29: Share of total budget spent on training and skill up-gradation of the staff (%)



Of the 175 Applied R&D labs/institutes, 142 labs/institutes spend between 0 and 2 percent of their budget towards skills upgradation of their staff, while around 27 labs/institutes spend over 4 percent of their budget on skills upgradation of their staff. Over 57 percent of the labs/institutes were in fact found to spend less than 1 percent of their budget on training of their scientific staff and their administrative staff.

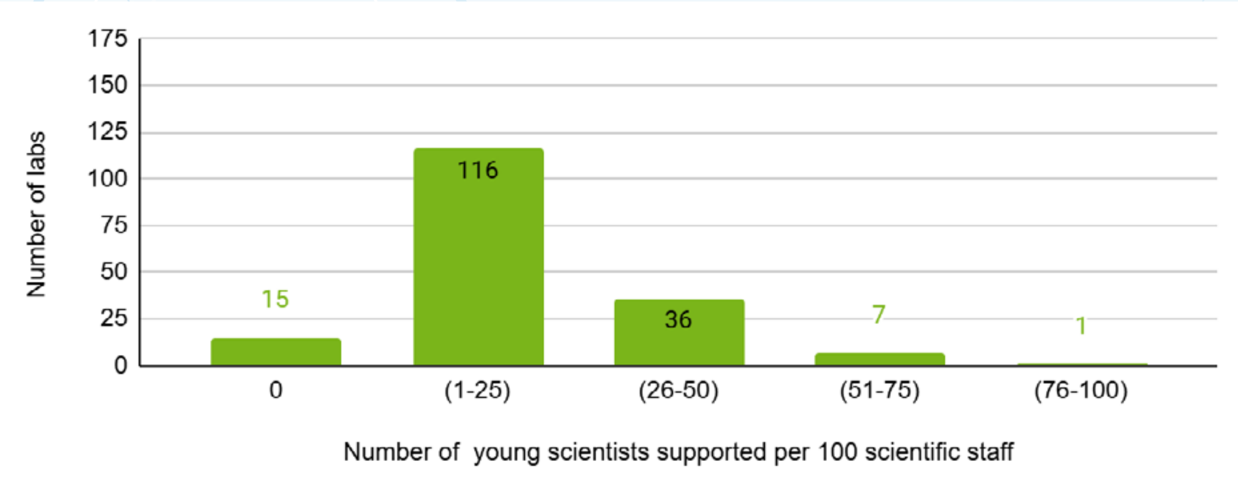
Labs/institutes would need to focus on a holistic approach to R&D and S&T spending which would need to include increased allocation towards training of their staff, both research and administrative, to complement the R&D and other activities of the lab.

Figure 9.30: Number of labs/institutes that had scientists undergo a career development programmes



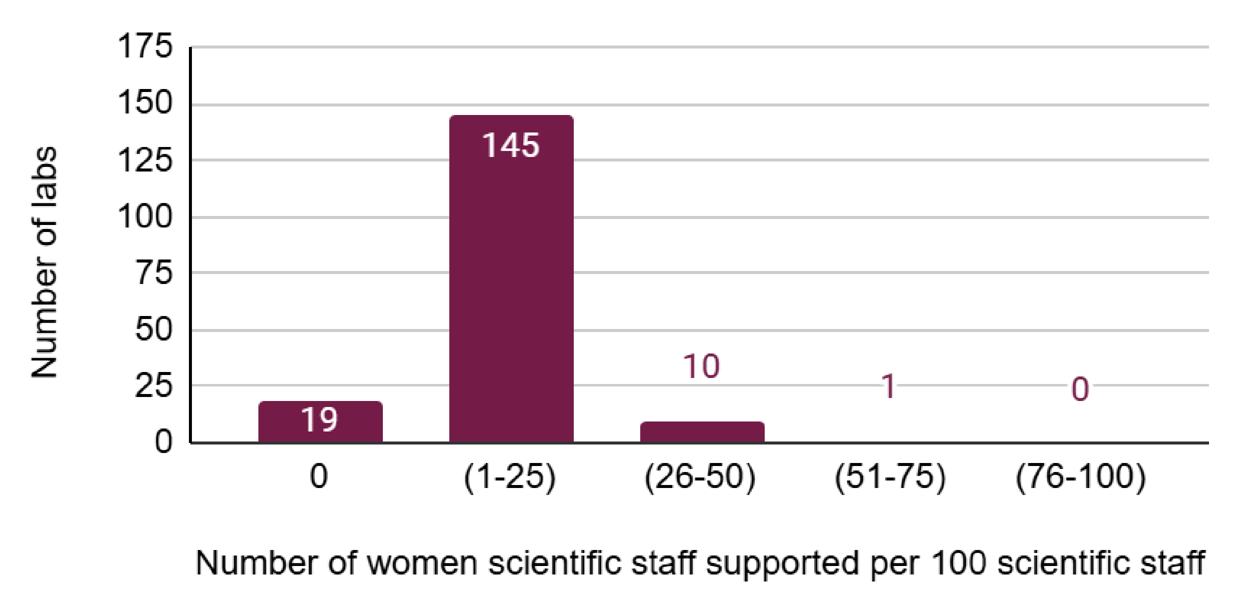
As can be seen in the accompanying chart, the majority of the labs/institutes had scientists participating in career development programmes within their parent ministry and departments and other departments. While 54 labs/institutes had scientists involved in career development programmes organized by international bodies, only 33 labs/institutes had scientists who participated in career development programmes organized by capacity building commissions.

Figure 9.31: Distribution of labs/institutes by number of young scientists supported



Of the 175 labs/institutes there were 160 labs/institutes that supported young scientists through conferences, training, sabbaticals, etc. As can be seen in the accompanying chart there were 116 labs/institutes that supported up to 25 young scientists per 100 scientific staff whereas 36 labs/institutes supported between 25 to 50 young scientists per 100 scientific staff. On the higher end there were only 7 labs/institutes that supported between 50 to 75 young scientists while only one lab from ICMR supported between 75 to 100 young scientists. Of the 7 labs/institutes that supported between 50 to 75 young scientists 2 labs/institutes each were from CSIR and ICAR, 1 lab each from ICMR and MoEFCC, and 1 lab from other central government ministries.

Figure 9.32: Distribution of labs/institutes by number of women scientific staff supported



Of the 175 applied R&D labs/institutes, 156 labs/institutes supported women scientific staff through conferences, training, sabbaticals, etc. There were 145 labs/institutes that supported up to 25 women scientific staff through conferences, training, sabbaticals, etc whereas only 10 labs/institutes supported between 25 to 50 women scientific staff. There was only one lab from which provided conferences, training, sabbaticals, etc to its women scientific staff while there were no lab that supported beyond 75 women scientific staff per 100 scientific staff.

Key Takeaways:

- There were 155 labs/institutes that introduced at least one new research field/innovation/service per year. It would require domain experts to evaluate the impact of these new research fields/innovations/services introduced.
- Of the reported labs/institutes, there are 93 labs/institutes that have more than 50 percent of their staff as permanent and contract researchers. There is scope for many labs/institutes to increase the share of permanent and contract researchers in their total staff. Given the number of Science & Engineering PhDs being produced every year in India, efforts should be made to attract many more young researchers from this talent pool to contribute to the scientific endeavors of the publicly funded R&D labs/institutes.
- Of the 175 labs/institutes there were only 61 labs/institutes that had R&D facilities available on the I-STEM national portal.

- 64 percent of the labs/institutes had national accreditation for their lab procedure while only 36 percent of the labs/institutes had international accreditation for their lab procedure. If engagement with industry as well as international collaborations are to increase, these effective management tools as well as necessary accreditations would be important practices to focus on for the balance labs/institutes.
- Establishing an EDI cell and increasing the share of women researchers in total scientific staff would be important for labs/institutes to work towards for several labs/institutes.
- Labs/institutes would also need to invest in upgrading the skills of their research as well as administrative staff to complement the other research activities being undertaken. Currently it appears the expenditure on training and skills upgradation of their staff is very low. Of the 142 labs/institutes reported above that spend up to 2 percent of their budget on training, there are 100 labs/institutes that spend less than 1 percent of their budget on training and skill upgradation of their staff.

Chapter 10

Services R&D Labs/institutes

Services research by definition is systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, directed to producing new products or processes or to improving existing products or processes. This chapter analyzes the responses of labs/institutes that chose to categorize themselves as doing Services R&D. The TRL levels of the technologies developed by these labs/institutes were 6 or higher.

Chapter Summary

- There were 36 labs/institutes that had developed up to 10 technologies (targeting SDGs and/or national programmes) per hundred scientific staff while 16 labs/institutes had developed 10 or more technologies
- The primary beneficiaries of the output from the services labs/institutes are government departments followed by individuals and industry
- Of the 74 labs/institutes there were 43 labs/institutes that saw an increase in the number of scientific staff, while 31 labs/institutes had a decrease in the number of scientific staff
- There were 56 labs/institutes that did not provide any incubation support to any startups. There were very few labs/institutes that supported startups through different support mechanisms.
- Of the 74 labs/institutes, there were 36 labs/institutes that had received national recognition/ accreditations, while 22 labs/institutes had received international recognitions/ accreditations
- While 40 labs/institutes obtained patents only 20 labs/institutes licensed out its patents. There were only 27 labs/institutes that obtained patents in emerging technologies, a higher number of patents were granted to these labs/institutes in industrial technologies, followed by bio-engineering technologies and sustainable technologies.
- There were 16 labs/institutes that introduced more than 2 new products and/or services per Rs.10 crore of budgetary support whereas 22 labs/institutes did not introduce a single new product or service in the period under consideration.

- Over 91 percent of the extramural funding received from government sources. While there were 53 labs/institutes that received up to Rs. 2 crore of extramural funding for every Rs. 10 crore of budget spent, only 16 labs/institutes received more than Rs. 4 crore extramural funding for every Rs. 10 crore of budget spent.
- There were 31 labs/institutes that had absolutely no national or international collaboration with industry while there were 11 labs/institutes that were engaged in both national and international industry collaborations
- There were 29 labs/institutes that introduced 3 new research fields/innovations/ services in each year for the period under consideration, while 26 labs/institutes introduced at least 2 new fields/ innovations/services on average each year.
- There were 57 labs/institutes that had procedures in place for sustainable sourcing of material. There were 25 labs/institutes that adhered to all of the 8 waste reclamation procedures whereas of the 74 labs/institutes 17 labs/institutes followed at least 6 of these procedures.
- 34 labs/institutes that opened its testing and research facility to startups and firms whereas only 26 labs/institutes had their R&D facilities registered on the I-STEM national portal
- There were 50 labs/institutes that had no EDI cell while the majority of the labs/institutes that did report the number of women scientific staff had 0 to 25 percent women scientists in total scientific and research staff.
- 58 labs/institutes spend between 0 and 2 percent of their budget towards skills upgradation of their staff and majority of them spend less than 1 percent of their budget on training.
- There were 66 labs/institutes that supported young scientists through conferences, training, sabbaticals, etc. While there were very few labs/institutes that supported between 25 to 50 women scientific staff, no labs/institutes supported beyond 50 women scientific staff per 100 scientific staff.

Services R&D Labs

74 **Labs** or close to **32%** self identified as applied R&D labs

11,490 **Total Scientific Staff**

25% Median Share of Women in Scientific Staff

57% Median Share of Young Researchers in Scientific Staff

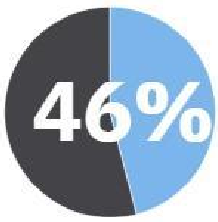
4 Research **Staff Appointed to National Committees** for Policy Improvement **per 100 Scientific Staff**

15% of Projects Executed were in **Collaboration with National Industry**

28 Patents Licensed Out

₹ 87 Thousand of Earnings from Technology Transfer per 1 Cr of Budget

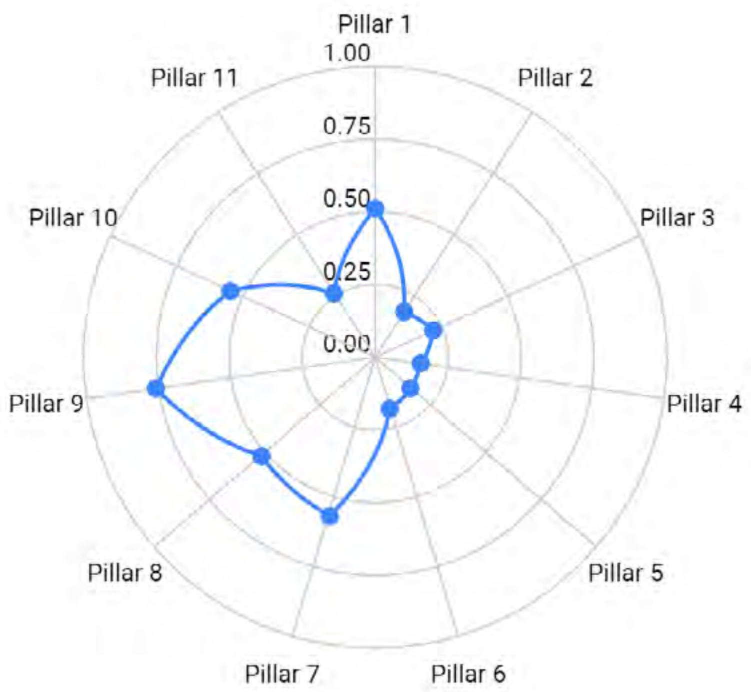
₹ 25 **Lakhs** in **Earnings from Consultancy** Received for Every 1 Cr of Budget



Labs That Opened Testing & Research Facilities to Startups and Industry

There were 74 labs/institutes that categorized themselves as Services R&D labs/institutes, of which there were 15 labs/institutes that were undertaking only services R&D while the remaining 59 labs/institutes were hybrid in nature i.e. they were also undertaking basic, and/or applied R&D.

Figure 10.1: Sub-pillar wise Average Scores



Of the 74 labs/institutes that categorized themselves as Services R&D labs/institutes, there were 18 CSIR labs/institutes and 14 ICAR labs/institutes, 13 labs/institutes from ICMR, 5 labs/institutes each from the Ministry of Ayush and MoEFCC, 4 labs/institutes from MeitY, 2 labs/institutes from DST, 1 lab each from DBT and Ministry of Earth Sciences, and the remaining 11 labs/institutes from other central government ministries. Of the 15 labs/institutes that were undertaking only Services R&D, there were 11 from major scientific agencies and 4 were from other central government ministries. The average budget for the overall sample of 74 services research labs/institutes was around Rs. 84 crore, while it was around Rs. 63 crore for the 15 labs/institutes that were engaged in only services R&D. The average number of scientific staff for the sample of 74 labs/institutes was 152, while the average number of scientific staff for the 15 labs/institutes engaged only in Services R&D was 53.

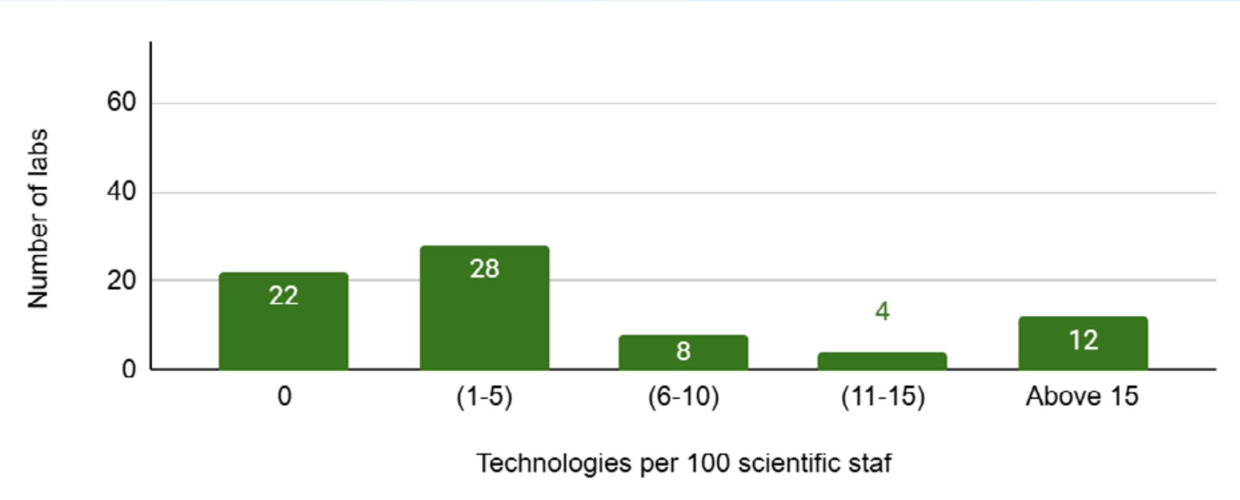
10.1 Pillar 1: Socio-economic Impact

In this pillar on socio-economic impact, some of the key indicators that have been captured include the number of technologies (with TRL levels 6 and higher) targeted towards SDGs or national programmes, the targeted beneficiaries of the labs/institutes programmes, skill development programmes conducted, increase in scientific staff and incubation of startups. The data presented in the charts below are based on an average of the two years under consideration, namely 2021-22 and 2022-23.

