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NITI Aayog

DEVELOPMENT MONITORING AND EVALUATION OFFICE

USING RESEARCH & DEVELOPMENT FOR IMPROVING SCHEME OUTCOMES AND FOSTERING INNOVATION

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Analysis by DMEO, NITI Aayog

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THEMATIC REPORT:

RESEARCH AND DEVELOPMENT

PREFACE

The Government of India (GoI) spends close to Rs. 14 lakh crores annually on development activities, through nearly 750 schemes implemented by Union Ministries. In 2019, the Development Monitoring and Evaluation Office (DMEO), NITI Aayog was assigned the task of evaluating 28 Umbrella Centrally Sponsored Schemes, which are schemes/programmes funded jointly by the Centre and the States and implemented by the States. This historic exercise, undertaken between April 2019 and February 2021, evaluated 125 Centrally Sponsored Schemes, under 10 Sectors, together covering close to 30% of the GoI's development expenditure, amounting to approximately Rs. 3 lakh crores per annum.

As a part of the evaluation studies, the Centrally Sponsored Schemes were also assessed based on various cross-sectional themes such as accountability and transparency mechanisms, use of technology, convergence, gender, social inclusion, regulatory framework, climate change, behavior change, Research and Development and private sector participation. These evaluation studies adopted a mixed-method approach and underwent a review process involving consultations with NITI Aayog subject matter divisions, concerned Ministries and Departments, and external sector experts. For the cross-sectional analysis across sectors, additional secondary research was undertaken by DMEO, and the findings were reviewed by experts in the respective domain in order to optimize the robustness of the evidence generated across the sectors.

The present report is an outcome of the cross-sectional assessment of Research and Development across all the Centrally Sponsored Schemes. In this report, we seek to identify and explain the need for innovation and Research and Development, elaborate on the findings for Research and Development from the UCSS Evaluations at sector and scheme level, the availability of research institutes dedicated for Research and Development in the country and elucidate the issues and challenges faced in undertaking Research & Development through qualitative and quantitative analysis of secondary literature.

We hope that this Report will help in strengthening elements of Research and Development in the design and implementation of central and state government programs. Building and adopting systems for enhancing Research and Development in government will greatly contribute to the achievement of national priorities, inculcate an innovation-led approach and contribute to the well-being of all sovereign citizens of India.

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Our invaluable partners in this exercise have been officials across the Government of India and the State Governments without whose cooperation and insights this report would not have been possible. Next, we must thank our external expert, Dr Amit Kapoor, Honorary Chairman at Institute for Competitiveness, India for his critical inputs and feedback which helped us refine and bring coherence to the report. We are also thankful to the Science and Technology vertical at NITI Aayog and Naman Agrawal, Specialist, from the vertical for his insightful comments on the draft of the report. Special thanks are accorded to the implementation teams at M/s Deloitte Touche Tohmatsu India LLP, IPE Global Limited, Ernst and Young LLP and M/s KPMG Advisory Services Private Ltd who worked against significant challenges to deliver the evaluation studies, which is the base of the analysis in this report.

DMEO team has been at the core of the cross-sectional analysis, and this report would not have been possible without the contributions of Mr Aditya Bhol, Ms Tanvi Bramhe and Ms Simar Kaur, who worked tirelessly on every detail of this herculean endeavour, under the guidance of Mr Antony Cyriac, Deputy Director-General and Mr Paramjyoti Chattopadhyay, Monitoring and Evaluation Specialist. The team would also like to thank Ms Fatima Mumtaz, Mr Parth Garg, Ms Maitrayee Purohit, Ms Veenu Singh and Mr Saksham Chauhan for their support at various stages of the study. Across the cross-sectional reports, Dr Shweta Sharma, Director also oversaw coordination, standardisation and monitoring of the processes.

In accordance with the massive scope and scale of the exercise, this report owes its successful completion to the dedicated efforts of a wide variety of stakeholders.

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AYUSH	Ayurveda, Yoga, Naturopathy, Unani, Siddha and Homoeopathy
BRICS	Brazil, Russia, India, China and South Africa
CSIR	Council of Scientific and Industrial Research
CSS	Centrally Sponsored Schemes
DAE	Department of Atomic Energy
DBT	Department of Biotechnology
DIET	District Institute of Education & Training
DOS	Department of Space
DRDO	Defence Research and Development Organisation
DSIR	Department of Scientific and Industrial Research
DST	Department of Science and Technology
GERD	Gross Expenditure on Research and Development
ICAR	Indian Council of Agricultural Research
ICMR	Indian Council of Medical Research
MEITY	Ministry of Electronics and Information Technology
MES	Ministry of Earth Sciences
MNRE	Ministry of New and Renewable Energy
MoEFCC	Ministry of Environment, Forest and Climate Change
MoES	Ministry of Earth Sciences
MoHFW	Ministry of Health and Family Welfare
MoHUA	Ministry of Housing and Urban Affairs
MoRD	Ministry of Rural Development
MoSJE	Ministry of Social Justice and Empowerment
MoWCD	Ministry of Women and Child Development
NCERT	National Council of Educational Research and Training
NIC	National Informatics Centre
NIEPA	National Institute of Educational Planning and Administration
NSTMIS	National Science and Technology Management Information System
PSU	Public Sector Undertakings
R&D	Research and Development
SCERT	State Council of Educational Research and Training
SIRO	Scientific and Industrial Research Organisation
UCSS	Umbrella Centrally Sponsored Schemes
UNESCO	United Nations Educational, Scientific and Cultural Organization

BACKGROUND

The Government of India implements close to 750 schemes with an annual expenditure of approximately 10 Lakh Crore. Of these, a total of 128 schemes are Centrally Sponsored Schemes (CSS) which are implemented by States but are funded jointly by both the Centre and States. For continuation of schemes from the 14th Finance Commission cycle to the 15th Finance Commission cycle, an independent third party evalaution was mandated for all CSS by the Government. The task of conducting these evaluations was assigned to Development Monitoring and Evaluation Office (DMEO), NITI Aayog. The exercise to evaluate 128 CSS, under 28 Umbrella CSS (UCSS), under 10 Packages or Sectors was undertaken between April 2019 and December 2020. The project incorporated direct input of approximately 33,000 individuals, through 17,500 household interviews, 7,100 key informant interviews and 1,400 focus group discussions. The views of Central, State, district, block, ward and village administrations, as well as non-governmental experts and civil society organizations were elicited.

The implementation of these CSS was assessed across key parameters - relevance, effectiveness, efficiency, sustainability, impact and equity under the REESI+E framework for evaluations formulated by OECD. Further, the studies also elaborated on performance of schemes on certain cross-cutting themes. This report elaborates on the findings of the evaluation study across key sectors- Agriculture, Women and Child Development, Human Resource Development, Urban Transformation, Rural Development, Health, Jobs and Skills, Water Resources, Environment & Forest and Social Inclusion, Law & Order and Justice Delivery on the cross-cutting theme- Research and Development (R&D). This report juxtaposes information from both primary and secondary sources from the UCSS evaluation reports and other secondary literature from other sources such as the Department of Science and Technology, to elucidate the need for R&D in various sectors, the present status of R&D at sectoral and scheme level, availability of research institutes dedicated for R&D, global comparison, issues, and challenges faced in undertaking R&D and the way forward.

1. OVERVIEW

Research and development are the cornerstones of economic and social progress of any nation. Innovation, whether borne out of necessity or curiosity, scientific or otherwise, leads to the efficient utilisation of resources for better social and personal outcomes. Innovation, research and development have garnered further importance in our transition from conventional resource-based and extractive economies to knowledge-based and resourceful economies. This is pertinent given the growing concerns of burgeoning inequalities, climate change and other socio-economic and environmental concerns. This makes R&D and innovation critical components of public policy at sub-national, national and international levels.

Being the second largest nation by population in the world, India is pivotal to the global R&D endeavours. While R&D in India strengthens its global relevance in terms of trade and commerce, it also reinforces the nation domestically with improvements in health, agricultural productivity, urban and rural development, water and environmental resources, human resources development, jobs and skills, law and order and other areas of strategic importance such as defence, space exploration and earth exploration. Thus, R&D and innovation are elemental to India's development agenda. This document explores the status of R&D across a gamut of schemes and programmes in various sectors. Though the analyses undertaken has primarily been based on the UCSS evaluations done by DMEO in the 2020-21, the study also attempts to contextualise this information in the broader milieu of R&D in India – trends of R&D expenditure across sectors, issues and challenges and way forward.

At first glance, the latest data available from the Department of Science and Technology reveals the inadequacy of R&D expenditure in India. The R&D expenditure in India has been around 0.7 per cent of its GDP and is significantly less compared to the global average of 1.7 per cent. This has been the case despite the steady rise in Gross Expenditure on Research and Development (GERD) in India. Majority of the GERD in India, nearly 67 per cent, is incurred by the public sector and comprises the contributions from the Central Government (45.4 per cent), State Governments (6.4 per cent), Higher Education (6.8 per cent) and Public Sector Industry (4.6 per cent). This highlights the top-down nature of R&D in India with inadequate contribution from state governments towards R&D. It is also seen from the latest data that the share of the private sector towards R&D was only 36.8 per cent in 2017-18.

Delving deeper into the statistics, the allocation of R&D across different sectors is analysed in the context of UCSS evaluations in the subsequent sections. In this study, only the share of the R&D through the centrally sponsored schemes have been explored. Such a methodology has been adopted with an intent to develop a broader understanding of R&D in India through the implementation of infrastructural, social and welfare schemes which are decentralised in implementation requiring active financial and non-financial support of state governments. This is discussed in detail in the present scenario section of the report. This, also in a way, limits the scope of the study. Nevertheless, the emerging details from the present scenario section are discussed further in the issues and challenges section through a broader and macro scrutiny of R&D in India utilising the United Nations Educational,

Scientific and Cultural Organization's (UNESCO) classification of socio-economic objectives for R&D. This has been done with the intent of presenting the case for augmentation of R&D in specific sectors in India through the juxtaposition of detailed information from schemes across different sectors with their R&D patterns through a broader global framework. But before that the present scenario sets the tone for a thorough understanding of the kind of R&D investments in different sectors through different programmes/schemes which require both central and state government's contribution.

The present scenario section comprehensively covers the following key aspects for understanding the research and development scenario: the funds allocated to undertake research and development activities, the scope and status of research and development in governance and public service delivery in India for major schemes/ programs, the status and availability of Institutes or centres or departments dedicated for research and development and lastly the participation of private sector participation. As mentioned earlier, this section is based on the findings from Evaluation of Centrally Sponsored Schemes (CSS) across few major sectors, namely, Agriculture, Fisheries and Animal Husbandry sector, Women and Child Development, Human Resource Development/ Education sector, Urban sector, Rural Development, Health, Jobs and Skills, Water Resources, Environment and Forest, Social Inclusion, Law and Order and Justice Delivery.

The agriculture sector in India has witnessed a robust growth of 3.4%, however, improved R&D in the sector can improve efficiency of agriculture and contribute to increasing production, productivity, food security etc. This report analysed 17 CSS schemes of the Ministry of Agriculture and Farmers' Welfare out of which 6 schemes were found to be performing satisfactorily on various aspects of R&D being assessed in the report. Similarly, the Ministry of Fisheries, Animal Husbandry and Dairying implements 11 schemes which were evaluated. Most of the schemes under this ministry have very little or no R&D component as part of the schemes. However, the Indian Council of Agricultural Research (ICAR) along with other national and regional research institutes caters to the research needs of this sector.

The Ministry of Women and Child Development considers R&D as an important component for increased effectiveness of schemes. The ministry implements 12 CSS which were analysed and it was found that 3 schemes have R&D efforts being undertaken as part of these schemes. Institutes like National Institute of Public Cooperation and Child Development (NIPCCD), Central Adoption Resource Agency (CARA), National Commission for Protection of Child Rights (NCPCR), National Commission for Women and Central Social Welfare Board, Statistics Bureau and NITI Aayog are undertaking R&D for this sector.

Education is one of the most important sectors for the socio-economic development of any nation and investment in R&D is key for a knowledge-based economy. The Ministry of Education (erstwhile Ministry of Human Resource Development) implements 8 CSS schemes under Department of School Education and Literacy and Department of Higher Education. As per the analysis, it was found that the emphasis on R&D as part of the schemes has been minimal and there is need for extensive efforts in this direction. Currently, institutes like Educational Consultants India Limited (EdCIL) along with the technical support group, in collaboration with NIC, NIEPA, NCERT, SCERTs, DIETs etc. have been conducting research within this sector.

With expanding cities and urban agglomerations, the demand for urban infrastructure and services has increased significantly heightening the relevance of research and development and implementation of innovative practices via various schemes for maximum outreach. The Ministry of Housing and Urban Affairs implements 5 CSS schemes of which 4 have strong R&D components. In addition to this, institutes like Town and Country Planning Organization, National Institute of Urban Affairs

(NIUA) and Building Material and Technology Promotion Council (BMTPC) also conduct research on issues related to urbanization and make recommendations to address the urban challenges.

Rural development is crucial for the overall development of India where rural areas accounted for 69 per cent of the population. Availability of good infrastructure, skill development and employment opportunities lead to development of rural areas. The Ministry of Rural Development has been giving importance to R&D and undertakes various R&D efforts in collaboration with institutes like National Institute of Rural Development and Panchayati Raj (NIRD&PR), Indian Road Congress, Central Road Research Institute (CRRI), Central Building research Institutes etc.

Research and development in the health sector is imperative to a nation and this is evident from the accelerated technological advances in the past few years over the world. Medical research has led to improved quality of life for the human race. However, with respect to India, the expenditure on health research and development has been low. Amongst the 5 CSS schemes implemented by the Ministry of Health and Family Welfare and Ministry of AYUSH, it was observed that the National AYUSH Mission has been undertaking consistent efforts for facilitating R&D with a dedicated fund earmarked for the same. The National Institute of Health and Family Welfare (NIHFW) is the major institute that caters to R&D needs for the promotion of health and family welfare programs in the country. Other institutes include the National and State Health Systems and Resource Centres.

Under the Jobs and Skills sector, The Ministry of Labour and Employment and Ministry of Skill Development and Entrepreneurship implement 5 CSS schemes where in it was observed that none of the schemes have a dedicated R&D component. The research needs are taken up mainly by autonomous bodies such as the V.V. Giri National Labour Institute (VVGNLI), National Institute for Career Service (NICS), Central Labour Institute, Mumbai, and some of the Regional Labour Institutes. In addition, the National Skill Development Corporation along with the Sector Skill Councils (SSC) and National Skill Development Agency (NSDA) are also facilitating R&D activities.

Water Resources are critical and important assets for sustenance of life and ecological balance. It is pertinent to mention that India is currently classified as a water stressed country based on globally accepted scientific measures for water stress. Therefore, the need for R&D in this sector cannot be understated. The Department of Water Resources, River Development and Ganga Rejuvenation of Ministry of Jal Shakti conducts R&D primarily via 4 premier Institutes i.e. Central Water and Power Research Station – Pune, Central Soil and Material Research Station – New Delhi, National Institute of Hydrology – Roorkee and Central Water Commission – Delhi under the Central Sector Scheme- Research and Development and Implementation of National Water Mission. Further, the Ministry of Environment, Forests and Climate Change (MoEFCC) implements 3 CSS schemes. All these 3 schemes have an R&D fund allocated and is undertaken by institutes like Wildlife Institute of India, National Centre for Biological Sciences, Forest Survey of India, Environmental Planning & Coordination Organisation (EPCO), Botanical Survey of India, Ashoka trust and Worldwide Fund for Nature (WWF) etc and some autonomous bodies as well. In addition, research on specific hydrological problems of different regions of the country is undertaken by a number of training, research and development institutes such as the Centre of Flood Management Studies, National Institute of Hydrology, Roorkee and All India Disaster Mitigation Institute, Ahmedabad. The analyses also underscore the active participation of some of the states and local research institutions.

Social inclusion is integral for the vision of New India and to achieve this, India has been making efforts toward the upliftment of marginalised groups through different kinds of affirmative action. Under the Ministry of Social Justice & Empowerment (MoSJE), implementing the Umbrella Scheme

for Development of Scheduled Castes (SCs), R&D activities are undertaken by its Planning Division, which provides Grants to Scholars, Grants for Workshops/seminars, and grants for publication, to undertake any scheme level research and development. Additionally, the National Institute of Social Defence, an autonomous body of MoSJE also undertakes research in the sector. However, none of the schemes under Umbrella Scheme for Development of have a dedicated R&D component. Under the Ministry of Tribal Affairs (MoTA), satisfactory performance is observed on various aspects of R&D in case of Umbrella scheme for development of Scheduled Tribes (STs). Most of the schemes under this Umbrella are dedicated to support R&D activities. The State Tribal Research Institutes (TRI) also play an active role in R&D for the development of Particularly Vulnerable Tribal Groups. Under Ministry of Home Affairs (MHA), the Bureau of Police Research and Development (BPRD), MHA, initiates various research studies specific to policing in India.

The evaluation of UCSS across different sectors underscores the lack of R&D for the implementation of different schemes. While commendably there do exist some best practices for most schemes which can be attributed to enterprising local and state level stakeholders, the institutional inclusion of R&D in the scheme guidelines for different sectors such as specific R&D budget, modalities for R&D or even associated R&D institutions has been inadequate. It was found that only 26 of the 111 schemes analysed through the UCSS evaluations for the sectors had R&D funding and only 40 of them had any designated primary research organisation. It is important to note that the UCSS evaluations help us understand the trends in R&D in implementation of different schemes which have decentralised implementation. Thus, the perspective that they engender on R&D provide key insights through the implementation of different schemes, thereby, helping develop an understanding of some of the modalities at different tiers of the government. However, R&D in India has mostly been funded by the central government through a few scientific agencies and the contributions by state governments and the private sector have been limited to a few sectors like agriculture, healthcare and education. Some of the issues and challenges that constraint R&D are discussed in a broader framework with secondary literature in the subsequent sections.

In the issues and challenges section, there is a detailed discussion of India's R&D contrasted to some of the top-performing countries in terms of per capita expenditure as well as other BRICS nations. It is seen that India's Gross expenditure in Research and Development (GERD), one of the primary measures of R&D, was around $ 63.2 billion and per capita expenditure in Purchasing Power Parity (PPP) was $ 47.2 which is almost one-sixth of the global average ($ 290.5 PPP). One of the primary reasons for India's poor performance in R&D was found to be the low share of the private sector investment in R&D. According to the National Science and Technology Management Information System (NSTMIS) R&D Statistics 2019-20, the private sector includes private industry, public industry/ PSUs and Scientific and Industrial Research Organisations (SIROs) collectively accounting for 37 per cent of total investment in R&D in India. 78 per cent of the industry sector's investment in R&D amounting to Rs 36,873 crore was done by the private industry sector. 11 per cent of the industry sector investment in R&D was done by the PSUs in the industry sector and other remaining 11 per cent of the investment in R&D was done by the SIRO. Another key finding has been the low share of R&D by the states. In 2017-18 the states' share towards R&D expenditure was only 6.4 per cent of the total R&D expenditure. Only 15 per cent of the total R&D institutions in India are from the state sector and only the states of Maharashtra, Karnataka, Tamil Nadu and Delhi have been found to contribute significantly to R&D with 65 per cent of patents filed from these states.

The low share of R&D in India can also be attributed to the overall low number of R&D institutions in India and the disproportionate allocation of resources to them. It was reported that in 2018, out

of a total of 6,862 R&D Institutions in India, 63 per cent of the R&D institutions were in the private sector industry followed by the state sector at 15 per cent, higher education sector at 10 per cent while other sectors which include central government sector and the public industry sector occupied a share of around 12 per cent. However, it is seen that most of the R&D expenditure, around 46 per cent, is done by 9 per cent of the R&D institutions in the central government. Further, it was seen that during the year 2017-18, 93% of the R&D expenditure incurred by the Central Government sources were channelled through 12 major scientific agencies such as the Defence Research and Development Organisation (DRDO), Indian Council of Agricultural Research (ICAR), Centre for Scientific & Industrial Research (CSIR) and Department of Space (DoS). The total share of these 12 scientific agencies was around Rs 48,000 cr in 2017-18. This underscores the top down nature of R&D in India.

Subsequently, an analysis has been done adopting UNESCO's socio-economic objectives for R&D and comparing them with corresponding sectors undertaken in the UCSS evaluations. It is to be noted that the UNESCO's socio-economic objectives cover a broader ambit of R&D areas compared to the sectors covered under the UCSS evaluations. It is seen that the majority of the investment in R&D happens in the areas of health followed by defence; agriculture, forestry and fishing; industrial production and technology; space exploration; transport, telecommunication and related infrastructure and energy. In addition, the share of R&D by the central government is the most in areas of strategic importance like defence, space exploration and agriculture followed by health, energy and transport and telecommunications where the share of the private sector is higher. This underscores the fact that some of the sectors undertaken for the UCSS evaluation such as education, drinking water and sanitation, water resources, social inclusion, urban and rural development are less prioritised areas for R&D investment and need more attention to meet targets of the related schemes and programmes.

Finally, in the way forward section the ongoing policy measures pertaining to augmenting R&D in India are discussed. The draft version of the Science, Technology and Innovation Policy and Scientific Social Responsibility Policy are briefly discussed with an intent to highlight how the propositions made under these documents can be utilised to leverage the contribution of the private sector towards R&D and encourage the states to invest in R&D to promote a more decentralised approach to R&D and innovation in the country. The India Innovation Index developed by NITI Aayog could be used to promote states' expenditure in R&D through competitive federalism. Similarly, the provisions of Corporate Social Responsibility could be leveraged to augment the contribution of the private sector towards R&D. With the finalisation of these documents and capitalising on existing frameworks and provisions, India will have a robust R&D ecosystem that would also ascertain the incorporation of R&D systematically into the formulation of different development schemes and programmes like the central sector and centrally sponsored schemes. The inclusion of the R&D institutions into the policy and programme implementation is instrumental to India's endeavour under the "Atma Nirbhar Bharat" to transform itself into a self-dependent and self-sufficient welfare state.

2. INTRODUCTION

India's development agenda is shaped by its vision to become a $ 5 trillion economy. Encompassing initiatives like "Make in India" and "Atma Nirbhar Bharat", the development agenda of India undeniably includes an innovation-oriented approach to upscale local manufacturing sectors, knowledge advancement and dissemination and services delivery. India's reinvigorated approach to economic development has been influenced by the positive correlation between research and development (R&D) and productivity that has been well researched and corroborated by studies around the world. The classical economic theories such as the Harrod-Domar and Solow-Swan models, attributing positive effects of technological progress, postulated its exogeneity and fixed effects on economic growth. However, with the discourse on economic well-being shifting from narrower concepts of growth to broader concepts of development, latter economic theories postulated the endogeneity of technological progress and its far-reaching effect on economic development. Economic theories postulated the positive effects of human capital (Lucas, 1988); of new ideas by profit-oriented researchers (Romer, 1990); infrastructure (Aschauer 1989); and product quality improvement (Grossman and Helpman 1991; Aghion and Howitt 1992) on economic development. A recent study has revealed that a 10 per cent in R&D investment could lead to productivity gains ranging from 1.1 per cent to 1.4 per cent (Donselaar and Koopmans, 2016).

India has, however, lagged in R&D reflected by its overall inadequate investment in R&D. The Gross Expenditure on Research and Development (GERD) of India has been consistently increasing over the years and nearly trebled from Rs. 39,437.77 crore in 2007- 08 to Rs. 1,13,825.03 crore in 2017-18. It was estimated to be Rs. 1,23,847.70 crore in 2018-19 (NSTMIS[1], Department of Science and Technology, 2020). However, GERD as a percentage of GDP remained at roughly 0.7 per cent during the years 2017-18 and 2018-19 respectively. Figure 1 shows the trend in GERD in India since 1995-96 until 2018-19. It can be seen that despite the steady growth in GERD in absolute terms, in relative terms it has remained within the ranged of 0.6 to 0.8 per cent of its GDP. With a detailed anlysis of R&D statistics from the Department of Science and Technology, it is seen that the majority of the contribution to investment in R&D is from the public sector with approximately 67 per cent in 2017-18 (NITI Aayog, 2020). Public sector investment comprises the contributions from the Central Government (45.4 per cent), State Governments (6.4 per cent), Higher Education (6.8 per cent) and Public Sector Industry (4.6 per cent) (Department of Science and Technology, 2020). Nevertheless, public investment on R&D was only Rs. 52,788 crore in 2014-15 which was still lower than all scientifically advanced countries and was even the lowest among the BRICS countries (Parliamentary Standing Committee, 2019). The private sector's contribution to R&D investment in India was only 36.8 per cent in 2017-18.

