GOVERNMENT OF KERALA
KERALA STATE PLANNING BOARD

THIRTEENTH FIVE-YEAR PLAN
(2017-2022)

WORKING GROUP ON

SCIENCE AND TECHNOLOGY

REPORT

INDUSTRY AND INFRASTRUCTURE DIVISION

KERALA STATE PLANNING BOARD
THIRUVANANTHAPURAM

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PREFACE

In Kerala, the process of a Five-Year Plan is an exercise in people's participation. At the end of September 2016, the Kerala State Planning Board began an effort to conduct the widest possible consultations before formulating the Plan. The Planning Board formed 43 Working Groups, with a total of more than 700 members – scholars, administrators, social and political activists and other experts. Although the Reports do not represent the official position of the Government of Kerala, their content will help in the formulation of the Thirteenth Five-Year Plan document.

This document is the report of the Working Group on Science and Technology. The Chairpersons of the Working Group were Dr D. Balasubramanianand Dr Suresh Das. The Member of the Planning Board who coordinated the activities of the Working Group was Professor T. Jayaraman. The concerned Chief of Division was Shri Joy.

Member Secretary

FOREWORD

Science, Technology and Innovation are critically important tools for increasing productivity and competitiveness, which in turn lead to improved job creation, prosperity and overall sustainable development of the State. In view of its unique geography, climate and population, the State of Kerala possesses opportunities and challenges that are distinctively different from that of the other states of our Country. Taking advantage of these opportunities and challenges for sustainable development, people from the grass root level or those working in advanced institutions and industries must be trained to come up with our own unique, innovative solutions to achieve this. It is in this backdrop, the Government of Kerala have established the Science, Technology and Environment Council (STEC) in 1972 which was reconstituted as Kerala State Council for Science, Technology and Environment (KSCSTE) in 2002 as an autonomous body with a broader mandate and vision to promote and inculcate Science and Technology temperament and associated activities for the benefit of the State of Kerala.

For the development of Kerala it is vitally important that we focus on the vibrant human resource.In this context, unique programmes of KSCSTE such as the "Sasthraposhini"which focuses on developingscientific skills among the school children and inculcate scientific temperament in them through establishing laboratories and trainingas well as the SARD (infrastructure) support in academic institutions and State laboratories . These schemes along with the other human resource development activities of KSCSTE such as research fellowships, back-to lab programme for women scientists, the Pratibha scholarships for plus two toppers of the State are all laudable.

The Council has also helped to promote technology development and transfer by providing funding to engineering projects and supporting rural/appropriate technologies. The A. P. J. Abdul Kalam Youth Challenge Programme where the youth are invoked to come up with unique/innovative ideas to solve societal issues and develop entrepreneurial venture. The Patent Information Centre of KSCSTE established in 2003, has been playing an important role in creating awareness about Intellectual Property Rights among the scientific community of the State.

In the area of Environment, the Councils has funded a number of projects related to environmental issues and supported a number of eco-clubs in schools and helped in increasing public awareness on the need to protect the ecosystem of the State. I am happy that some of the programmes related to the have been ranked as the best in the Country by the Ministry of Environment and Forests.

The science popularization schemes of KSCSTE such as funding of projects to encourage science literature and promotion of science writing particularly in Malayalam has helped to improve the reach of science and technology to the common man and helped to improve their scientific temper.

The Report also emphasisesthe efforts of the R&DInstitutionsof the Council such as Kerala Forest Research Institute (KFRI), Centre for Water Resource Development and Management

(CWRDM), Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI), Malabar Botanic Garden and Institute for Plant Sciences (MBGIPS), Srinivasa Ramanujan Institute for Basic Sciences (SRIBS), National Transportation Planningand Research Centre (NATPAC) and Centre for Earth Science Studies (CESS, which became a National Institute under Ministry of Earth Sciences in 2014) and Kerala School of Mathematics (KSoM, a joint initiative with Department of Atomic Energy) promoting and practicingS&T relevant to the State. The grant-in-aid Institutions like Integrated Rural Technology Institute (IRTC),Sophisticated Testing andInstrumentation Centre (STIC)have been active in promoting development of S&T inrural sectors as well as providinginstrumentation support both for academic institutes as well as industries.