- Of the 74 labs/institutes, there were 22 labs/institutes that had not developed any technologies, 36 labs/institutes had developed up to 10 technologies (targeting SDGs and/or national programmes) per hundred scientific staff while 16 labs/institutes had developed 10 or more technologies.
- The primary beneficiaries of the output from the services labs/institutes are government departments followed by individuals and industry.
- There were 20 labs/institutes that were not involved in conducting skill development programmes. At the higher end, there were 12 labs/institutes that conducted over 30 skill development programmes per hundred scientific staff.
- Of the 74 labs/institutes, 43 labs/institutes saw an increase and 31 saw a decrease in the number of scientific staff.
- Only 18 labs/institutes of the 74 services labs/institutes were providing incubation support to startups.

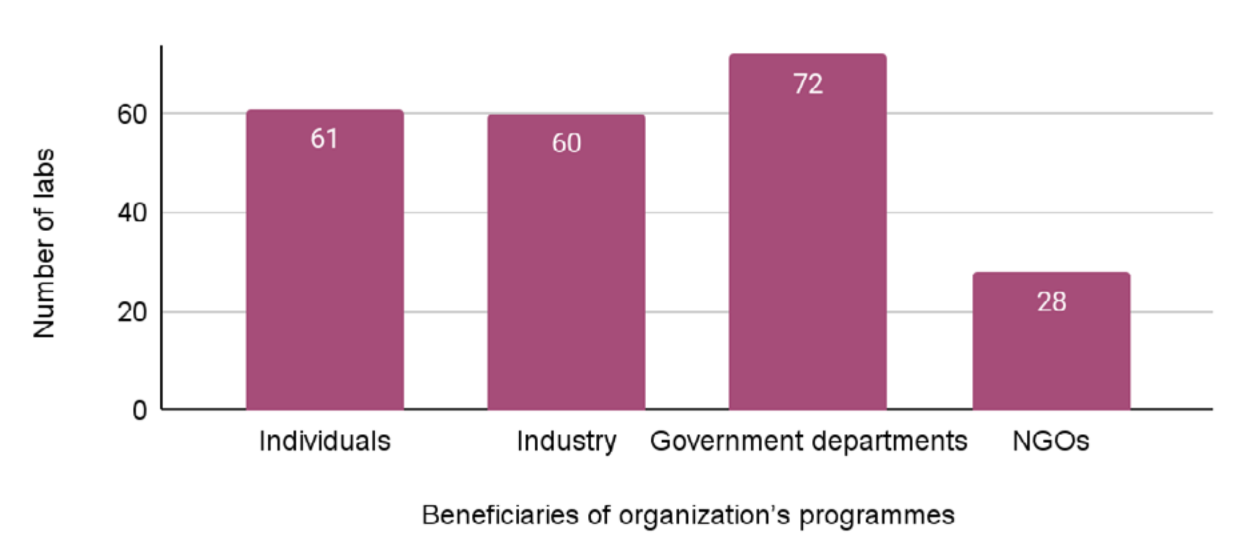
10.1.1 Sub-pillar 1: Contribution to SDGs and national programmes

Figure 10.2: Technologies targeted towards SDGs & National Programmes (TRL 6 and higher)



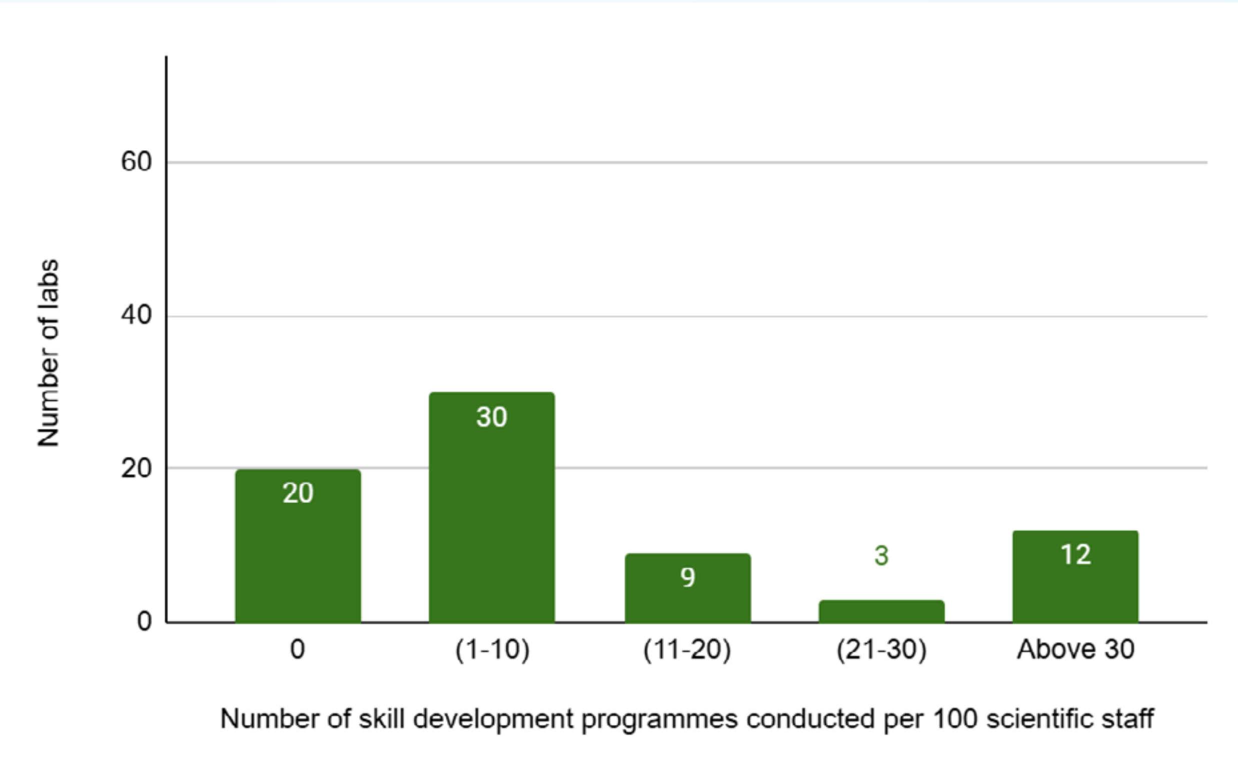
There were 22 labs/institutes that had classified themselves as Services R&D labs/institutes that had not developed any technologies with TRL 6 and higher (targeting SDGs and/ or national programmes). Of the remaining 52 labs/institutes, there were 36 labs/institutes that had developed up to 10 technologies per 100 scientific staff while 16 labs/institutes had developed more than 10 technologies per 100 scientific staff with TRL 6 and higher. The 16 labs/institutes with 10 or more technologies per hundred scientific staff included 3 labs/institutes from CSIR, 2 labs/institutes each from ICAR and Ministry of Ayush, 1 lab each from ICMR, MeitY and MoES and the remaining 6 labs/ institutes from other central government ministries.

Figure 10.3: Beneficiaries of organization's programmes



For Services R&D labs/institutes, most labs/institutes were targeting government departments through their research and programmes. Around 61 labs/institutes targeted individuals as a beneficiary group through their research and programmes, just slightly higher than industry who were targeted by 48 labs/institutes. Close to 38 percent of the labs/institutes targeted NGOs through their work.

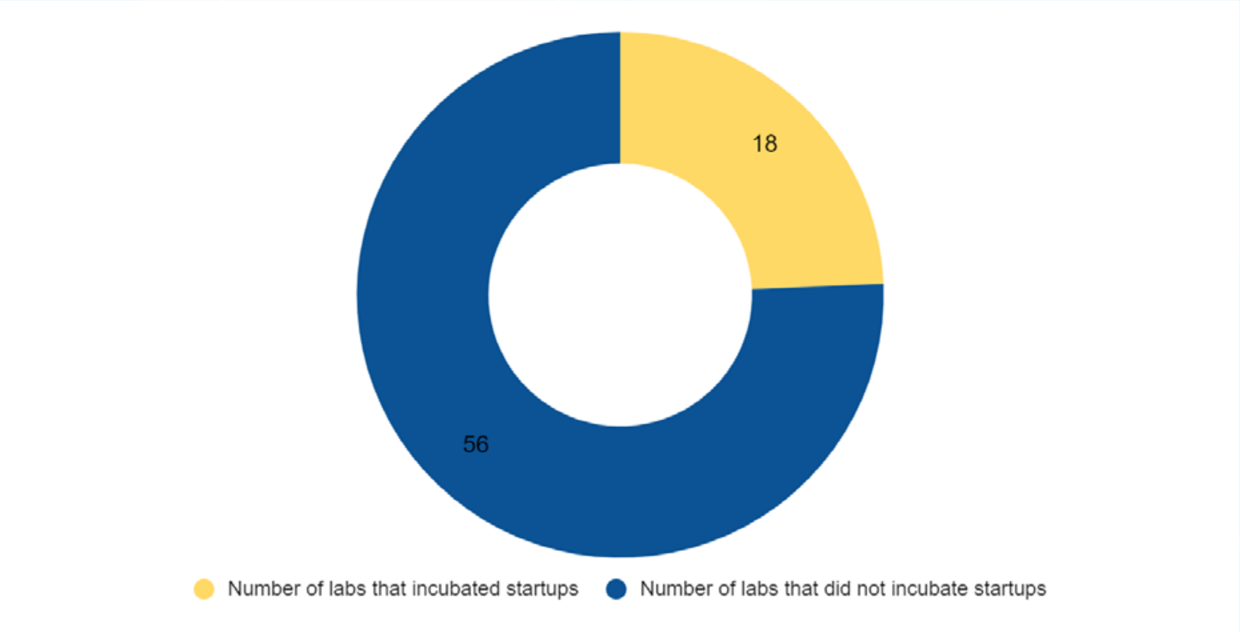
Figure 10.4: Number of skill development programmes conducted per 100 scientific staff



There were 20 labs/institutes that did not conduct any skill development programmes. Of the remaining 54 labs/institutes, there were 30 labs/institutes that conducted up to 10 skill development programmes per 100 scientific staff on average per year. At the higher end there were 12 labs/institutes that conducted over 30 skill development programmes per 100 scientific staff. The 12 labs/institutes at the higher end comprised 3 labs/institutes from CSIR, 2 each labs/institutes from ICAR and Ministry of Ayush, 1 lab each from DST and MoEFCC while the remaining 3 labs/institutes were from other central government ministries.

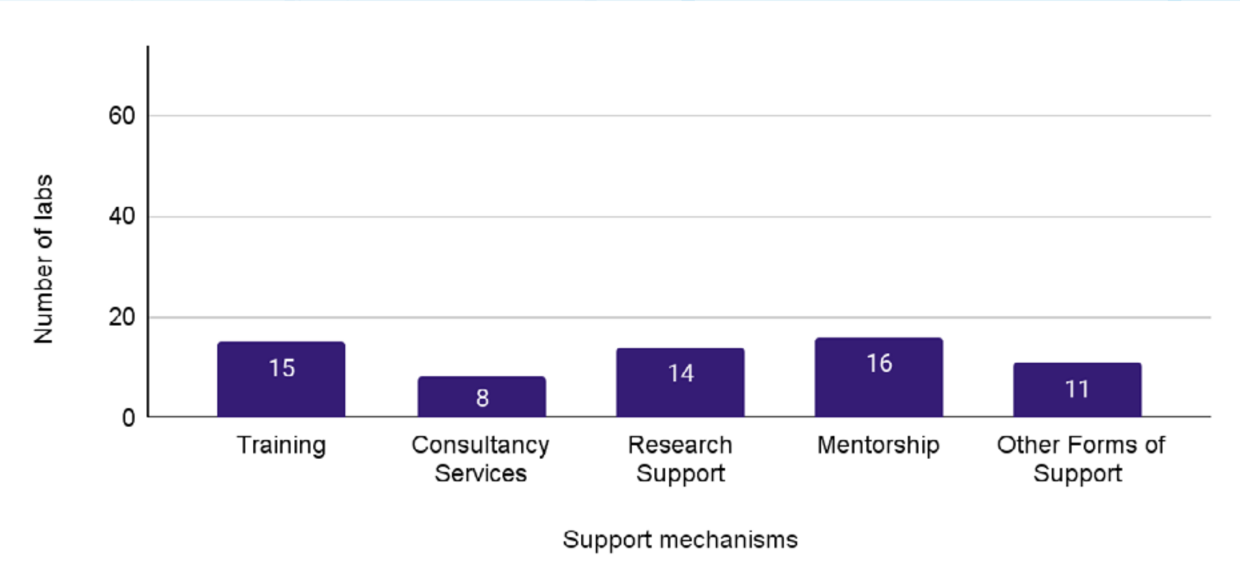
10.1.2 Sub-pillar 2: Employment generation and human resource development

Figure 10.5: Startups incubated



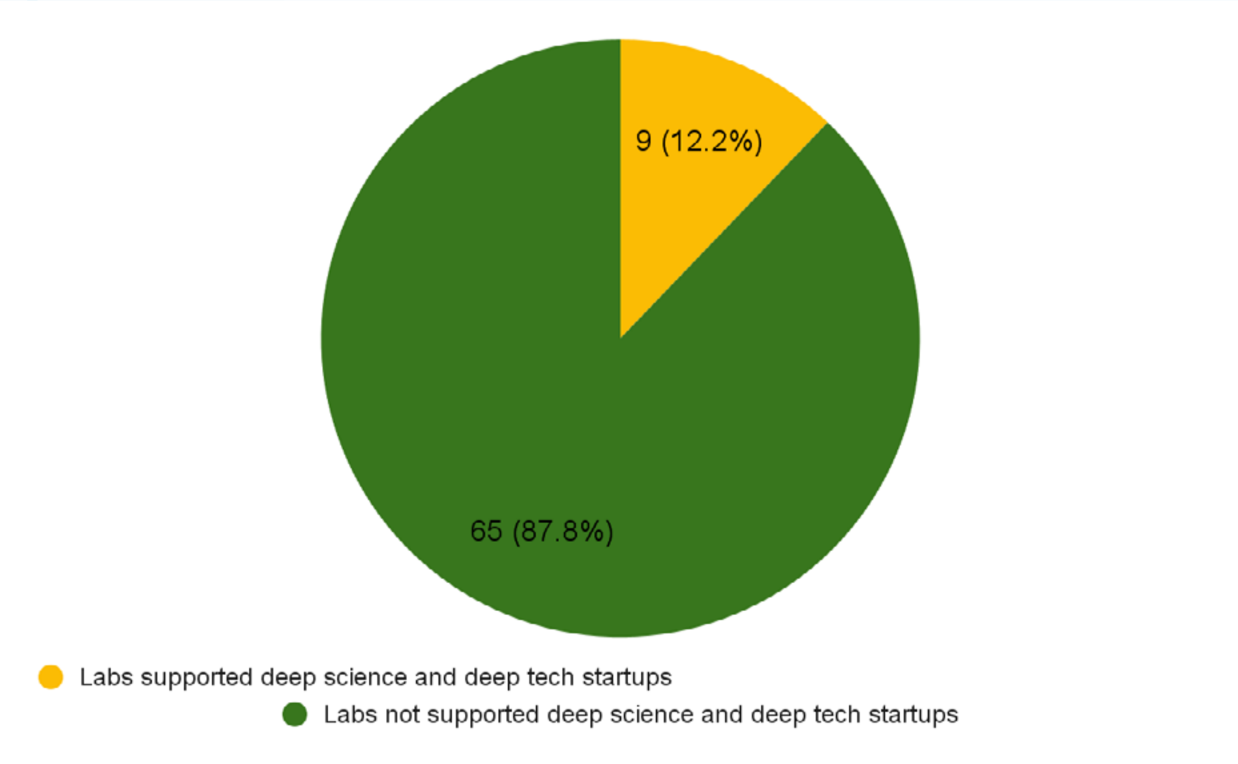
There were only 18 labs/institutes undertaking Services R&D that were incubating startups while 56 labs/institutes did not provide any incubation support to any startups.

Figure 10.6: Startups supported through different support mechanisms



Of the 74 labs/institutes there were very few labs/institutes that supported startups through different support mechanisms. 16 labs/institutes provided mentorship, 15 labs/institutes provided training, 14 labs/institutes provided research support while 11 labs/institutes supported startups through different forms only 8 labs/institutes provided consultancy support. Of these 8 labs/institutes that provided consultancy support 2 labs/institutes each were from CSIR and ICAR, 1 from MeitY, and the remaining 3 labs/institutes were from other central government ministries.

Figure 10.7: labs/institutes supported deep science and deep tech startups



Of the 74 labs/institutes there were only 9 labs/institutes that provided support to deep science and deep tech startups. Of these 9 labs/institutes 4 labs/institutes were from CSIR, 2 from DST, 1 lab each from ICAR and ICMR, while the remaining 1 lab was from other central government ministries.

Key Takeaways:

- There were 16 labs/institutes that developed 10 or more technologies (targeting SDGs and/ or national programmes) per hundred scientific staff. These included 10 labs/institutes from major scientific agencies and the remaining 6 labs/institutes from other central government ministries.
- Currently only 28 percent of labs/institutes are targeting NGOs through their programmes, and more labs/institutes may wish to start engaging with NGOs for greater socio-economic impact.

- There were 12 labs/institutes that conducted over 30 skill development programmes per hundred scientific staff. Of these 12 labs/institutes, 9 were from major scientific agencies.
- There were more Services R&D labs/institutes that saw an increase in scientific staff as compared to those that saw a decrease in scientific staff during the period under consideration.
- More services labs/institutes should consider providing support to startups even if direct incubation support may not be feasible. There is significant scope for these labs/institutes to be engaged in multiple ways with the startup ecosystem, either through provision of consultancy and research support or through the use of their facilities where feasible.