1 National Science and Technology Management Information System (NSTMIS) formerly known as Science and Technology Statistics (STS), a division of Department of Science and Technology, GoI, has been entrusted with the responsibility of carrying out the studies relating to resources devoted to S&T activities at regular intervals. The Division published the first report Research and Development Statistics in the year 1973-74.

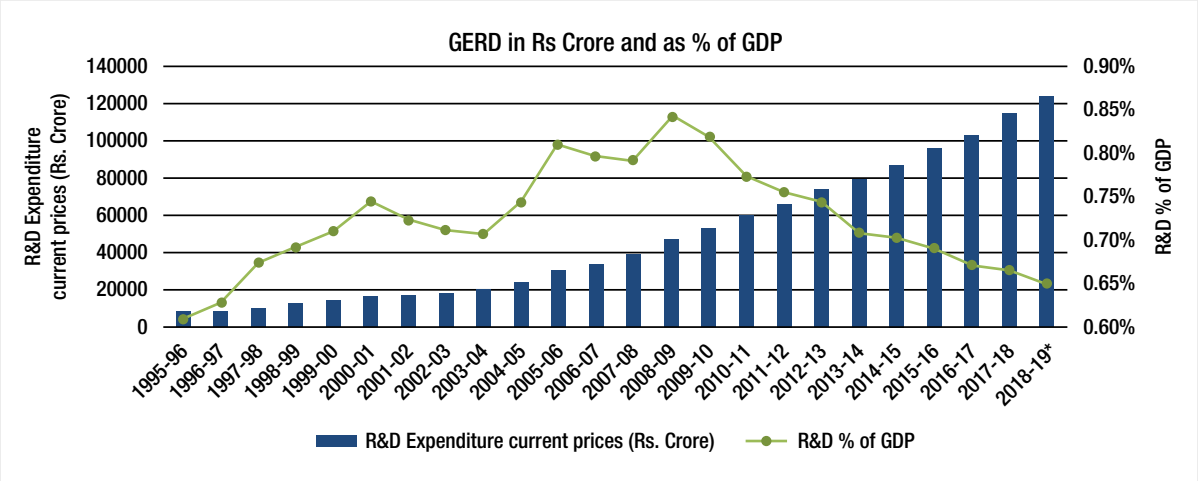


Figure 1: *Gross Expenditure on Research and Development (GERD) of India over the years*

Source: NSTMIS, DST, GoI

In a global comparative framework, India's performance in terms of R&D investment and other measures has been low. India's contribution to the World GERD in 2017-18 was only India 2.9 per cent. India managed to improve its rank in the Global Innovation Index (GII)[2] from 81 in 2015 to 48 in 2020 (ESI, 2021). India ranks third amongst lower middle-income group economies following Vietnam and Ukraine. India also performed quite impressively regionally, ranking first in the GII rankings in Central and South Asia. The GII 2020 report also placed India among the "above expectations for level of development" category in lower-middle income countries considering its remarkable progress in the last decade. However, India's performance in R&D can be described as skewed considering the seven pillars of the GII – knowledge and technology outputs (KTO); market sophistication; business sophistication; human capital and research; institutions; creative outputs and; infrastructure. India has performed fairly well in KTO and market sophistication ranking 27th and 31st globally, but its ranking in the other pillars have been poor – business sophistication (55th), human capital and research (60th), institutions (61st), creative outputs (64th) and infrastructure (75th). Evidently, India has been banking on its competencies where R&D efforts have been rather impressive but this has been unfavourable to some of the more structural pillars where efforts are wanting.

The R&D in India can be grouped under a variety of funding sources and performers. The funding sources could be categorised broadly to include the Central Government, State Governments and the industry (private sector). The performers could be grouped to include the national laboratories, universities, in-house R&D laboratories and non-profit organisations. There could be multiple combinations of funding sources and performers through which R&D is actually carried out. For example, in India, the Central Government funds scientific research that is conducted by central universities, national laboratories and incubation centres within autonomous institutions or Public Sector Undertakings (PSUs). The major R&D performing bodies in India inter alia include

2 GII is co-published by Cornell University, INSEAD, and the World Intellectual Property Organization (WIPO), a specialized agency of the United Nations. It seeks to assist economies in evaluating their innovation performance. GII has two sub-indices: **Innovation Input Sub-Index and Innovation Output Sub-Index**, and seven pillars, each consisting of three sub-pillars, further divided into a total of 80 indicators. The Innovation Input sub-index and the Innovation Output Sub-Index have equal weight in calculating the overall GII. The Innovation Input sub-index has five pillars: (i) Institutions; (ii) Human Capital and Research; (iii) Infrastructure; (iv) Market Sophistication; and (v) Business Sophistication. The Innovation Output Sub-Index has two pillars (i) Knowledge and Technological outputs and (ii) Creative outputs. GII was first conceptualised in 2007.

the Department of Atomic Energy (DAE), Department of Space (DOS), Defence Research and Development Organisation (DRDO), Council of Scientific and Industrial Research (CSIR) and Indian Council of Agricultural Research (ICAR). Some of the major R&D funding group under the central government include Department of Science and Technology (DST), Department of Biotechnology (DBT), Ministry of Earth Sciences (MES) etc among others. It should be noted that many of the major performing bodies are instituted within the funding agencies which are usually the different ministries of the Central Government. This is a manifestation of the majority public sector, particularly central government institutional level, expenditure in R&D. The Department of Scientific and Industrial Research (DSIR) instituted within the Ministry of Science and Technology grants recognition to such R&D organisations as Scientific and Industrial Research Organisation (SIRO) categorized based on four thematic areas: (a) Natural and Applied Sciences; (b) Agricultural Sciences; (c) Social Sciences and; (d) Medical Sciences. Besides keeping the account of private sector in-house R&D units, some private R&D organisations are also given the SIRO recognition. However, only 427 institutions were recognised as SIROs accounting for nearly 4.3 per cent of total GERD in 2017-18.

The objective of this report has been to explore the status of R&D and innovations as a cross-sectional theme across the whole gamut of development sectors and the different schemes launched by the central government of India. For this purpose, the paper attempts to highlight this information at both micro and macro levels. For a micro analysis, the report presents the findings of evaluation reports previously undertaken by DMEO, NITI Aayog to highlight sectoral and scheme-wise provisions for R&D. Concurrently, the macro analysis is done with an objective to present the prioritisation of R&D across all sectors and thematic areas through a meta-analysis of collated information from the evaluation reports and secondary analyses. In the following sections a detailed account of current status of R&D across different sectors and respective schemes; issues and challenges pertaining to augmentation of R&D in India and way forward.

The present scenario section compiles and discusses broad findings on R&D from the UCSS evaluations undertaken for different sectors. There has been an attempt to present a scheme-wise status of R&D within the sectors. Each of the sectors discussed also include a best practice which evinces the effectiveness of R&D for innovative ways of scheme implementation. The subsequent section on issues and challenges highlights some of the key concerns for R&D in India. These concerns have been elicited from a detailed literature review and there has been a conscious attempt to contextualise this with the sectors and schemes discussed in the present scenario section. Traversing through relevant R&D statistics, the issues pertaining poor GERD, low number of research institutions, disproportionate numbers of research personnel, low number of tangible outcomes in form of patents and low priority of unquantifiable outcomes for the social sector in terms of knowledge creation and diffusion has been discussed in the section. Finally, in the way forward section some suggestions on burgeoning India's R&D by capitalising on existing frameworks and policies have been made. The potential of R&D in India is considerably high and so are its conceivable rewards. Thus, this paper isn't confined to a discussion of the concerns alone, but also strives to propose remedies for the augmentation of R&D with the sincerest hope to instruct fruitful policy interventions with plausibly remarkable ramifications.

3. PRESENT SCENARIO

Research and Development results in development of new knowledge, techniques and technologies in a nation. These new techniques and technologies then help to improve productivity and help in economic growth. The expenditure made in Research and Development ensures growth across different sectors which lead to the economic development of any country. It has been observed that most of the developed countries of the world spend huge amounts of their budget on R&D. The global spending on R&D is approximately USD 1.7 trillion. However, only 10 countries account for 80% of this amount. Whereas India spends as little as 0.7% of its GDP, i.e., USD 47,574.7 Million, towards R&D activities. Of this, Government spending accounts for approximately 57% followed by Businesses and Universities[3].

Based on Evaluation of Centrally Sponsored schemes across a few major sectors, we discuss in detail how funds are allocated to undertake R&D activities, the scope and status of R&D in governance and public service delivery in India for major schemes/ programs, the status of availability of Institutes or Centres or departments dedicated for R&D and private sector participation in R&D across these sectors.

3.1 AGRICULTURE

The contribution of Indian agriculture sector to the GDP has been approx. 20% in 2020-21 and the sector has been able to reach this benchmark after 17 years (the contribution to GDP was 20% in 2003-04). Despite the pandemic which had an adverse effect on most of the sectors, the Indian agriculture was able to maintain a robust growth of 3.4 percent. This growth is attributable to record food grain production, increased exports, expanding food processing industry etc. India is targeting to double the farmers' income by 2022. Experts opine that improving R&D in the sector can improve efficiency of agriculture which will contribute to improved production, productivity, food security and farmers' economic position. However, the expenditure on R&D is less than 1 % of Agricultural GDP. Spending on agricultural R&D in India still hovers around 0.40% of agricultural GDP (about Rs 8,000 crore only in 2019-20), while most other countries spend more than 1%. (Economic Times, 2020)

The Department of Agriculture, Cooperation and Farmer's welfare implement 18 schemes of which only 2 schemes (Rashtriya Krishi Vikas Yojna (RKVY-RAFTAAR) and Mission for Integrated Development of Horticulture) have funds earmarked for R&D. The R&D projects under the two schemes are conducted in collaboration with Indian Council of Agriculture Research (ICAR) and National Level Agencies like National Centre for Cold-chain Development (NCCD), Directorate of Cashew-nut and Cocoa Development (DCCD), Directorate of Areca-nut and Spices Development (DASD), National Horticultural Research and Development Foundation (NHRDF), National Bee Board

3 http://uis.unesco.org/apps/visualisations/research-and-development-spending/

(NBB) and Spices Board etc. In addition to this the Ministry has 4 autonomous bodies- National Institute of Plant Health Management, National Institute of Agricultural Extension Management (MANAGE), National Council for Cooperative Training and Chaudhary Charan Singh National Institute of Agricultural Marketing which are also involved in conducting research in the sector. The total fund allocated to these bodies for FY2021-22 has been INR 28.40 Crore. Given the importance of R&D in the Agriculture sector, the Ministry has a separate department dedicated for agricultural research and education with a budget allocation of INR 8513.62 Crore for FY 2021-22.

Moving onto the availability of Institutes or Centres or departments dedicated for R&D with respect to the agricultural sector, the Indian Council of Agricultural Research (ICAR) is an apex research organization of the country, spearheading agricultural research, education and extension activities for productivity enhancement and diversification of Indian agriculture. In addition to ICAR, the National Agricultural Research and Education System (NARES) is also one of the top research institutes contributing to transformative changes in the agricultural domain.

ICAR has a vast network of 96 ICAR institutes, 77 All India Coordinated Projects/Networks, four deemed universities, two Central Agricultural Universities and 641 Krishi Vigyan Kendras (KVKs). In addition, there are 62 state Agricultural/ Veterinary/ Horticultural/ Fishery universities and 4 general universities with agricultural faculty, as part of the NARES. The research programs under the umbrella of ICAR are designed to harnessing the power of science and technology that promotes food, nutritional and livelihood security of vast population of our country. ICAR has also contributed significantly in paving the way for Green Revolution in agriculture in the past. Thorough research and technology developments by ICAR alongside with its partners in the NARES have enabled India to increase the production of food grains by 5-fold, horticultural crops by 6-fold, fish by 12-fold (marine 5-fold and inland 17-fold), milk by 8-fold, and eggs by 27-fold since 1950-51.

The Rashtriya Krishi Vikas Yojana promotes R&D through collaboration with ICAR, to fund agricultural research infrastructure, and for strengthening Krishi Vigyan Kendras (KVKs).

National Food Security Mission: Engaging with State Agriculture Universities (SAUs), and National and International research organizations for research themes.

Under the Mission for Integrated Development of Horticulture (MIDH) , National Level Agencies (NLAs) like NCCD, DCCD, DASD, NHRDF, NBB, Spices Board etc. for which 100% grant is provided under MIDH, for carrying out various interventions like Research & Development, capacity building, skill development, leading to overall development of horticulture in the country. Concurrence is being established with PMKSY, RKVY and NMMI for implementation of other components. Further, Centre of Excellence (COE) have been established with Israel, Holland and Germany. The areas of collaboration under COE are primarily related to Post harvest management, water management technologies, pollination technologies, plant protection and disease control, irrigation-fertigation, development of new varieties, Farmer organisation and training and demonstration.

R&D activities in the National Food Security Mission (NFSM) aim to facilitate strategic research, address specific issues, and minimize gap between actual yield and potential yield. The NFSM allows engaging with State Agriculture Universities (SAUs), and National and International research organizations for research themes, including but not limited to, conservation of natural resources (land, water) and their efficient use, Integrated Nutrient Management, Integrated disease and pest management, modification/refinements in farm machines/tools for various soils types/cropping systems, up scaling of improved crop varieties/hybrids in NFSM adopted states/agro-climatic zones under water/thermal stress conditions, nutrient management in acidic/alkaline/sodic soils, and any

other approach for enhancement of productivity and production. The scheme also encourages exposure visits to international organizations.

Box 1: Best Practice – Agriculture

India Agritech Incubation Network

India Agritech Incubation Network (IAIN) has been setup at IIT-Kanpur with a target to impact almost 50,000 farmers through 60 enterprises working on technological solutions for agriculture. The Bill and Melinda Gates Foundation (BMGF) and Tata Trusts, in collaboration with Collectives for Integrated Livelihood Initiatives (CInI) and the Government of Uttar Pradesh, have jointly set up the IAIN. It aims to provide incubation support to innovators and agritech entrepreneurs, to come up with innovative technological solutions to positively impact the lives of smallholder farmers in the state of Uttar Pradesh.

Under this initiative, the Social Alpha Quest for Agritech Innovations has been announced in July 2019. In the first phase, around 12 innovations are proposed to be selected, which would receive incubation support for the next 1-2 years. The initiative would aim to bring about new technological innovations in the following areas:

- Improving productivity and yield intensification
- Better post-harvest loss management and value-addition
- Enhancing access to market and improving traceability

Research and Development is an important component under the Sub-Mission on Seed and Planting Material. For augmenting research support, collaboration has also been made with ICAR and SAUs. In addition, The National Seed Research and Training Centre (NSRTC), Varanasi (Uttar Pradesh) has been functioning since October 2005 and has been notified as Central Seed Testing and Referral Laboratory (CSTL) with effect from 01.04.2007. The objective of CSTL, NSRTC is to maintain uniformity in seed testing and to ensure supply of quality seeds at National level. It also acts as Referral Laboratory under Court of Law for seed related issues. NSRTC is a premiere institute for capacity building in relation to maintaining Seed Quality Assurance. During 2018-19 (till 15th January 2019) NSRTC had organized 8 National Training Programme on various seed related issues for the benefit of various stakeholders of Govt., Public and Private Sector etc.

The Sub Mission on Agroforestry (SMAF) calls for regular research on new models of agro forestry, hence, R&D is a critical component of the Mission. Therefore, the Mission has linkages with various institutes of ICAR/SAUs/ National / International Institutes. The Central Agroforestry Research Institute (CAFRI), ICAR, and the South Asia Regional Programme of World Agroforestry, jointly published a book, Successful agroforestry models for different agro-ecological regions in India, which contained a comprehensive account of 40 successfully tested agroforestry systems for 20 different agro ecological regions in India. In addition, ICAR has published other papers on the topic, including, Promising Agroforestry Tree Species in India and Guidelines to Produce Quality Planting Material of Agroforestry Species. Under the Mission, SAUs / ICAR Institutes/ CAUs/CSIR/ICFRE institutes / State Government/ other National & International level agencies/ organizations are encouraged to undertake projects for demonstration and extension purposes on area specific innovative agroforestry models.

Under National Bamboo Mission (NBM), the focus of R&D activities is to increase the production and productivity of bamboo by identifying its superior clones, improvement of processing technology,

development of new products and improvement of tools & machinery, etc. With an aim to promote R&D activities, a sub-committee for the same has been established. This sub-committee has been entrusted with the responsibility of deliberating on issues related to propagation and cultivation (identification of appropriate species, planting techniques, tissue culture, development of new varieties, improving the productivity of bamboo plantations in the country. The Deputy Director General (Research), ICFRE is the Convener of this sub-committee and members are drawn from inter alia ICAR, CAFRI, DST, State Agriculture Universities, Central Food Technological Research Institute (CFTRI), etc. Strengthening collaborations with international organizations such as International Network for Bamboo and Rattan (INBAR), World Agroforestry Centre (ICRAF) and Food and Agriculture Organisation (FAO) is a key focus point under this Mission.

Integrated Scheme on Agricultural Cooperation (ISAC) aimed towards building a robust ecosystem of cooperatives in the agricultural sector of the country, emphasizes on continual development of its activities both on the financing as well as on the education and training part. Laxmanrao Inamdar National Academy of Cooperative Research and Development (LINAC) was established by NCDC as its training and research institute. Throughout the year multiple training programmes are conducted by LINAC for the personnel involved in NCDC assisted projects/schemes. Few research studies are also conducted by NCCT on cooperatives in order to develop them in tandem with the evolving environment, technology and new requirements in the sector.

Moving onto animal husbandry, some of the key research institutes in livestock management in India are National Dairy Institute, Indian Veterinary Research Institute, National Institute of Animal Nutrition and Physiology, Bengaluru, ICAR-National Institute of High Security Animal Diseases, Bhopal along with National Research Centres on various animals and Veterinary & Animal Science Universities. Under the Department of Agricultural Research and Education, Indian Council of Agricultural Research (ICAR) conducts various research in animal science to increase productivity and double farmer's income.

Box 2: Best Practice – Animal Husbandry

Producing sexed sperm for increasing milk production through RKVY funds

The case study pertains to interventions in West Bengal using RKVY funds in 2008-09.

West Bengal being traditionally a low milk producing state wished to increase its milk producing capacity to become self-sufficient, and improve dairy processing potential in the state. This required targeted quantitative, qualitative and genetic improvement of cattle population along with strengthening of infrastructure for collection and processing of milk from the rural producers and marketing to the urban consumers by cooperatives, private sectors as well as government.

Hence, in order to increase the production, the Paschim Banga Go-Sampad Bikash Sanstha (PBGBS) undertook production of sexed sperm by introducing 'BD Influx High Speed Cell Sorter' in the Frozen Semen Laboratory, at the Haringhata Farm. The project was taken up under RKVY with a total outlay of Rs. 2.90 crores, during 2007-08 and 2008–09 and completed in November, 2009. The process involved pre-determination of sex by sorting 'X' and 'Y' chromosome bearing live sperm cells using the DNA content of sperm as the discriminatory parameter. This helped in production of large number of female calves, which ultimately boosted milk production. The production reached 4.47MT in 2010-11, and stood at 5.38MT in 2017-18. The RKVY funding was critical in the intervention here as no other scheme was functioning in the sector to enable such an investment.

It is pertinent to highlight here that this technology of Sorted sexed semen is marketed in many countries like US, New Zealand, Denmark, and Australia at very high prices. However, by replicating this technology, the animal husbandry department was able to exploit the benefits of this technology at an affordable and subsidised cost.

Research and development under the Livestock Health & Disease Control scheme primarily focuses on discovering more effective vaccines, creating more robust hospital infrastructure, and having access to user-friendly learning programmes.

It is observed that the Department of Agricultural Research and Education funds research programmes of ICAR - National Institute of Veterinary Epidemiology and Disease Informatics (NIVEDI). The National Institute of High Security Animal Diseases (NIHSAD) has contributed significantly by detecting many animal diseases of exotic origin and preventing them from entering our country, handling exotic/ emerging animal diseases, providing rapid diagnosis and conducting basic and applied research on emerging animal pathogens.

The Rashtriya Gokul Mission scheme calls for regular research on new vaccinations, AI techniques and breed improvement. Hence, for carrying out the regular research, ICAR, Universities, Colleges, and research institutions actively participate in the Mission. In addition, key research areas that ICAR is helping in relate to development of roadmap for genomic selection in cattle and buffaloes for National Bovine Genomic Centre for Indigenous Breeds. Further, ICAR-National Dairy Research Institute, Karnal and Artificial Breeding Research Centre are together involved in maintaining breeding bulls consisting of Sahiwal, Tharparkar, Karan Fries and Karan Swiss breeds of cattle and Murrah breed of buffalo. They are also working on production, processing, preservation and utilization of quality semen from cattle and buffalo bulls of high genetic merit. The Central Frozen Semen Production & Training Institute (CFSP&TI) also undertakes R&D, training, equipment testing, semen production, etc.

The scheme-wise summary of R&D for this sector is provided in Table A1 in the annexure.

3.2 WOMEN AND CHILD DEVELOPMENT

Social health of any nation depends a great deal upon the status, roles and responsibilities available to women. Further, well-nurtured children with full opportunities for growth and development in a safe and protective environment is extremely important as they are future of country. India, since independence has prioritized empowerment, protection, and welfare of women and children and several policy initiatives, schemes etc. implemented over the years by the Government along with establishment of multiple bodies/ organizations for protection of right of women and children.

The Ministry of Women and Child Development considers Research and Development a key component in increasing the effectiveness of various WCD scheme's performance. However, only 4 out of 12 Centrally Sponsored Schemes have funds allocated for Research and Development activities. Out of these 4 schemes the Gender Budgeting, Research, Publication and Monitoring majorly focuses on R&D activities in the gender budgeting sub-sector. Research projects under Grant-in-Aid for Research and Publication are in the fields of welfare and development of women and children, including Food and Nutrition aspects. The priority within these broad areas is given to research projects of applied nature keeping in consideration plan policies and programmes, and social problems requiring urgent public intervention.

The autonomous bodies- National Institute of Public Cooperation and Child Development (NIPCCD), Central Adoption Resource Agency (CARA), National Commission for Protection of Child Rights (NCPCR), National Commission for Women and Central Social Welfare Board, which are affiliated to the Ministry also engage in R&D activities for the sector. In FY 2021-22, budget of INR 211 crore is allocated to these autonomous bodies. This amount is 13.27 per cent more than the allocation for 2019-20 and it is only 0.007 percent of total budgetary allocation for MoWCD. Further, the allocation for "Gender Budgeting and Research, Publication and Monitoring" is just Rs 8 crores for 2020-21.

The key components and designated agencies for carrying out research activities across the WCD sector are: Statistics Bureau of the Ministry: The need for compiling quality and credible data/ information about the various initiatives taken by the Ministry has been well recognised. The issue that the Ministry targets to address through its various schemes/programmes has a diverse impact on various social, cultural, and economic aspects. Therefore, research of ongoing programmes and certain situational analysis are also important for efficient progress and for the attainment of goals as mandated by the Ministry. The Statistics Bureau has been entrusted to collect and compile statistics and to sponsor research on welfare and development of women and children.

With respect to the availability of Institutes and centres pertaining to R&D under WCD Sector, National Institute of Public Cooperation and Child Development (NIPCCD), Central Adoption Resource Agency (CARA), National Commission for Protection of Child Rights (NCPCR), National Commission for Women and Central Social Welfare Board, Statistics Bureau and NITI Aayog are some of the R&D dedicated research institutes available in the country.