Kerala Biotechnology Commission has initiated many programmes to activate the Biotechnology sector in the State. The efforts of the Commission to bring together industries and R&D institutions of the State to work on industrially relevant problems are noteworthy.KBC's efforts to promote need based biotechnology research relevant to the State and the Biotechnology Integration for Rural Development programme to empower rural folks for sustainable livelihood generation through developing biotechnology related products is a laudable attempt to promote biotechnology at the grass root level.

There are many sectors in Kerala where science and technology can play an important role in making our State more competitive, such as in agriculture. The Council is planning initiating new programs in partnership with agricultural universities for enabling adaptation of technology available elsewhere or developing them indigenously to solve specific problems.The Council can also takea lead role in making the State more competitive in Educationandhealth-care sectors through partnering with health institutes,R&D centres and Universities in the State.

The plan for next Five-Years projected in this document including novel new schemes and programmes initiated for the promotion, support and popularisation of S&T trajectories and the focussed research programmes initiated by the R&D Institutions shall go in a big way for the overall growth and development of the State of Kerala during the next Five-Years and beyond.
We would like to place on record the invaluable support and help rendered by the members of the Working group, the Vice-Chairman and members of the State Planning Board and the Staff of the perspective Planning Divisions as well as the Directors of the R&D Institutes of KSCSTE for the compilation of this report. Hope and wish that this document becomes a blue print for formulating the Thirteenth Five-Year Plan for the overall growth of the State through Science & Technology interventions.

Dr. D. Balasubramanian
Co-Chairperson

Dr. Suresh Das
Co-Chairperson

CONTENTS

CHAPTER 1
INTRODUCTION

1. Government of Kerala has adopted a Policy Resolution on Science and Technology based on the recommendations of the Kerala State Committee on Science and Technology in 1974.Kerala was the first State in the country to constitute a State Committee for Science and Technology on the model of the National Committee on Science and Technology.In 2002, Government of Kerala has reviewed the structure of the Science, Technology and Environment Committee (STEC) and also the policy on Science, Technology and Environment so that the organization and the policy are in tune with the then conditions and development needs of the State. The STEC was also restructured as the Kerala State Council for Science, Technology and Environment (KSCSTE). In line with the Science and Technology policy 2002, the Department of Science and Technology and the Kerala State Council for Science, Technology and Environment have been making quality interventions in the S&T development of Kerala viz.science education, scientific research, environmental protection and in traditional systems of knowledge and innovation. A chain of Research and Developmental institutes has also been built up during these years. The government set up a separate Department of Science and Technology in 1972 to foster scientific research in different disciplines as a tool for the contextualized development of Kerala. During the last more than four decades, ever since the creation of STEC, through the various schemes, projects and institutions, multifarious activities have been undertaken by the Department of Science and Technology. These activities have successively added value to the entire Science and Technology Enterprise in Kerala. Kerala has also formulated Programmes of Action in tune with the changing phases of the National Policies in Science and Technology. India's Scientific Policy Resolution (SPR) of 1958 which resolved to "foster, promote and sustain""the cultivation of science and scientific research in all its aspects" continues to impact even now the scientific activities of the State. The Technology Policy Statement (TPS) of 1983 and the National Science and Technology Policy (STP) of 2003 have also found appropriate places in Kerala's strategic interventions in Science and Technology. The State has been continually integrating programmes of socio-economic sectors with the Research and Development interventions of the State to address the developmental priorities of the State. This has also helped in instilling an innovation culture. In line with the objectives of the 2010-2020, Decade of Innovation, various committees of the Government of India have been working for the last two years for the formulation of a new Science, Technology and Innovation policy for the country. In the recently concluded 100th Annual session of the Indian Science Congress Prime Minister of India released India's Science, Technology and Innovation Policy 2013.