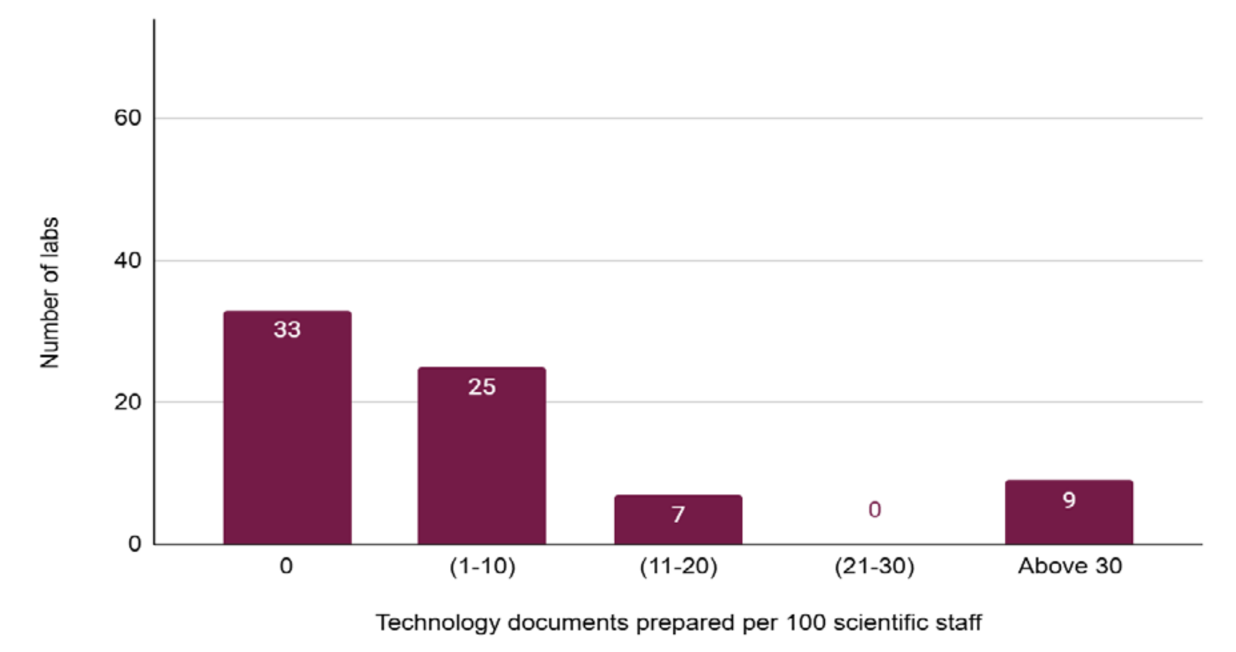
10.2 Pillar 2: Science, Technology and Innovation Excellence

For the pillar on STI excellence, the indicators captured below pertain to technology documents prepared,national and international recognitions, technology transfer, contribution to policies and regulations, new services and/or products introduced, earnings from government and non-government sources, external funding received by the labs/institutes and collaborations on projects.

- While only 36 labs/institutes had received recognition for their work nationally, only 22 out of the 74 labs/institutes had received any international recognition.
- Around 36 out of the 74 labs/institutes had contributed to the formulation of national and international policies, standards or regulations.
- There were 22 labs/institutes that had not introduced any new product or service during the two years under consideration while 36 labs/institutes had introduced up to 2 products per Rs. 10 crore of budget spent.
- A majority of the earnings for the labs/institutes came through consultancies, both from government and non-government sources. Of the 74 labs/institutes there were 46 labs/institutes that had earned up to Rs. 1.5 crore from non- government sources and 43 labs/institutes that had earned up to Rs. 1.5 crore from government sources per Rs. 10 crore of budget spent.
- With respect to collaborations on projects with industry, there were 43 labs/institutes that had ongoing national collaborations while there were 11 labs/institutes that had ongoing international collaborations. There were many more collaborations on projects with academic institutions. Of the 74 labs/institutes 60 labs/institutes had national collaborations with academic institutions and/ or research labs/institutes while 37 labs/institutes had international collaborations with academic institutions and/ or research labs/institutes.

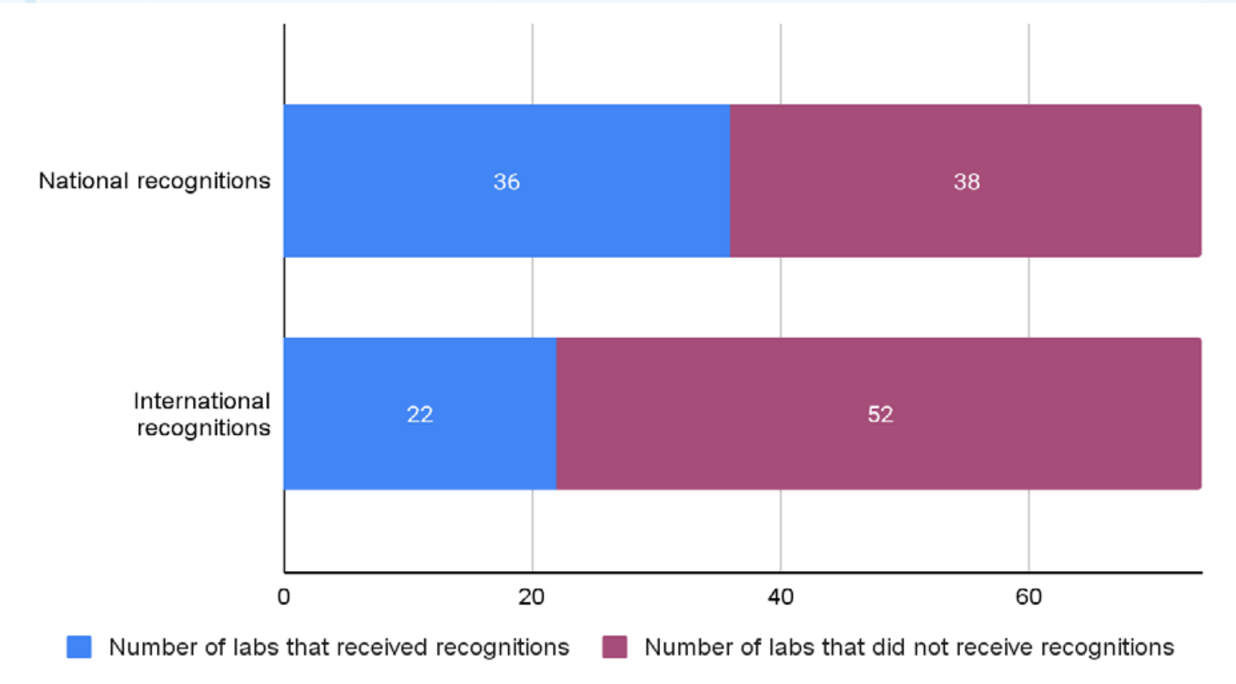
10.2.1 Sub-pillar 3: Scholarly research, development output and quality

Figure 10.8: Number of technology documents prepared per 100 scientific staff



There were 33 labs/institutes that had not prepared any technology document as part of a project. Technology documents that were to have been considered here pertained to design, dossiers, regulatory submissions etc. Of the remaining 41 labs/institutes, around 32 of them produced up to 20 technology documents per 100 scientific staff while there were 9 labs/institutes that produced more than 30 technology documents per 100 scientific staff. These 9 labs/institutes at the higher end comprised 2 labs/institutes from CSIR. 1 lab each from ICAR, DST and Ministry of AYUSH and 4 labs/institutes from other central government ministries.

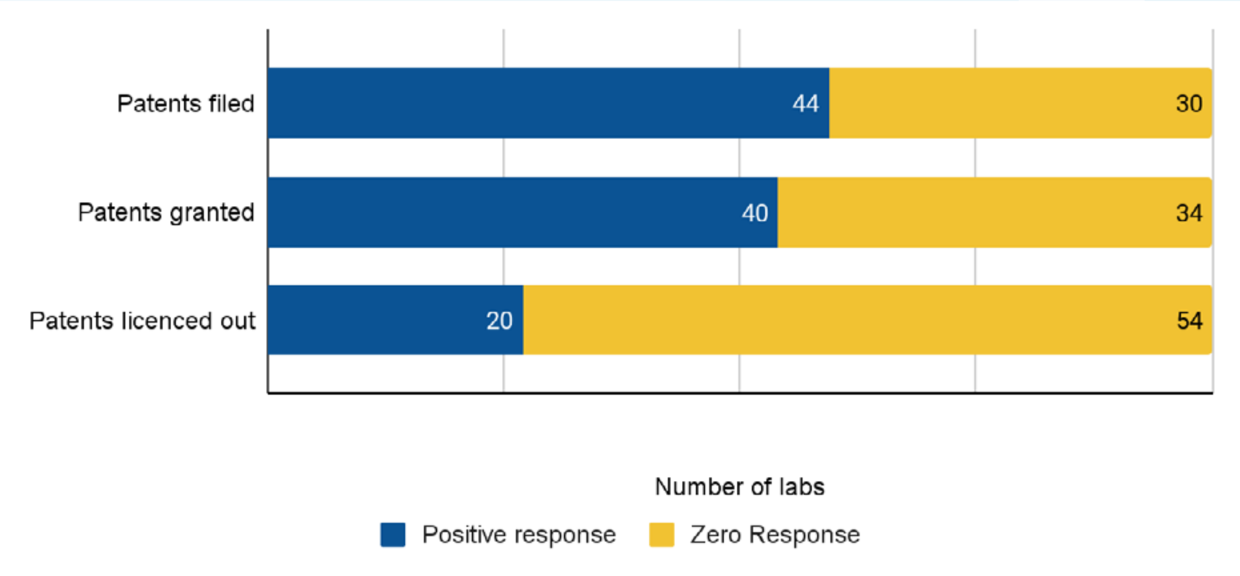
Figure 10.9: Number of labs/institutes that received/not received recognition



Of the 74 labs/institutes, there were 36 labs/institutes that had received national recognition/ accreditations, while 38 labs/institutes had not received any national recognition. Separately, there were 22 labs/institutes that had received international recognitions/ accreditations while 52 labs/ institutes had not received any international recognition.

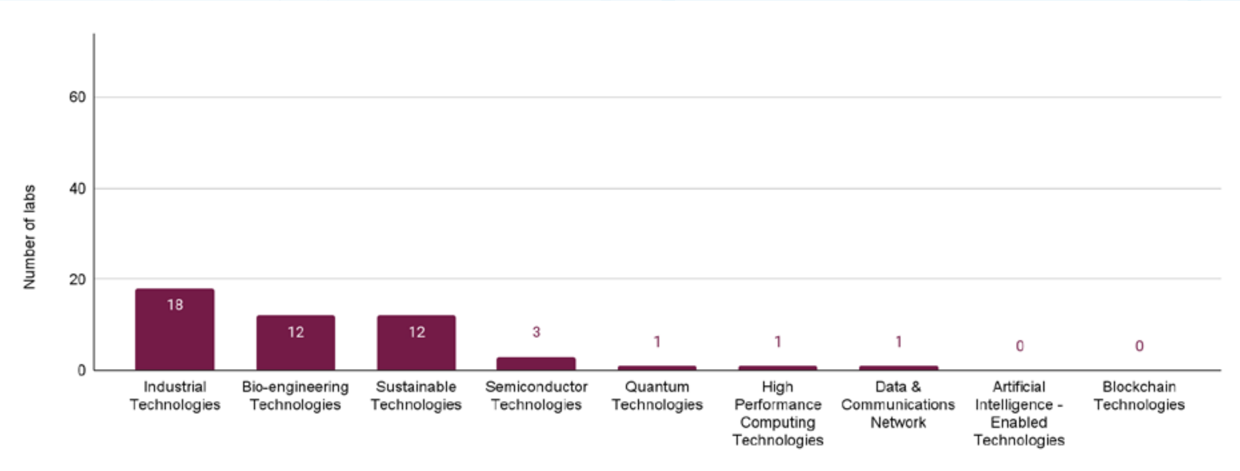
10.2.2 Sub-pillar 4: Development and innovation output and quality

Figure 10.10: Patents filed, granted, and licenced out



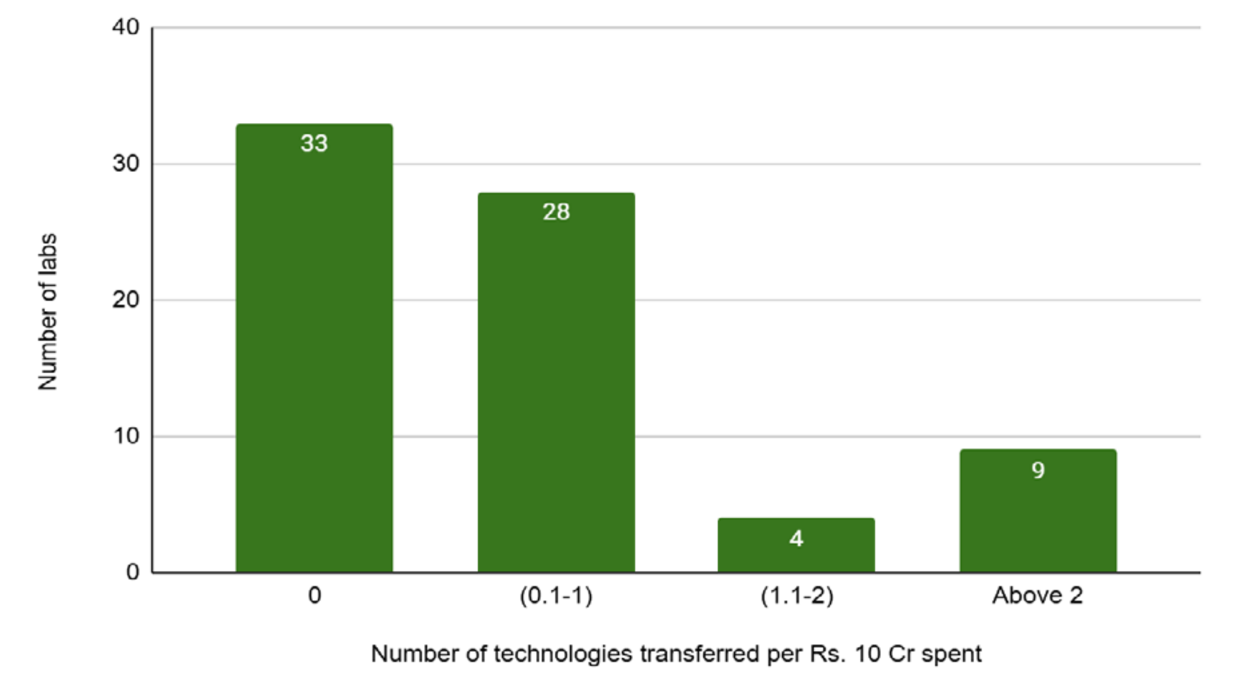
When it came to patents filed and patents granted, the data above shows that 59 percent of the labs/institutes filed patents in the period under consideration, while around 54 percent of the labs/ institutes also obtained patents during this period. However when it came to licensing out patents, the share of labs/institutes dropped to nearly a third. Although a large number of labs/institutes are filing patents and obtaining patents, the total number of patents filed or granted per 100 scientific staff is very low.

Figure 10.11: Patents granted in emerging areas of technologies



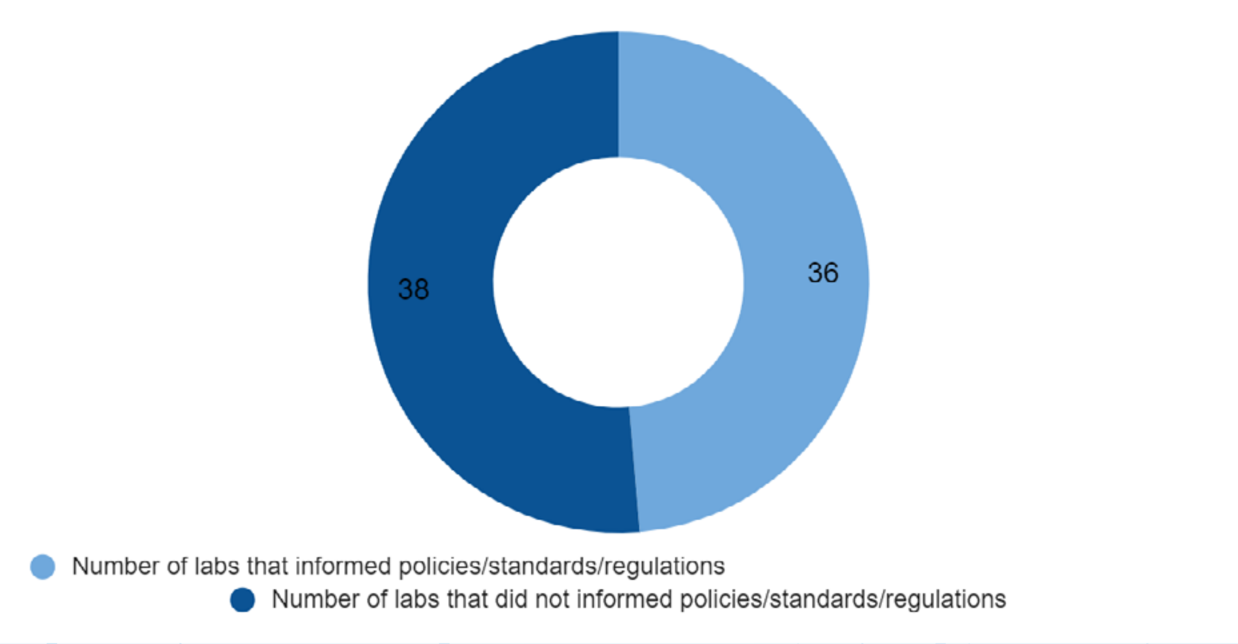
There were 27 labs/institutes that obtained patents in the emerging areas of technology while there were 47 labs/institutes that did not obtain any patents in any emerging areas of technology. As can be seen in the accompanying chart a higher number of patents were granted to these 27 labs/institutes in industrial technologies, followed by bio-engineering technologies and sustainable technologies. Of these 27 labs/institutes 13 labs/institutes were from CSIR, 5 from ICAR, 4 from ICMR, 1 from DST, and the remaining 4 labs/institutes were from other central government ministries.