The MoWCD also conducts an Internship program for young students under the Research Scheme. Broadly, this programme is designed to appraise the enrolled interns from various Academic Institutions about the policies and programmes of the Ministry. They are also encouraged to undertake pilot projects/ micro-studies focusing on the ongoing activities of the Ministry. During the period January 2018 to March 2019, 146 short-term and 12 long-term interns were trained an amount of Rs. 18.16 lakhs were spent against the Revised Budget Estimate of Rs. 20.00 lakhs. (MoWCD, Annual Report, 2018-19).

The National Institute of Public Cooperation and Child Development (NIPCCD) was instituted in 1966 as an academic institution, to deliver quality training and research in the areas of topical concerns related to women and child development. Particularly, under the Anganwadi Services Scheme, NIPCCD has several volumes of the compilation of ICDS research, which covers the research studies on ICDS conducted during 1996- 2008. It includes various studies on Administration of ICDS, Adolescent Girls, Anaemia, Anganwadi Workers Training Centres, Community Participation in ICDS, Evaluation of ICDS, Functioning of AWCs, Health Status, Nutrition and Malnutrition, Preschool Education, Time Management, Training of Functionaries and World Bank Assisted ICDS Projects.

R&D have also been a critical part of another flagship programme of Government of India, the POSHAN Abhiyaan or National Nutrition Mission. This programme aims to improve nutritional outcomes for children, pregnant women and lactating mothers. NITI Aayog has played an overarching role with a microanalysis of the problems persisting and defined an in-depth strategy for course correction. Most of the recommendations presented in the Strategy document have been subsumed within the design of the POSHAN Abhiyaan.

Box 3: Best Practice – Women and Child Development

Ensuring Transparency, Quality, Efficiency & Accountability in THR distribution in Gujarat – PuShTI "Poshan umbrella for Supply chain through Tech Innovation"

The PuShTI project aims to apply digital technology for transparent, timely and accurate supply chain management of Take Home Ration (THR) with a bottom up approach by eliminating the gap between actual requirement and supply of THR. It is being implemented by Department of Women and Child Development, Gujarat, Gujarat Co-operative Milk Marketing Federation, SUMUL, AMUL & BANAS Dairy Unions and Gujarat Info Petro Limited (GIPL).

In 2017, Government of Gujarat signed an agreement with the Gujarat Cooperative Milk Marketing Federation (GCMMF) to procure energy dense micronutrient fortified food in form of THR and to ensure uninterrupted supply of THR through manufacturing at three leading District cooperative milk unions as Banas, Amul and Sumul Dairy under GCMMF. Three different products i.e. Balshakti for children, Matrushakti for pregnant & lactating women and Purnashakti for adolescent girls is designed considering the requirement of the specific age groups. To streamline the THR service delivery and real-time monitoring, a software has been developed by the Department. Monthly indenting, approval and delivery of THR packets up to AWC level is being monitored through the dashboard. It also comprises of a web-based application for demand & supply cycle and an Android based App for transportation solutions. This system ensures smooth, transparent, speedy and error free supply of THR at the Anganwadi centres.

Benefits:

- The project ensures transparency as the entire processes are available at public domain and all the stakeholders D/o WDC, GCMMF AWC etc. are made equally responsible
- Quality- It is ensured as THR is initially tested at Amul lab and after passing of decided parameters it is distributed at AWCs. To cross check the quality, it is again tested in Government of Gujarat Food & Drug Laboratory and after passing of the test, it is allowed to distribute to beneficiaries for consumption.
- Safety of products is ensured by proper packaging of the product to make it free from contamination.
- Standardization is done by making same quality & quantity of product in the entire state as per the prescribed norms.
- Community involvement and Social Audit (as the distribution of THR is also done on monthly basis on 4th Tuesday in the presence of local persons)
- The entire supply chain management follows the principle of demand driven supply as opposed to the supply driven management.
- OTP based tracking of distribution of THR up to AWCs.
- Online certification of delivery is provided in the system in order to ensure timely and correct payment to the supplier.
- Timely and regular supply of THR on monthly basis on 4th Tuesday (supply on monthly basis at the scheduled time)- Timely delivery of THR ensures timely distribution of Ration to beneficiaries, which will directly support in nutritional indicators.

The scheme-wise summary of R&D for this sector is provided in Table A2 in the annexure.

3.3 HUMAN RESOURCE DEVELOPMENT

Education is one of the fundamental factors in both social and economic development. Substantial investment in education is key for a sustainable growth. With the emerging knowledge-based economy, the importance of research productivity, knowledge production, technological innovation, and highly skilled manpower cannot be stressed enough. The importance of a strong human resource was realised and Ministry of Education (erstwhile Ministry of Human Resource Development) was created in 1985 for providing basic education and all-round development of the citizens. The ministry has two departments- Department of School Education & Literacy responsible for development of school education and literacy in the country and Department of Higher Education which is engaged in bringing world class opportunities of higher education and research to the country.

The emphasis on R&D is minimal in the school education. The constituent Centrally Sponsored Schemes for school education have a specific component towards Research and Development, for which up to 6 percent of funding (including project management and LEP component) can be allocated. However, actual utilization is found to be only over half of outlay. A small component of Research is also undertaken by NCERT. The budgetary outlay for NCERT from Overall Budget of Dept of School Education and Literacy is Rs 500 cr.

However, the department higher education allocates budget for various Research And Innovation schemes like- Training and Research in Frontier Areas; National Initiative for Design Innovation; Startup India Initiative in Higher Educational Institutions; Unnat Bharat Abhiyan; Implementation of the IMPRINT Research Initiative(Impacting Research Innovation and Technology); Impactful Policy Research in Social Science (IMPRESS); Scheme for Promotion of Academic and Research Collaboration (SPARC), Scheme for Transformational and Advanced Research in Sciences (STARS), and Multidisciplinary Education and Research Improvement in Technical Education-EAP (MERITE). The total allocation for these schemes was Rs 283.94 cr in 2020-21 and for 2021-22, Rs 237.40 have been allocated.

There is no separate outlay for R&D for teacher education and adult education. The funds under 'Miscellaneous Activities' can be used by the CTEs for undertaking Research. Under Rashtriya Uchchatar Shiksha Abhiyan - RUSA 2.0, over INR 1000 crores were allocated for promotion of R&D.

Moving forward to the Institutes or centres available in the HRD Sector, under the National Education Mission (NEM), Sarva Shiksha Scheme and Rashtriya Madhyamik Shiksha Abhiyan, R&D activities for school and elementary education are undertaken by Educational Consultants India Limited (EdCIL) along with the technical support group, in collaboration with NIC, NIEPA, NCERT, SCERTs, DIETs etc.

Further, the National Institute of Educational Planning and Administration (NIEPA) carries out research activities in education sector (including minority education), specifically under the umbrella programme for Development of Minorities Scheme for Providing Education to Madrasas/Minorities (SPEMM).

With respect to the Centrally Sponsored Scheme on Teacher Education (CSSTE), SCERTs and DIETs already have a lot of publications, abstracts, action research etc. around TLM, teaching practices, classroom transactions etc. and continuously encourage R&D.

Box 4: Best Practice – Human Resource Development

Jnanabhumi portal in Andhra Pradesh

Summary: AP created a state-wide Jnanabhumi portal for higher education institutes. The portal integrates educational scholarship services and builds synergies for students, institutes, and other stakeholders.

Objectives and rationale: The portal was created to address challenges related to scholarship disbursements to students studying in higher education institutes by creating a single stop solution for all students across the state. The process of application, verification, monitoring, and disbursement was integrated

Key stakeholders:

Key Stakeholders	Influence	Role
Government of AP	High	Overall supervision and implementation support
Multiple departments of the state	High	Planning, Funding, monitoring, execution, and risk assessment
Banks	Medium	Integration of financial system and disbursement of funds
Higher Education institutes	Medium	Integration with the portal
Students	Low	Beneficiaries

Implementation strategy:

- A state-wide IT portal was created. All the higher education institutes were mandated to register on the institutes.
- All the students registering in such institutes were asked to register on the portal
- All departments with scholarship programs for students registered on the portal. Banks were tasked to integrate the student Aadhar bank accounts with the portal
- Scholarship module was made part of admission module. Application process was made simple by minimizing documents. Timely verification of documents was done, and subsequent release of scholarship was initiated.

Resource utilization: Not enough Data.

Impact: 8,535 colleges were registered on the portal along with 15.80 lakh student beneficiaries. 18 implementing bodies and more than 4000 bank branches were integrated to truly make the system universal.

Key lessons learned:

- Usage of IT solution to build transparency in disbursement of benefits
- Integration of multiple stakeholders on a single platform

Sustainability:

The scheme will further improve synergy by introducing common academic calendars, integrating student and teacher information like attendance, and monitoring of hostels.

The scheme-wise summary of R&D for this sector is provided in Table A3 in the annexure.

3.4 URBAN DEVELOPMENT

There has been a rapid urban population in India in the last few decades. The expanding urban population increases the demand for urban infrastructure and services. To cater to the needs of the huge urban population, there is a need for research and development and implementation of innovative practices via various schemes so that the outreach is maximum. For R&D in the urban sector, Ministry of Housing and Urban Affairs has various autonomous bodies like- Town and Country Planning Organization, National Institute of Urban Affairs (NIUA) and Building Material and Technology Promotion Council (BMTPC) which have been established with the objective to bridge the gap between research and practice on issues related to urbanization and suggest mechanisms to address the urban challenges. The combined budget allocation for these autonomous organizations is INR 24.53 Crore.

MoHUA has launched various schemes- Smart Cities Mission (SCM), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Pradhan Mantri Awas Yojana- Urban (PMAY-U), Swacch Bharat Mission- Urban (SBM-U) and DeenDayal Antyodaya Yojana- National Urban Livelihood Mission (DAY-NULM) with the objective of improving the urban liveability by providing various amenities to the residents. Apart from dedicated organizations for conducting research and development, these schemes also have a dedicated fund from the scheme budget which have been allocated for conducting research activities.

The Smart Cities Mission is aligned to initiatives like resilient cities, future cities, or sustainable cities. As per the guidelines of this scheme, 2 per cent costs from Central Government funding for SCM have been set aside for Administrative & Office Expenses focussed on MoHUA activities, research, pilot studies, evaluation, and capacity building. Similarly, the guidelines for AMRUT also have provision for MoHUA A&OE funds to be utilised for commissioning of research and applied studies.

In addition, the India Urban Data Exchange (IUDX) is a research initiative that has been developed in partnership between the Smart Cities Mission and the Indian Institute of Science (IISc), Bengaluru[4]. IUDX serves as an open-source software platform for cities, industry and researchers to share cities data sets that can be exchanged, or even traded in the future. City level platforms are built over this, to create city level data exchanges. Multiple partners from private sector and non-profits have been onboarded in the program. Such a combination of these datasets shall allow rapid innovation, as well as a comprehensive understanding of and planning for urban needs and challenges.

Box 5: Best Practice – Urban Development

Visakhapatnam's park for differently abled

The 'All Abilities Park' in Visakhapatnam is a neighbourhood level park, especially designed for differently abled children. Opened in 2018 and spanning 2156 sqm, the park is an example of open spaces that engage the users, is interactive and enhances visitor experience.

Objective and Rationale:

- To provide suitable infrastructure and services accessible to all citizens and every section of the society.
- The main goal was to ensure that the differently abled do not feel discriminated against in terms of entertainment avenues.

4 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1700246

Key Stakeholder: Greater Visakhapatnam Smart City Corporation Limited

Implementation strategy:

- The 'All Abilities Park' services the needs of the differently abled children without segregating them from the rest of the community. Built at a cost of Rs. 3.5 Cr, the park is equipped with sensory experiences including tactile pavements and textured walls.
- The park targets all types of differently abled users, including visually impaired, hearing impaired, those with physical disabilities.
- With the complete play equipment imported from Singapore which is mostly made of rubber makes it a safe design and also solves the problem of rusting and damage. Also, the park is constructed in such a manner that a person in a wheelchair can cover every corner of the park with ease. The park overlooks the Vizag coastline.
- To provide knowledge about plants, tire planting, a technique of growing plants in tires, has been incorporated at the park. The park gives an opportunity for children to express themselves on the large blackboard that has been incorporated on one side.

Resource Utilization:

- This unique park has been built at a cost of around Rs. 3.5 crores through SCM funds.

Impact:

- The shortcomings in the existing park became the objectives of this intervention. Like lack of innovative and stimulating play spaces, reinforcing play areas with planting designs.
- Citizens' patronage to the park has been on the rise since 2018. Schools dedicated to differently abled students regularly ensure a visit to this park.
- This project showcases the city's strong emphasis on enhancing the social infrastructure in an equitable manner. Further, the park provides good quality open spaces and encourages citizens to spend more time outdoors, thereby aiding physical activity and healthy living.
- The 'All Abilities Park' seeks to balance the needs of the differently abled without isolating them from the rest of the community.

Key Challenges and Lessons Learnt:

- Small scale but impactful projects that promote equity, add value to the quality of life of citizens. Such projects are easily replicable.
- The major focus lies on 3 factors Approachability, accessibility and usability of space.
- The project has aimed at exhibiting the city's strong emphasis on upgrading the social infrastructure which will also improve the health of all its citizens.

The PMAY (U) guidelines have also dedicated five per cent of the allocation under the Scheme for capacity building, IEC activities and A&OE. Research studies are also part of the capacity building component, and research and documentation are fully funded by Central Government. Since FY 2015-16, INR 173.4 crores have been provided to BMTPC and IITs (Kanpur, Madras, Roorkee) for R&D under PMAY (U), with highest share to BMTPC for DHPs and LHPs. In addition, States/ UTs are empowered to undertake their own research studies as per local requirements.

The DAY- NULM scheme also supports and encourages innovative urban poverty alleviation initiatives through its Innovative and Special Projects (I&SP) Component. The guidelines state that 'a project taken up under this component may include pioneering approaches, innovations to strategies under DAY-NULM, or catalysing efforts in geographical areas where these have not been undertaken before' (MoHUA, 2018). Five per cent of the total central funds are earmarked for this component, and all the projects are entirely funded through the Centre's allocation. As per Mission MIS, a total of INR 95.15 lakh has been utilised to support four projects.

Further, to foster upcoming technology ventures at the grass-root levels and catalyse R&D, another notable initiative in the Urban sector are the launch of the Affordable Sustainable Housing Accelerators (ASHA). Under this initiative, incubation and acceleration support will be provided to future technologies that are pre-prototype (not yet market ready) and post-prototype (market ready but require strategic guidance and acceleration). For this purpose, ASHA-India Centres are being created under the following institutions: IIT Bombay, IIT Kharagpur, IIT Madras, IIT Roorkee and Council of Scientific and Industrial Research–North East Institute of Science And Technology (CSIR-NEIST), Jorhat. Acceleration will be conducted by MoHUA through its technical arm BMTPC, and in collaboration with Knowledge Partners of GHTC-India.

The scheme-wise summary of R&D for this sector is provided in Table A4 in the annexure.

3.5 RURAL DEVELOPMENT

The Ministry of Rural Development has been one of the few ministries which has a major focus on R&D as a part of its various schemes. As per the Annual Master Circular, 2019-20, the cost of research studies may be incurred through the 6 percent administrative expense of the State under MGNREGS. The National Institute of Rural Development and Panchayati Raj (NIRD&PR), an autonomous organization under the Union Ministry of Rural Development, is a premier national Centre of Excellence in Rural Development and Panchayati Raj. DoRD provides 100 percent funding support towards plan and non-plan expenditure of the institute. NIRD&PR has been publishing reports for MGNREGS with topics ranging from participation of women, inclusion of persons with disabilities and Social Audit Reports. The institute has a separate centre/department which takes care of training and research for MGNREGS.

Similarly, the PMAY-G scheme guidelines also makes provision for Special Projects wherein 5 percent of the Central allocation under PMAY-G is retained at the Central Government level as a reserve fund. This fund is to be used for financing the proposals for Special Projects received from States. Under Special Projects, there is scope for States to submit proposals for new technology demonstration – especially with a focus on affordable and green technologies and using locally available materials. However, due lack of data on the number and kind of Special Projects being funded, it is difficult to come to any conclusion regarding the level of fund utilization.

Indian Road Congress, Central Road Research Institute (CRRI) and NIRD&PR are some of the research institutes involved in R&D under PMGSY. Further, multilateral organizations like ILO and World Bank have also contributed technical inputs by way of robust research studies and evaluations of PMGSY. However, the analysis of expenditure incurred on R&D works from funds made available to the National Rural Infrastructure Development Agency revealed that there has been a significant fall in the expenditure incurred between FY 2016-17 and FY 2018-19, with only a slight recovery in FY 2019-20. This reveal discouraging trends in terms of fund utilization for R&D efforts.

There is a provision of Innovation Fund within DAY-NRLM (apart from the fund allocated to NIRD&PR) which is 5 percent of scheme allocated budget and also contributes to research and development. However, it is difficult to measure the effectiveness of the Innovation Fund given that no data on its usage or the outcomes achieved through this fund are available on the MIS portal. NIRD&PR works dedicatedly on research & development in this scheme whereby it focuses on strengthening the implementation of NRLM through capacity building of SRLMs, developing appropriate resource material for capacity building of CBOs and SRLM staff, conducting induction and various thematic training to different categories of Resource Persons of SRLMs, SIRD staff & CBAs, organizing various workshops such as Vision building, Leadership development, Management, Annual Action plan preparation and write shops and documenting the various Best Practices that emerge in SRLMs.

Box 6: Best Practice – Rural Development

Sanitary Napkin Unit run by SHG members of West Bengal State Rural Livelihood Mission

Introduction:

The story of Kesabchak Srijani Sangh (KSS), Tarakeswar, West Bengal, is that of a handful of young ordinary women with extraordinary dreams and determination to make it a big. Back in 2005, seven women from Kesabchak village in rural Bengal came forward to form a group to work for the cause of menstrual hygiene for women. They decided to manufacture low cost sanitary napkins and to distribute them in rural Bengal.

Background:

Sanitary napkin is an essential product for health and hygiene of adolescent girls and women. It is an alternative to unhygienic cloth pieces used traditionally during menstruation. Yet, napkin has low penetration in India due to its high cost. According to a recent National Family Health Survey, NFHS 2015-16, about 58% of total menstruating women use hygienic (single use) means to tackle menstruation. This figure varies between 78% in urban and 48% in rural areas

It was in 2005 that Keshabchak Gram Panchayat had started forming SHGs with local women. In 2008, eight VOs and twenty-two SHGs were formed. A small group was formed with the ambition to make and supply sanitary napkins in the locality at a cheap price. They received support from the Block and the Gram Panchayat. In 2009, Kesabchak Srijani Sangha (CLF) purchased 3.5 katha land in Kulteghori village of Tarakeswar block at a price of Rs. 3.55 Lac. They borrowed money from the newly formed SHG groups and also utilized some of their own funds to purchase land for Napkin Making Unit. Next year in 2010, they built a two storied building on 1.75 katha land at a cost of Rs. 27 Lac.

Details of the Intervention:

For manufacture of sanitary napkin, KSS, Hooghly, needs to get approval from the Department of Health and Family Welfare, Government of West Bengal. The validity of the approval is for one year and needs a renewal every year. Apart from KSS, the Health Department gave approval to four other agencies. All these units need to depend on the state and district hospitals to get orders. Demand of sanitary napkins depends on number of patients in the hospital. With fixed number of hospital beds there is fierce competition amongst the suppliers. KSS perceives this risk of being dependent only on government hospitals. Hence, to mitigate this risk they intend to enter into open market to cater local domestic customers also. Another segment that KSS is targeting is the government and aided schools where napkin vending machines are installed for dispensing napkins. KSS also intend to supply napkins for this machine.

Impact:

Currently, with the support of West Bengal State Rural Livelihood Mission, KSS has become a CLF Cooperative with 50 women involved in making of sanitary napkins. Apart from napkin making they also provide education, training, and technical assistance to existing and start-up enterprises. It is now a business owned by its members, controlled democratically by its members, and operated for benefit of its members. Further, The Napkin Making Unit has annual revenue of Rs. 44 Lac, and Cost of Goods Sold (COGS) of Rs. 37.6 Lac. This gives a Gross Profit of Rs. 6.4 Lac. The Selling, General and Administrative (SGA) expenses is Rs. 2.25 Lac, and Depreciation is Rs. 34,533. This gives the Operating Profit of Rs. 3.8 Lac. All members believe in ethical values of honesty, openness, social responsibility, and caring for others. They are one of the five enterprises in West Bengal that have been given government license to manufacture sanitary napkins. They supply napkins to major government run state and some district hospitals.

Ministry of Rural Development has been giving R&D its due importance and most of the schemes of the Ministry not only have R&D component but also have dedicated fund allocated as a part of the scheme.

The scheme-wise summary of R&D for this sector is provided in Table A5 in the annexure.

3.6 HEALTH

Research and development activities in the health sector are of very high value to the society[5]. The health care systems around the world have witnessed rapid technological advances. Decades of medical research have led to increased longevity of human race, improved diagnosis, and treatments etc. However, research outputs are closely linked to expenditure on research. Numerous research highlights that India's expenditure on its health research is low and as per a study conducted by Ray et. al. in 2016, only 25 (4.3%) of 579 medical institutions and hospitals that were evaluated produced more than 100 papers in a year. Further, the study also highlighted that 57.3% of medical colleges did not have even a single publication in a decade.[6]

The Ministry of Health and Family Welfare (MoHFW) and Ministry of AYUSH have been implementing several Centrally Sponsored Schemes across states for improving the health service delivery and outcomes in the country. The National Rural Health Mission and National Urban Health Mission and Tertiary Care Programs are implemented by MoHFW. The policy research and development needs under these schemes are catered to by National and State Health Systems Resource Centres. In addition to this, MoHFW has various autonomous bodies[7] that cater to the research needs in the sector as well as across schemes. The overall budget allocated to these autonomous bodies[8] in FY 2021-22 is INR 10,924.11 Crore. The Ministry of AYUSH implements National AYUSH Mission. The Ministry undertakes research and development activities in Ayurvedic Sciences, Homeopathy, Unani Medicine etc. through its autonomous bodies such as Central Council for Research in Ayurvedic Sciences (CCRAS), Central

5 https://www.ncbi.nlm.nih.gov/books/NBK9571/

6 https://www.djo.org.in/articles/28/2/Medical-Research-in-India.html#3

7 Includes - Indian Council for Medical Research (ICMR), Bhopal Memorial Hospital and Research Centre, All India Institute of Medical Science (AIIMS), Post Graduate Institute of Medical Education and Research, Jawaharlal Institute of Post Graduate Medical Education and Research, National Institute of Mental Health and Neuro-Sciences, North Eastern Indira Gandhi Regional Institute of Health and Medical Sciences, Regional Institue of Medical Sciences, Regional Institute of Paramedical and Nursing Sciences, Lokpriya Gopinath Bordoloi Regional Institute of Mental Health and other autonomous bodies.

8 Includes autonomous bodies under Department of Health and Family Welfare and Department of Health Research.

Council for Research in Homeopathy (CCRH) and Central Council for Research in Unani Medicine (CCRUM) . The total budget allocated to these bodies for FY- 2021-22 is INR 1918.69 Crore.

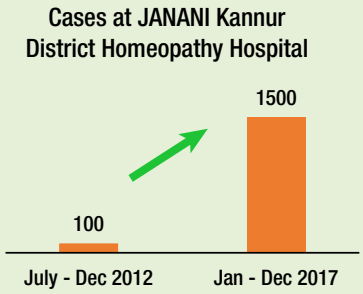
Based on analysis of budget for both MoHFW and Ministry of AYUSH, it is observed that the fund allocated towards research and development in the health sector has been increasing over the years. However, none of these schemes have a dedicated R&D component or fund allocated for such activities.

Box 7: Best Practice – Health

Innovative AYUSH Practices in Kerala- JANANI

JANANI is an initiative of the Department of Homeopathy, Government of Kerala that was launched in Kannur in 2102. The initiative employs homeopathy treatments for the infertility in public health facilities. Cases like repeated abortions, polycystic ovary disease, endometriosis, fibroids and related problems which are known to be some of the reasons for female infertility are tackled under JANANI.