2. The Kerala State Planning Board had constituted a 9-member committee chaired by Prof. C. G. Ramachandran Nair, Former chairman, Kerala Science, Technology andEnvironmentCommittee (STEC) in 2011.The committee had series of interactions with planners and scientist at all levels and submitted a concrete set of recommendation for the KSCSTE and the Department of Science and Technology for the contextual development of the State of Kerala.

Key Elements of S and T Policy 2013

1. Continuing the promotional activities for the spread of scientific temper amongst all sections of the society and creating everybody scientifically literate.
2. Encouraging high quality research and development to take Kerala to much higher levels of original research and cutting edge technologies.
3. Facilitating science and technology-based industries by effectively showcasing national and global technology development success stories.
4. Building a critical mass of scientists and technologists in Kerala for collaborative work in specific disciplines.
5. Identifying thrust area programmes looking at the natural resources of Kerala, particularly the diverse plant resources and specific mineral resources
6. Attracting externally funded projects for doing 'big science' from national and international funding agencies and from the corporate sector.
7. Creating science and Technology- based start-up for young entrepreneurs and student entrepreneurs.
8. Assessing the opportunities and challenges in the economic, social and environmental context of Kerala
9. Deploying specific schemes for providing research facilities for starting researchers
10. Providing training for environment management
11. Developing schemes for Technology Innovations
12. Creating science talent among children to motivate them for taking up science as a career
13. Formulating a scheme of selecting trainee scientists
14. Promoting Centre-State participation in deploying developed technologies in the areas of agriculture, fisheries, forestry and veterinary science on an S & T based approach
15. Identifying Kerala-specific thrust areas of traditional industry, constructions and energy
16. Providing S&T based skills and solutions for issues in water management, health and sanitation
17. Connecting the Science, Research and innovation system with the inclusive economic growth agenda of the state
18. Providing an enabling environment for gradual introduction of private sector participation in R&D
19. Promoting conversion of R&D inputs into societal and commercial applications
20. Implementing reforms in institutional structure, autonomy and research funding
21. Enhancing the capacities of existing R&D institutions in the State in a focused way
22. Formulating a scheme for Research Assessment Exercise (RAE) and grading individual scientists, groups and institutions on the basis of globally accepted parameters like publications, IP creating and knowledge transfer
23. Developing a scheme for a accreditation of laboratories which serve hospitals, universities, industries, R&D institutions and other organisations on the lines of the National Accreditation Board for Laboratories
24. Providing opportunities for women in science and technology and for reducing the gender disparity in doing and managing science

25. Promoting participation of researchers in climate change studies, water management, coastal mineral resources, integrated river action plan
26. Promoting traditional knowledge systems in agriculture and health
27. Incorporating quality parameters like citation analysis and impact factor for enhancing the quality of research publications
28. Revising recruitment and promotion policies by integrating quality and performance criteria
29. Creating an integrated R& D cluster servicing value chain in the long run
30. Promoting Kerala as a prominent research centre for select knowledge-based industries\
31. Promoting research inputs for high –end / technology enhanced manufacturing activity
32. Providing platforms and enhance industry-academia collaboration
33. Providing technically advanced and best in class research infrastructure
34. Cresting an effective networking platform between the stakeholders in Kerala `s research segments
35. Addressing the dearth in capital and finance options in the traditional R & D markets
36. Shifting from asset centric to outstanding and virtual lab models
37. Devising a fragmented approach to IP creation – modular integration approach
38. Lowering tolerance to redundancy and increasing talk of'efficiency' in R & D
39. Increasing use for commercial feasibility and financial scenario planning in science and technology
40. Creating an Industry interface in research area selection
41. Providing collaborative approach on solving industry related issues
42. Educating on basic valuation and finance skills for scientists to look at financial feasibility
43. Charting a road map for creating a forum to look at industry tie ups in research institutions
44. Enhancing public and political understanding of science