Figure 10.12: Technology transferred per 10 crore of budget spent



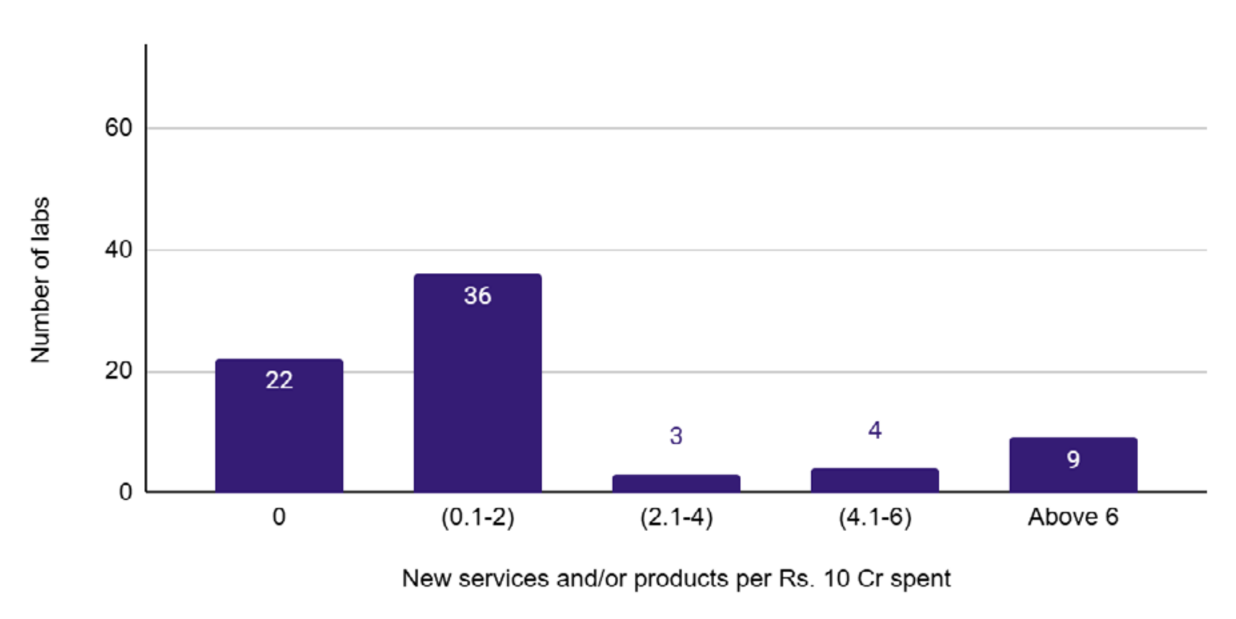
33 of the labs/institutes did not transfer any technologies during the period under consideration. Of the remaining 31 labs/institutes, there were 22 labs/institutes that transferred up 1 technology per Rs. 10 crore of budget spent. Of the total technologies transferred, around 42 percent were through licensing out of patents and other IPR.

Figure 10.13: Number of labs/institutes that informed national and international policies/ standards/regulations



Of the 74 Services R&D labs/institutes, there were only 36 labs/institutes that contributed to informing national and international policies or regulations through their scientific staff.

Figure 10.14: New services and/or products introduced per 10 crore of rupees spent



There were 22 labs/institutes that did not introduce a single new product or service in the period under consideration. There were 36 labs/institutes that introduced up to 2 new products and/or services per Rs. 10 crore of budgetary support while 16 labs/institutes introduced more than 2 new products and/or services per Rs. 10 crore of budgetary support. Of these 16 labs/institutes that introduced more than 2 new products and/or services per Rs. 10 crore of budgetary support, there were 4 labs/institutes from ICAR, 2 labs/institutes each from CSIR, ICMR and MoEFCC, 1 lab from the Ministry of Ayush and the remaining 5 labs/institutes from other central government ministries.

10.2.3 Sub-pillar 5: Commercialisation of technologies and revenue generation

With respect to earnings from government and non-government sources which includes domestic non- government and international non- government sources, consultancies have been the major source for the Services R&D labs/institutes. As can be seen in the pie chart below, very little in earnings has come by way of technology transfer.

There were 9 labs/institutes that had no earnings from government sources while 6 labs/institutes had no earnings from non-government sources. There were 19 labs/institutes that did not have any earnings from either government or non-government sources. Of the 74 labs/institutes there were 43 labs/institutes that had earned up to Rs. 1.5 crore per Rs. 10 crore of budget spent from government sources and 46 labs/institutes that had earned up to Rs. 1.5 crore per Rs. 10 crore of budget spent from non-government sources.

However, for these labs/institutes that had earned up to Rs. 1.5 crore per Rs. 10 crore of budget spent, 20 labs/institutes had earned up to Rs. 0.5 crore from both government and non-government sources. At the higher end, there were 12 labs/institutes that had earnings of more than Rs 1.5 per Rs. 10 crore of budget spent from government sources and 9 labs/institutes that had these earnings from non-government sources. Of these labs/institutes at the higher end, there were 6 labs/institutes that had earnings from both government and non-government sources that were greater than Rs. 1.5 crore per Rs. 10 crore of budget spent.

Figure 10.15: Earnings from government and non-government per 10 crore of rupees spent

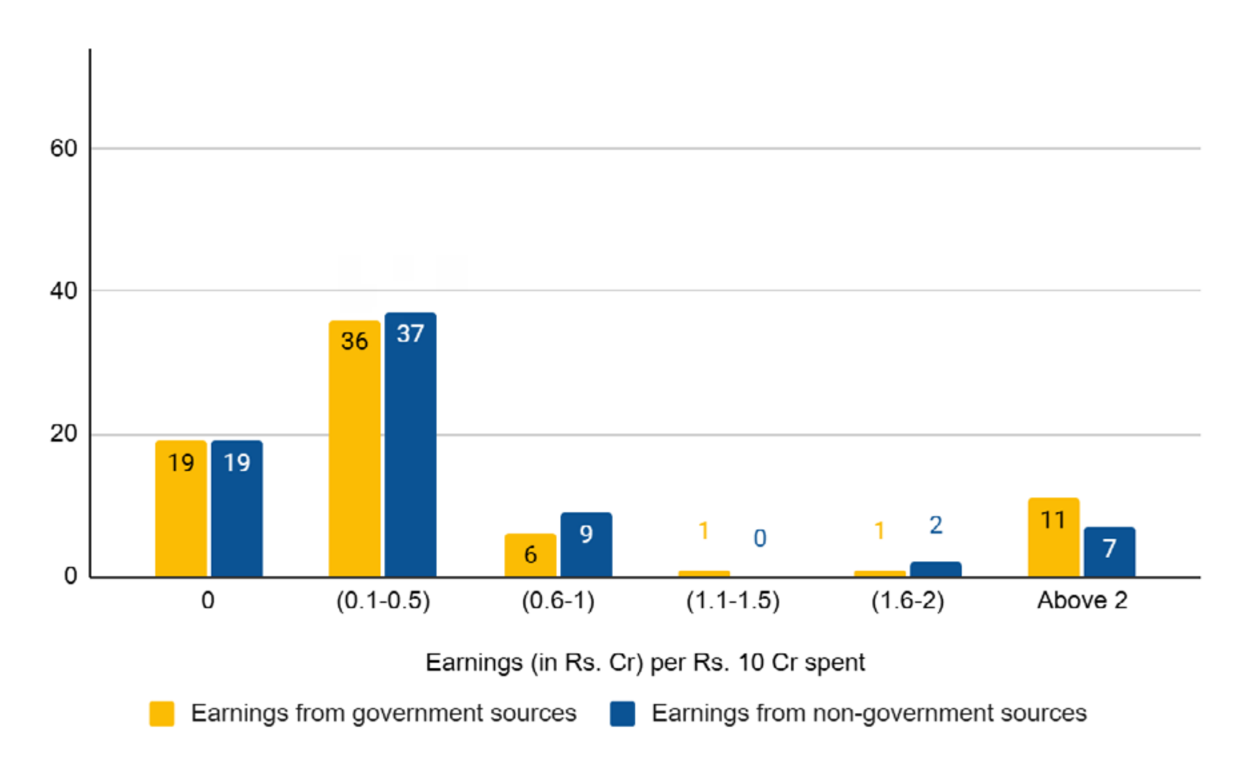


Figure 10.16: Share of consultancy, training and technology transfer fees (%)

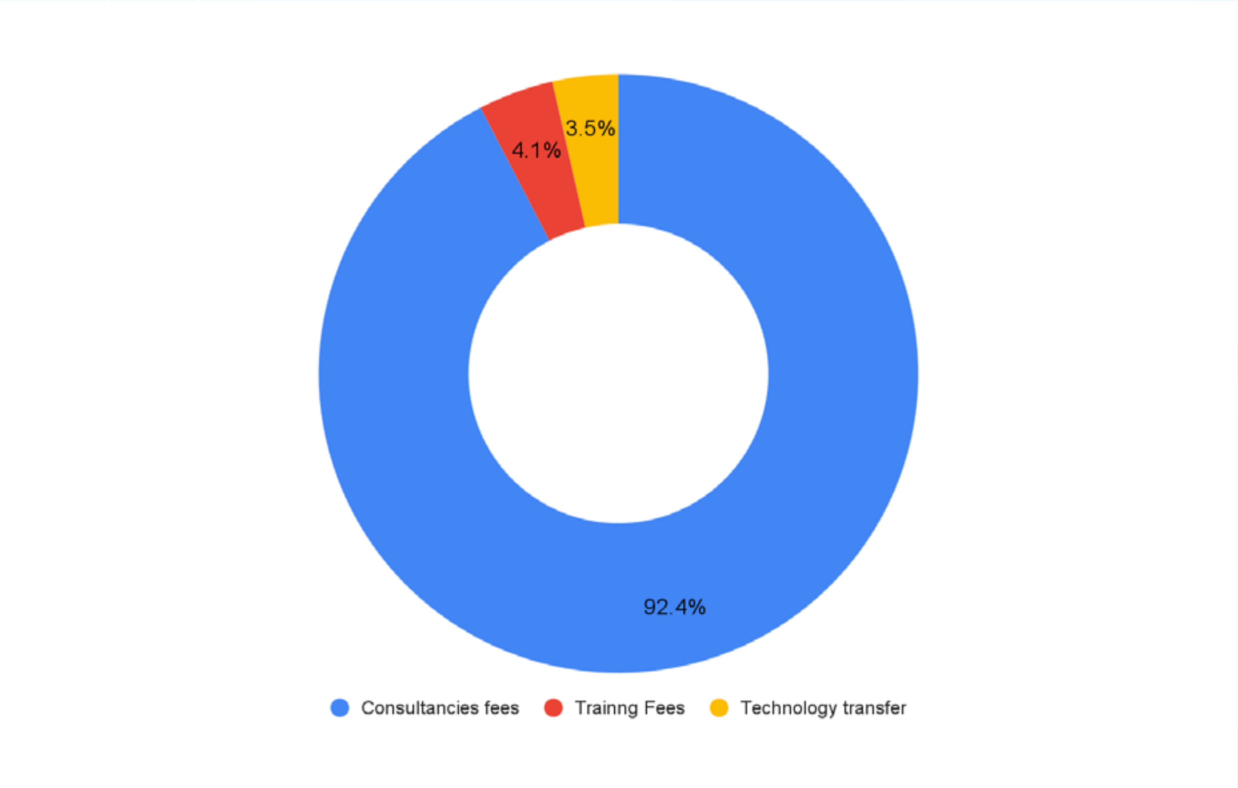


Figure 10.17: Extramural funding received from government per 10 crore of rupee spent

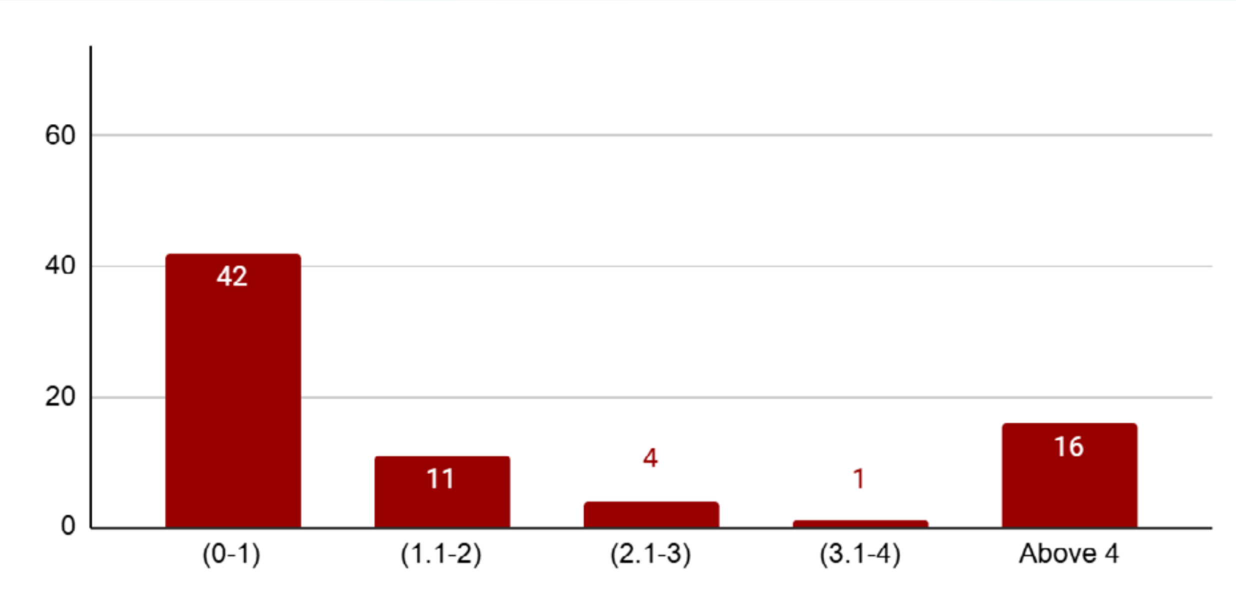
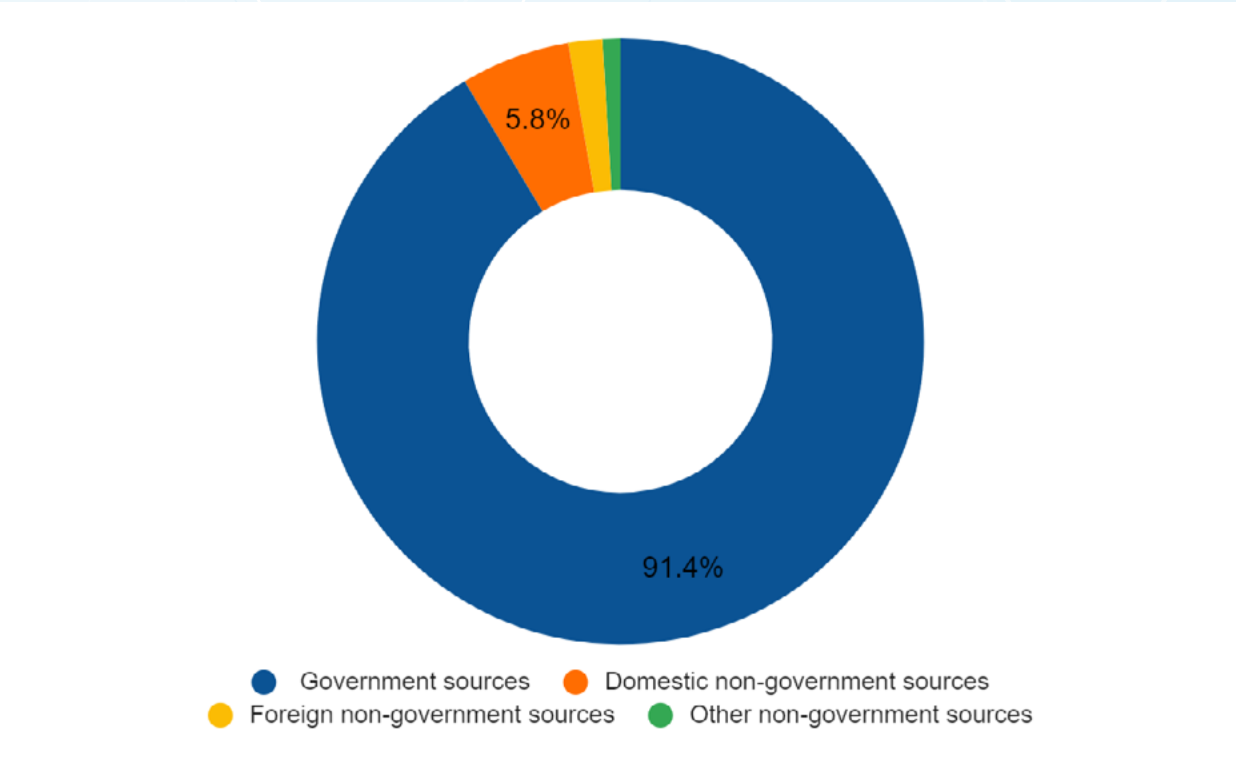