Implementation of the practice:



The government implemented this project as a pilot study in the homeopathy department using plan funds. An infertility centre was set up in Kannur District hospital wherein the treatment was free of cost including the medicines under the district panchayat fund. After the pilot in 2012 by 2013, the department introduced infertility treatment centres at Thiruvananthapuram and Kozhikode as well.

Results of the practice:

Over time, there has been an exponential growth in the number of infertility cases being registered and treated at Kannaur district Homeopathy hospital. As per the Economic Survey 2018-19, the cases have increased to approximately 1500 in 2017.

JANANI has been extremely beneficial for those who were unable to conceive even after undergoing 10-15 years of treatment like IVF (In Vitro Fertilisation), ICSI (Intra-Cytoplasmic Sperm Injection) (EY Primary Analysis: KIIs, 2019).

The JANANI scheme of Government of Kerala has spread awareness about the availability of Homeopathy treatment for infertility in public health facilities. The total number of conceptions after homeopathic intervention through JANANI project till March 2019 is 1655of which 966 were reported as successful deliveries (EY Primary Analysis: KIIs, 2019).

Lessons learnt:

- With the success of pilot project, expansion strategies for scaling up and increasing the reach with the creation of a greater number of centres were effective.
- The involvement of district panchayat through the funding of medicines and community outreach was successful.
- IEC activities like medical camps, awareness classes and district specific initiatives were also useful. For example, a family meet of beneficiaries is conducted in Kozhikode.

Under the Health sector, in case of policy research and development of frameworks and guidelines, the National Health Systems Resource Centre (NHSRC) acts as the apex institution for technical assistance and evidence-based policy/strategy development and the State Health Systems Resource Centre (SHSRC) provides additional technical support to the State's Department of Health and Family Welfare. Further, the National Institute of Health and Family Welfare (NIHFW) acts as an 'apex technical institute' as well as a 'think tank' for the promotion of health and family welfare programs in the country. In addition, the Ministry of AYUSH also supports research and development in accredited AYUSH Centres of Excellence in non-governmental sector, private sector engaged in AYUSH education, drug development and research, clinical research and folk medicine.

The scheme-wise summary of R&D for this sector is provided in Table A6 in the annexure.

3.7 JOBS AND SKILLS

The increasing demand for competitiveness across the globe, skill development has gained importance. Skill development specifically has an impact on two major challenges- unemployment and poverty, faced by most developing nations. With higher economic growth, the demand for skilled workforce increases, however, in India, the higher economic growth could not translate into employment and resulted in jobless economic growth. In addition, the economy also faces a serious issue which is mismatch of job requirement and skillsets of job seekers[9].

These issues highlighted above point towards the pressing need for R&D activities to be undertaken in both jobs and skilling sectors to understand the requirements of the market and to develop courses/ trainings that are aligned to the market needs.

The schemes implemented by Ministry of Labour and Employment do not have an R&D component or specific fund allocation for R&D as a part of the scheme. The research needs within the sector are catered to by various autonomous institutes - V.V. Giri National Labour Institute (VVGNLI), National Institute for Career Service (NICS), Central Labour Institute, Mumbai, and Regional Labour Institutes (Chennai, Kolkata, Kanpur, Faridabad and Shillong).

Further, the Pradhan Mantri Kaushal Vikas Yojana (PMKVY) scheme, implemented by the Ministry of Skill Development and Entrepreneurship (MSDE), does not have a R&D component or specific R&D budget as well. It is pertinent that a specific budget for R&D is imperative for driving scheme efficiency and conducting predictive data analytics and hence ensure that desired outcomes are achieved. However, to foster R&D and improve PMKVY scheme via data analytics and impact evaluations, the National Skill Development Corporation (NSDC) possesses a research wing. In addition to NSDC, the Sector Skill Councils (SSC) and National Skill Development Agency (NSDA) are also facilitating R&D activities.

Box 8: Best Practices – Jobs and Skills

Andhra Pradesh State Skill Development Corporation

Introduction: AP has structured an entity on a PPP mode along with NSDC and private partners to initiate and oversee skill development initiatives Andhra Pradesh State Skill Development Corp (APSSDC). The state has launched various initiatives for enhancing private sector participation in skill development, and was awarded the Best State in Skill Development' in 2017 and 2018 by ASSOCHAM.

9 https://www.researchgate.net/publication/332565015_Skill_Development_Research_in_India_a_Systematic_Literature_Review_and_Future_Research_Agenda

Initiatives: An overview of various initiatives being undertaken by APSSDC is provided below:

- APSSDC in collaboration with Dassault Systems has set up a virtual learning 3D-Experience Center on Hub and Spoke model in various universities and around 53 Engineering Colleges are set to train students in Design, Manufacturing and Analysis in the domains of Aerospace and Automotive with a target to train 1 lakh candidates in three years.
- APSSDC has partnered with SIEMENS to set up state of the art training centre to impart industry relevant skills to 1 lakh students per annum
- APSSDC is working closely with the various industries such as KIA Motors, Ashok Leyland, Asian paints, Apollo Tyres etc. to understand their manpower requirements and assist them by providing with the training and recruitment avenues.
- Skill trainings on Employability Skill Enhancement Module have been initiated aiming at beneficiaries of Mukhya Mantri Yuvanestham, a flagship program of Govt. of AP providing unemployed youth allowance.
- Other initiatives include investments for a model skill development training facility by HCL technologies, setting up of model skill development centers within existing ITIs for short term courses by Hitachi and Johnson Controls, skill training centers by GMR group.
- APSSDC has a presence in more than 1,250 institutions which includes 425 (Tribal Welfare & Social Welfare) schools with coverage of 1.88 lakh students, 525 degree colleges with coverage of 3.56 lakh students and 300 engineering colleges with coverage of 2 lakh students.
- APSSDC offers Soft skills & English and IT & Computational thinking programs to school students and industry relevant courses for degree students in partnership with industry e.g. Tally, Zoho, Amazon Web services, NSE Academy, INSTAEMI, Coursera etc. and courses with Google, Udacity, Amazon, Coursera, Udemy, Adobe, Autodesk etc. for engineering students to enhance employability

Outcomes/Impact:

- AP ranked as one among the top 5 states with Highest Employability quotient and amongst Top 10 where maximum hiring takes place as per Skill India report 2020.
- International collaboration undertaken with Stanford, North Eastern Universities, IUCEE
- Highest number of students selected as University Innovation Fellows (UIF) by Stanford University
- Impactful programs for Faculty Improvement, Digital literacy, financial literacy etc
- First Google code lab in the country and has largest certified Google coders.
- APSSDC helped Kia Motors in conceptualizing Basic Technical Course (BTC), assisted Johnson Controls - Hitachi India in setting up 5 Model Skill Development Centres in ITIs, established 6 Centres of Excellence and 34 Technical Skill Development Institutes in collaboration with Siemens, set-up 53 virtual learning 3D experience centre on hub-and-spoke model.

Under another scheme of MSDE i.e. Skills Acquisition and Knowledge Awareness for Livelihood (SANKALP), a National Skills Research Division within the NSDA is proposed to be formed. This Research Division shall act as catalyst and an independent think tank to analyse labour market trends, undertake impact evaluation of skill development programmes and provide policy inputs to all related bodies in skill development.

The scheme-wise summary of R&D for this sector is provided in Table A7 in the annexure.

3.8 WATER RESOURCES, ENVIRONMENT AND FORESTS

Water resources are critical national assets and are important for sustaining life, food security, ecological balance etc. With increasing population, rapid urbanization, industrial development and inefficient agricultural practices, the demand for freshwater has increased manifolds. Further, spatial variance in water availability and water pollution are major causes of concern. India is currently classified as water-stressed based on the Falkenmark Water Stress Indicator[10]. Therefore, to mitigate these challenges in equitable and sustainable manner, the need for research and development in this sector cannot be understated. The Department of Water Resources, River Development and Ganga Rejuvenation of Ministry of Jal Shakti implements various scheme under the umbrella of Pradhan Mantri Krishi Sinchai Yojna. None of the schemes implemented by the department have earmarked fund for R&D as a part of the schemes. However, the department has a Central Sector Scheme- Research and Development and Implementation of National Water Mission under which research activities are conducted through 4 premier institutes viz Central Water and Power Research Station – Pune, Central Soil and Material Research Station – New Delhi, National Institute of Hydrology – Roorkee and Central Water Commission – Delhi. Further, regional institutes like NERIWALM, Assam and WALMI, Aurangabad have also been involved in R&D activities for this sector. The total fund allocated for the Central Sector Scheme- Research and Development and Implementation of National Water Mission in FY 2021-22 is 29.50 Crore. The budget allocation for this scheme has dropped by 41% from the previous year.

Lately, the importance of environment and need for its conservation has been recognized across the globe. An important step in this direction was the National Environment Policy (2006) which emphasized on the need to identify emerging concerns arising from better scientific understanding, socio- economic development and development of multilateral environmental regimes. A dominant theme of the policy is that while conservation of environmental resources is necessary to secure livelihoods and well-being of all, the most secure basis for conservation is to ensure that people dependent on resources, obtain better livelihoods from the fact of conservation, than from degradation of the resource. The Ministry of Environment, Forests and Climate Change (MoEFCC) in its efforts to responding to the challenges related to forests, wildlife, pollution, and climate change, has launched 3 Centrally Sponsored Schemes- National Mission for a Green India, Integrated Development of Wildlife Habitats and Conservation of Ecosystems. All the three schemes have a dedicated fund for R&D earmarked as a part of the scheme guidelines. These R&D activities are carried out by organizations like- Wildlife Institute of India, National Centre for Biological Sciences, Forest Survey of India, Environmental Planning & Coordination Organisation (EPCO), Botanical Survey of India, Ashoka trust and Worldwide Fund for Nature (WWF) etc. In addition to this, MoEFCC also has various autonomous bodies which undertake research activities in the sector. The total budget allocated for these autonomous bodies in FY 2021-22 is INR 305.50 Crore.

10 Reassessment of water availability in basins using space inputs, Central Water Commission, June 2019

With regard to the Flood Management and Border Areas Programme (FMBAP), in order to deal with the specific hydrological problems of different regions of the country, a number of training, research and development institutes are in place such as the Centre of Flood Management Studies, National Institute of Hydrology, Roorkee, All India Disaster Mitigation Institute, Ahmedabad, National Institute of Disaster Management, and Indian Institute of Remote Sensing.

Further, the Central Water Commission (CWC) has a dedicated research and design wing which primarily guides and supports in planning, feasibility studies, standardization and designs of river valley projects in the country, safety aspects of major and medium dams, hydrological studies for the projects and coordination of research activities, etc.

Box 9: Best Practices – Water Resources, Environment and Forests

Comparative Benefit-Cost analysis to evaluate most appropriate material for canal lining: Case Study of Neera Devdhar Canal

Problem statement: Water flowing in canals is prone to seepage and evaporation losses. Seepage losses are dependent on channel geometry while evaporation losses are proportional to area of free surface. Increased seepage losses in unlined canals may lead to rise in water table, resulting in waterlogging and soil salinity. This would reduce cultivable area and may further need installation of costly drainage systems.

Intervention:

- The benefits of canal lining and corresponding B-C ratio were evaluated in Neera Devdhar canal. The results obtained upon lining are as follows:

	HDPE + Concrete	HDPE + Shotcrete	IITD + Concrete	IITD + Shotcrete
B/C Ratio	10.43	7.33	9.59	6.88

- Seepage losses were found to reduce by 70% upon lining with concrete while they reduced by 90% when lined with shotcrete. However, these materials would also require continuous maintenance due to expansion and contraction of cracks.
- The study concluded HDPE sheets as best option for lining to aid in reducing seepage losses from lining cracks. Subsidies are also provided by the government to use these sheets for lining.
- Concrete and shotcrete may be used as covering, towards protecting HDPE from damages.
- Further, sensor system (Radar/ bubbler) may be used to evaluate discharge at different sections of canal. This could aid in locating section-wise seepage losses.

Impact: With the help of HDPE sheets and sensor system, seepage losses in canal may reduce up to 100%. This would lead to increase in command area, reduce requirement for maintenance and increase channel capacity.

Box 10: Best Practices – Water Resources, Environment and Forests

Automating the Irrigation Census – ensuring data reliability

Problem Statement: Minor Irrigation schemes in India are large in number and the data generated at field level are collected through manual canvassing of paper schedules. As a result, inadvertent delays and errors are experienced during validation and tabulation of data. On account of the massive importance of MI census data in terms of its applicability by various important government agencies like MoWR, CWC, CGWB, Water Resources Departments at State level for framing policies pertaining to appropriate usage of groundwater and rejuvenation of the sources, a need for having web-based application for accuracy and quick processing of data was felt by the MI Stat wing, MoWR. It was understood that adoption of the system may led to certain advantages like elimination of duplicate entries, timeliness, need based generation of tabulated data and archiving of historical data.

Intervention: National Informatics Centre (NIC) was requested to develop a software, meeting the above-mentioned requirements. The work was adequately taken up by all States and extended to the districts, wherein adequate manpower was appointed for data entry. In the 5th MI census, a web-based software was created for the first time wherein, three different schedules for data entry namely, village schedule, ground water schedule and surface water schedule were introduced. For the 6th MI census and 1st Census of Water Bodies, five schedules viz., village schedule, ground water schedule, surface water schedule, urban schedule and the water body schedule, were incorporated for web-based data entry. The reliability of the data was checked through sample checks by the supervisors. In order to ensure data accuracy, timely tabulation of data and analysis, a software was developed with the following features:

- User friendliness
- Data verification ability
- Modules for data tabulation
- Data dissemination through websites
- Inbuilt models for identifying trends like pattern
- Decision Support System with Query Module

The overall objective of the project was to gather correct data. The databases collected from all States/ UTs have been merged for making a National level database and several reports have been generated. The application has been divided into three modules based on their functionality i.e. Data Entry Module, Abstract Creation and Decision Support System (DSS). The objective of Data Entry Module is to gather the validated base/enumerated data. Abstract Creation Module will process these data (base/enumerated data) for generating a database that will be used by Decision Support System. DSS Module will generate all types of reports, queries and provide useful information.

Impact: Some of the major impacts noticed due to wide application of the web-based software are as follows:

- Efficient planning and decision making for development of Water Resources through consistent and consolidated information.
- Empowerment of end users to perform in-depth analysis
- Prediction of irrigation potential utilization and segmentation of areas through Online Analytical Processing (OLAP) models.

Replicability: The application documentation can be shared with other sectoral departments. Currently the scope of Irrigation Census is limited to Minor Irrigation only. The modules can be made applicable for medium and micro-irrigation schemes as well. Such an approach will bring majority of the irrigation schemes and their data under single accessibility. This will facilitate coverage of broader issues pertaining to irrigation and will help the policy makers in framing better schemes or revising components of the existing schemes as well.

Sustainability: Such a system can definitely be sustained by enabling strong data archives and archives of the analyses. Introduction of newer modules, software and update of the application on regular basis will ensure easier use of the application. Better analysis through application of Machine Learning techniques will also help the researchers towards analysis of village specific irrigation issues in a detailed manner.

States which have been implementing the FPM scheme have built collaborations with Forest Survey of India for fire alerts and recording forest fire incidents. Likewise, the World Bank has been engaged under the Green India Mission (GIM) sub-scheme to conduct 'Ecosystem Services Improvement Project' in selected landscapes of Chhattisgarh and Madhya Pradesh states to enhance the outcomes of the GIM. The goal of the project was to improve forest quality and productivity along with reforestation, arresting land degradation, capacity building and enhancing NTFP trade to improve the livelihoods of forest dependent communities in Central Indian Highlands. Similarly, Forest Protection (FPD) division has developed the National Action Plan on Forest through collaboration with the World Bank and consultations with major stakeholders such as the State Forest Departments and National Disaster Management Authority.

With respect to the Integrated Development of Wildlife Habitats' (IDWH), research and development is predominantly carried out by organisations such as: Wildlife Institute of India, National Centre for Biological Sciences, Indian Institute of Forest Management, Forest Survey of India (for forest cover mapping).

Further, it was observed during interviews undertaken during UCSS evaluations that most of the state-level stakeholders were undertaking research projects under the schemes with WII and other local research institutions with regards to the local populations of various species and their characteristics. For example, in Andhra Pradesh, it may be noted that there was active interest in undertaking research projects to study animal behaviour, bird migration and other innovative measures through partnerships with Bombay Natural History Society and Sálim Ali Centre for Ornithology and Natural History. In Kerala as well, there were ongoing research projects with PhD students and local research institutes, in addition to the research done by Kerala Forest Research Institute. In Madhya Pradesh and Maharashtra, research projects were underway with WWF and WCT.

3.9 SOCIAL INCLUSION, LAW AND ORDER AND JUSTICE DELIVERY

India struggled for long with exclusion and discrimination against the marginalized communities. Since Independence India has been making efforts to bring the marginalized groups at par with the rest of the society by empowering them. Social inclusion is integral for the vision of New India. With the larger vision of building and sustaining a new India, the focus is on ensuring that the benefits of India's demographic dividend do not leave out the marginalized and vulnerable, particularly persons belonging to SC, ST, and Minorities etc. The Government has taken numerous steps to reach out to the vulnerable groups, especially through the Centrally Sponsored Schemes (CSS). These include schemes of Ministry of Social Justice & Empowerment (MoSJE), Ministry of Tribal Affairs (MoTA), Ministry of Minority Affairs (MoMA), Ministry of Home Affairs (MHA), Ministry of Law and Justice (MoLJ).

MoSJE implements various scholarship and infrastructure schemes for the development of Scheduled Castes and Other Vulnerable Groups. In most of these scheme's R&D activities are undertaken by the Planning Division, which provides Grants to Scholars, Grants for Workshops/seminars, and grants for publication, to undertake any scheme level research and development. However, no dedicated fund has been allocated for R&D as a part of the scheme. The Ministry via its pre-matric and post-matric scholarship schemes provides grants to scholars, grants for workshops/seminars, and grants for publication, to undertake any scheme level R&D. Additionally, the National Institute of Social Defence (NISD), an autonomous body of MoSJE also undertakes research in the sector. In FY 2021-22, NISD has been allocated INR 21 Crore.

MoTA implements schemes focused on educational empowerment of Scheduled Tribes. The ministry also implements schemes for development of particularly vulnerable tribal groups. In addition to this, there are schemes[11] which are dedicated to support R&D activities under the Sector. In FY 2021-22, a total budget of INR 130 Crore has been allocated for these schemes.

The flagship CSS- Pradhan Mantri Jan Vikas Karyakram is implemented by MoMA to improve the socio-economic conditions of the minorities and reduce imbalances in the identified MCAs by providing basic amenities for improving the quality of life. However, the scheme undertakes creation of infrastructure, primarily in the sectors of education, health, and skill development and does not have any fund earmarked for R&D activities. The limited R&D activities in the sector are carried out by National Commission for Minorities.

Box 11: Best Practice – Social Inclusion, Law and Order and Justice Delivery

Best Practices

Box 11: Use of Web Portal and Mobile Application for Geotagging of Developmental Projects in Arunachal Pradesh

Introduction:

In order to create a common platform for data sharing and to ensure transparency and accountability, the state government of Arunachal Pradesh made it mandatory to monitor progress of all Centrally Sponsored Schemes (CSSs) and state schemes through satellite-based monitoring and geotagging of development projects. This initiative was undertaken for periodical assessment of stages of developmental projects.

11 Tribal Festival, Research, information and Mass Education sub-scheme under Vanbandhu Kalyan Yojana and Support to Tribal Research Institutes.

Intervention:

Geotagging is done before, during and after completion of projects, with photographic evidence, before funds are released under Pradhan Mantri Jan Vikas Karyakram (PMJVK). Arunachal Pradesh government has developed a monitoring application named, 'Arunachal Monitoring', which is used for geotagging and collecting photographic evidence. The data is collected and uploaded directly on the portal. Fifty per cent of the funds have been released for setting up of the app. For the release of the remaining 50 per cent funds, the districts have to submit photographic evidence of the projects by uploading them onto the portal. Later on at the time of sanctioning of funds, the state department verify the status of projects through the photographic evidence uploaded on the portal. Hence, the projects are digitally monitored by the district level committee and the evidences collected are used for sanctioning of funds by the state department. In order to ensure smooth implementation, the field officers were imparted training on procedures and report-generation mechanism. Also, field visits were undertaken for conducting practical training for geotagging of projects.

Impact:

The initiative helped in strengthening the database and promoted ease in sharing data between the Centre and state. The state departments could constantly monitor the progress of developmental projects using satellite imagery and geotagged coordinates of work sites.

State Tribal Research Institutes (TRI) under the Scheme for the development of Particularly Vulnerable Tribal Groups have been predominantly conducting various research projects. For instance, State TRIs such as Maharashtra TRI and Kerala TRI have undertaken research projects related to Particularly Vulnerable Tribal Groups (PVTGs). In addition, Maharashtra TRI along with Mumbai University conducted a research study on FRA related to PVTGs. Kerala TRI along with Tribal department of Kerala conducted a baseline survey of PVTGs.

The National Commission for Minorities conduct studies, research, and analysis on the issues relating to the socio-economic and educational development of minorities under the Pradhan Mantri Jan Vikas Karyakram scheme.

With respect to the Umbrella Scheme of Modernisation of Police Forces, Bureau of Police Research and Development (BPRD) has a significant role to play under smart policing in umbrella. BPRD is engaged with MHA in the formulation of document of minimum benchmark to be followed by States in undertaking procurement/acquisitions .It has also prepared a document on 'Standards for Modern Police Station Buildings' in India.

The National Crime Records Bureau (NCRB) which is responsible for implementing schemes like Crime and Criminal Tracking Network and Systems (CCTNS) and e-Courts has undertaken the documentation of successful practices like Compendium: CCTNS Good Practices and Success Stories.

The scheme-wise summary of R&D for this sector is provided in Table A8 in the annexure.

3.10 OVERVIEW OF R&D ACROSS THE SECTORS

Table 1 presents the gist of the UCSS evaluations done across the 9 sectors considered for this study. It can be seen that total 112 schemes analysed only 26 CSS had funds available for R&D and 41 schemes are associated with a primary research organisation for its R&D and implementation. In both absolute and percentage terms HRD has the highest number of schemes with funds for R&D. It is seen that for implementation of most of the schemes R&D is low on the priority.

Table 1: Overall Assessment of UCSS across 9 sectors

Package No.	Package/ Sector Name	Total No. of Schemes Evaluated	No. of Schemes with Funds available for R&D	No. of Schemes with Primary Research Organisation	No. of Schemes with Supporting Research Organisation	No. of Schemes with Primary and Supporting Research Organisation
1	Agriculture	28	4	9	8	5
2	WCD	12	4	3	3	1
3	HRD	8	6	2	7	2
4	Urban Transformation	5	4	1	3	
5	Rural Development	6	3	3	2	2
6	Health	5	1	3	2	2
7	Jobs and Skills	5	0	5	4	4
8	Water Resources, Environment and Forests	15	3	2	5	1
9	Social Justice	28	1	13	2	2
	Grand Total	**112**	**26**	**41**	**36**	**19**

Table 2 highlights the major issues and prescribed recommendations pertaining to specific schemes from the sectors undertaken in the study. This information has been collated from the UCSS evaluation reports.

Table 2: Sector-wise issues and recommendations for R&D

Sector/ Sub-sector	Issues and Recommendations
Agriculture (Agriculture and Farmer's Welfare)	**Main Issue:** Limited knowhow on tech products, technology, best agricultural practices **Rashtriya Krishi Vikas Yojana :** **Specific components under the Scheme to address the Issues:** Collaboration with ICAR, to fund agricultural research infrastructure, and for strengthening Krishi Vigyan Kendras (KVKs) **Component's Performance:** The scheme promotes R&D through collaboration with ICAR. However, data on number of research studies undertaken, or increase in R&D since scheme inception is not available. **Recommended Way Forward:** The Department/ State governments along with ICAR should seek to identify areas requiring research. **National Food Security Mission:** **Specific components under the Scheme to address the Issues:** Engaging with State Agriculture Universities (SAUs), and National and International research organizations for research themes **Component's Performance:** The performance of the component has been satisfactory. 4-5 projects have been sanctioned for research on increasing shelf-life of millets to Indian Institute of Millets Research (IIMR), Hyderabad. The improved practices for demonstrations in the scheme are also identified in consultation with SAU through their Regional Research Stations/KVKs located in the area. **Recommended Way Forward:** NFSM may take up research for seed treatment and prevent root-stock disease. More focus can be on developing disease and frost resistant crops.