3. The overall Policy Vision for the S & T policy 2013 is Science, Technology and Innovation for Sustainable Development and Inclusive Growth in the socio-cultural and economic context of the State of Kerala. Human resource development and creating critical number of scientists working in each and every discipline relevant to the development of Kerala are the major challenges. Delivery of Science and Technology led solutions for improving the quality of life of the people and the environment is the thrust of the policy. The Report is largely framed in conformity to this vision.

CHAPTER 2
TWELFTH FIVE-YEAR PLAN (S AND T)

A Review

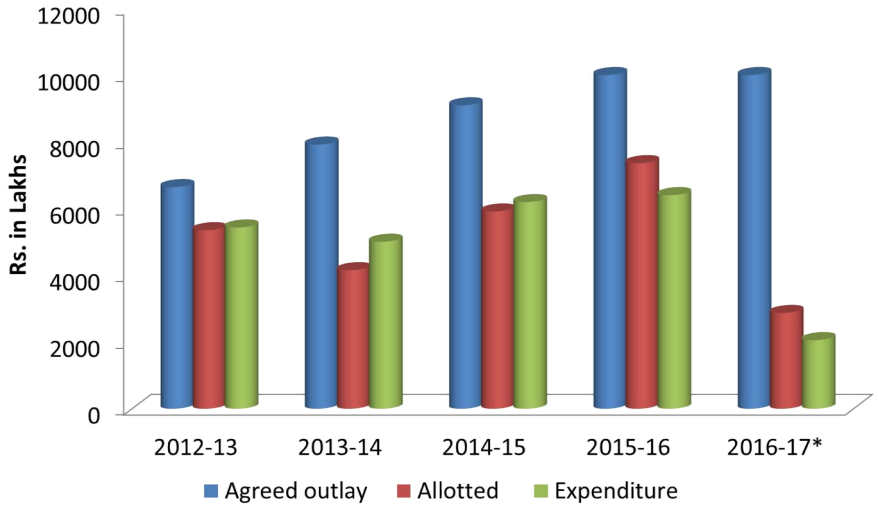
4. The **Twelfth Five-Yearplan** earmarked an outlay of **Rs.716 crores**(Rs.501 crores for KSCSTE and Rs. 215 crores for RCC) for scientific services and research; while it wasRs. 440 crores(Rs. 344.85 crore for KSCSTE, Rs. 83.58 crore for RCC and Rs. 12.52 crore for Kerala State Pollution Control Board) during the 11th plan period. Pollution Control Board did not figure in the Twelfth Five-Year Plan and the budget for the twelfth plan depicted a substantial escalation compared to the Eleventh Five-Year Plan

Table 1 *Year-wise outlay and expenditure during the 12thPlan period*

Financial Year	Agreed outlay (Rs. in Lakhs)	Allotted (Rs. in Lakhs)	Expenditure (Rs. in Lakhs)
2012-13	6645	5351.892	5434.82022
2013-14	7920	4153.61	5006.87331
2014-15	9097	5914.32	6195.06016
2015-16	10,004	7361.66	6403.94185
2016-17	10,004	2871.33*	2056.72543*

Note:(*till Sep.2016)

Figure 1 *Financial performance of KSCSTE during the 12thPlan period*



5. Kerala State Council for Science, Technology and Environment (KSCSTE) is an autonomous body under the Ministry of Science & Technology, Government of Kerala, constituted in November 2002 to act as an agency for change and development through

science and technology. Established in 1972 as Science, Technology and Environment Committee (STEC), in accordance with the Science Policy of Government of Kerala, the STEC was reconstituted as KSCSTE in 2002 and is governed by the State Council (SC) with the Chief Minister of Kerala as the President and an Executive Council (EC), chaired by the Executive Vice President (EVP) of KSCSTE.Presently, there are seven full-fledged R&D centres, two emerging research centres and two Grant –in- aid institutions under the umbrella of KSCSTE.