Figure 10.18: Extramural funding from government and non-government sources

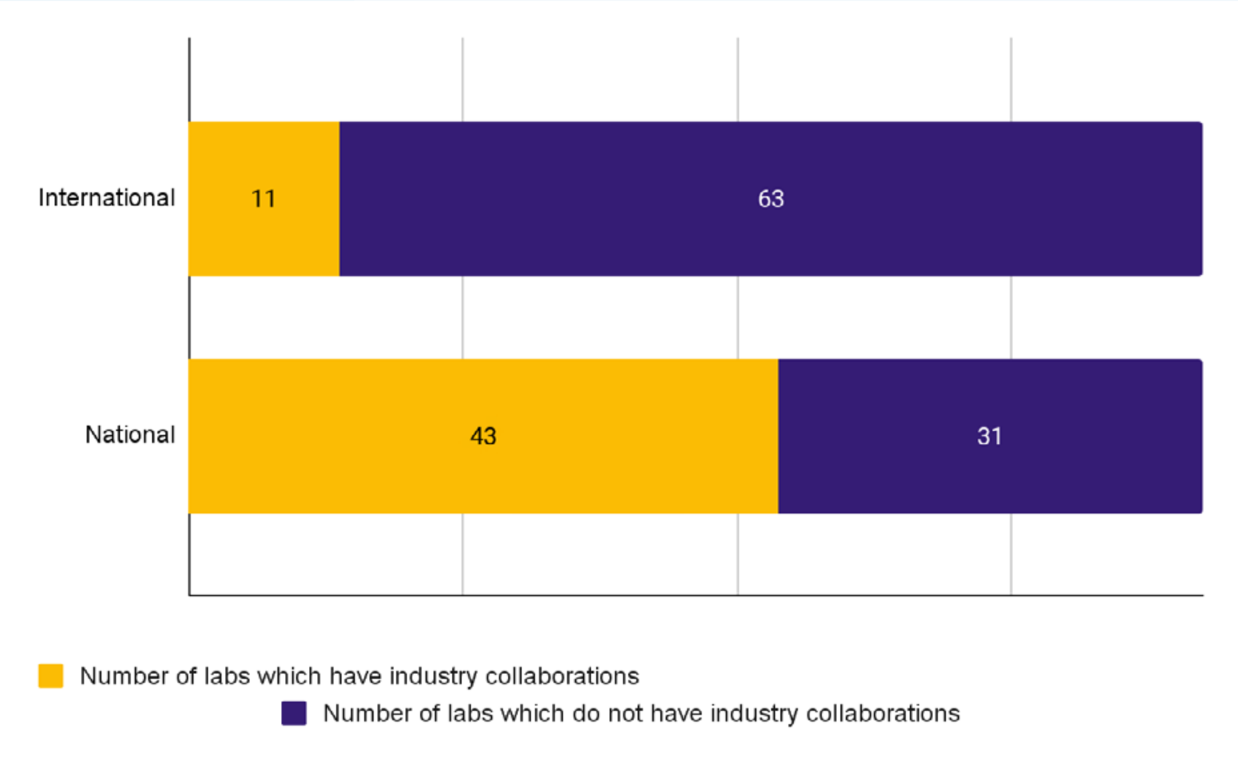


Over 91 percent of the extramural funding that the Services R&D labs/institutes received during the period under consideration was from government sources, around 6 percent from domestic government sources, around foreign non-government sources, and around 0.95 percent from other non-government sources. Looking at the extramural funding received from government sources, there were 53 labs/institutes that received up to Rs. 2 crore of extramural funding for every Rs. 10 crore of budget spent. There were around 16 labs/institutes that received more than Rs. 4 crore through extramural funding for every Rs. 10 crore of budget spent. Of these 16 labs/institutes, there were 5 labs/institutes from ICAR labs/institutes, 4 labs/institutes each from ICMR, 2 labs/institutes each from CSIR and MEITY, 1 lab from DBT, and 2 labs/institutes from other central government ministries.

Around 32 labs/institutes did not receive any extramural funding from non-government sources, non- government sources include domestic non- government, foreign non-government and other non- government sources. There was only 1 lab from MeitY that received more than Rs. 4 crore through extramural funding from domestic non-government sources for every Rs. 10 crore of budget spent. None of the labs/institutes received more than Rs. 4 crore of extramural funding from foreign non-government sources. Most of the labs/institutes that did receive any extramural funding from non- government sources received up to Rs. 1 crore for every Rs. 10 crore of budgetary support.

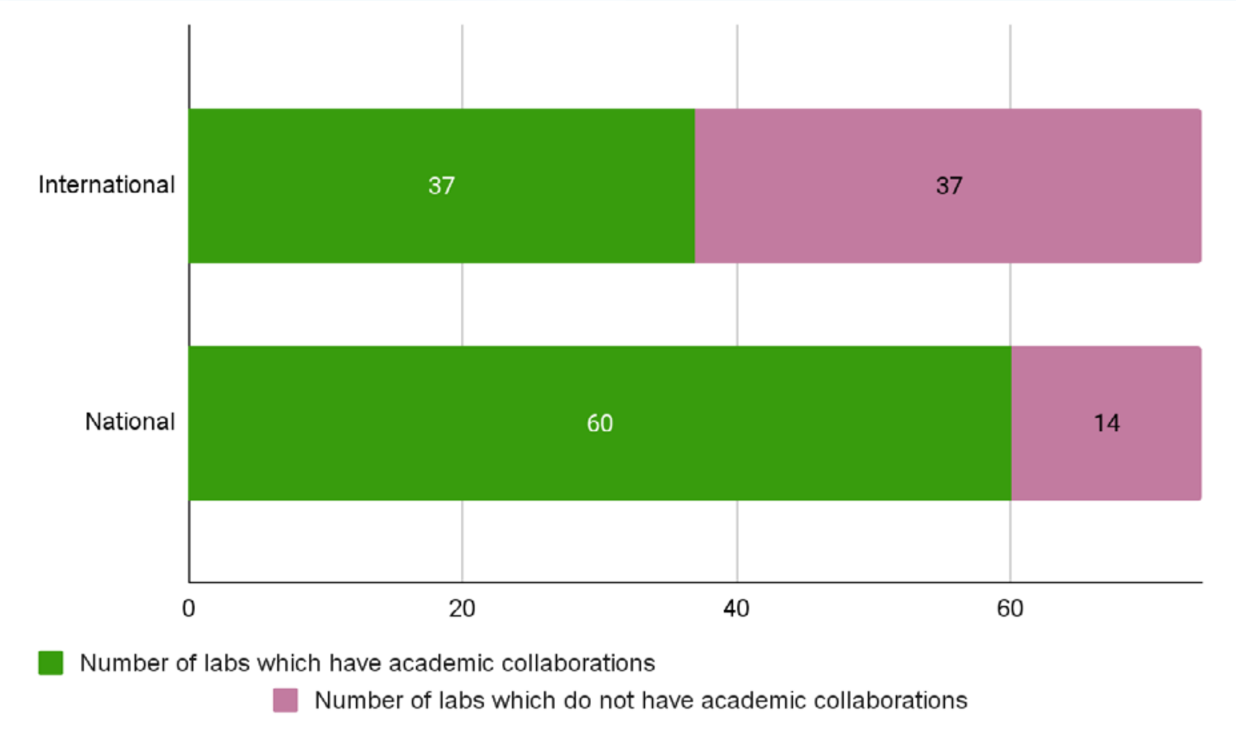
10.2.4 Sub-pillar 6: Collaborative research

Figure 10.19: International and National industry project collaborations



Just 11 labs/institutes were engaged in international collaborations on projects with industry during the period under consideration while 43 labs/institutes had ongoing national industry collaborations. There were 31 labs/institutes that had absolutely no national or international collaboration with industry while there were 11 labs/institutes that were engaged in both national and international industry collaborations. Of these 11 labs/institutes, there were 5 labs/institutes from CSIR, 2 labs/ institutes from ICMR, 1 lab each from DST and MeitY and 2 labs/institutes from other central government ministries.

Figure 10.20: Collaborations with academic institutions and/ or research labs/institutes



Compared to industry collaborations, there were a lot more labs/institutes engaged in project collaborations with both international and national academic institutions and/or research labs/institutes. There were 37 labs/institutes that had international and 60 labs/institutes that had national collaborations with academic institutions and/or research labs/institutes. Of the 37 international collaborations, there were 31 labs/institutes which had up to 5 collaborations per 100 scientific staff while there were 6 labs/institutes which had more than 5 international collaborations per 100 scientific staff. Of these 6 labs/institutes which had more than 5 international collaborations, there were 2 labs/institutes from ICMR, 1 lab each from CSIR, DBT, DST and the remaining 1 lab was from other central government ministries.

Of the 60 labs/institutes that had national collaborations with academic institutions and/or research labs/institutes, there were 20 labs/institutes which had up to 5 collaborations per 100 scientific staff while 21 labs/institutes had between 5 to 20 collaborations per 100 scientific staff. On the higher end there were 19 labs/institutes which had more than 20 collaborations per 100 scientific staff. Of these 19 labs/institutes 6 labs/institutes were from ICMR, 5 labs/institutes from ICAR, 3 labs/institutes from MoEFCC, 2 labs/institutes from CSIR, 1 lab each from DST and MeitY and the remaining 1 lab was from other central government ministries.

Key Takeaways:

- There is significant scope for labs/institutes to provide services in the preparation of technology documents.
- Of the 74 labs/institutes only 36 labs/institutes had received recognition for their work nationally, the international recognition is received by just 22 labs/institutes. Increased recognition may help labs/institutes attract opportunities to provide more services to industry and partner institutions.

- Around 36 out of the 74 labs/institutes had contributed to the formulation of policies, standards or regulations. There is scope for labs/institutes to participate and increase their contribution to global policy and regulatory formulation.
- Out of the 74 labs/institutes, 22 labs/institutes did not introduce any new service or a product during the two reporting years while 36 labs/institutes introduced up to two new services or products. Given that these labs/institutes are performing services R&D, they may be encouraged to introduce more new services.
- With respect to earnings from government and non-government sources, consultancies have been the major source for the Services R&D labs/institutes.
- Over 91 percent of the extramural funding that the Services R&D labs/institutes was from government sources. Most of the labs/institutes that did receive any extramural funding from non- government sources received up to Rs. 1 crore for every Rs. 10 crore of budgetary support.
- Increased collaborations with industry and offering services to international industry too, may contribute to increased earnings through consultancies.

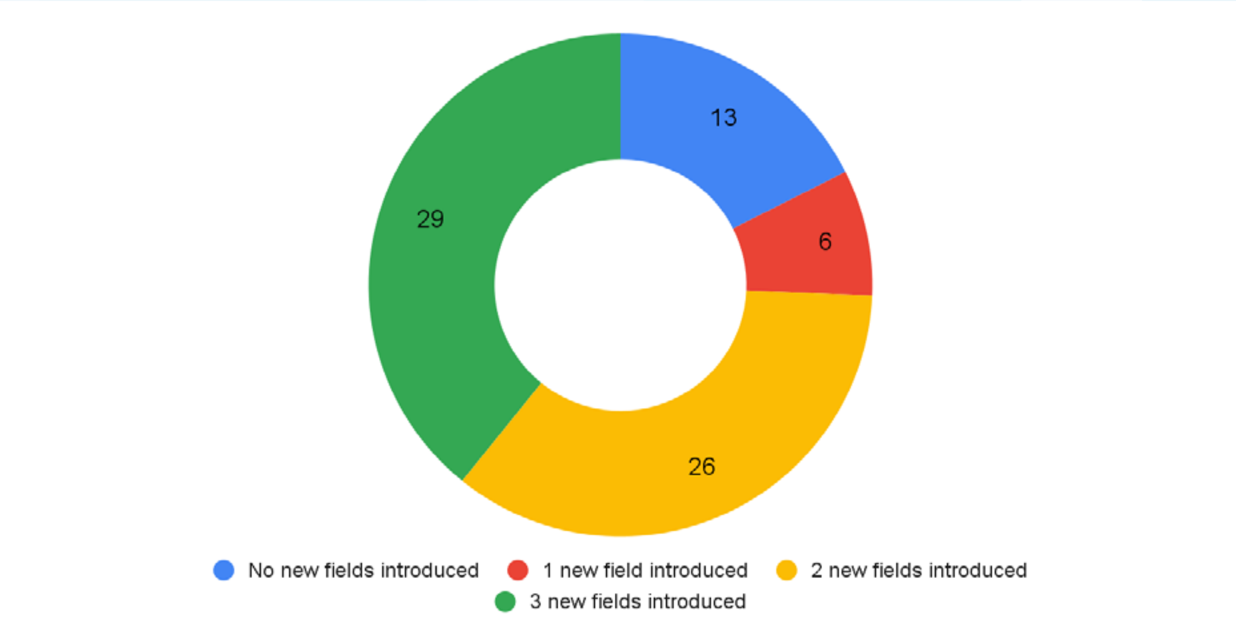
10.3 Pillar 3: Organizational Effectiveness

The indicators considered here look at the number of new research fields/innovations/services that have been introduced by a lab in each year under consideration, the share of permanent scientists and contractual researchers in the overall staff, indicators on effective management systems and adherence to governance best practices indicators on EDI and the amount spent towards building internal capabilities of the staff.

- There were 61 labs/institutes that introduced at least one new research field/innovation/ service on average every year for the period under consideration, of which 29 labs/ institutes introduced 3 new research fields/innovations/services each year.
- There were 40 labs/institutes that had a share of permanent scientists and contractual researchers in total staff greater than 50 percent while there were 9 labs/institutes for whom the share of permanent scientists and contractual researchers was less than 25 percent.
- In terms of governance, the labs/institutes were following best practices for nearly all the parameters, except when it came to deployment of a software to track and manage research projects through their lifecycle where just 65 percent of the labs/institutes had done so.
- There were 27 labs/institutes that did not support any outside researchers.
- A majority of labs/institutes did not have an EDI cell, while 38 labs/institutes had a share of women researchers in their total scientific staff that was between 0 and 25 percent.
- There were 54 out of the 74 labs/institutes that spent less than one percent of their budget on the skills upgrade of their staff.

10.3.1 Sub-pillar 7: Mandate alignment

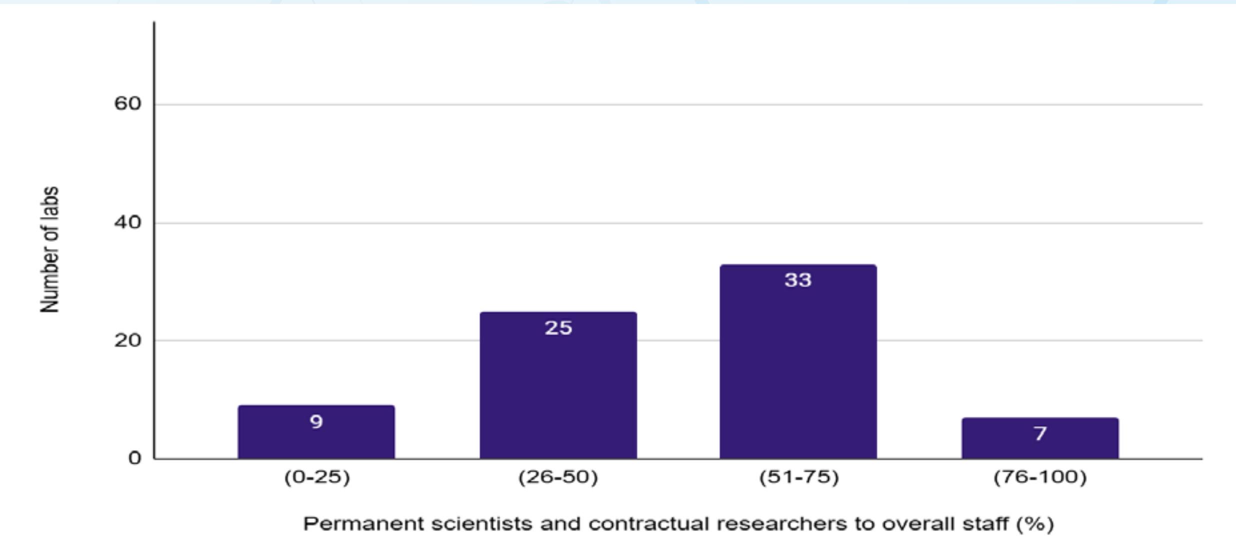
Figure 10.21: New research fields/innovations/services introduced by the labs/institutes



All labs/institutes have a scientific strategy in place to work towards their mandate. Nearly all the labs/institutes as part of their mandate have defined existing problems related to the social and economic situation of the nation and have been working towards solving these problems. Many of the labs/institutes have also seen the mission and vision for their research evolve over the past five years. Of the 74 labs/institutes that had classified themselves as undertaking Services R&D, there were 29 labs/institutes that introduced 3 new research fields/innovations/ services in each year for the period under consideration, while 26 labs/institutes introduced at least 2 new fields/ innovations/services on average each year. There were 6 labs/institutes that introduced one new field/innovation/service on average each year. The new fields/innovations/services introduced by these labs/institutes would need to be evaluated separately by domain experts.