Sector/ Sub-sector	Issues and Recommendations
Agriculture (Animal Husbandry)	**Main Issue:** Limited Technical Know-how **NLM :** **Specific components under the Scheme to address the Issues:** Strengthening of research for feed and fodder development **Component's Performance:** The Mission provides 5% budget for certain activities including research. However, no information on research activity conducted under NLM was obtained for the UCSS Evaluations. **Recommended Way Forward:** New know-how or adaptation of international best practices in feed and fodder can lead to improvement in productivity of animals **LHDC:** **Specific components under the Scheme to address the Issues:** Research and development under the scheme is encouraged to discover more effective vaccines, create more robust hospital infrastructure, and more user-friendly access to learning programmes. **Component's Performance -** The Department funds research programmes of ICAR National Institute of High Security Animal Diseases (NIHSAD) has contributed significantly by detecting many animal diseases of exotic origin and preventing them from entering our country, handling exotic/emerging animal diseases, providing rapid diagnosis and conducting basic and applied research on emerging animal pathogens. **Recommended Way Forward:** There needs to be more focus on this component for development of effective vaccines. **RGM:** **Specific components under the Scheme to address the Issues:** NA **Component's Performance -** The Department collaborates with ICARfor R&D and has been working on production, processing, preservation and utilization of quality semen from cattle and buffalo bulls of high genetic merit. Central Frozen Semen Production & Training Institute (CFSP&TI) also undertakes R&D, training, equipment testing, semen production, etc. **Recommended Way Forward:** There needs to be more focus on this component for development of effective vaccines.
Agriculture (Fisheries)	**Main Issue:** Weak linkages with R&D **IDMF**: **Specific components under the Scheme to address the Issues: Institutional Arrangement for Fisheries Sector** - To continue the Plan Activities of the Four Fisheries Institutes of the DADF **Component's Performance:** There are only few specialised institutions imparting education and training in fishing sector and most of these institutions lack quality trainers, infrastructure and environment for longterm skill-based training. **FADF:** **Specific components under the Scheme to address the Issues: Institutional Arrangement for Fisheries Sector** - Innovative projects/activities designed to enhance fish production/productivity/value **Component's Performance -** The scheme is fairly new hence component-wise progress is not available

Sector/ Sub-sector	Issues and Recommendations
Jobs and Skills	**PMRPY:** Periodic market studies for improving scheme outcomes and impact are recommended through collaborative efforts of social science and labour market research institutes and think tanks such as V.V. Giri National Labour Institute, NILERD and TISS. Baseline, mid-term and end-term evaluations should be undertaken for understanding the scheme impact. **NCS, NSC SC-ST:** Periodic research on the below aspects may further enhance the efficiency of the scheme: ◆ To inform for any changes/ updates required in the project components ◆ To enhance the capacity of the career counsellors, vocational guidance experts and other officers, in terms of new creating awareness and knowledge around upcoming job sectors, new occupations, upcoming job roles etc. **NCS DA:** The requirement is for a periodic review and market study, to be updated on the upcoming assistive technology and innovative mechanism and to enable larger participation and facilitation of services to PwD. Specific policy to monitor the periodic research and development needs to be in place and support of existing institutions, international collaboration and external third party research can be considered.
HRD	**RUSA:** 1. Fund Sufficiency: There is lack of flexibility in funding components under the scheme. The scheme currently has defined ratios for fund usage under various components for construction, maintenance, and equipment. In hilly areas and north eastern states, there are challenges due to higher costs of construction leading to shortage of funds to complete the activities. Increase flexibility for funding for faculty development, faculty recruitment, and R&D components and the funding should be linked to outputs 2. Only 20 institutes have been funded under R&D component of the scheme. There is a need to increase the coverage of the same. Also, there is a need for a stronger evaluation process and a strengthened dedicated committee/body to evaluate research proposals and enhance overall research productivity under the scheme, particularly in light of research component seeing a greater allocation of funds under RUSA 2.0.
WCD	**SAG:** Given the multi-sectoral nature of SAG interventions, the scheme should look to undertake research studies periodically. It should focus on expanding the pathways to facilitate learning better by creating linkages with the private sector and research institutions and foundations. **BBBP:** While the scheme guidelines do not provide any strategy for systematic learning or reflection, there is evidence of States sharing good practices adopted for cross-learning. BBBP website lists the innovations undertaken by various States and regions under the scheme, thereby strengthening pathways for the adoption of good practices on a country-wide basis. Going forward, BBBP should develop a comprehensive strategy for undertaking R&D efforts and cascading learnings through various channels.

Sector/ Sub-sector	Issues and Recommendations
WCD	**Working Women Hostel Scheme:** Dedicated research is required to understand the aspirations of women using the hostel and thereby develop plans for upgrading facilities and including components from other programmes and schemes. It is, however, important that formative or process evaluations are carried out before a period of five years to provide course correction measures. **PMMVY:** Given the nature of the scheme – one that vitally seeks to transform health-seeking behaviours through economic incentives and awareness creation activities – the potential for research is vast. Possibilities for cross-learning – from similar cash transfer initiatives in South Asia and the world – need to be explored. **Gender Budgeting, Research, Publication and Monitoring:** Moving forward, in-depth research needs to be undertaken both before launching a scheme or including it under gender budgeting as well as after its implementation, i.e. both ex-ante and ex-post analysis is required. In the absence of such research, scarce resources may be spent on activities that do not deliver the desired results, but also be unaware of this reality and persist with the mistake for longer than necessary. Gender audits of key government programmes such as Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) should be in the research agenda for Gender Budgeting.
Urban	**AMRUT** It is observed that the PMAY(U) Mission has setup a Technology sub-mission that focuses on introducing new technologies and innovative construction methods. The sub-mission has initiated a number of programs to encourage innovation. A similar initiative may be taken up in AMRUT Mission also. Some aspects that may be covered could be: ◆ Identifying and piloting of water conservation and water management technologies, ◆ Encouraging start-up ideas in the areas of water/waste-water treatment, sewage/ sludge treatment, etc. ◆ Further collaborate with research institutions in India and internationally. **PMAY (U):** Based on the interactions with different stakeholders it has been ascertained that, limited technical knowledge of the Government officials and at times low-cost selection procurement method hinders the adoption of alternative technologies. It has been highlighted by different stakeholders working in construction technology space that all the emerging technologies identified in India are getting implemented by private sector and to large extent by Government as well, however there are some areas which can further be explored such as; focusing on better construction project management methods and building monitoring methods by incorporating lean technologies, 'Digital Twin' in construction etc. As indicated by different key informants, land titling and urban land records are key areas of concern which should be explored to address the land challenges faced by individuals and Government. **NULM:** State-level officials during the consultations revealed that greater training on the ISP component is required

Sector/ Sub-sector	Issues and Recommendations
Health	**AYUSH:** There is a need to converge different disciplines in conducting the research based on a robust research protocol with focus on epistemological identities of AYUSH principles and practices. The utilization of AYUSH strengths in Public Health can be one of the priority areas for research Under R&D (central sector scheme), a separate component on research & development for integrated care pathway should be launched. Evidence based integrated care pathway would help AYUSH mainstream itself. The R&D component of central sector scheme should provide adequate fund to facilitate research on development and operationalization of Integrated Care Pathway involving AYUSH and modern medicine. Integrated care pathway would also help in reducing the manpower and infrastructure requirements for modern medicine. There is a need for more focus on the mainstreaming of AYUSH services to increase the first point of contact for AYUSH services. AYUSH should have a component under R&D (central sector scheme) for promoting integrated care pathway along with modern medicine.
Rural	**MGNREGS:** R&D efforts should focus on calibrating India's social safety net programmes to present circumstances: The objectives and design of India's safety net programs, whether food or cash based, need to evolve with economic growth and the changing nutritional needs of the marginalized populations. The future role of safety nets needs to be more transformational rather than vulnerability reducing. Overall effectiveness of safety nets would depend to a large extent on how they are combined with structural reforms and long-term interventions to increase human capabilities and address structural poverty through that. Synergies between agriculture and safety nets, therefore, become essential. Urbanization, especially, poses a challenge as well as opportunity in restructuring the safety net architecture. The future research and development themes should take into account the fact that India would be more urban than rural by 2050. **PMAY-G:** Additional research is needed to evaluate the current situation of houseless and people living in kuccha houses to review whether the objective of providing pucca houses to all can be fulfilled with the current target. **DAY-NRLM:** Overall, the R&D component within the scheme can be further strengthened by providing a separate fund for the same (within or outside innovation fund). Also, the utilization of such funds and the objectives achieved by them need to be presented in the public domain.
Social Inclusion	**Umbrella Scheme for Development of Scheduled Castes (SCs):** Schemes such as PMAGY, PoA and PCR Act and Pre-Matric Scholarship Scheme to Those Engaged in occupations Involving Cleaning and Health Hazards can be used to develop social researches on the SC community. **Pre-Matric Scholarship Scheme to the Children of those Engaged in Occupations involving Cleaning and prone to Health Hazards:** There is a need for push towards conducting socioeconomic research on manual scavengers, tanners, flayers& rag pickers. **Scheme for Assistance for Prevention of Alcoholism and Substance (Drugs) Abuse:** As pointed out in the evaluation report on RRTCs as well as during the KIIs with IRCAs there is a need to focus on research and development in the course and curriculum being used by the organizations to impart training to service providers (IRCA) as the content being used is outdated and needs improvement.

4. ISSUES AND CHALLENGES

4.1 LOW INVESTMENT IN R&D IN INDIA

Though expenditure in R&D is only one of the indicators that helps in gauging the levels of R&D in a country, it definitely speaks volumes about where R&D fits in any country's priority list and hence its approach to achieving its development goals. In this context, the current expenditure on R&D in India does seem incommensurate to its aspirations and its development agenda. The economic growth in India has been commendable but it is still is at a high risk of getting stuck in a middle-income trap due to the poor levels of research and innovation in the country. The meta-analysis of the sector and scheme evaluations corroborate the low rates of R&D in India. Of the total 111 schemes evaluated for 9 sectors only 26 have R&D funds allocated to them. India's GERD was around 0.7 per cent of its GDP in 2017-18 despite the increase in per capita R&D expenditure from PPP $ 29.2 in 2007-08 to PPP $ 47.2 in 2017-18. Table 3 presents a comprehensive list of countries in terms of their total R&D expenditure and per capita R&D. Developed countries like Switzerland, Singapore, Israel, Republic of Korea and Sweden top the list in terms of per capita expenditure on R&D. The BRICS countries are highlighted in the green cells. It can be seen that India ranks lowest in terms of per capita R&D expenditure even though the total R&D expenditure amount is more than all of the BRICS and other middle-income countries other than China.

Table 3: Comparison of R&D Expenditure across high-income and middle income countries

Category	Country	R&D Expenditure (billion current PPP $)	R&D Exp. as % of GDP	Per capita R&D (current PPP $)	Per capita GDP (current PPP $)
Top Countries in terms of per capita R&D	Switzerland	17.9	3.4	2152	66299.6
	Singapore	11.1	2.2	1965	96552.6
	Israel	15.4	4.5	1867	38867.8
	Republic of Korea	91	4.6	1780.5	38824.1
	Sweden	17.2	3.3	1736.7	51404.8
World		**2192.4**	**1.7**	**290.5**	**17117.2**
BRICS and other middle-income countries in descending order of per capita R&D	**China**	**499.1**	**2.1**	**351.2**	**16782.2**
	Russian Fed.	**41.9**	**1.1**	**287.7**	**25766.9**
	Brazil	**41.1**	**1.3**	**197.9**	**15662.2**
	South Africa	**6.1**	**0.8**	**108.5**	**13464.2**
	Mexico	11.3	0.5	91.3	19432.2
	Venezuela	1.8	0.3	61	12640.7
	India	**63.2**	**0.7**	**47.2**	**7169**
	Sri Lanka	0.3	0.1	12.9	12878.6
	Pakistan	2.6	0.2	12.4	5249.2
	Philippines	1.2	0.2	12	8340.3

Source: *UNESCO & World Bank website accessed March, 2020; India-R&D Statistics 2019-20, DST, GoI*

Figure 2 shows the linear relationship between per capita R&D and per capita GPD of 31 countries. It is clear that there is a positive relation between both these indicators with the correlation coefficient between them as high as 0.84. However, India lies at the bottom left of the chart and below the goodness of fit line indicating the low returns to existing R&D in terms of GDP growth. It is possible that one of the factors could be India's large population (population of the respective countries shown by the sizes of the bubbles). The R&D expenditure is clearly not commensurate to the population of the country. However, in comparison even though China's population size is comparable to India's, its per capita R&D expenditure is clearly much higher than India's and even higher than the world average of per capita R&D.

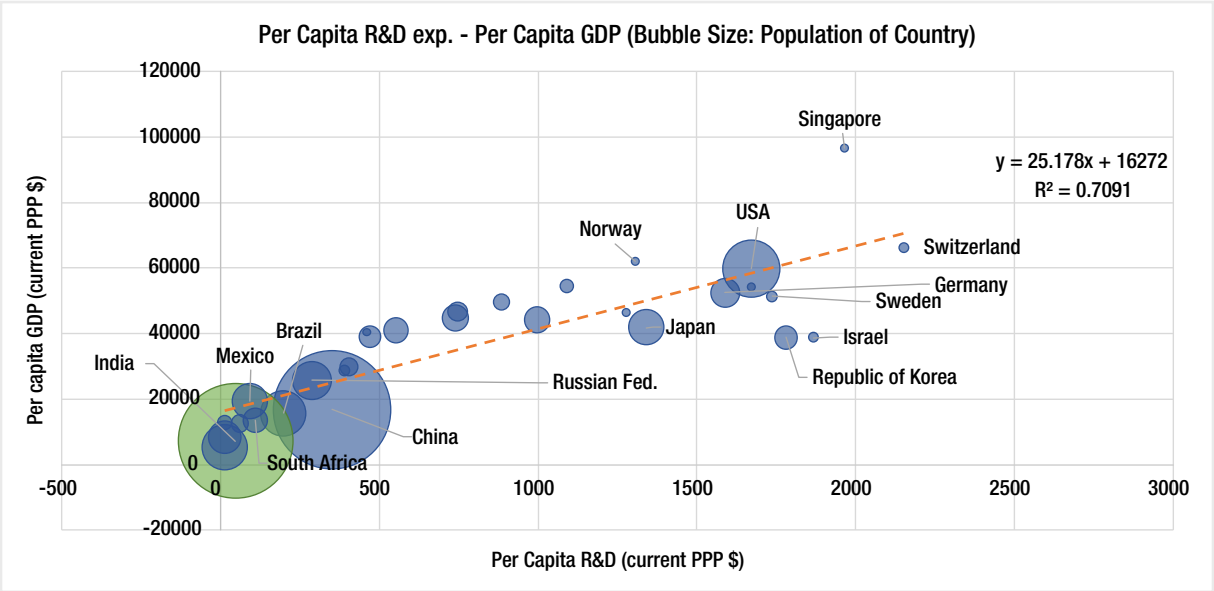


Figure 2: *Correlation between per capita R&D expenditure and per capita GDP across countries*

Source: *UNESCO & World Bank website accessed March, 2020; India-R&D Statistics 2019-20, DST, GoI*

4.2 LOW SHARE OF PRIVATE SECTOR IN R&D IN INDIA

One of the major factors deterrents to augmentation of R&D in India has been the lower contribution to R&D from the private sector. Figure 3 shows that since 2004-05 the investment in R&D in India has steadily increased from Rs 24,117 crore to Rs 1,23,848 crore (estimated amount) in 2018-19. Both the public and private investments in R&D have also risen but the CAGR of private investment in R&D from 2004-05 to 2018-19 was 14.4 per cent compared to 10.2 per cent for public investment. Nevertheless, the share of private investment still remains lower than public investment despite growing from 25 per cent to 37 per cent (estimated for 2018-19) of the total share of R&D in India over these years.

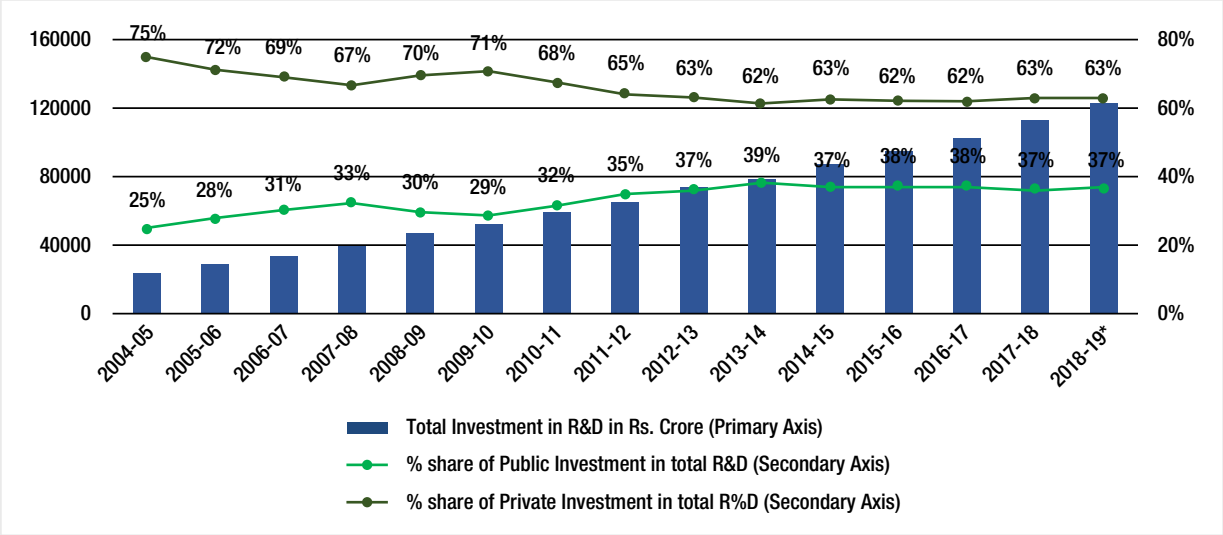


Figure 3: *Public and private expenditure in R&D in India over the years*

Source: *NSTMIS, DST, GoI*

The NSTMIS provides information on the public and private investments in R&D under institutional and industry categories (see Figure 4). It is seen that Industrial Sector spent Rs. 47,109.13 crore on R&D activities and accounted for 41.4% of total R&D expenditure during 2017-18. 78 per cent of the industry sector's investment in R&D amounting to Rs 36,873 crore was done by the private industry sector. 11 per cent of the industry sector investment in R&D was done by the PSUs in the industry sector and other remaining 11 per cent of the investment in R&D was done by the SIRO. Effectively, only 36.8 per cent of the investment in R&D is done by the business sector. Though majority of the SIROs are private organisations or institutions the disaggregation of SIROs across sector is available in the NSTMIS data.

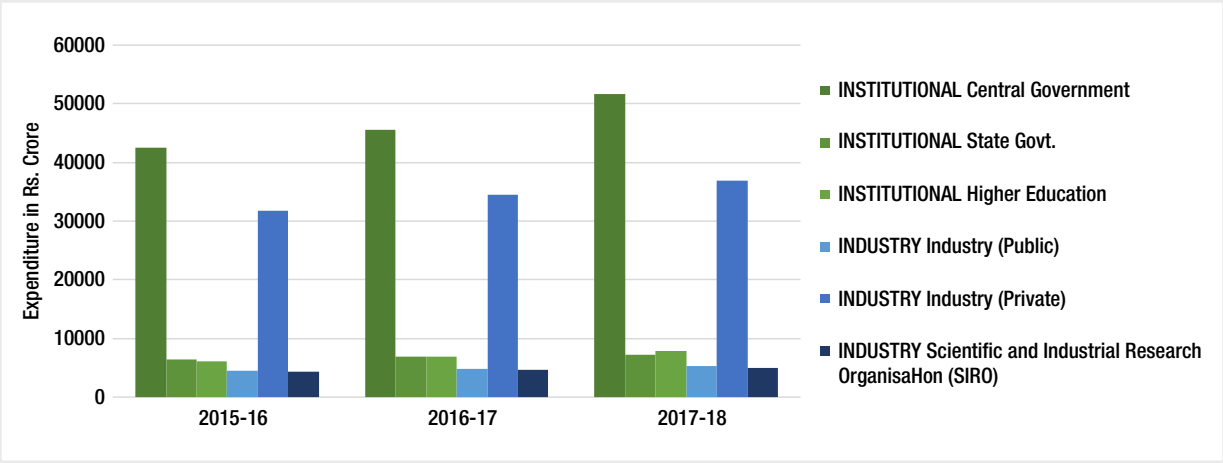


Figure 4: *Trends in Institutional and Industry R&D expenditure in India over the years*

Source: *NSTMIS, DST, GoI*

One of the key takeaways here is the nature of investment and expenditure incurred by the public sector industry is only one-seventh (roughly 14 per cent) of the private sector industry investment in R&D. In the later section there is a detailed analysis of the same in the context of R&D across the development themes.

4.3 LOW INVESTMENT IN R&D BY STATES

Besides the low investment by the private sector, India also faces the challenge of low investment by states in R&D. In 2017-18 the states' share towards R&D expenditure was only 6.4 per cent of the total expenditure. In addition to this it was found that around 88 per cent of the total investment in R&D activities was on development of agriculture and allied areas. It was found that most of the states as per the R&D statistics released by the DST fall below the national average of R&D expenditure for all the states. Only Andhra Pradesh, Assam, Gujarat, Haryana, Karnataka, Madhya Pradesh, Punjab, Tamil Nadu and Uttar Pradesh perform better than the state governments' average expenditure in R&D (see Figure 5)

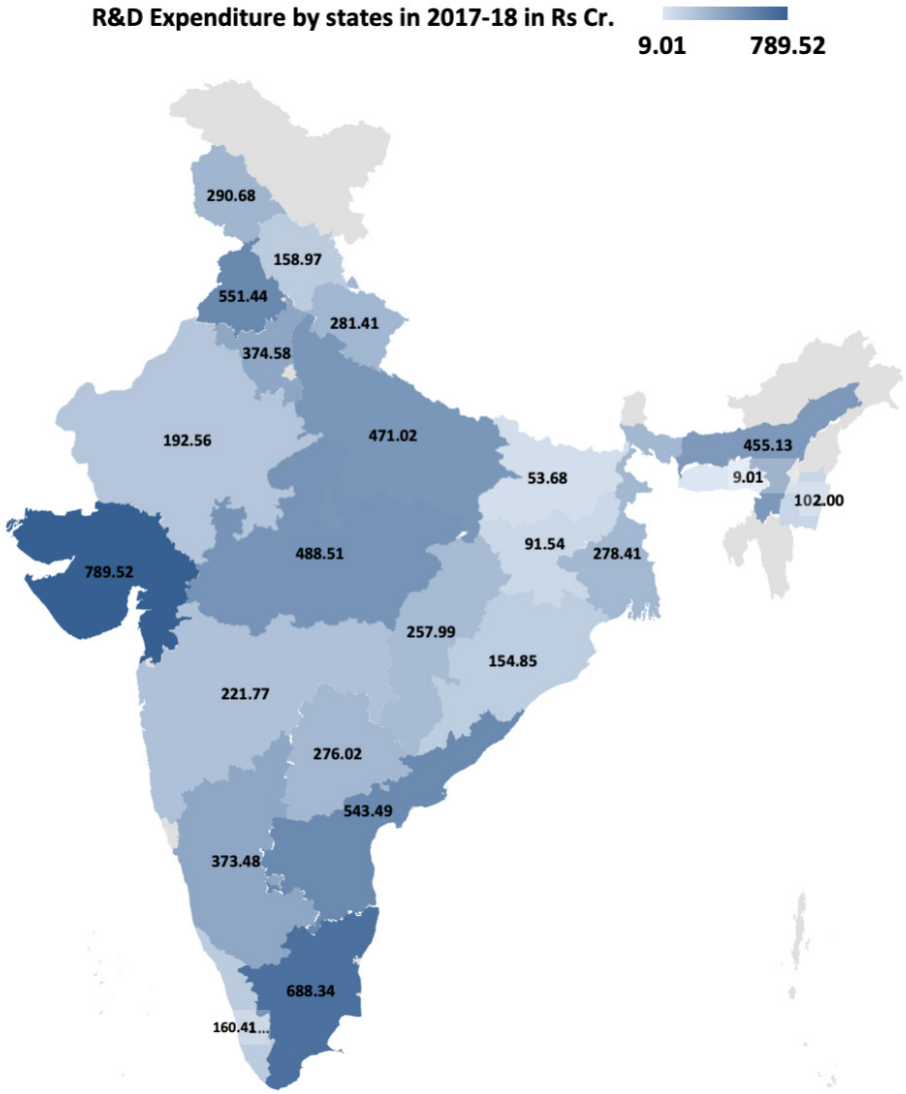


Figure 5: *Trends in R&D Expenditure by State Governments in India*

Source: *NSTMIS, DST, GoI*

It was also seen that out of the total 15,550 patents filed by at Indian Patent Office during 2017-18, 65% of them were filed from the States of Maharashtra, Karnataka, Tamil Nadu and Delhi. In addition to this, in the context of UCSS, it is evident that states' contribution to R&D has been limited mostly to sectors like agriculture, health and education. States' contribution has been the highest for agriculture through various state universities and state agricultural research centres.