Major objectives of KSCSTE

1. to identify thrust areas in science and technology for speeding up the socio-economic development and enhancing the quality of life and environment in Kerala
2. to advise the Government on the formulation of policies and strategies and suggest measures for implementation, which will promote the application of science and technology to meet the perceived needs of the society, and manage natural resources
3. to assist in the preparation of the Science and Technology Development Plan of the State and in its implementation
4. to promote effective coordination between Centres of Scientific and Technological research, Government agencies, farms and industries including the private sector so that knowhow generated by scientific research is fruitfully deployed by transfer of technology
5. to support and coordinate research programmes in the universities and institutes of the Government, research and development laboratories of the private sector with a view to optimizing the scientific output
6. to consider and advise the Government on all such matters as are relevant to the application of science and technology to the economic, industrial, educational and social development of Kerala
7. to advise local self-governments on the use of Science & Technology for local application and local development
8. to network the Science and Technology agencies within and outside the country
9. to make the Science, Technology and Environment plans responsive to the development needs of Kerala and to detail them with the programmes of the economic, scientific and service departments of the Government such as agriculture, industries, power, water, energy, education and IT, educating and helping the Scientists and Innovators in protecting intellectual property rights.

6. The main objective of KSCSTE, therefore, is to plan and formulate science, technology and innovation policy pertaining to the development of the State. The schemes and programmes of the Council are primarily aimed at development of high quality science education system in the State through infrastructure strengthening for basic research and promotion of science pedagogy.

7. Situated at SasthraBhavan, Pattom, Thiruvananthapuram, KSCSTE operates 40 major schemes and programmes to promote S&T in the State providing support for scientific research, human resource and infrastructure development, technology and innovation,

environment conservation, science popularization and communication in addition to managing the R&D Centres and supporting Grant-in-aid Institutions.

8. The Plan allocation to KSCSTE under S&T component is made under following heads. The Head of account for KSCSTE Plan is 3425-60-200-71-36.
    1. Infrastructure strengthening of KSCSTE
    2. Research and Development Institutions under KSCSTE
    3. Schemes and Programmes of KSCSTE
    4. Grant-in-aid support to S&T Institutions
    5. Biotechnology Development
    6. Special Programmes of KSCSTE
    7. Karamana River Scientific Management Project (Pilot)

9. There are seven R&D Centres under KSCSTE:
    1. Kerala Forest Research Institute (KFRI)
    2. Centre for Water Resources Development and Management (CWRDM)
    3. Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI)
    4. National Transportation Planning and Research Centre(NATPAC)
    5. Kerala School of Mathematics (KSoM)
    6. Malabar Botanic Garden and Institute for Plant Sciences (MBGIPS)
    7. Srinivasa Ramanujan Institute for Basic Sciences (SRIBS)

10. The affairs of the R&D Centres are managed by the Director with the support of a Management Committee. The supervision and direction of the research programmes of the Centres are provided by a Research Council (RC).The Research Council has seven expert members with four from outside the State, including the Chairman and three from the State, including the Director who shall be the Convener. The RC meets at least twice in a year, and is vested with the responsibility to approve, monitor, review and guide the S&T projects and research activities.

Kerala Forest Research Institute (KFRI)

11. Kerala Forest Research Institute (KFRI) has a multidisciplinary team of experts conducting research on tropical forests and forestry. Founded in 1975, the institute has contributed significantly to the research in tropical forestry and biodiversity conservation over the past four decades of its existence. KFRI functioning under STEC became a part of KSCSTE in 2002. The institute is envisioned as a Centre of Excellence in Tropical Forestry to provide scientific support for decision making on matters related to forestry, with particular emphasis on conservation, sustainable utilization and scientific management of natural resources.