10.3.2 Sub-pillar 8: Resource Management

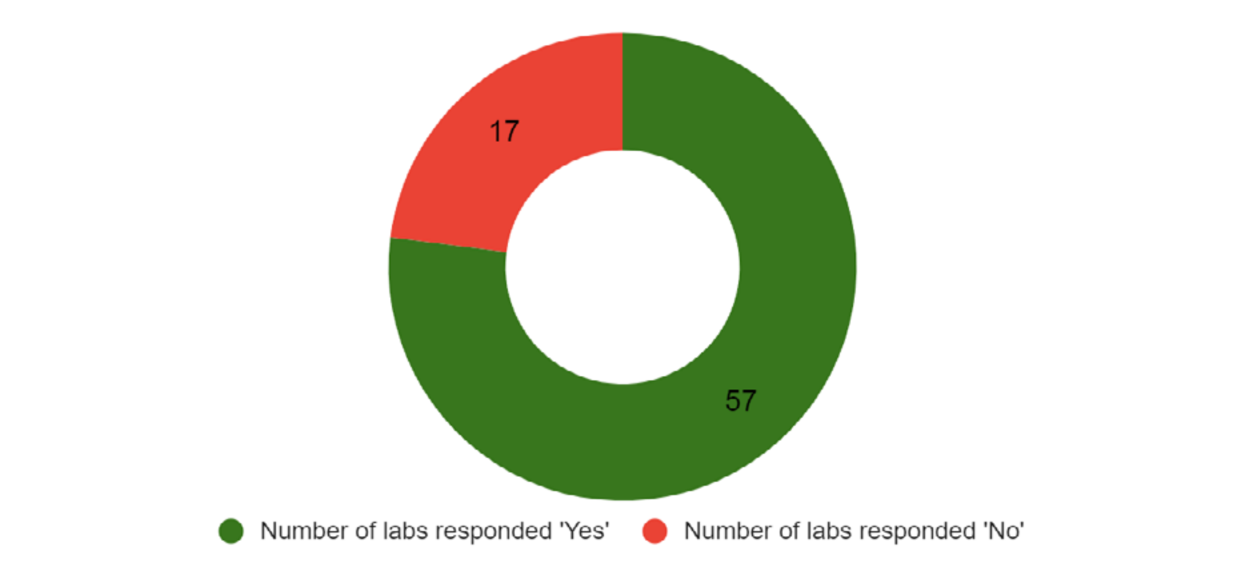
Figure 10.22: Share of permanent scientists and contractual researchers to overall staff (%)



Of the 74 Services R&D labs/institutes, 40 labs/institutes had a share of permanent scientists and contractual researchers in total staff that was over 50 percent. There were 9 labs/institutes for whom the share of permanent scientists and contractual researchers were less than 25 percent.

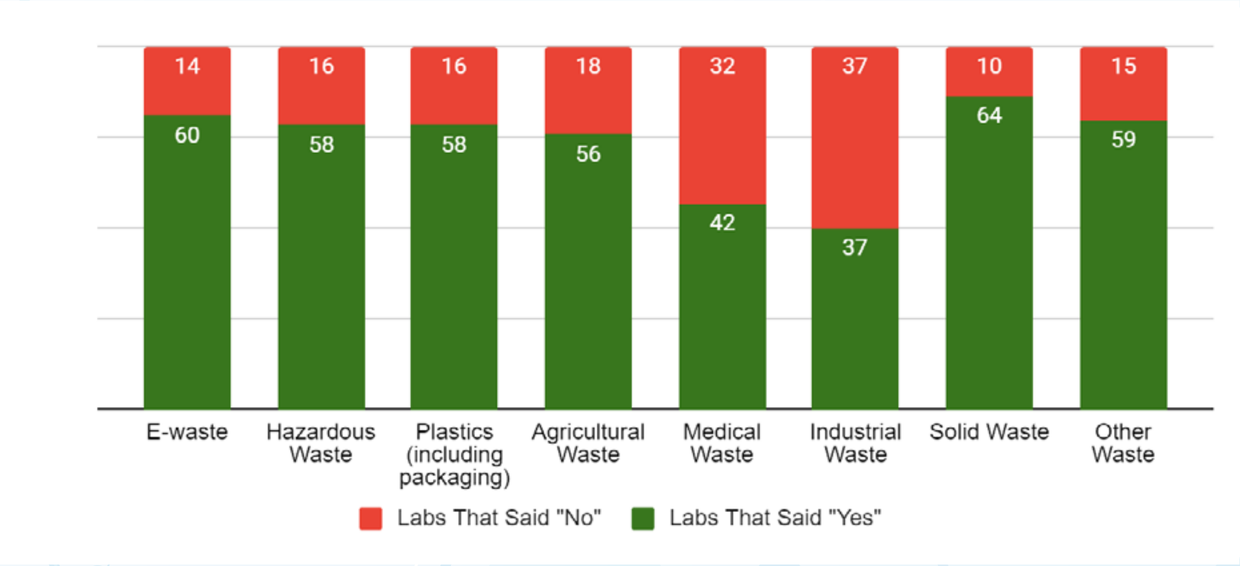
10.3.3 Sub-pillar 9: Governance

Figure 10.23: Sustainable sourcing of materials



There were 57 labs/institutes that had procedures in place for sustainable sourcing of material. Of these 57 labs/institutes 17 labs/institutes were from CSIR, 9 from ICAR, 7 from ICMR, 4 labs/institutes each from MeitY and the Ministry of Ayush, 3 from MoEFCC, 2 from DST, 1 lab each from DBT and MoES, and the remaining 9 labs/institutes were from other central government ministries.

Figure 10.24: Number of labs/institutes with safe waste reclamation policies



The policies related to safe waste reclamation under the new Business Responsibility and Sustainability Reporting (BRSR) include e-waste, hazardous waste, plastics (including packaging), agricultural waste, medical waste, industrial waste, solid waste, and other types of waste. There were 25 labs/institutes that adhered to all of the 8 waste reclamation procedures whereas 17 labs/institutes followed at least 6 of these procedures. While 60 labs/institutes followed the e-waste procedures there were 14 labs/institutes that had yet to incorporate these.

Table 10.1: Effectiveness of Management System

Question	Share of labs/institutes that responded 'Yes' (%)
Does your organization have initiatives in place to promote intra-organisational collaborations?	99
Has your organization adopted any digital technologies that would enhance R&D activities?	78
Does your organization have necessary ethics guidelines and policies in place?	97
Does your organization have a sexual harassment mitigation cell with requisite policies and procedures?	100
Does your organization have a public grievance redressal cell?	100

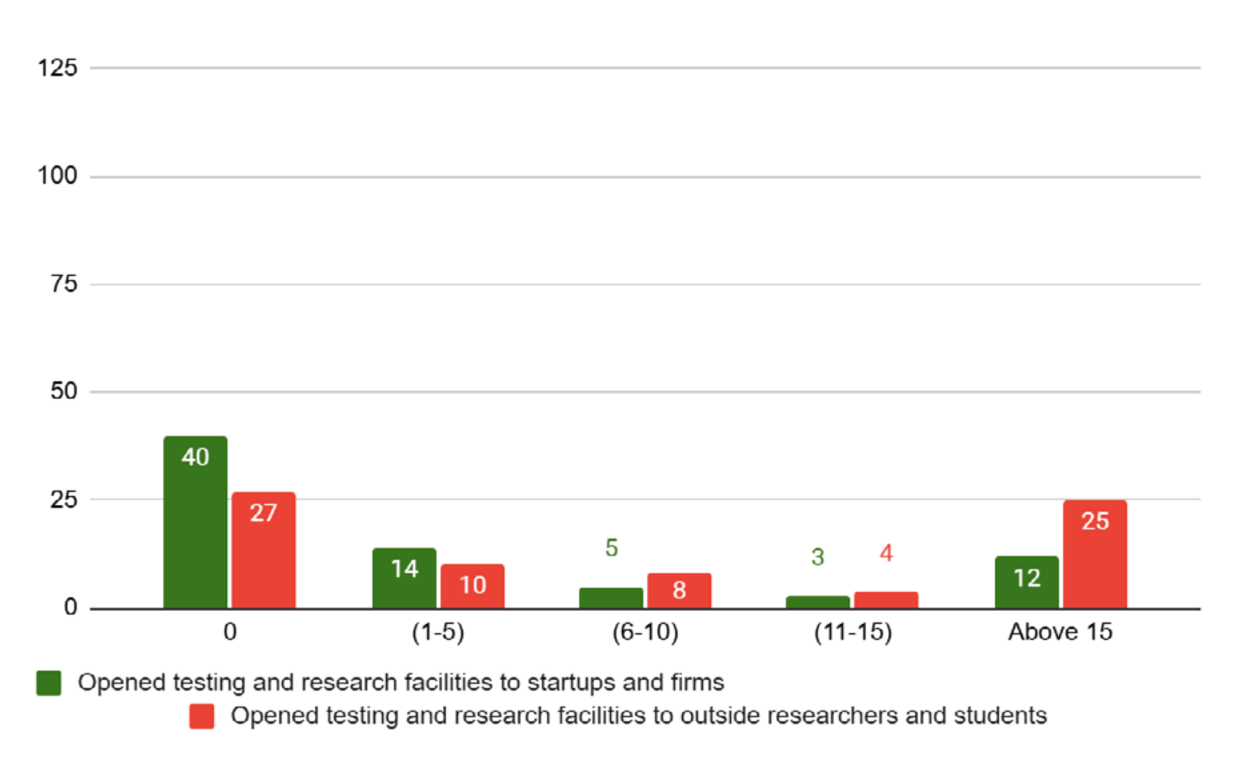
As can be seen in the table above, nearly all labs/institutes have adhered to the effective management system in terms of promoting collaborations within the organization, having the necessary ethics guidelines in place, have established a sexual harassment mitigation cell with necessary policies and also have a public grievance redressal cell. While 78 percent of the labs/institutes have adopted digital technologies to enhance their R&D activities.

Table 10.2: Adherence to governance best practices

Question	Share of labs/institutes that responded 'Yes' (%)
Does your organization have national accreditation/certification for its lab procedure?	64
Does your organization have international accreditation/certification for its lab procedure?	42
Are your organization's R&D facilities available on the I-STEM national portal?	35
Does your organization's website follow all security protocols as mandated by the Government of India?	89
Is your organization's website differently-abled friendly?	55

On governance related best practices 64 percent of the labs/institutes had a national certification and 42 percent of tha labs/institutes had international certification of their lab procedure. With respect to the other practices such as the organization's website following all security protocols as mandated by the government of India, while majority of the labs/institutes follow this practice there were only 55 percent of the reported labs/institutes had organization's website differently-abled friendly. Also there were only 26 labs/institutes that had their R&D facilities registered on the I-STEM national portal.

Figure 10.25: Number of outside researchers per 100 scientific staff



Of the 74 Services R&D labs/institutes, there were 47 lab labs/institutes that opened its testing and research facility to outside researchers and students. Whereas there were 34 labs/institutes that opened its testing and research facility to startups and firms.

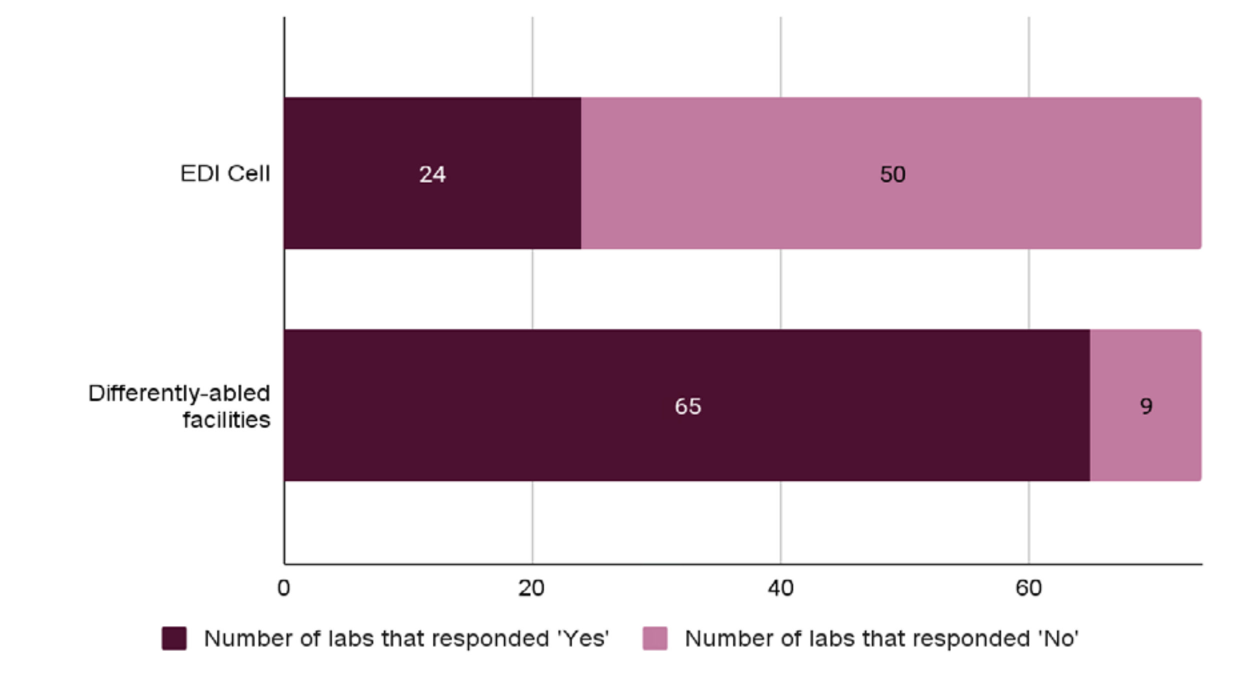
Around 18 of these labs/institutes had up to 10 outside researchers and students per 100 scientific staff that were able to access the labs/institutes' facilities. As can be seen in the chart, there were 27 labs/institutes that did not have outside researchers and students accessing their facilities while 17 labs/institutes opened it's testing and research facility to up to 5 outside researchers and students per 100 scientific staff. There were 61 labs/institutes that opened its testing and research facility to more than 15 outside researchers and students per 100 scientific staff.

When it comes to startups and firms there were around 48 of these labs/institutes that had up to 10 startups and firms per 100 scientific staff that were able to access the labs/institutes' facilities. There were 95 labs/institutes that did not have startups and firms accessing their facilities while 36 labs/institutes opened its testing and research facility to up to 5 startups and firms per 100 scientific staff. There were 23 labs/institutes that opened its testing and research facility to more than 15 outside researchers per 100 scientific staff.

Of the 23 labs/institutes who opened its testing and research facility to more than 15 startups and firms and of the 61 labs/institutes that opened its testing and research facility to more than 15 outside researchers and students, there were 16 labs/institutes who supported both.

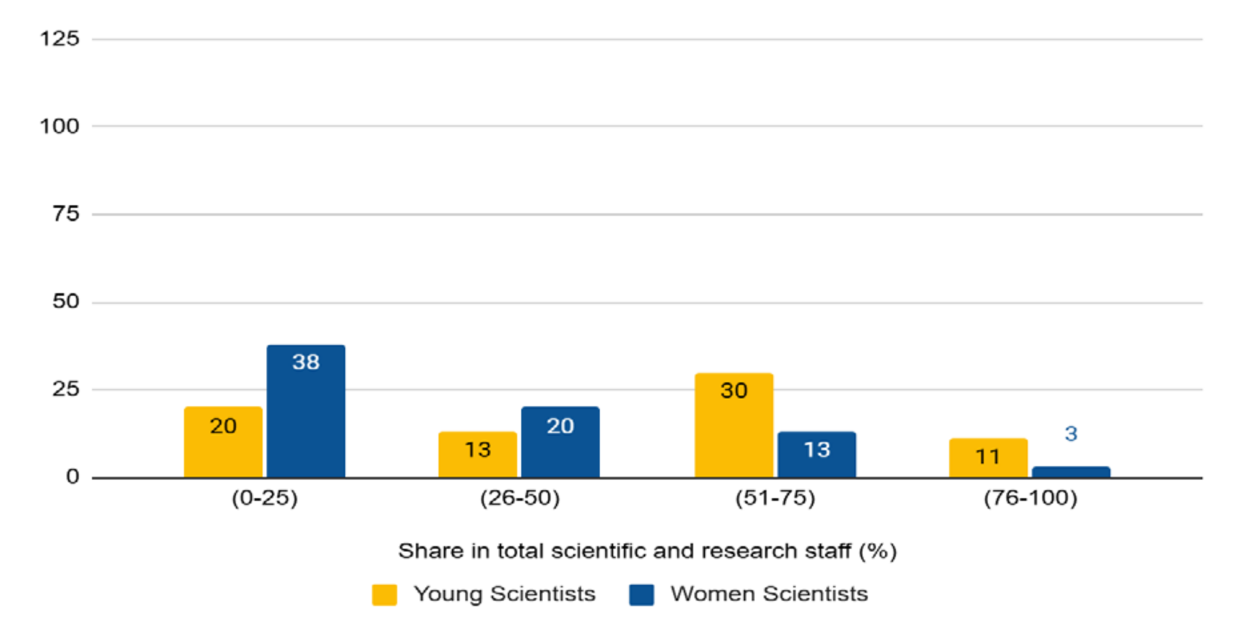
10.3.4 Sub-pillar 10: Equity, diversity, and inclusion

Figure 10.26: Provisions of EDI cell and differently-abled friendly facilities



Not all labs/institutes had an EDI cell. There were just 24 labs/institutes that said they had an EDI cell while 65 labs/institutes said their labs/institutes were differently-abled friendly. It would be important for labs/institutes to continue to strive towards greater inclusion by having a requisite cell or committee in place to address concerns around EDI.