4.4 DEARTH OF R&D INSTITUTIONS

Expenditure on R&D is not the only metric for measuring R&D. It is a necessary but not a sufficient metric to comprehend the institutional capacities of the state or industry as well as the outcomes and impact of R&D. To this end, an analysis of the number of R&D institutions and researchers in the country becomes a pertinent metric to expound on the non-financial resources for R&D.

The report on R&D statistics provides information on the number of R&D institutions in the India. It was reported that in 2018, out of a total of 6,862 R&D Institutions in India, 63 per cent of the R&D institutions were in the private sector industry followed by the state sector at 15 per cent, higher education sector at 10 per cent while other sectors which include central government sector and the public industry sector occupied a share of around 12 per cent. Figure 6 shows the growth of R&D institutions across the broad sectors. It can be seen that from 2010 to 2018 only the private sector industry and higher education sector have shown an increase. Private sector industry shows the highest growth at 10 per cent and higher education sector has had a growth of 3 per cent. Collectively, these two sectors contribute significantly to the overall growth of R&D institutions in India despite the central and state sectors R&D institutions have decreased from 2010 to 2018.

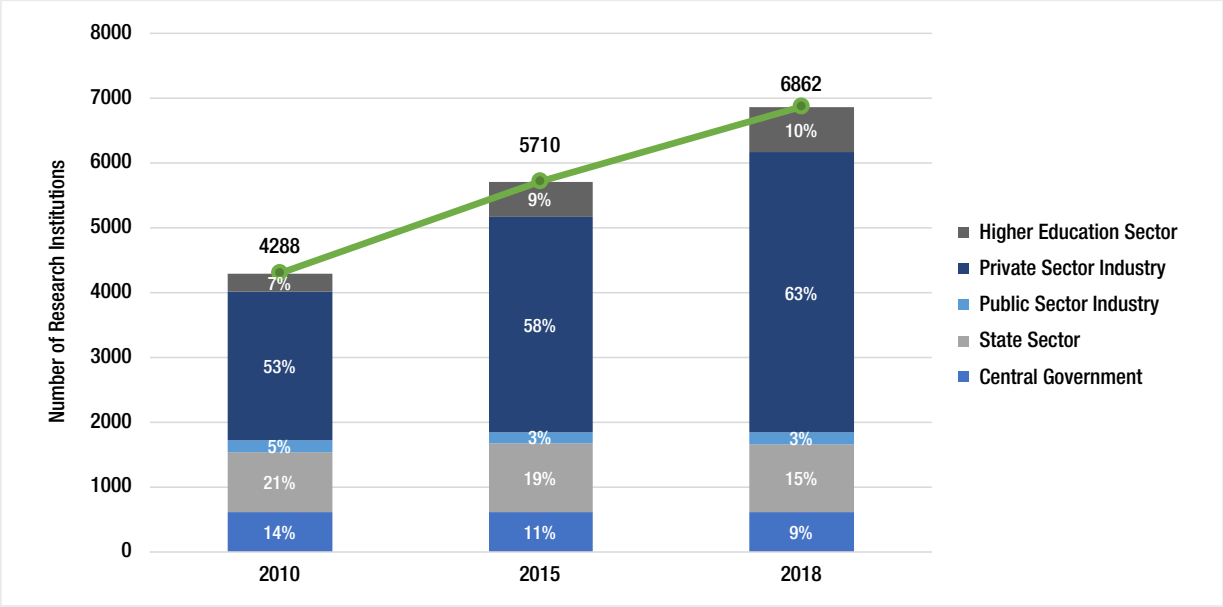


Figure 6: *Number of R&D Institutions across public and private sectors over the Years*

Source: *NSTMIS, DST, GoI*

An important takeaway on this front in the context of development themes/packages/sectors analysed in the previous section is the overall improvement of private R&D institutions across all the development themes. It is seen that for sectors/packages like agriculture and allied activities which is a state subject, the state level disaggregation of R&D investment is not available, thus, making it difficult to understand the state sectors contribution to this package. However, it is noticed that the for agricultural machinery sector which would be an integral p-art of agriculture and allied activities the public industry sector investment in 2017-18 was only Rs. 0.59 crore by two industrial units compared to investment in the same sector by the private sector industry at Rs 831.69 crore through 98 industrial units. Figure 7 provides a detailed account of the industry group wise investment by the private industry sector.

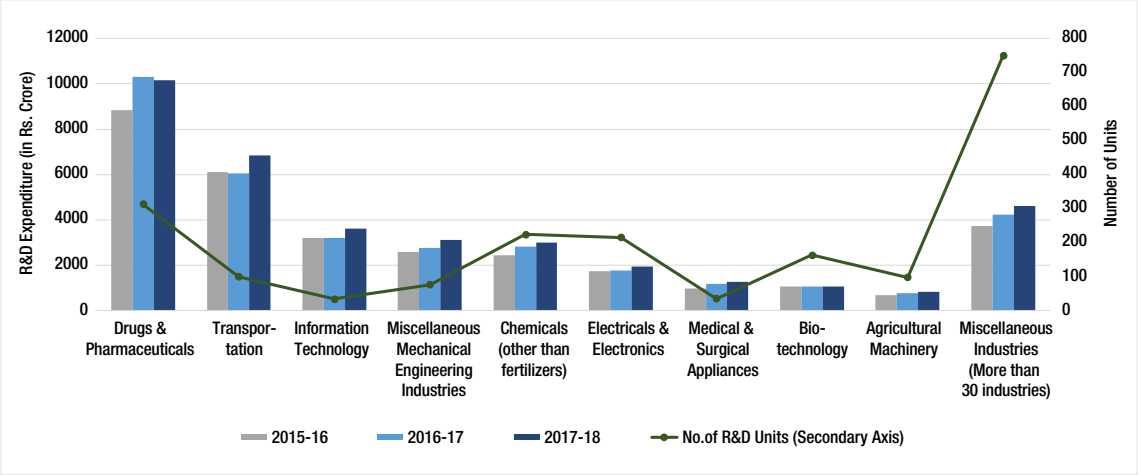


Figure 7: *Major Areas of R&D Expenditure by Private Industry Sector*

Source: *NSTMIS, DST, GoI*

It can be inferred from figure 7 that clearly private participation in India in terms of R&D is higher in the sectors which also happen to be core competency areas of its economy – pharmaceuticals, IT, chemicals and transportation. While agriculture and allied activities too is one of the competent sectors with relatively less industrial support, it can be seen that the innovations in term of technology pertaining to agricultural machinery (see figure 7) and fertilisers (in miscellaneous industries) are largely driven by the private industry sector compared to public industry sector. This is also partly due to the primary involvement of public industry sector in areas of strategic importance and larger public outcomes like energy, mining, defence and industrial machinery (see Figure 8). But this speaks volumes on private industry participation in different sectors since it is clear that the R&D contribution of private industry is higher in core industry and competent areas, and lags behind for other sectors where overall industry participation is low. Here also lies the lessons for the government to thrust overall industry participation in the non-competent areas which would have a signalling effect on the private industry sector to commit significantly to R&D in those areas.

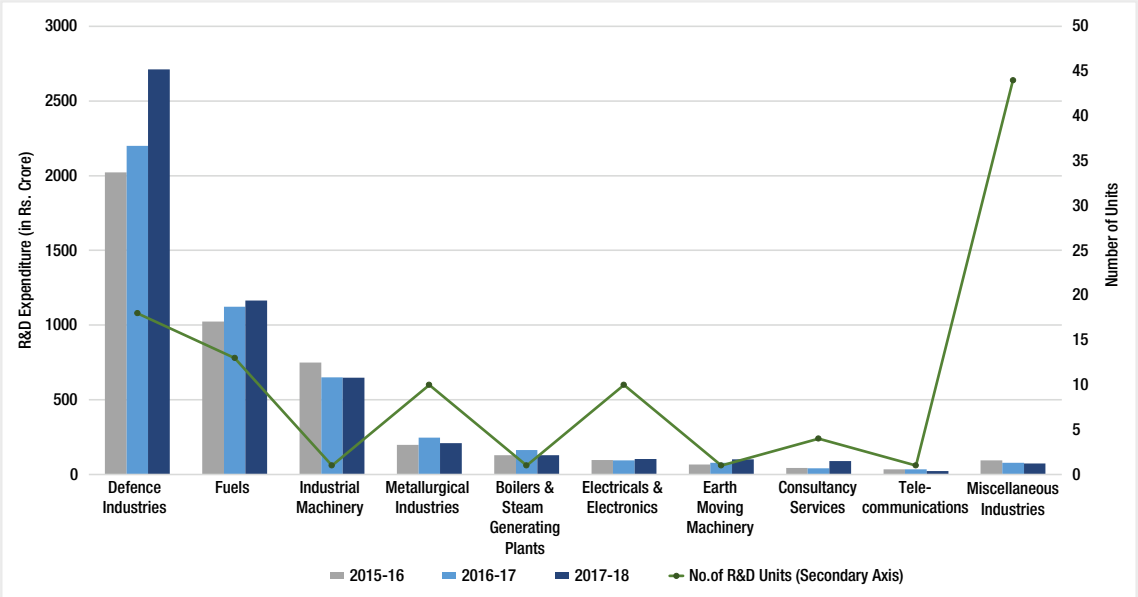


Figure 8: *Major Areas of R&D Expenditure by Public Industry Sector*

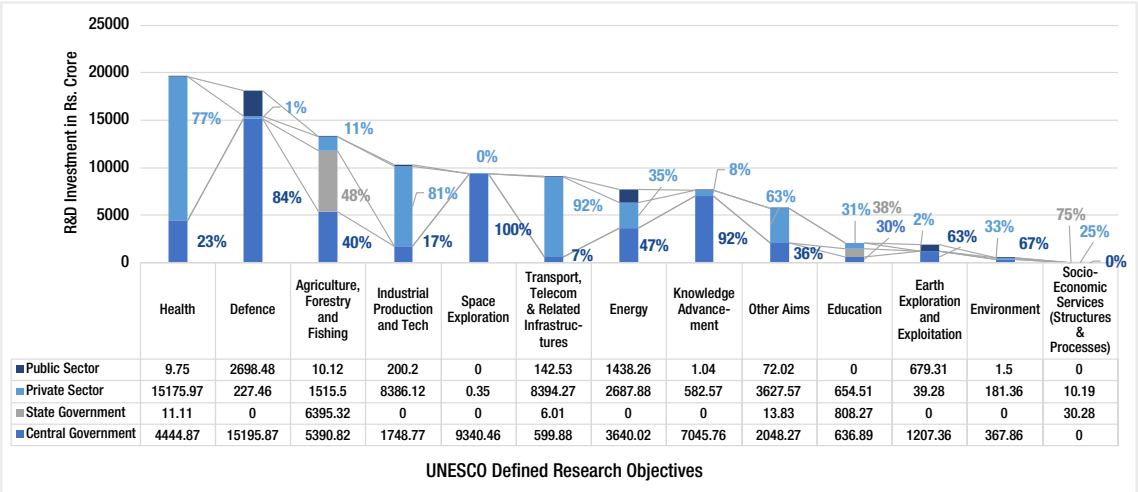
Source: *NSTMIS, DST, GoI*

4.5 SKEWED PRIORITISATION OF THEMATIC AREAS

In the current section we have gleaned on the trends in R&D investment across sectors through a detailed analysis of secondary data on R&D statistics. Though the secondary analysis has been informative, it has not necessarily been congruent to the context of the previous sections comprising review of R&D across the following sectors:

- Agriculture
- Women and Child Development
- Human Resource Development (Education)
- Urban Transformation
- Rural Development
- Health
- Jobs & Skills
- Water Resources, Environment and Forest
- Social Inclusion, Law and Order & Justice

However, given the piecemeal and siloed approach to development topics like R&D in India it becomes imperative to bring learnings from separate studies together for a more holistic understanding of the subject. To this end the information on investment in R&D across the broad socio-economic objectives can be utilised to bring different studies together for a more comprehensive trend analysis. For this purpose, the United Nations Educational, Scientific and Cultural Organization's (UNESCO) classification of socio-economic objectives for R&D has been used. The 13 broad socio-economic objectives classified by the UNESCO are – Defence; Development of Agriculture, Forestry and Fishing; Education; Energy; Environment; Exploration and Exploitation of Space; Exploration and Exploitation of the Earth; General Advancement of Knowledge; Health; Industrial Production and Technology; Political & Social Systems, Structures & Processes (including socio-economic services); Transport, Telecommunication and other Infrastructures and; Other Aims[12]. Figure 9 shows the R&D investment across these broad UNESCO defined socio-economic activities with the labels coloured according to the colour schema of the legends for public sector, private sector, state government and central government.



	Health	Defence	Agriculture, Forestry and Fishing	Industrial Production and Tech	Space Exploration	Transport, Telecom & Related Infrastructures	Energy	Knowledge Advancement	Other Aims	Education	Earth Exploration and Exploitation	Environment	Socio-Economic Services (Structures & Processes)
Public Sector	9.75	2698.48	10.12	200.2	0	142.53	1438.26	1.04	72.02	0	679.31	1.5	0
Private Sector	15175.97	227.46	1515.5	8386.12	0.35	8394.27	2687.88	582.57	3627.57	654.51	39.28	181.36	10.19
State Government	11.11	0	6395.32	0	0	6.01	0	0	13.83	808.27	0	0	30.28
Central Government	4444.87	15195.87	5390.82	1748.77	9340.46	599.88	3640.02	7045.76	2048.27	636.89	1207.36	367.86	0

Figure 9: *Assessment of R&D Expenditure across UNESCO defined Socio-economic Objectives for R&D*

Source: *NSTMIS, DST, GoI*

Note: *1. R&D expenditure on Higher Education Sector is not included, 2. Private Sector includes Scientific and Industrial Research Organisations (SIROs), 3. Objectives Standardised as per UNESCO Classification, 4. 0 represent `NIL'.*

12 "Other Aims" research objective of UNESCO includes – Culture, Recreation, Religion and Mass Media

It can be seen from the figure that health sector that includes the pharmaceuticals industry and medical and surgical appliances tops the list of R&D expenditure overall and also in terms of absolute investment by the private industry sector which stands at Rs 15,176 crore. It is followed by defence which has most amount of R&D investment in absolute terms by the government with 84 per cent contributed by the central government and another 15 per cent contributed by public industry sector. In percentage terms, it is seen that central government expenditure is 100 percent for space exploration followed by general advancement of knowledge at 92 per cent and defence at 84 per cent. Similarly in percentage terms private sector's investment is highest for transport and telecommunications at 92 per cent followed by industrial Production and technology at 81 per cent and health at 77 per cent, though in absolute financial terms the private sector's investment is highest for health socio-economic objective. State governments' contribution is the highest in absolute financial terms for agriculture, forestry and fishing which are state subjects, accounting for nearly 48 per cent of the total expenditure in the corresponding objective. However, it is evident that the R&D in social infrastructure like education and socio-economic services are less prioritised in India.

It is also evident that the expenditure borne by central government and/or public industry sector is abysmal in social infrastructure as compared to areas considered of strategic importance like space exploration, defence and general advancement of knowledge. The same can be inferred from figure 10 which provides a disaggregation of R&D expenditure by central government across major ministries, departments and programmes excluding its investment in major scientific agencies. This figure corroborates the assertions made regarding the prioritisation of defence, fuel, mining and metallurgy, engineering and other infrastructure related machinery.

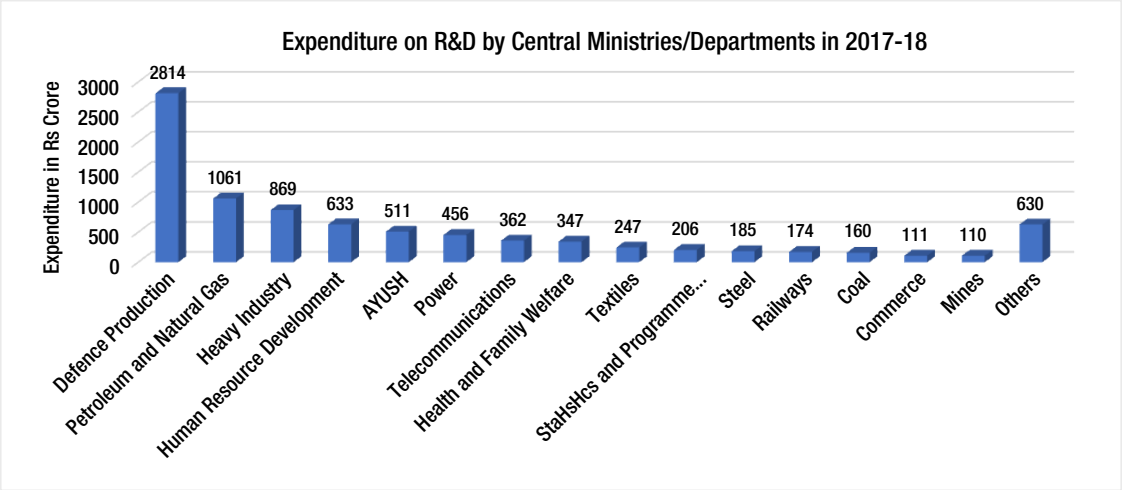


Figure 10: *Expenditure in R&D by Central Ministries/Departments in 2017-18*

Source: *NSTMIS, DST, GoI*

During the year 2017-18, it is observed that 93% of the R&D expenditure incurred by the Central Government sources were channelled through 12 major scientific agencies such as the Defence Research and Development Organisation (DRDO), Indian Council of Agricultural Research (ICAR), Centre for Scientific & Industrial Research (CSIR) and Department of Space (DoS). The total share of these 12 scientific agencies was around Rs 48,000 cr in 2017-18. In Figure 11 it can be seen that DRDO accounted for the maximum share of 31.6% of R&D expenditure followed by DOS (19.0%), ICAR (11.1%), DAE (10.8%), CSIR (9.5%) and DST (7.3%), DBT (3.7%) and ICMR (3.1%), MoES (2.3%), MEITY (0.8%), MoEFCC (0.5%), MNRE (0.1%) during 2017-18.

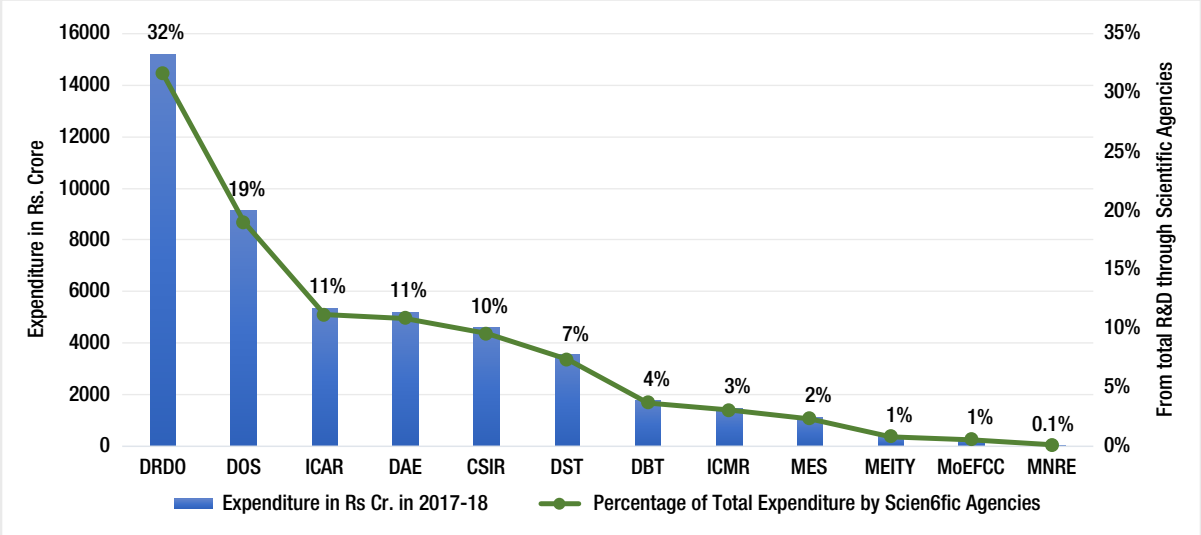


Figure 11: *Share of R&D Expenditure by 12 Major Scientific Agencies in India*

Source: *NSTMIS, DST, GoI*

It is to be kept in mind that the central government's expenditure on R&D in ministries, departments and programmes shown in previous figure was only Rs. 8,875 crore. This is only 18.5 per cent of the R&D expenditure by major scientific agencies funded by the central government which stood at Rs. 48,045 crore in 2017-18. Further analysis reveals that only Rs 1706 cr. of R&D expenditure could be directly linked to the packages/sectors covered in the present scenario section. Table 4 shows a juxtaposition of the NSTMIS economic activities with the UCSS evaluation packages. It can be seen that the highest R&D expenditure by the Central government is done in the health package followed by human resource development. Though this kind of analysis sheds some light on the prioritisation of sectors by the central government, it is limited in its scope given the difficulty in classifying some cross-cutting schemes under specific socio-economic objectives or under specific ministries/ departments. For example, the economic activity of health and family welfare may be understood to fall under the ambit of Health package, however, it largely covers schemes like Poshan-ICDS which also makes it relevant for Women and Child Development package.

Table 4: Share of R&D expenditure compared across UCSS sectors and NSTMIS Activities

*Expenditure in Rs Cr. On R&D By Central Ministries/Departments Other Than Major Scientific Agencies**				
UCSS Packages Evaluated	**Economic Activities (NSTMIS)**	**2015-16**	**2016-17**	**2017-18**
Agriculture	Agriculture, Cooperation and Farmers' Welfare	2.92	3.26	3.79
	Animal Husbandry, Dairying and Fisheries	24.02	27.79	23.73
	Fertilizers	22.85	20.4	17.94
Health/WCD	AYUSH	260.85	350.31	510.59
	Health and Family Welfare	317.59	323	346.58
	Health Research	0.5	0.51	0.66
Human Resource Development	Human Resource Development	434.8	552.41	632.94

*Expenditure in Rs Cr. On R&D By Central Ministries/Departments Other Than Major Scientific Agencies**				
UCSS Packages Evaluated	**Economic Activities (NSTMIS)**	**2015-16**	**2016-17**	**2017-18**
Jobs & Skills	Labour and Employment	8.44	9.2	7.34
	Skill Development and Entrepreneurship	0.31	0.4	0.09
Rural Development	Rural Development	60.88	56.03	63.8
Social Inclusion, Law and Order & Justice	Empowerment of Persons with Disabilities	1.46	1.31	1.18
	Social Justice and Empowerment	0.09	0.08	0.05
Urban Transformation	Housing and Urban Affairs	6.65	5.94	5.89
Water Resources, Environment and Forest	Water Resources, River Development and Ganga Rejuvenation	80.62	86.16	91.72
Total		1221.98	1436.8	1706.3
*Includes only those economic activities that could be linked to Packages covered in the study				

Source: *DMEO Analysis*

Further, for agriculture it was already seen figure 9 (see above) that states expenditure in R&D was around 48 per cent of total R&D for the sector. However, that is not captured in the table above. Thus, some packages and economic activities that fall in the union list but are on the state or concurrent list as per the seventh schedule of the constitution would require a deeper inspection to comprehend their R&D prioritisation by the government. In such cases the R&D requirements and investments would be less centralised contrasted to activities like defence or space exploration.