12. Sustainable management of forests requires a strong science and technology base.It requires a shift in thrust for forest management assigning greater importance to the environmental functions of forests.Working in collaboration with the Forest department and other

stakeholders, the Kerala Forest Research Institute continues to play a key role in improving the science foundation of forest management.

Table 2 *Financial Performance during the 12thFive-Year Plan Period*

Year	2012-13	2013-14	2014-15	2015-16	2016-17
Allotted amount	820.00	793.32	802.50	746.64	186.66
Expenditure	820.00	793.32	802.50	746.64	150.00*

*Note:*as on September 2016

13. Major achievements during 12th Plan
    1. Govt. of India had identified KFRI as one of the organizations for imparting training to the officers of the Indian Forest Service (IFS)
    2. The institute has offered various training programmes to the society in subjects concerned with biodiversity conservation and natural resources management.
    3. All the publications of KFRI are in public domain and can be accessed by interested persons.
    4. The Scientists have published 40 research papers in National Journals, 74 in International journals, 11 books, 3 book chapters and 3 popular articles and submitted 500 gene sequences in GenBank during the 12th plan period.
    5. 15 researchers were awarded with Ph.D. degree; trained 493 in different sectors; conducted 46 training programmes; supported 2 international, 16 national and 4 regional conferences.
    6. Released CDs concerned with all KFRI Research Reports in one CD, bibliography on teak and bamboo, forest resources of Kerala, bamboos, teak defoliator (Video), flowering plants of Kerala, identification of trees of Kerala, weeds of India (*Mikania*).
    7. Identification manuals were prepared for rattans, palms and bamboo and forest trees of Kerala.
    8. Bio-resource quantification of the State using remote sensing and ground truthing, bamboo planting to prevent soil erosion and river bank stabilization, bamboo resource estimation using remote sensing, sustainable utilization of three endemic reed species, Erankol, Koorankolly and Arayamboo and post-harvest technologies for bamboo stocking are the other recent contributions.
    9. Other activities of the Institute include summer course during the month of April for the benefit of students through open registration.
    10. May 21 is celebrated as Teak Museum Day and various programmes organized for the benefit of public. Specialized training in teak cultivation and management offered to the interested sections of the society.
    11. Other prominent days like World Environment Day, World Forest Day, World Bamboo Day, Wildlife Week were also celebrated.
    12. Teak Museum (the only one of its kind in the whole world) display all traditional household articles made in teakwood and the Museum imparts knowledge of various activities of teak through these programmes.
    13. KFRI also maintains a Bamboo Processing Centre at its FRC campus in Veluppadam for CFC demonstration, training and for the changing bamboo innovations to enterprises.

Centre for Water Resource Development and Management (CWRDM)

14. CWRDM is a premier R & D institution in the water sector established by the Government of Kerala in February 1978. The Centre was amalgamated with the KSCSTE in 2002. CWRDM has substantially contributed to the scientific hydrologic studies and water management in the region. The Centre provides research inputs for water resources development and management, especially in the humid tropics and has expertise in tackling different problems pertaining to watershed development, wetland management, water management for agriculture, forest and urban hydrology, estuarine management, groundwater development, water quality management, water related environmental issues and irrigation and drainage issues. The Centre is proud to have many ongoing and completed programmes funded by national and international agencies including Government of India, United Nations Development Programme, United Nations Environment Programme, UNICEF, World Bank and National Academy of Sciences (USA). Presently, CWRDM has 10 scientific divisions and 3 extension centres.