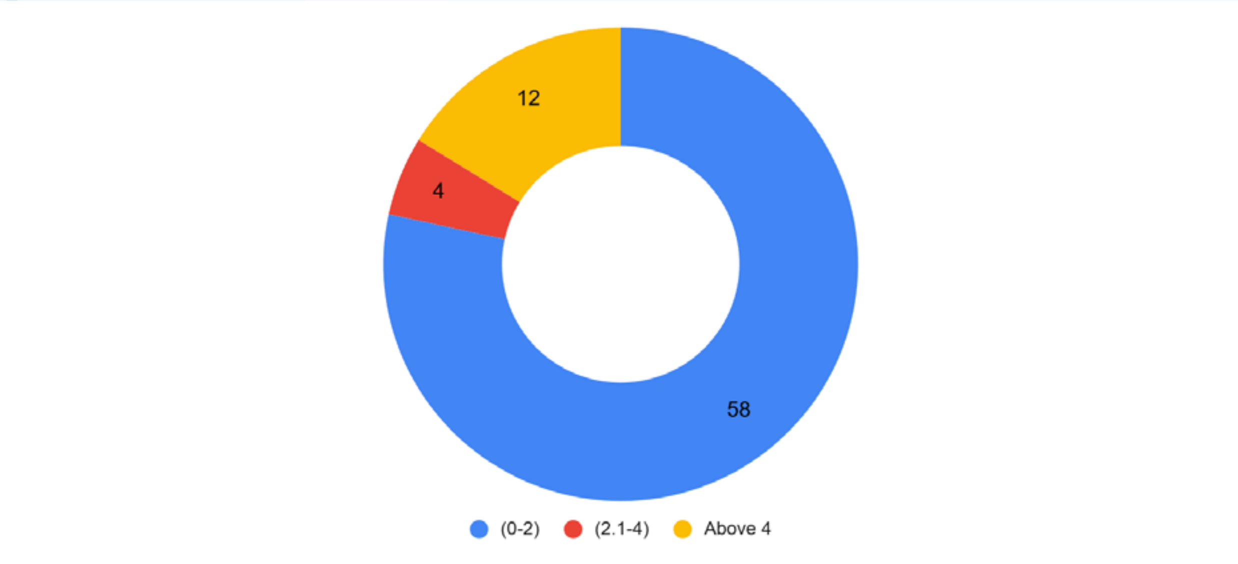
Figure 10.27: Share of young scientists and women scientists to the total scientific and research staff (%)



There were 20 labs/institutes for whom the share of women scientists as a share of total scientific and research staff was between 25 to 50 percent while 13 labs/institutes had a share between 50 to 75 percent. The 38 labs/institutes for whom the share of women scientists in total scientific and research staff is between 0 to 25 percent have scope to push for greater gender diversity among their research staff. With respect to young researchers (below the age of 40), 41 out of the 74 labs/ institutes had a share of young researchers in total scientific and research staff that was greater than 50 percent.

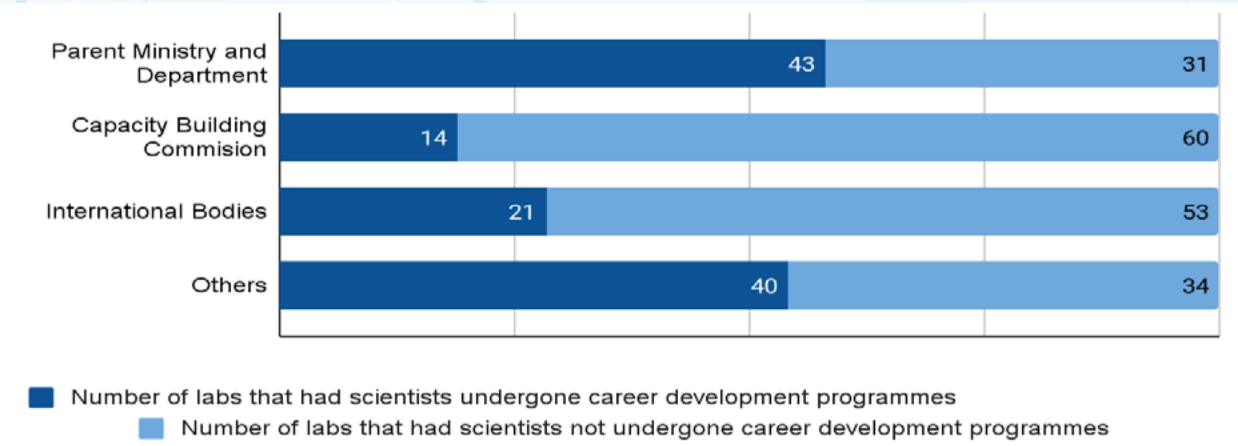
10.3.5 Sub-pillar 11: Internal capacity building

Figure 10.28: Share of the total budget spent on training and skill up-gradation of the staff (%)



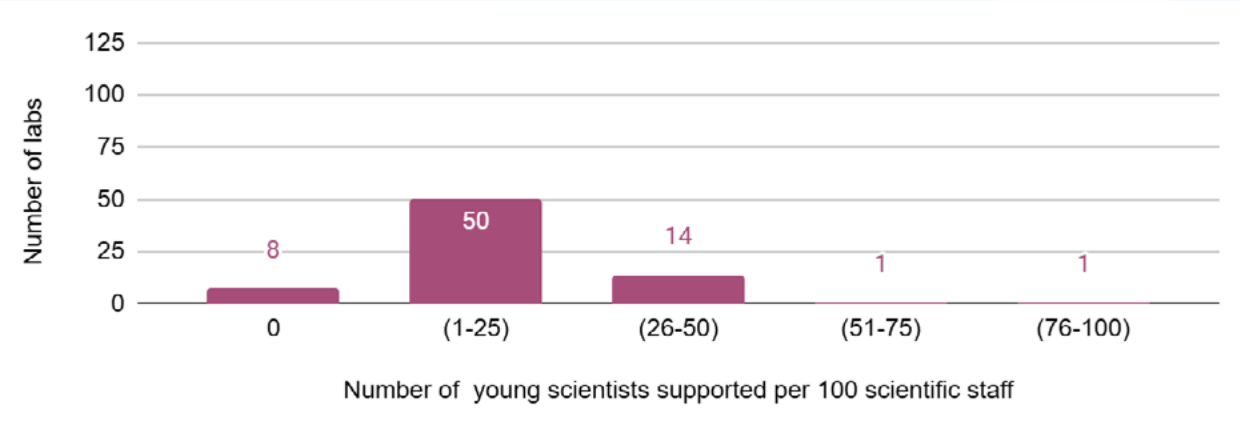
Most labs/institutes have allocated very little of their budget towards training of their staff, both research as well as administrative staff. Of the 74 services R&D labs/institutes, 58 labs/institutes spend between 0 and 2 percent of their budget towards skills upgradation of their staff. In fact 54 of these 58 labs/institutes spend less than 1 percent of their budget on training. Increased expenditure on training and skill upgradation would help complement the R&D and other activities of the labs/ institutes. Labs/institutes should consider a holistic approach to their R&D and S&T expenditure that sees increased allocation towards training of their scientific and research staff as well as administrative staff to support their scientific and research staff.

Figure 10.29: Number of labs/institutes that had scientists undergo a career development programmes



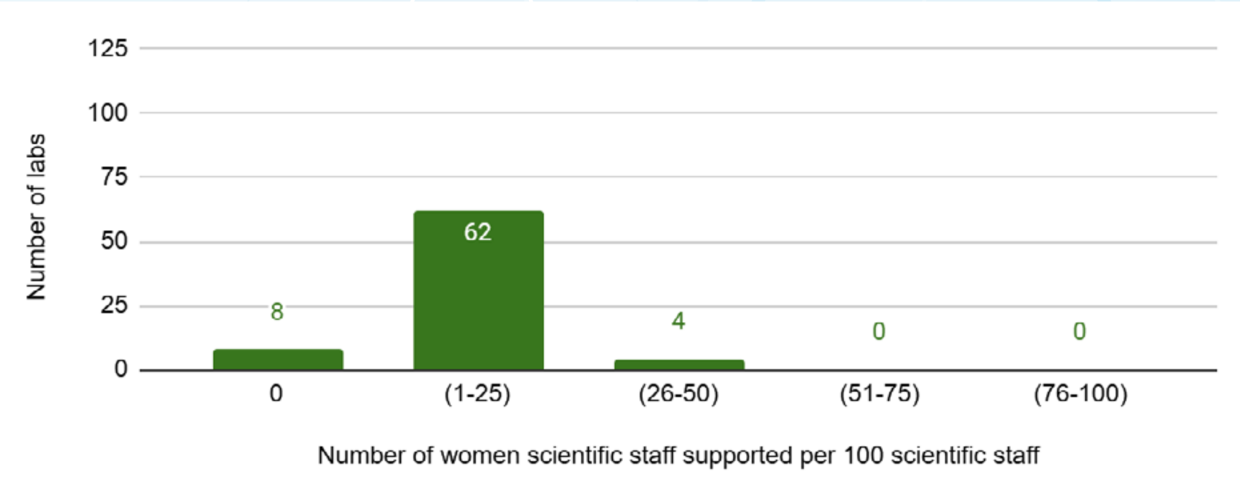
As can be seen in the accompanying chart, the majority of the labs/institutes had scientists participating in career development programmes within their parent ministry and departments and other departments. While 21 labs/institutes had scientists involved in career development programmes organized by international bodies, only 14 labs/institutes had scientists who participated in career development programmes organized by capacity building commissions.

Figure 10.30: Distribution of labs/institutes by number of young scientists supported



There were around 89 percent or 66 Services R&D labs/institutes that supported young scientists through conferences, training, sabbaticals, etc. As can be seen in the above chart there were 50 labs/institutes that supported up to 25 young scientists per 100 scientific staff whereas 14 labs/ institutes supported between 25 to 50 young scientists per 100 scientific staff. On the higher end there were only 1 lab each that supported between 50 to 75 young scientists and between 75 to 100 young scientists.

Figure 10.31: Distribution of labs/institutes by number of women scientific staff supported



Of the 129 labs/institutes, 66 labs/institutes supported women scientific staff through conferences, training, sabbaticals, etc. There were 62 labs/institutes that supported up to 25 women scientific staff through conferences, training, sabbaticals, etc whereas only 4 labs/institutes supported between 25 to 50 women scientific staff. There were no labs/institutes that supported beyond 50 women scientific staff per 100 scientific staff. Of these 4 labs/institutes that supported between 25 to 50 women scientific staff 1 lab each were from major scientific ministries while 1 lab was from other central government ministries.

Key Takeaways:

- It would be important for domain experts to review the new research field/ innovation/ service introduced by the labs/institutes. Nearly all the labs/institutes were seen to introduce at least one new research field/innovation/service per year.
- There were 10 labs/institutes for whom the share of permanent scientists and contractual researchers was less than 25 percent. Of the 10 labs/institutes, there were 4 labs/institutes that were from other central ministries.
- It is important for the labs/institutes to make its website differently-abled friendly for inclusion of differently- abled staff at their organizations.
- More organizations being registered on the I-STEM portal will encourage the startups, firms, outside researchers, and students by optimizing the use of organizations' available resources.
- Supporting outside researchers as a service should be encouraged by labs/institutes undertaking Services R&D. This would also ensure greater opportunities for researchers from industry, startups and even academic institutions to make use of the facilities and research support of the lab.
- There were 54 out of the 74 labs/institutes that spent less than one percent of their budget on the skills upgrade of their staff. Increased spending on staff would possibly allow labs/ institutes to undertake a variety of services apart from research activities such as the staff in turn conducting a variety of skills development programmes for the wider population etc.

Chapter 11

Enhancing Innovation Excellence

India's position in the GII has been rising for the last few years. India is currently ranked 39th out of 133 economies.[16] India is at a pivotal moment in her growth trajectory, blessed with a significantly young population with rising aspirations and at the same time faced with geopolitical headwinds and a rapidly changing global science and technology landscape. If India is to achieve her goal of Viksit Bharat by 2047, and take her rightful and deserved place as one of the leading nations measured not only by the level of GDP but also by the safety and well being of her citizens, then it is incumbent on every institution and every capable individual in the private sector, government machinery and the higher education sector to rise up to the occasion and perform to their full potential to deliver on the ambitious and achievable goal of Viksit Bharat. This includes the publicly funded organizations that span a number of key scientific ministries and government departments and are the subject of analysis in this report.

This report and the recommendations that follow draw upon global best practices to guide the public funded organizations to increase their contributions meaningfully towards a number of SDG goals and national priorities through their research capabilities, to help the nation navigate the various challenges she faces on the socio economic front, from health challenges to ensuring a more diverse scientific base through opportunities for women scientists, and finally to contribute to skilling and creating meaningful employment by working alongside industry and startups. This means setting ambitious targets internally, re-orienting and aligning their fields of research where necessary with stated national priorities, and yet play a critical balancing act to ensure that the spirit of scientific inquiry and good science does not suffer. Going forward, keeping the goal of Viksit Bharat as the north star, the focused output from the organizations should be realized in an environment "where the mind is without fear" in addressing the numerous socioeconomic and technology challenges and "the head is held high" as they deliver solutions to the wider community, "where knowledge" is accessible and benefits every citizen, and "where the clear stream" of science and "reason has not lost its way into the dreary sand of dead habit" in ensuring India becomes an inclusive science and technology superpower. In other words, with a rapidly evolving technology landscape globally, the organizations must transform, adapt and overcome all challenges to meet the goal of Viksit Bharat.

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[16] *https://pib.gov.in/PressNoteDetails.aspx?NoteId=153223&ModuleId=3&reg=3&lang=1*

As custodians of a large share of public funding, it is now imperative that the public funded organizations showcase their strengths and improve and adapt on areas of relative weakness. By showcasing their strengths, policies can be tailored and the organizations can be guided so that the research output can have a direct impact on the domestic economy as well as the global economy. Several organizations covered in this exercise are already impacting the wider economy in numerous ways and this has been brought out in the report - but this needs to be extended to all the participating organizations and a sense of purpose and accountability has to be adhered to, to enable the country to achieve its growth potential for a sustained period of time.

The Framework adopted by NITI Aayog has indicators based on comparisons of similar global frameworks with inputs from several leading authorities and representatives of key scientific ministries at the time it was adopted. It has been tailored to meet the needs of India's key priority areas and also provide opportunities for the organizations to imbibe what should be their focus going forward. The report gauges the performance of the organizations with respect to their socio-economic contribution, their STI excellence and current organization capabilities and practices. For the participating organizations, the report provides guidance on areas of untapped potential or areas that may not currently be on their radar but nevertheless deemed a national priority - it also provides an opportunity to strengthen existing activities which they may be currently working on through greater collaborations for instance both with industry and other public research organizations or HEIs. For the policy maker, the report offers a broad long term strategic focus needed towards the goal of Viksit Bharat, the foundations and focus that need to start now. It also offers very detailed operational recommendations that can be set in motion immediately, the implementation of which will contribute to the success of the longer term strategies.

The recommendations are arranged as follows and are imperative to pave the road to Viksit Bharat:

A. A Broad Set of 7 Strategic Recommendations

B. A Detailed Set of 4 Actionable Recommendations grouped as below:

   1. Becoming a Science Superpower
   2. Strengthening Public R&D Linkages with India's innovation ecosystem
   3. Boosting Lab Competitiveness
   4. Institutionalizing the process of data collection and validation

11.1 Strategic Recommendations

Recommendation 1: Every lab should be mandated to review their existing mandates and release a roadmap for technology development in line with the Viksit Bharat vision.

Recommendation 2: The mandate may focus on key critical technologies as identified by the Government on priority basis by the respective public funded R&D organizations. Labs could consider including other impact areas like support to strategic sector, capacity building, manufacturing and prepared for industry 5.0 and new material and new chemical processes.

Recommendation 3: Research activities of labs/institutes could be made available on a dedicated portal for wider use by different stakeholders including industry, startups, VCs, etc.

Recommendation 4: India's public funded R&D organizations should work in close collaboration with other research centers and academic institutions.

Recommendation 5: All labs/institutes should strive to increase collaborations with industry and attract firms to invest in projects by aligning research objectives with industry needs and availing of funding under ANRF.

Recommendation 6: Adopt practices or support research scholars for industry intensive PhD programs like the Prime Minister's Fellowship Scheme for Doctoral Research.

Recommendation 7: Support the creation of a dedicated IPR Management Cell with the incubation centers in all institutions. These nodal centres of excellence on IP Matters will further help enhance the volume and value of IPRs and subsequent technology transfer emerging from the organizations.

11.2 Actionable Recommendations

11.2.1 Becoming a Science Superpower

India can play a bigger role on the global stage and expand her growth ambitions on a global scale through STI. This would require showcasing research being undertaken at these labs/institutes that have potential to tackle and mitigate global challenges like climate change, food security, green energy solutions, healthcare, etc.

Recommendation: Review Lab Mandates and releasing roadmaps for Viksit Bharat

Every lab should be mandated to review their existing mandates and release a roadmap for technology development in line with the Viksit Bharat vision.

Recommendation: Aligning Research with Critical Technologies identified by Government of India

The mandate should focus on the science and technology behind the critical technologies identified by the Government of India and should be taken up on a war footing by public funded R&D organizations.