To summarise this particular issue with R&D in India, it can be said that there are both problems of skewed prioritisation and centralised focus on specific areas over others. Without discounting or disregarding areas deemed of strategic importance like space exploration and defence which are vital to India's global status, it is equally important for India to strengthen its human capital and social capital. This is imperative considering India's development agenda which should be coherent with all goals listed in the Sustainable Development Goals (SDGs).

4.6 LOW RATES OF TANGIBLE OUTCOMES

One could also argue based on the findings of this and other studies that the biggest deterrents for R&D augmentation in India would be the low rates of impacts and outcomes. Some of these outcomes are tangible and can be measured in terms of patents and research publications. India was ranked 9th in terms of patents filed According to World Intellectual Property Organisation, India's Patent Office was ranked 7th out of the top 10 Patent Filing Offices in the world. In 2017-18 a total of 47,854 patents were filed in India. Out of these patents 15,550 (32 per cent) patents were filed by Indian residents (see Figure 12). Patent applications filed in India were dominated by disciplines like mechanical, chemical, computer/electronics, and communication. The Research and Development Statistics reports that nearly 62 per cent of the foreign patents filed in India during 2017-18 were from four countries viz USA (31.5%), Japan (13.9%), Germany (8.6%) and China (8.0%).

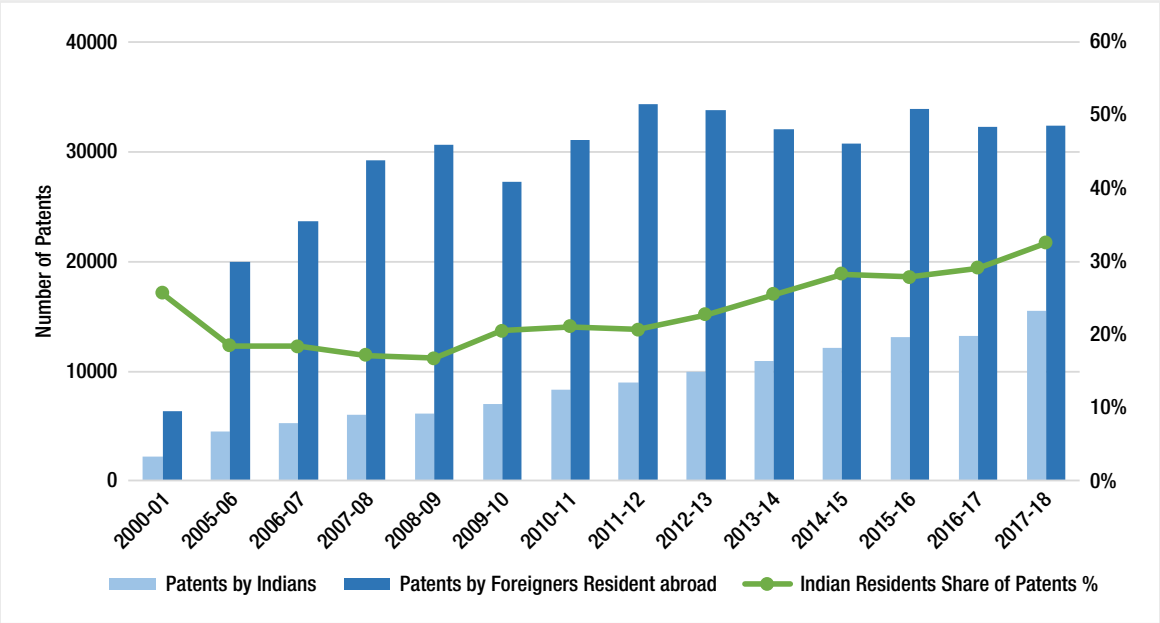


Figure 12: *Trends in Patents filed in India over the Years*

Source: *NSTMIS, DST, GoI*

Besides patents another important indicator of R&D outcomes are research publications. India ranked 7th in the world based on the absolute number of researchers which stood at approximately 3.4 lakhs in 2017-18. However, India's rank was abysmal in terms of researchers per million. India was ranked 28th in the world with only 255 researchers per million people. This is poor compared to the other BRICS countries - Russian Federation (2822), China (1225), Brazil(888) and South Africa(492). Nevertheless, according to the National Science Foundation (NSF) India ranked 3rd in the world in terms of Science & Engineering (S&E) articles in all fields with more than 1.3 lakh articles.

4.7 DIFFICULTY IN TRACKING INTANGIBLE OUTCOMES

The intangible or unquantifiable outcomes of R&D have been very difficult to measure, especially for the social sectors. The intangible outcomes would include the larger ambit of knowledge creation and/or reforms undertaken which enhance R&D capacities for the future. This makes it difficult to measure the returns to investment in R&D since not all outputs/outcomes could be measured in terms of patents. However, that being said the intangible outcomes such as knowledge creation forms the bedrock of innovation and it would be pertinent to understand how this is augmented by R&D in the country. As discussed in previous section, the tangible outcomes of R&D in terms of research publications becomes a repository of knowledge created from different research activities. The R&D statistics by the Department of Science and Technology has assessed the R&D activities across broad objectives of Basic Research, Applied Research, Experimental Development and Other Related S&T activities[13]. It can be seen from Figure 13 that at the aggregate level (excluding private industry sector) applied research is the most significant kind of research activity followed by experimental development. While the contribution of central government is inclined towards experimental development it can be see that for the state governments and SIROs applied research is prioritised.

13 R&D : Research and Development = Basic Research + Applied Research + Experimental Development. S&T : Science and Technology = R&D + Other related S&T activities.

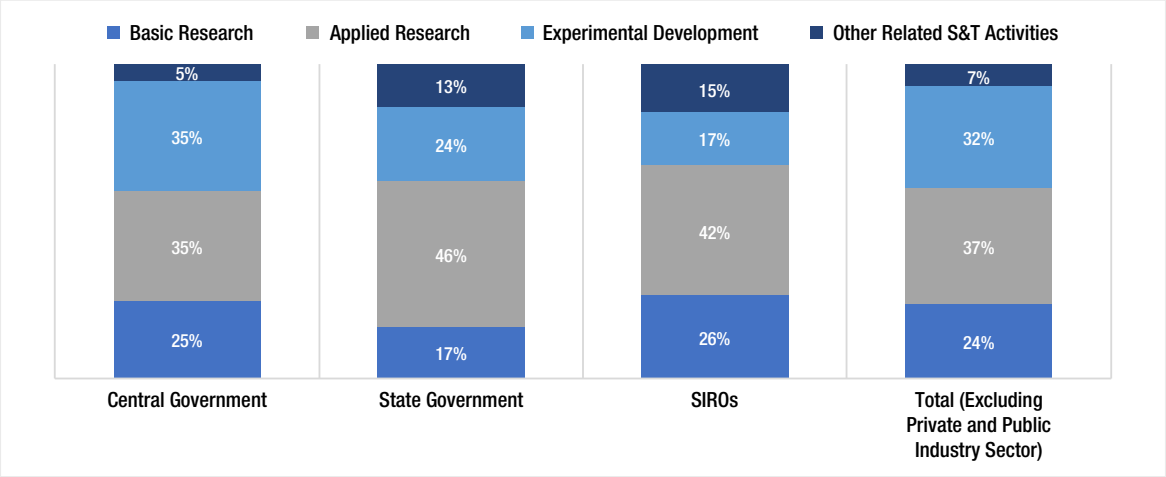


Figure 13: *R&D Expenditure across Broad Objectives*

Source: *NSTMIS, DST, GoI*

4.8 INADEQUACY IN NUMBER OF RESEARCHERS AND PARTICULARLY FEMALE RESEARCHERS

The exploration of NSTMIS data on R&D statistics for 2017 reveals that in terms of absolute numbers the number of researchers in India, 3.4 lakh, is comparable to Republic of Korea with 3.8 lakh researchers. However, in terms of relative measure for number of researchers, it is seen than India has only 255 researchers per million compared to 7498 in Republic of Korea. Figure 14 depicts the relation between per capita GPD (in current PPP $) and per capita R&D with respect to number of researchers per millions across different developed and developing economies. It is evident that positive correlation between GDP and R&D is effected by number of researchers per million with number of researchers per million clearly much higher in the developed economies than the developing economies.

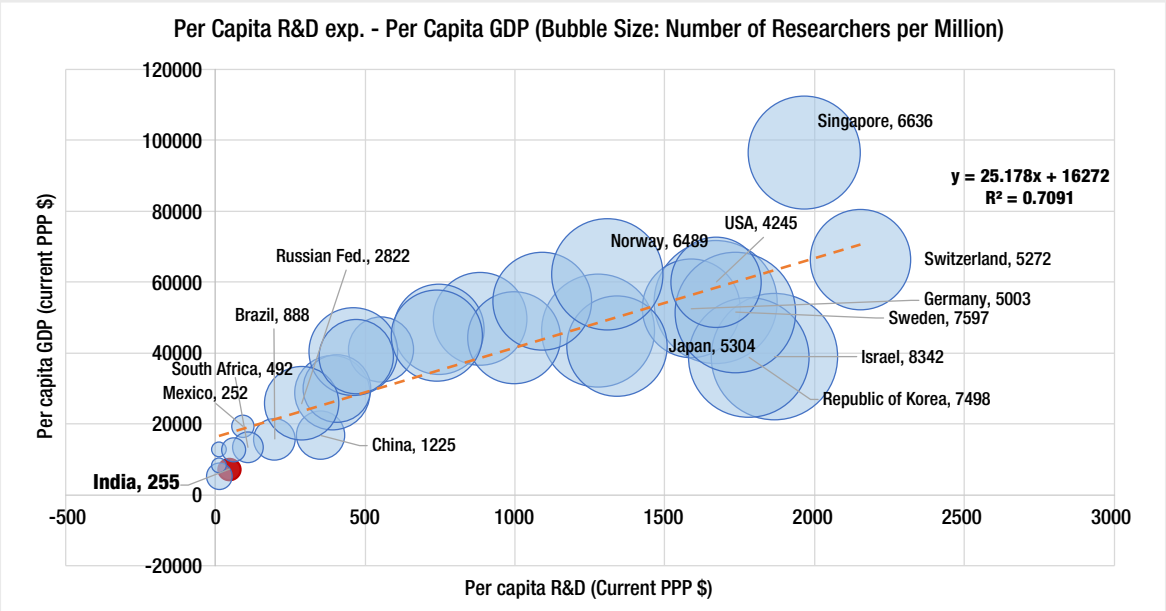


Figure 14: *Correlation between GDP and GERD based on Number of Researchers Across Countries*

Source: *NSTMIS, DST, GoI*

It is also seen that the number of research personnel engaged or employed in different institutional sectors of R&D investment. Figure 15 provides a share of research personnel engaged in three major areas[14] of R&D expenditure and the percentage share of expenditure on R&D across these sector for 2018 NSTMIS data. It is observed that while institutions under central government[15] have the majority share of R&D expenditure (77%), the percentage of researchers engaged here is only 30%. Contrastingly, higher education engages the highest share of researchers (61%) but sees very incommensurate R&D expenditure (12%).

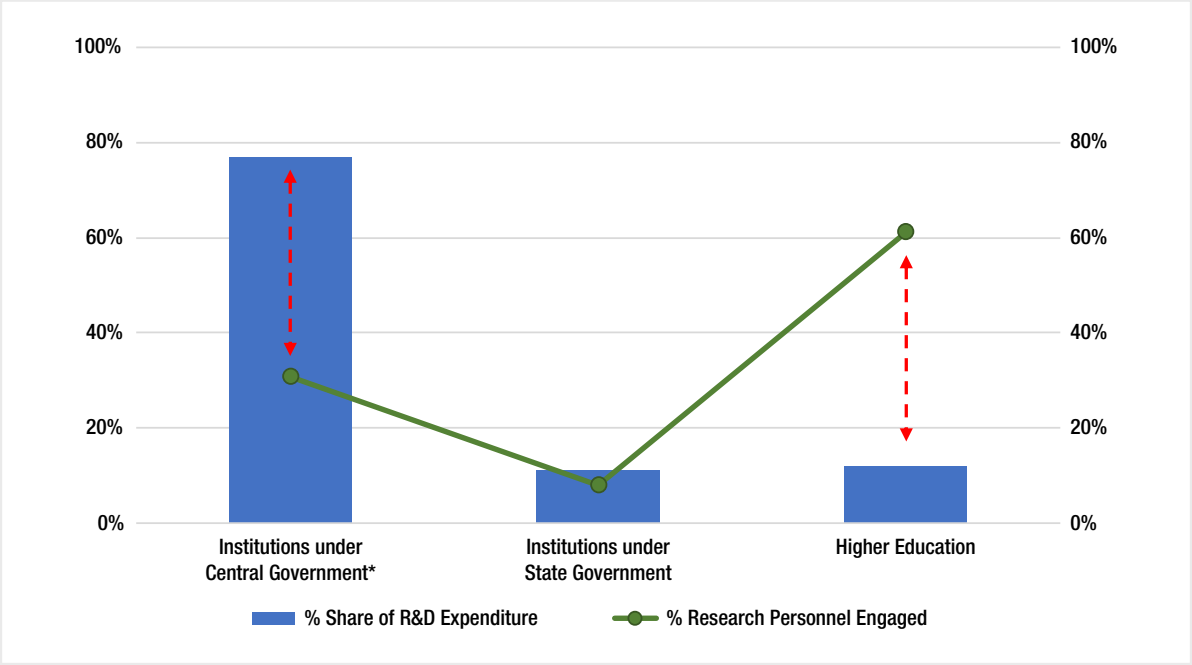


Figure 15: *Share of Researchers Engaged across Institutions*

Source: *NSTMIS, DST, GoI*

It is also quite appalling to see that the engagement of women as researchers in India is very abysmal. Of the institutions analysed above it is seen that only 15.8 % of the research personnel are females. Highest share of engagement of women as researchers is institutions under state government and institutions under central government with both sectors employing 24% female researchers. However, the poorest employment of female researchers is seen in higher education institutions with only 13%.

14 Industry sector has not been considered in this analysis due to lack of verifiable data on number of researchers. Thus, the three sectors mentioned here institutions under central government, state government and higher education add up to 100% of expenditure for this analysis.

15 Includes Institutions under Central Ministries/Departments and Major Scientific Agencies

5. WAY FORWARD

The assessment of R&D across different sectors, as has been undertaken in this document, is a momentous and monumental task. While the pertinence of such an exercise can't be discounted by any means, the measurement of R&D in terms of gross expenditure, patents and research personnel engaged in different sectors undermines the much larger scope and objectives of R&D and innovation. Innovation and R&D include multisectoral processes that involve various stakeholders – individuals and institutions, from the gamut of state, market and society. The process of measuring them across sectors is cumbersome. Nonetheless, the attempt to unravel some of the facts and findings regarding R&D from the UCSS evaluations as has been undertaken in this document is a new step in the direction of understanding the innovations adopted in government schemes.

Analysing and highlighting the evidence of R&D in government schemes too poses different kinds of challenges as was witnessed during the compilation of this document. The findings based on secondary literature to complement micro assessment through UCSS evaluations with macro findings suggest that most of R&D investment in India is done by the central government through central sector schemes/programmes and/or through a few scientific agencies. Further, the central government's focus has been on R&D in sectors pertaining to strategic importance such as defence, atomic energy and space exploration, all of which have seen the steepest increase in the recent years. Concurrently, some of the sectors that had been covered in the UCSS evaluations such as health, agriculture, human resource development and water resources, environment and forests also see major R&D investments in schemes like AYUSH, Green Revolution, Samagra Shikhsa and Namami Gange. Infrastructure related R&D investments too have been commendable. However, the social innovations in the sectors of education, social inclusion, rural and urban development and experimental development in all of the packages covered especially for water resources, environment and forests have remained quite low. The investment in social sectors have also remained low due to the lack of any well-defined mechanisms to track the R&D accompanying the implementation of different central sector and centrally sponsored schemes but pertain to intangible inventions contributing to knowledge creation and diffusion.

The review of the UCSS evaluations, besides presenting such broad observations on R&D in the sectors, have also, and more importantly so, led to a deeper perspective on the modalities of internalising R&D within scheme documents and the pertinence of R&D with respect to different scheme objectives. The simultaneous exploration of R&D through sector-wise analysis of schemes and through the national level R&D statistics helps identify some of the concerns as have been highlighted in the previous section. In addition to this, the usage of such analytical lens helped identify some of the recommendations that can augment R&D in India. While some of the suggestions are borne from the analyses undertaken during this exercise, others are derived from the examination of the provisions made under the Science, Technology and Innovation Policy of December 2020, the India Innovation Index formulated by NITI Aayog and other relevant frameworks, mandates and mechanisms already existing within and across sectoral structures.

5.1 EXECUTION OF PROVISIONS MADE IN STIP AND SSRP TO IMPROVE R&D ECOSYSTEM IN INDIA

The Science, Technology and Innovation Policy (STIP) of December, 2020 and the Scientific Social Responsibility (SSR) policy of September, 2019 are both in their draft state and are being finalised by the Department of Science and Technology. Both of these documents strive to streamline the R&D and innovations in India and echo the motives of "Atma Nirbhar Bharat" while recommending alignment to India's development agenda. The STIP is the fourth such policy pertaining to R&D in India following the Technology Policy Statement (1983), Science and Technology Policy (2003) and Science, Technology and Innovation Policy (2013). STIP proposes top-down and bottom-up approach utilising existing institutions in a synchronised manner through an overarching framework to amplify R&D. It proposes the establishment of a National STI Observatory that will act as a central repository for all kinds of data related to and generated from the STI ecosystem which shall also comprise STI units setup within every ministry/department in the central, state and local government levels; public and private sector enterprises and; start-ups with earmarked budgets to pursue STI activities. It also proposes the creation of a Technology Support Framework to be enacted through a Strategic Technology Board (STB) will be constituted to act as a link connecting different strategic departments and a Strategic Technology Development Fund (STDF) will be created to incentivize the private sector and HEIs. The policy also proposes establishing a capacity building authority to improve STI governance to enhance inter-ministerial coordination, promote decentralisation and cross-vertical and horizontal linkages. The policy also emphasizes on mainstreaming of equity and inclusion within the STI ecosystem through an Equity & Inclusion (E&I) charter that will strive to eliminate all forms of discrimination, exclusions and inequalities in STI.

The SSR policy predates the STIP and was instrumental for the latter in terms of guiding it to incorporate elements of integrating the societal aspect into the R&D process. With a clear outline of the central and state government and autonomous agencies designated as the implementers, the SSR policy identifies the individuals, groups and communities such as farmers, students, local bodies, women's groups, self-help groups, informal sector enterprises; micro, small and medium enterprises (MSMEs); start-ups; non- governmental organizations (NGOs); anganwadi workers; bio-diversity management committees (BMCs);etc. as beneficiaries. Private corporations are to act as supporters engaging actively in the process of realising R&D and its assimilation into productive channels independently or through public private partnerships (PPP) by contributing their Corporate Social Responsibility (CSR) funds. This paves the way for augmenting private sector's contribution to R&D in India which has been low in India.

5.2 UTILISATION OF INDIA INNOVATION INDEX TO ENCOURAGE STATES' CONTRIBUTION TO R&D THROUGH COMPETITIVE AND COOPERATIVE FEDERALISM

In 2020, NITI Aayog published the India Innovation Index in collaboration with the Institute for Competitiveness. The India Innovation Index has been created categorically for measuring R&D at the sub-national level. The index provides an extensive framework for the constant evaluation of the innovation ecosystem of the 28 Indian states and 9 union territories. The primary objectives of the index are – (i) Ranking all states and union territories based on their index score, (ii) Identifying opportunities and challenges and, (iii) Assisting in modifying governmental policies to foster innovation. The index is based on 5 enabling pillars – (1) Human Capital, (2) Investment, (3) Knowledge

Workers, (4) Business Environment and (5) Safety and Legal Environment, and 2 performance pillars – (1) Knowledge Output and (2) Knowledge Diffusion, thus providing a very comprehensive framework for the assessment of states in terms of R&D. Comprising a total of 36 indicators, the index has been used to rank all the states. Such a framework is pertinent to not only keep a track of the performance of the states but also devise adequate strategies for the states to improve on different indicators. The India Innovation Index is in compliance with the ongoing thrust for competitive and cooperative federalism and should be used accordingly to burgeon R&D in states.

5.3 INCORPORATION OF R&D IN THE SCHEME DESIGN FOR DIFFERENT SECTORS

Through the investigation undertaken in the report it has been found that very few of the centrally sponsored schemes have specifically allocated funds for R&D or evening clauses for R&D including alignment with a primary or secondary research institution for their implementation. It is also found that there exists no guidelines at the centre for the inclusion of R&D in any of the scheme documents – central sector and/or centrally sponsored schemes. This is perhaps because of the very centralised allocation of funding for R&D through major scientific agencies which leads to a very unfavourable condition for R&D and innovation at decentralised levels in the states, institutions and private sector. Despite the lack of such directives or guidelines to internalise R&D in scheme documents at the central level, it has been found that some ministries do emphasize the incorporation of R&D in their scheme documents. This is done through their vision documents, annual reports as well as some major umbrella schemes. Such impetus has been found plentily in the documents of ministries/ departments which thrive on R&D like DoS, DAE and more recently MNRE. Besides these, some of the central ministries and departments like Ministry of Power, Jal Shakti Ministry and Ministry of Agriculture have in the recent times emphasized on the creation of digital ecosystems for better monitoring and evaluation of their respective schemes. These creation of such digital ecosystems could be capitalised on by a concurrent thrust from the respective ministries to use these as the basis for R&D for different scheme implementations.

5.4 LEVERAGING CSR FUNDS FOR R&D TO AUGMENT PRIVATE SECTOR INVESTMENT

The participation of the private sector in R&D in India has been low compared to the countries which pioneer in R&D where the private sector's contribution is significantly high. The top ten economies in the world have an average of 68 % of R&D contributed by their business sector. In India, however, the contribution by the business sector was around 37 % of its total GERD. As reported by the Economic Survey of India, this is despite the liberal tax incentives provided by the Government of India. Unfortunately, despite the favourable conditions for the business sector, Indian residents contribute only 36 per cent of patents filed in India as compared to 62 per cent on average in the top ten economies. Indian firms also perform below expectation on innovation for their level of access to equity finance, which is the most crucial for innovation. This is also despite the fact that, India is the first country in the world to legally mandate CSR on its business sector.

To plug the lapses by the private or business sector's contribution to R&D, the Ministry of Corporate Affair's scheme of national CSR award 2018 has for the first time introduced the grounds for innovation and use of technology. With a carefully designed award categories covering some of the critical sectors like Education, Skill Development & Livelihoods, Women and Child Development,

Agriculture and Rural Development and Environment and sustainable development including solar energy, the scheme list priority schemes within each of the categories. For example, within the Skill Development & Livelihoods category for CSR awards priority of schemes like Stand-up India: Access to credit for unemployed youth; Start-up India: Promotion of Start-ups through incubation; Pradhan Mantri MUDRA Yojana and; Make in India have been placed. For other categories too schemes which entail and envisage R&D have been prioritised with an intent to award businesses and corporations for scalable and replicable CSR projects. Further, a category called "Technology Incubation" has been created to award CSRs undertaken for the implementation of Start-up India and Digital India schemes.