Table 3 *Financial Performance during the 12thFive-Year Plan Period*

Year	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17***
Amount	1516.00	1254.01	1735.91	2138.32	694.15
Financial achievement	1419.30	1459.82	1569.17	1915.66	705.59

*Note:**as on September 2016

1. Major achievements during 12th Plan
2. Ministry of Drinking Water & Sanitation, Govt. of India, has recognized CWRDM as a Key Resource Centre (KRC) for imparting training on Water Supply & Sanitation to different stakeholders.
3. CWRDM is recognized as WALMI of Kerala to impart training to Department officials, Farmers, elected representatives and all stakeholders involved in Land and Water Management
4. Received NABL accreditation by the DST, Govt. of India, for the Water Quality Laboratory of CWRDM
5. Coordinated with Ministry of Environment and Forests, Govt. of India and Directorate of Soil Conservation, Govt. of Kerala for implementation of management action plan in the Ramsar wetlands *viz.*, Ashtamudi and Sasthamkotta.
6. CWRDM carried out feasibility studies on inter-linking of rivers in Kerala with rivers of other States
7. Prepared Integrated River Basin Management Plan of Chaliyar Basin
8. Rejuvenation and Pollution Abatement ofPamba River
9. Revised State Water Policy
10. Participated in Save Pamba –Save Vembanad Campaign
11. Prepared Liquid Waste Management and Seepage Management Policies for Kerala
12. Prepared a comprehensive Master Plan for the Conservation of Sasthamkotta wetland
13. CWRDM along with CESS and KFRI prepared a Wetland Atlas of Kerala

14. Prepared a draft bill on State River Basin Management Authority.
15. Formulation of guidelines for implementing manual dredging of minor ports
16. Carried out essential baseline studies for formulating policy for house boat tourism at Vembanad Lake**.**
17. Establishment of National facility for research in basic and applied sciences using stable isotope techniques, with funding from DST, Govt. of India
18. CWRDM has been recognized as one of the Key Research Partners by International Institute of Applied Systems and Analysis (IIASA), Austria
19. Duplicated.
20. Academic & Research Linkages developedwith KTH, Mac Master University, NRSC, IITs, NITs, etc.and signed Memorandum of Understanding with National Institute of Hydrology (NIH), Roorkee and College of Engineering Trivandrum.
21. Organized several international / national / state level symposia, workshops, conferences and seminars for the visibility of the organization and to disseminate the findings. To name a few ***International meet*** of NASA – LCLUC; ***International Symposium*** on IWRM during 2014 ; Workshop on Water Vision -2030 during 2015;26th& 28th Kerala Science Congress, during 2014 & 2016; etc.
22. ***Govt. of Odisha:*** Training programmes on Agricultural Water Management for Senior and Middle Level Officers of Department of Agriculture and Food Production,
23. ***HIRMI, Haryana***: One weekTraining-cum Exposure visit of Officers and Farmers
24. ***TNAU, Tamilnadu***: 'Training cum- study tour on 'Water management' for the Asst Engineers of AgriEnggDept, Govt. of Tamil Nadu
25. Drip Fertigation technology transfer
26. Wick irrigation as a water saving irrigation technique in terrace gardens to promote vegetable cultivation in all the Districts of Kerala
27. Mangrove & Aquaculture cultivation promotion
28. Ferro-cement technology for roof-top rainwater storage tanks – Handbook published
29. Development of springs as a source of rural water supply
30. Isotope technique to solve hydrological problems
31. Introduction and distribution of Drinking Water Card in selected panchayats like Kunnamangalam, Olavanna, etc.
32. Publication of two hand-books on Water and Sanitation for children of LP and UP levels on "Clean Water – Safe Water" under UNICEF support
33. A manual on drip irrigation has been brought out by the centre (Both in English andMalayalam) under MoWR, GoI support
34. Established Water Quality Laboratory – Analysis of Water samples and giving the results as per the prescribed fees.
35. CWRDM has established a Water Heritage Museum, portraying the history of development and management of water resources in Kerala and to create awareness on conservation and management of water at a nominal fee to general public
36. The Scientists have published 56 research papers in National Journals, 36 in International journals, 51 books and 93 technical reports during the 12th plan period.
37. Nine researchers were awarded with Ph.D. degree; trained 1573 in different sectors; supported 2 international and 30 regional conferences