Recommendation: Benchmarking Research As Per Global Standards and Best Practices

Appropriate authority may consider formulating guidelines.

Furthermore, a benchmarking study could be conducted to map the performance of Indian R&D labs/institutes against their counterparts in countries like Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia, French National Centre for Scientific Research (CNRS) and Chinese Academy of Sciences (CAS).

Recommendation: Invigorate Public Research to addressing development and societal challenges in alignment with national needs and priorities

Awareness of the linkages with societal outcomes and development indicators is critical for a robust research and innovation ecosystem. Based on the current lab responses, most targeted SDGs include Good health and well-being Goal and Industry, innovation and infrastructure Goal whereas very few labs/institutes focus on goals such as Sustainable cities and communities, Affordable and clean energy, Partnerships for the goals. An increase in awareness at the researcher level could aid in motivating researchers further as they associate their work with a larger benefit to society. We suggest the following interventions:

- A module on the Sustainable Development Goals (SDGs) can be integrated in career development programs and workshops for researchers to increase awareness

- The mandate of the labs/institutes can be revisited to check for their alignment with the national needs and priorities.
- Many labs/institutes of the country are involved in public services be it disaster management, weather forecasting, climate changes and so on. It is of utmost importance that such societal programmes are well captured, documented and adequately encouraged. Scientists may be selected for appropriate awards for undertaking research based on national interests.
- A surveillance programme can be launched for the identification of specific national needs. This should focus on developing lab capacities and strengthening the labs/institutes towards these catering to unmet societal needs.

Recommendation: Improve access to scientific resources by educational institutes to encourage younger generations

We find that labs/institutes have certain outreach activities such as open days to encourage interest in science among younger generations. We suggest the following interventions in addition to these ongoing activities:

- Introduce additional activities under the Atal Tinkering labs/institutes to increase Scientific Temper among students
- Introduce specialized degree or diploma programmes to students from HEIs based on the area of research focused on by the lab, to facilitate cross learning and to introduce research methods and technologies to the students at an early stage

Recommendation: Improve Science Communication

Effective science communication is crucial for bridging the gap between the research happening at public R&D labs/institutes and the common public. Collaborations can be built with Civil Society to disseminate research in schools. Scientists can also improve public understanding of their work and foster a greater appreciation for science through leveraging different media, developing interactive sessions, engaging with the community and highlighting real world applications.

Recommendation: Share findings from the research to inform policy

Data submitted by the labs/institutes showed that not many labs/institutes are contributing towards policies, regulations and standards being framed in the country as well as internationally. While most of the labs/institutes perform laudable research in their respective areas, it would greatly benefit the society and the country if their research findings are also taken into consideration while a policy, regulation or standard is being brought into action.

This is equally true on the global stage. For India to truly become a science superpower, it is imperative that we improve the visibility of scientists who can contribute meaningfully on the global stage and that the research being undertaken in the public R&D labs/institutes can be taken into account while framing international regulations.

Recommendation: Leverage the position of Science Counsellor in Indian missions abroad

India has cooperation agreements with 83 countries. The position of the Science Counsellor can be leveraged to strengthen India's position as a science superpower and attract foreign direct investment into R&D.

Recommendation: Increased participation in global forums and contribution to global policy

India is a part of several high profile technology initiatives like the US-India innovation handshake. Increased participation in global forums can increase the visibility of Indian science globally. Many developing countries are eager to collaborate with India for research and technology partnerships and this must be leveraged fully besides strengthening existing partnerships with countries like the US, Japan, UK, Russia, South Korea and Israel. Scientists from labs/institutes should be engaged on a regular basis in presenting technologies to Indian and international industries, universities, business councils, international industry associations, embassies etc. at platforms like the aforementioned technology promotions and outreach events. This will also encourage labs/institutes to explore access to extramural funds through collaborative R&D with industry and other avenues.

11.2.2 Strengthening Public R&D Linkages with India's innovation ecosystem

Recommendation: Publication of Research Activities on India Science, Technology and Innovation Portal

Research activities of labs/institutes could be made available on the India Science, Technology and Innovation portal along with TRLs for wider use by different stakeholders like industry, startups, VCs, etc.

Recommendation: Enhancing Collaborations with Academia

India's public funded R&D organizations should work in close collaboration with other research centers and academic institutions. A general council should be established to oversee the projects undertaken jointly. This general council should be under the aegis of the O/o PSA.

Recommendation: Increasing Collaborations and Engagement with Industry

All labs/institutes should strive to increase collaborations with industry and attract firms to invest in projects by aligning research objectives with industry needs and availing of funding under ANRF. The engagement with the industry remains limited in terms of collaborative projects. A close cooperation between labs/institutes and industry is essential to increase the real world impact of research through new technology innovations, products and services. Labs/institutes should consider conducting regular 'open days' wherein industry (local firms or SMEs) can visit and interact with the scientific staff and explore different ways of collaborating on research projects.[17]

Collaborations and engagement with industry is not uncommon in CSIRO, CNRS and CAS. These organizations have achieved a large degree of financial autonomy by reducing their dependence on core government grants and increasing revenue from opening up research facilities, IP commercialization, prototyping, and collaborative research projects with industry.

[17] *Nabar, J, and Singhania. D. "Public R&D in India: Pathways to Increasing Its Effectiveness." CTIER Handbook: Technology and Innovation in India 2023.*

Recommendation: Adopt practices or support research scholars for industry intensive PhD programs like the Prime Minister's Fellowship Scheme for Doctoral Research

The Prime Minister's Fellowship Scheme for Doctoral Research is a public-private partnership (PPP) initiative[18] aimed at encouraging young, talented, enthusiastic, and result-oriented scholars to take up industry-relevant research.

Recommendation: Provide more incubation support

Currently just 64 labs/institutes are providing incubation support. Startups have become an important part of India's innovation ecosystem. Improving linkages through providing more incubation support is one of the pathways to strengthen ecosystem linkages.

Recommendation: Setting up of Section 8 companies to provide support to startups

102 labs/institutes have reported providing some form of support (training, incubation, research, mentorship, etc). 13 labs/institutes reported having set up a section 8 company to provide support to startups. A Section 8 company may be able to provide more startups incubation support by also attracting external funding. Successful models in the country such as Venture Centre in Pune can be studied to develop a best practices handbook for labs/institutes.[19]

The startup support models of CSIRO of Australia and CAS of China can be studied for successfully supporting startups and creating spinouts. Both of these organizations have supported early stage startups in exchange of equity when these startups may have limited resources. Furthermore, they also hold equity in successful spin outs like Lenovo where CAS is the biggest shareholder.

Recommendation: Increasing Participation on the I-STEM portal

The Indian Science, Technology, and Engineering Facilities Map (I-STEM) project is an initiative of the Office of PSA. The main objective of this portal is to provide support to researchers by facilitating sharing of costly R&D resources/equipment to optimize the usage of these resources established across the country. This saves public money and saves institutions from the financial burden of buying new costly equipment when it already exists in the country.[20] Only 78 labs/institutes have responded to being registered on I-STEM.

Recommendation: Opening up of research and testing facilities

Sharing of resources of the labs/institutes such as sophisticated and advanced synthetic/analytical equipment with state universities and other HEIs will also be useful in building long term scientific capacity, especially in smaller cities where educational institutions may not have access to such resources. The recent announcement from ICMR[21] can be studied by other ministries and departments to form a model for opening up research facilities to other stakeholders in the ecosystem.

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[18] *https://www.primeministerfellowshipscheme.in/*

[19] *Nabar, J, and Singhania. D. "Public R&D in India: Pathways to Increasing Its Effectiveness." CTIER Handbook: Technology and Innovation in India 2023.*

[20] *https://psa.gov.in/CMS/web/sites/default/files/psa_custom_files/Anthology%20of%20S%26T%20Activities.pdf*

[21] *https://indianexpress.com/article/health-wellness/union-budget-2023-opening-icmr-labs-to-medical-colleges-is-a-win-win-for-all-and-a-big-boost-to-medical-research-8418145/*

Recommendation: Increased collaborations through science clusters

Science & Technology Clusters (S&T Clusters), a flagship initiative of the Office of PSA, were established after the recommendation of the PM-STIAC. The S&T Clusters operate in a three-tiered pyramid approach. The bottom tier involves creating a shared ecosystem among the institutions, the second-tier places focus on becoming a regional solution provider, and the topmost tier is aimed at the clusters becoming nationally and globally competitive.[22] Collaborations on joint long-term research projects/programmes with a focus on local outcomes can be increased to positively affect the innovation ecosystem.

Recommendation: Improve cross-linkages with HEIs

Higher Education Institutes (HEIs) and research labs/institutes are the two knowledge creating pillars of the Indian STI ecosystem. Improving linkages between HEIs and labs/institutes can lead to better research at universities, fostering research talent as well as harnessing the strengths of HEIs and labs/institutes towards better outcomes. We suggest the following:

- Improve mobility through secondment of faculty members from HEIs to the research labs/ institutes and the scientists from the labs/institutes being sent to HEIs for academic courses and collaborative research
- Create new mechanisms for cross-cutting learning through peer-to-peer networks among researchers and academics[23]

The models of CSIRO in Australia, CNRS in France and CAS in China provide pathways for establishing greater linkages with HEIs. These include co-location of labs with HEIs like CSIRO, setting up joint research units like CNRS, or converting them into universities like CAS.

11.2.3 Boosting Lab Competitiveness

These recommendations are geared specifically for boosting lab competitiveness, which can lead to greater research impact, more effective use of resources and improved outcomes. These recommendations encourage introspection of a lab's own capacity and capability and trigger action on improving both.

Recommendation: Creation of Dedicated IPR Management Cell

Support the creation of a dedicated IPR Management Cell with the incubation centers in all institutions. These nodal centres of excellence on IP Matters will further help enhance the volume and value of IPRs and subsequent technology transfer emerging from the organizations.

Recommendation: Continued focus on increasing share of women researchers needed

There remains a persistent gap in the participation of women researchers across labs/institutes. A concerted effort is needed to improve the gender ratio in labs/institutes. Through the analysis, we see that the share of median women in contractual work is 20% and 9% of permanent women

[22] *https://psa.gov.in/CMS/web/sites/default/files/psa_custom_files/Anthology%20of%20S%26T%20Activities.pdf*

[23] *CTIER Handbook: Technology and Innovation in India 2023*

scientists in this round. The following action points can be considered to increase the share of women researchers:

- Women researchers at JRF & SRF level should be converted to full time employment
- Promote rules for lateral entry of women scientists should be in place
- A roadmap for a recruitment drive is needed to address the leaky pipeline
- Improve capacity building of women scientists at the lab- Of the 10,697 women researchers reported in this round, only 1,546 women researchers were sent for workshops, sabbaticals

Recommendation: Proactively promote equity, diversity and inclusion at lab level

Institutional commitment to the principles of equity, diversity and inclusion are reflected through the presence of institutional mechanisms such as the presence of EDI cells and other related policies. We find that there are a number of labs/institutes without EDI cells and we recommend that the starting point for this recommendation could be to ensure setting up of EDI cells, followed by discussions on how to improve equity, diversity and inclusion at lab level. As the world grows more and more digital, it is imperative for labs/institutes to ensure that their websites are differently abled friendly to ensure that knowledge is accessible to everyone.

Recommendation: Encourage labs/institutes to attain certification and accreditation for lab procedures

In this round, 58% of labs/institutes have reported having national accreditation and 33% have reported having international accreditation. The labs/institutes should be encouraged to attain these certifications and given guidance to better understand the procedure for attaining these certifications. Workshops can be organized to train these labs/institutes on the importance of certification and accreditation. Not only will this help labs/institutes conduct more projects with international organizations, but also improve internal lab processes and resource utilization.

Recommendation: Increased digital adoption required

With 82% of labs/institutes having adopted some digital technologies (AI/ML, IoT, 3d printing) to improve their R&D, the remaining labs/institutes must be supported and guided to adopt digital technologies for better R&D outcomes.

Recommendation: Labs/institutes should be encouraged to increase focus on IPR

Just 141 labs/institutes were granted at least one form of IPR (patents, copyrights, trademarks, etc). Of these 121 had patents while just 88 held patents in emerging tech areas. This is clearly a space that can greatly impact competitiveness. The following are immediate steps that can be undertaken at ministerial level to strengthen IPR:

- Specialized workshops can help the labs/institutes know more about the process of creating an IP, the procedure for filing IPRs and at the same time, protect their intellectual property once published
- Labs/institutes need to also increase their focus on emerging tech areas like AI, Quantum, Industrial technology, semiconductors, sustainable technologies, etc

Recommendation: Converting non-worked patents into technology opportunities

58 labs/institutes that reported holding 1118 patents that were currently not being worked. Every effort should be made to look at opportunities to commercialize or license out these patents.

Some may be used to ring-fencing a technology, nevertheless a fraction of these may still offer opportunities that should be explored.

- The Centre could provide the highest level of professional techno-legal services for securing and protecting the IP generated
- The Centre will manage the patent portfolio as a business activity, including converting not worked patents into worked patents for benefit of the larger society

Recommendation: Help improve licensing of patents and technology transfers

While many labs/institutes do provide technologies for use, sometimes even free of cost, for the benefit of society, there is a gap between obtaining IPR and its eventual licensing/ technology transfer. Labs/institutes can improve interaction with cluster of startups and SME ecosystems to improve technology commercialization

11.2.4 Institutionalizing the process of data collection and validation

Data is a crucial part of informed decision making. In this section, recommendations are geared specifically for institutionalizing the process of data collection and validation.

Recommendation: Build data capabilities within labs/institutes

Despite the Director's sign off on all data, several labs/institutes did have data issues. More needs to be done to strengthen the data capabilities within labs/institutes. It may be helpful to further train existing data officers and embed a data tracking system internally that is periodically used for decision making.

Recommendation: Train and hire dedicated data officers

The quality of data received from labs/institutes in this round suggests that most labs/institutes lack internal capacity to collect, track and process internal data that can improve lab outcomes. The data officer nominated for this exercise can become a useful resource for the lab in this respect. The data officer would need to have a deep, overall understanding of the organization's work and should be in a position to coordinate with different departments within the organization to collect data required.

Recommendation: Support of line ministries/departments in data collection

We found that line ministries/departments can play an important role in supporting the data collection process in a way that complements their other efforts in contributing to national statistics. Many labs/institutes do not have access to either database or latest available softwares to report data. For example, during the course of the exercise, many labs/institutes reported they were using older versions of spreadsheet software that did not support automation easily. Relevant ministries should support /assess/identify ways for labs/institutes to obtain access identify ways for labs/ institutes to obtain access to latest subscriptions databases and softwares.

Recommendation: Get labs/institutes to report key data in their annual reports and websites

Better alignment of the data reported in annual reports with the indicators in the framework will reduce duplication of efforts and reporting burden and track lab output and outcomes more regularly. This will help feed better into a dashboard or national statistics portal on innovation in India.

Recommendation: Important to invest in embedding the data templates in portal

While signoff was required, effort was made to create user friendly templates. Backend programming will help reduce errors and prevent editing of current templates shared in Excel format and support accuracy in the data.

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The Centre for Technology, Innovation and Economic Research (CTIER) was established in December 2015 to raise the level of debate and awareness amongst policy makers, industry and researchers in India about the essential role of technical capability in economic development, and how it is best fostered. We aim to inform policy making on the back of high quality empirical economic research, as well as impact higher education in India.

CTIER's work is contributing to systemic change in India's R&D and innovation ecosystem. CTIER is a trusted source of data for all those shaping India's innovation and technological trajectory.

CTIER has built strong linkages with industry and the academic community. The Centre's unique analysis and insights are informing policies introduced to strengthen India's R&D and innovation ecosystem.

CTIER's programmatic interventions are helping build capabilities needed to transform Indian industry into an innovation powerhouse. CTIER has also been at the forefront of shaping academic thought in economics of innovation.

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Confederation of Indian Industry

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the development of India, partnering Industry, Government and civil society, through advisory and consultative processes.

CII is a non-government, not-for-profit, industry-led and industry-managed organization, with around 9,000 members from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 365,000 enterprises from 294 national and regional sectoral industry bodies.

For more than 125 years, CII has been engaged in shaping India's development journey and works proactively on transforming Indian Industry's engagement in national development. CII charts change by working closely with Government on policy issues, interfacing with thought leaders, and enhancing efficiency, competitiveness, and business opportunities for industry through a range of specialized services and strategic global linkages. It also provides a platform for consensus-building and networking on key issues.

Through its dedicated Centres of Excellence and Industry competitiveness initiatives, promotion of innovation and technology adoption, and partnerships for sustainability, CII plays a transformative part in shaping the future of the nation. Extending its agenda beyond business, CII assists industry to identify and execute corporate citizenship programmes across diverse domains including affirmative action, livelihoods, diversity management, skill development, empowerment of women, and sustainable development, to name a few.

For 2024-25, CII has identified "Globally Competitive India: Partnerships for Sustainable and Inclusive Growth" as its Theme, prioritizing 5 key pillars. During the year, it would align its initiatives and activities to facilitate strategic actions for driving India's global competitiveness and growth through a robust and resilient Indian industry.

With 70 offices, including 12 Centres of Excellence, in India, and 8 overseas offices in Australia, Egypt, Germany, Indonesia, Singapore, UAE, UK, and USA, as well as institutional partnerships with about 300 counterpart organizations in almost 100 countries, CII serves as a reference point for Indian industry and the international business community.

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