Since the inception of this scheme, the first National CSR Awards ceremony was organized on 29 October 2019 with Hon'ble President of India as the Chief Guest and has been organised since then. This platform could be used to encourage the business sector to invest in CSRs which prioritise R&D and in this process actively strive to improve the improve the private sector's contribution to R&D expenditure in India.

5.5 ESTABLISHMENT OF INCUBATION CENTRES IN CENTRAL AND STATE UNIVERSITIES TO PROMOTE INNOVATION

With swift technological advances especially in the past few decades, its presence has been permeating to different aspects of our social and economic exchanges. This presents a unique opportunity to benefit from it both directly and indirectly where technology can catalyse improvement in other sectors. Cognizant of this potential, capitalising on India's comparative advantage in IT, GoI has in recent times introduced various interventions to fast-track development in specific sectors. Startup India Initiative, Startup India Seed Fund, A Scheme for Promotion of Innovation, Rural Industries and Entrepreneurship (ASPIRE), Credit Guarantee Fund Trust for Micro and Small Entreprises (CGTMSE), Atal Innovation Mission and the more recent Startup Accelerators of MeitY for Product Innovation, Development, and Growth (SAMRIDH) Scheme to name a few. These schemes and funds have been introduced to bolster the startup ecosystem which thrives on R&D, encourage incubators to provide adequate technical and non-technical support and convenient access to venture capital and seed funding to startups and MSMEs in the country. The Startup India Initiative, in particular, strives to create a conducive environment through a well designed portal creating a network between startups, investors, mentors, incubators, accelerators and government bodies.

It would also be immensely beneficial to link these initiatives, schemes and funds to central and state universities. While there are very few premium universities which are better endowed in terms of financial and human resources to enable a robust R&D environment, most universities ail from the lack such resources. Aligning these universities with the startups, incubators and other related bodies could be mutually beneficial. The universities could benefit through their partnerships with startups and other corporations from internships programs for the students and in turn the corporations could benefit by setting up incubators in the research facilities of the universities and nurturing and skilling the students of the universities for future employment.

5.6 BETTER TRACKING OF R&D RELATED DELIVERABLES BASED ON OUTPUT-OUTCOME MONITORING FRAMEWORK FOR ALL THE SECTORS

The analysis undertaken in the document reveals the gaps in both R&D expenditure across different sectors as well as institutional mandates and mechanisms to facilitate and further R&D. While some

of the mechanisms already exist for the strategically important sectors like space, defence and recently renewable energy, they are lacking in the social sectors women and child development, rural development and social inclusion. Without in-built mandates that envisage R&D in scheme guidelines for centrally sponsored and central sector schemes, there is an oversight of R&D in the pursuit of achieving targets or outputs at the cost of sustainable outcomes. For this purpose identifying deliverables for all schemes across sectors based on the Output-Outcome Monitoring Frameworks (OOMF) is pertinent. Accordingly, careful attention should be paid to the annual revisions of OOMF when R&D related outputs and outcomes can be assessed and revised. This is particularly important for the social sectors where the some of the outcomes and outputs are unquantifiable unlike the tangible outputs and outcomes in manufacturing or services sectors. This makes a clear identification of deliverables over and above the scheme targets all the more necessary.

India has been on the path of steady growth in the recent times and is poised to become one of the leading economies in the world. While the recent pandemic had curtailed the growth for some time, the existence of strong governance mechanisms have made its economy resilient if not entirely resistant. Nevertheless, the lessons from the pandemic especially in terms of the R&D undertaken to develop vaccines and sustain scheme implementation to check and reverse the economic downswing speak volumes of India's potential. However, instead of creativity arising out of such adversity, the process of R&D and innovation needs to be perpetual. This can and should be assured through the existing institutional mechanisms and due reforms where ever required to make R&D and innovation the mainstay of the Indian economy as has been envisioned under the "Atma Nirbhar Bharat".

ANNEXURE

Table A1: Agriculture and Allied Activities' Schemes

Sl. No	Sector/ Sub-sector	Scheme	Acronym	R&D Fund Available	Name of Research Institute/ Organization	Supporting Organizations	Remarks	Performance in R&D
1	Agriculture and Farmer's Welfare	Pradhan Mantri Krishi Sinchai Yojana – Per Drop More Crop	PMKSY-PDMC	NA	NA			NA
2		Rashtriya Krishi Vikas Yojna (RKVY-RAFTAAR)	RKVY-RAFTAAR	Yes	ICAR	Krishi Vigyan Kendras	Funds earmarked for RKVY ICAR is an autonomous organization under Ministry of Agriculture and Farmers' Welfare	Average
3		Mission for Integrated Development of Horticulture	MIDH	Yes	No	National Level Agencies (NLAs) like NCCD, DCCD, DASD, NHRDF, NBB, Spices Board		Average
4		National Food Security Mission	NFSM	No	No	State Level Agricultural Universities, National and International Research organizations	Research is being done, but no separate mention of any fund allocation.	Satisfactory
5		Sub Mission on Agriculture Extension	SMAE	No	No	Different organizations shall collaborate to educate farmers		Average
6		Sub Mission on Agriculture Mechanisation	SMAM	NA	NA			Average
7		Integrated Scheme for Agricultural Marketing	ISAM	NA	NA			Not Relevant

Sl. No	Sector/ Sub-sector	Scheme	Acronym	R&D Fund Available	Name of Research Institute/ Organization	Supporting Organizations	Remarks	Performance in R&D
8	Agriculture and Farmer's Welfare	Mission Organic Value Chain Development for North Eastern Region	MOVCNER	NA	NA			NA
9		Soil Health Management	SHM	NA	NA			NA
10		Sub-Mission on Seed and Planting Material	SMSP	No	NSRTC, ICAR	SAUs	ICAR collaborates with SAUs to undertake research work	Average
11		Rainfed Area Development	RAD	NA	NA			NA
12		Paramparagat Krishi Vikas Yojana	PKVY	No	No			Average
13		Sub-Mission on Plant Protection and Plant Quarantine	SMPPQ	NA	NA			NA
14		Sub Mission on Agroforestry (SMAF)	SMAF	No	ICAR	SAUs, National and International Institutes	Extensively researched area, but no allocation of funds mentioned explicitly	Satisfactory
15		National Bamboo Mission	NBM	No	A committee of members from several eminent organizations			Satisfactory
16		Integrated Scheme on Agricultural Cooperation	ISAC	No	LINAC	NCCT	Extensively researched area, but no allocation of funds mentioned explicitly LINAC was established by NCDC which itself is under Ministry of Agriculture	Satisfactory
17		Integrated Scheme on Agriculture Census and Statistics	ISACS	NA	NA			Not Relevant

Sl. No	Sector/ Sub-sector	Scheme	Acronym	R&D Fund Available	Name of Research Institute/ Organization	Supporting Organizations	Remarks	Performance in R&D
18	Animal Husbandry	National Dairy Plan-I	NDP-I	Yes	ICAR: NIANP, IVRI, NDRI, NIHSAD	Several state animal science universities and national research institutes		Satisfactory
19		National Livestock Mission	NLM	Yes	ICAR		5% of the allocated budget	Average
20		Dairy Entrepreneurship Development Scheme	DEDS	NA	NA			Not Relevant
21		National Programme for Dairy Development	NPDD	NA	NA			NA
22		Livestock Health & Disease Control	LHDC	No	ICAR		The scheme funds research projects undertaken by ICAR NIHSAD and NIVEDI	Average
23		Rashtriya Gokul Mission	RGM	No	ICAR		Extensively researched area, but no allocation of funds mentioned explicitly	Satisfactory
24		Dairy Processing & Infrastructure Development Fund	DIDF	NA	NA			NA
25		Livestock Census and Integrated Sample Survey	LC & ISS	NA	NA			Not Relevant
26		Supporting State Cooperatives Dairy Federations	SSCDF	NA	NA			Not Relevant
27	Fisheries	Integrated Development and Management of Fisheries	IDMF					NA
28		Fisheries and Aquaculture Infrastructure Development Fund	FIDF					NA

Source: *UCSS Evaluations 2020, Development Monitoring Evaluation Office (DMEO), NITI Aayog*

Table A2: Women and Child Development Schemes

Sl. No	Sector/ Sub-sector	Scheme	Acronym	R&D Fund Available	Remarks	Name of Research Institute/ Organization	Supporting Organizations	Remarks	Performance in R&D
1	WCD	Stakeholder and Beneficiary Behaviour Change		Yes	Combined fund of 2.33 Crores allocated for research purposes under Grant-in-Aid for Research and Publications Scheme	Statistics Bureau of the Ministry of Women and Child Development. National Institute of Public Cooperation and Child Development (NIPCCD) under Ministry of WCD.			NA
2		Anganwadi Services Scheme		No	Extensively researched area, but no allocation of funds mentioned explicitly	NIPCCD		Research is conducted by NIPCCD, NFHS	Average
3		POSHAN Abhiyaan		No	Extensively researched area, but no allocation of funds mentioned explicitly		Harvard T H Chan School of Public Health through its India Research Centre and BMGF. UNICEF and NITI Aayog also support it.		Satisfactory
4		Pradhan Mantri Matru Vandana Yojana	PMMVY	No	There are provisions but no immediate operational capacity	National PMMVY Section/Cell		However, there are no specific strategies and operational capacity for research	Satisfactory
5		Scheme for Adolescent Girls	SAG	No		No			Needs Improvement
6		Child Protection Scheme	ICPS	No	Extensively researched area, but no allocation of funds mentioned explicitly	No		No institutes as such, but team of professionals undertake research	Needs Improvement
7		Beti Bachao Beti Padhao	BBBP	Yes	Provision for budget allocations at Central Level	No		No clarity with respect to research strategy.	Satisfactory
8		Swadhar Greh Scheme		No		No			Needs Improvement

Sl. No	Sector/ Sub-sector	Scheme	Acronym	R&D Fund Available	Remarks	Name of Research Institute/ Organiza-tion	Supporting Organiza-tions	Remarks	Performance in R&D
9	WCD	Working Women's Hostel Scheme		No		No	SCRW's are responsible for researhc work	There are provisions for research	Average
10		Mahila Shakti Kendra Scheme	MSK	Yes	Though information in this regard is highly limited.	No		There are provisions to be taken care of, but no actual operations	Average
11		Gender Budgeting, Research, Publication and Monitoring	GBRPM	Yes		No	Institute of Public Finance and Policy (NIPFP)		Average
12		One-Stop Centre Scheme	OSC	No		No		Provisions are there but no actual capacity	Average

Source: *UCSS Evaluations 2020, Development Monitoring Evaluation Office (DMEO), NITI Aayog*

Table A3: Human Resource Development Schemes

Sl. No	Sector/ Sub-sector	Scheme	Acronym	R&D Fund Available	Name of Research Institute/ Organization	Supporting Organizations	Remarks	Performance in R&D
1	School Education and Literacy	National Education Mission	NEM	Yes	No	NIC, NCERT, SCERTs, NIEPA, DIET	6% of funding for Research and Development (UCSS) under Central Sponsored Schemes	Unsatisfactory
2		National Programme of Mid-day Meal in Schools	NP-MDMS	Yes	No	Private sector participation	3% MME fund under MDM	Unsatisfactory
3		Umbrella Programme for Development of Minorities Scheme for Providing Education to Madrasas/ Minorities	SPEMM	No	No	NIEPA and private sector contribution		Unsatisfactory
4		Sarva Shiksha Scheme (Part of Samagra Shiksha)	SSA	Yes	EdCIL	NCERT, NIC, NIEPA	Overall allocation for REMS, Project Management and Learning Enhancement is not more than 6 per cent of total allocation EdCIl is a public sector undertaking under the control of Ministry of Education, India	Unsatisfactory
5		Rashtriya Madhyamik Shiksha Abhiyan (Part of Samagra Shiksha)	RMSA	Yes	EdCIL	NCERT, NIC, NIEPA	Overall allocation for REMS, Project Management and Learning Enhancement is not more than 6 per cent of total allocation EdCIl is a public sector undertaking under the control of Ministry of Education, India	Needs Improvement

Sl. No	Sector/ Sub-sector	Scheme	Acronym	R&D Fund Available	Name of Research Institute/ Organiza-tion	Supporting Organiza-tions	Remarks	Performance in R&D
6	School Education and Literacy	Saakshar Bharat (Padhna Likhna Abhiyan)		No	No	SRCs, CSR by several companies		Unsatisfactory
7		Centrally Sponsored Scheme on Teacher Education	CSSTE	Yes	No	SCERTs, DIETs, BITEs	Separate funds allocations under various schemes	Unsatisfactory
8	Higher Education	Rashtriya Uchchatar Shiksha Abhiyan	RUSA	Yes	No		Rs 1000 crores	Needs Improvement

Source: *UCSS Evaluations 2020, Development Monitoring Evaluation Office (DMEO), NITI Aayog*

Table A4: Urban Development Schemes

Sl. No	Sector/ Sub-sector	Scheme	Acronym	R&D Fund Available	Name of Research Institute/ Organiza-tion	Supporting Organizations	Remarks	Performance in R&D
1	Urban	Smart Cities Mission	SCM	Yes	No	IISC, private and public partners	2% funding allocated for SCM is used for research	Satisfactory
2		Atal Mission for Rejuvination and Urban Transformation	PMAY (U)	Yes	No	MHRD, Centres of Excellence and other research institutions	Provision is there, but no mention of amount of funds Tie up with MHRD through IMPRINT programme	Satisfactory
3		Pradhan Mantri Awas Yojana -Urban	AMRUT	Yes	BMTPC		Fully funded by central government Building materials and technology promotion council (BMTPC) is a technical arm of MoHUA	Satisfactory
4		Swacch Bharat Mission -Urban	SBM (U)	NA	NA			NA
5		National Urban Livelihood Mission	NULM	Yes	No	Public Private Community Partnership	5% of centre's allocation of budget	Satisfactory

Source: *UCSS Evaluations 2020, Development Monitoring Evaluation Office (DMEO), NITI Aayog*

Table A5: Rural Development Schemes

Sl. No	Sector/ Sub-Sector	Scheme	Acronym	R&D Fund Available	Name of Research Institute/ Organization	Supporting Organizations	Remarks	Performance in R&D
1	Rural	Mahatma Gandhi National Rural Employment Guarantee Act	MGNREGA	Yes	NIRD&PR		6% administrative expense of the state under MGNREGS	Average
2		Pradhan Mantri Aawas Yojna - Gramin	PMAY-G	Yes		DoRD, CBRI	5 percent of the Central allocation under PMAY-G as reserve funds Undertake research not mentioned as a part of the scheme	Satisfactory
3		Pradhan Mantri Gram Sadak Yojna	PMGSY	No	NIRD&PR	Indian road congress, Cenreal Road Research Institute	Extensively researched area, but no allocation of funds mentioned explicitly	Average
4		Day - National Rural Living Mission	DAY-NRLM	No	NIRD&PR		No separate corpus for R&D in this scheme, but NIRD&PR undertakes research work in this respect	Average
5		National Social Assistance Programme	NSAP	No	No			Average
6		Shyama Prasad Mukherjee Rurban Mission	SPMRM	Yes	No		5% of CGF is to be allocated for research work, but lack of information on usage of funds No operational capacity	Average

Source: *UCSS Evaluations 2020, Development Monitoring Evaluation Office (DMEO), NITI Aayog*

Table A6: Health Schemes

Sl. No	Sector/ Sub-sector	Scheme	Acronym	R&D Fund Available	Name of Research Institute/ Organization	Supporting Organizations	Remarks	Performance in R&D
1	Health	National Rural Health Mission	NRHM	No	NIHFW	NHSRC, SHSRCs	NIHFW is an autonomous body under MoHFW	NA
2		National Urban Health Mission	NUHM	No	NIHFW	NHSRC, SHSRCs	NIHFW is an autonomous body under MoHFW	Data Not Available
3		Tertiary Care Programs		NA	NA			NA
4		Human Resources for Health and Medical Education		NA	NA			NA
5		National AYUSH Mission	AYUSH	Yes	CCRAS, CCRUM, CCRH		CCRAS, CCRUM, CCRH are autonomous bodies under Aayush Ministry	Average

Source: *UCSS Evaluations 2020, Development Monitoring Evaluation Office (DMEO), NITI Aayog*

Table A7: Jobs and Skills Schemes

Sl. No	Sector/ Sub-sector	Scheme	Acronym	R&D Fund Available	Name of Research Institute/ Organization	Supporting Organizations	Remarks	Performance in R&D
1	Jobs and Skills	Pradhan Mantri Rojgar Protsahan Yojana	PMRPY	No	VVGNLI, NICS, CLI	Regional labour institutes (Chennai, Kolkata, Kanpur, Faridabad and Shillong)	No separate allocation of funds. No private sector contribution in this regard. There is no scope for continuous R&D in this scheme. Note that VV Giri Institute, NICS and CLI are institutes under Ministry of Labour and Employment	NA
2		National Career Service	NCS	No	VVGNLI, NICS, CLI	Regional labour institutes (Chennai, Kolkata, Kanpur, Faridabad and Shillong)	No separate allocation of funds. No private sector contribution in this regard.	NA
3		National Career Service for DA	(NCS-DA)	No	NICSNOIDA, VVGNLI		No separate allocation of funds. No private sector contribution in this regard.	NA
4		National Career Service for SC/STs	(NCS-SC/ST)	No	VVGNLI, NICS, CLI	Regional labour institutes (Chennai, Kolkata, Kanpur, Faridabad and Shillong)	No separate allocation of funds. No private sector contribution in this regard.	NA
5		Pradhan Mantri Kaushal Vikas Yojana	PMKVY	No	NSDC	SSC, NSDA	No separate allocation of funds. No private sector contribution in this regard.	NA

Source: *UCSS Evaluations 2020, Development Monitoring Evaluation Office (DMEO), NITI Aayog*

Table A8: Social Inclusion, Law and Order and Justice Delivery Schemes

Sl. No	Sector/ Sub-sector	Umbrella Scheme Name	Scheme	R&D Fund Available	Name of Research Institute/ Organization	Supporting Organizations	Additional Remarks	Performance in R&D
1	Social Justice	Umbrella Scheme for Development of Scheduled Castes (SCs)	Post-Matric Scholarship for SC	No	Planning Commission under Ministry		Ministry has a separate division named Planning division which provides Grants to Scholars, Grants for Workshops/ seminars, and grants for publication, to undertake any scheme level research and development.	Needs Improvement
2			Pre-Matric Scholarship Scheme to the Scheduled Castes Students Studying in Classes IX and X	No	Planning Commission under Ministry		Ministry has a separate division named Planning division which provides Grants to Scholars, Grants for Workshops/ seminars, and grants for publication, to undertake any scheme level research and development.	Needs Improvement
3			Pre-Matric Scholarship Scheme to the Children of those Engaged in Occupations involving Cleaning and prone to Health Hazards	No	Planning Commission under Ministry		Ministry has a separate division named Planning division which provides Grants to Scholars, Grants for Workshops/ seminars, and grants for publication, to undertake any scheme level research and development.	Needs Improvement
4			Babu Jagjivan Ram Chhatrawas Yojana for SC Boys and Girls	No	Planning Commission under Ministry		Ministry has a separate division named Planning division which provides Grants to Scholars, Grants for Workshops/ seminars, and grants for publication, to undertake any scheme level research and development.	Needs Improvement

Sl. No	Sector/ Sub-sector	Umbrella Scheme Name	Scheme	R&D Fund Available	Name of Research Institute/ Organization	Supporting Organizations	Additional Remarks	Performance in R&D
5	Social Justice	Umbrella Scheme for Development of Scheduled Castes (SCs)	Pradhan Mantri Adarsh Gram Yojana	No	No			Needs Improvement
6			Centrally Sponsored Scheme for Implementation of the Protection of Civil Rights Act, 1955 and the Scheduled Castes and the Scheduled Tribes (Prevention of Atrocities) Act, 1989	No	No		National Crime Records Bureau undertaken some analysis	Needs Improvement
8		Umbrella Scheme for Development of OVGs	Post-Matric Scholarship Scheme for OBC Students	No	Planning Commission under Ministry		Ministry has a separate division named Planning division which provides Grants to Scholars, Grants for Workshops/ seminars, and grants for publication, to undertake any scheme level research and development.	Needs Improvement
7			Pre-Matric Scholarship Scheme for OBC Students	No	Planning Commission under Ministry		Ministry has a separate division named Planning division which provides Grants to Scholars, Grants for Workshops/ seminars, and grants for publication, to undertake any scheme level research and development.	Needs Improvement

Sl. No	Sector/ Sub-sector	Umbrella Scheme Name	Scheme	R&D Fund Available	Name of Research Institute/ Organiza-tion	Supporting Organiza-tions	Additional Remarks	Performance in R&D
8	Social Justice	Umbrella Scheme for Develop-ment of OVGs	Construction of Hostels for OBC Boys and Girls	No	Planning Commission under Ministry		Ministry has a separate division named Planning division which provides Grants to Scholars, Grants for Workshops/ seminars, and grants for publication, to undertake any scheme level research and development.	Needs Improvement
9			Dr. Ambedkar Post-Matric Scholarship Scheme for EBC Students	No	Planning Commission under Ministry		Ministry has a separate division named Planning division which provides Grants to Scholars, Grants for Workshops/ seminars, and grants for publication, to undertake any scheme level research and development.	Needs Improvement
10			Dr. Ambedkar Pre and Post-Matric Scholarship for DNTs	No	Planning Commission under Ministry		Ministry has a separate division named Planning division which provides Grants to Scholars, Grants for Workshops/ seminars, and grants for publication, to undertake any scheme level research and development.	Needs Improvement
11			Scheme for Assistance for Prevention of Alcoholism and Substance (Drugs) Abuse	No	NISD		NISD is an advisory body for Ministry of Social Justice and Empowerment	Average

Sl. No	Sector/ Sub-sector	Umbrella Scheme Name	Scheme	R&D Fund Available	Name of Research Institute/ Organiza-tion	Supporting Organiza-tions	Additional Remarks	Performance in R&D
12	Social Justice	Umbrella scheme for develop-ment of Scheduled Tribes (STs)	Pre-matric scholarship scheme for needy Scheduled Tribe students studying in classes IX and X	NA	NA			Satisfactory
13			Scheme A1: Post-matric scholarship scheme to the students belonging to Scheduled Tribes for studies in India	Yes	No		Ministry has a separate scheme named 'Support to TRI' to undertake any scheme level research and development.	Satisfactory
14			Support to Tribal Research Institute	No		State TRIs	State TRIs report having conducted research in this aspect	Satisfactory
15			Mechanism for marketing of Minimum Support Price (MSP) for Minor Forest Produce (MFP) and development of value chain for MFP (MSP for MFP)	NA	NA			NA
16			Special Central Assistance to Tribal Sub-Plan/ Schemes	NA	NA			NA
17			Scheme for the development of Particularly Vulnerable Tribal Groups	No		State TRIs	State TRIs report having conducted research in this aspect	Satisfactory
18			Tribal Festival, Research, Information and Mass Education' scheme	No	No		Provision is there, but no explicit mention of research component	Satisfactory

Sl. No	Sector/ Sub-sector	Umbrella Scheme Name	Scheme	R&D Fund Available	Name of Research Institute/ Organization	Supporting Organizations	Additional Remarks	Performance in R&D
19	Social Justice	Umbrella Programme for Development of Minorities	Pradhan Mantri Jan Vikas Karyakram	No	National Commission for Minorities		NCM is established under Ministry of Minority Affairs	Satisfactory
20		Umbrella Scheme of Modernisation of Police Forces	Assistance to States for Modernization of Police	No	Bureau of Police Research and Development		BPRD is an organization under MoHA	NA
21			Assistance to States for Special Projects for Upgrading Police Infrastructure	NA	NA			NA
22			Crime and Criminal Network Tracking System (CCTNS)	NA	NA			NA
23			Special Central Assistance for 30 Most LWE Affected Districts	NA	NA			NA
24			Special Infrastructure Scheme (SIS) including the Construction of 250 Fortified Police Stations	NA	NA			NA

Source: *UCSS Evaluations 2020, Development Monitoring Evaluation Office (DMEO), NITI Aayog*

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