Kerala School of Mathematics (KSoM)

15. Kerala School of Mathematics (KSoM), an institution meant for advanced learning and research in Mathematics is established in 2003, is a joint venture of Kerala State Council for Science, Technology and Environment(KSCSTE) , Government of Kerala and Department of Atomic Energy (DAE),Government of India. KSOM aims to play a catalytic role in reviving the great mathematical tradition of Kerala in the modern paradigm. The school which will be run as a national facility envisages promotion of mathematical research in the country and Kerala in particular, through activities such as research at doctoral and post-doctoral level, workshops in frontier areas of mathematical science, national and international conferences, instructional conferences, structured courses and lectures for young mathematicians, training for post-graduate students, research scholars and teachers. While contributing to the development of mathematics in the region, the School will be a meeting ground for mathematicians from home and abroad

Table 4 *Financial Performance during 12thFive-Year Plan Period* rupees in lakh

Year	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17 (Tentative)**
Amount	100.00	66.64	91.65	86.68	21.67
Financial Achievement	62.04	52.60	54.95	51.37	12.42

16. Major achievements during 12th Plan period
    1. *Development of Library* – with print and digital resources catering to the growing information and intellectual requirements of researchers, faculties and students.
    2. *Development of Computing Facilities* – with additions of powerful facilities for providing support for diverse computing requirements, access to bibliographic databases and archives for rapid retrieval of relevant information and for updating and dissemination of academic and research materials.
    3. *Extension of Physical Infrastructure* – Extension of classroom and lecture hall facilities in a way that they provide a conducive environment which is needed for adequate learning and research.
    4. Constructed a well-designed Hostel block capable of accommodating over 50 occupants with canteen and other facilities including LAN/*Wifi* connection.
    5. Published 8 international research articles; supported 9 international, 16 national and 33 regional seminars.

Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI)

17. The institute was established in 1979 by Government of Kerala under STEC for conserving the tropical plant genetic resources and to develop strategies for their sustainable utilization. JNTBGRI became a part of KSCSTE in 2002.The institute is currently conserving more than 4000 species of flowering plants and about 300 species of non-flowering angiosperms, which is the highest number of plant species conserved among the botanic gardens in Asia. The institute has an extension centre *viz*., SaraswathyThangavelu Centre at

Puthenthopewhere the Bioinformatics Centre is established. The Government of India has recognized the JNTBGRI as a National Centre of Excellence. Presently, the institute has 9 scientific divisions involved in research activities including ex-situ conservation and management of plant wealth of the country, biodiversity documentation, systematic studies, conservation and management, bio prospecting (biotechnological, phytochemical and pharmacological) of plants for sustainable utilisation, documentation of indigenous knowledge, education, extension and training on conservation and sustainable utilization of plants with financial assistance from different state and national funding agencies.

Table 5 *Financial Performance during 12thFive-Year Plan Period* rupees in lakh

Year	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
Amount	720.00	910.00	1029.00	1201.00	1201.00
Financial Achievement	513.89	515.488	695.644	652.11	200.16

18. Major achievements during 12thFive-Year Plan
    1. Mandatory programme of the institute such as biodiversity conservation and sustainable utilization continued.A total of 4,000 plant species/ varieties are maintained in the conservatories.Among these 450 species were newly introduced during the plan period.
    2. 30 species of flowering plants and 12 species of Mushrooms were described new to Science from the Western Ghats.
    3. Well established herbarium housing 32,000 specimens of flowering plants and 16,000 specimens of Mushrooms are maintained.
    4. Biotechnological, Phytochemical and Pharmocological prospecting of about 125 species of economic importance completed.
    5. The complete plant wealth of the Western Ghats was documented and published.This work records 7402 flowering plants among which 5588 are indigenous, 375 exotic, 1279 endemic, 1438 cultivated/planted.
    6. Successfully implemented the greening work of games villages and 6 stadiums in connection with National Games 2015 which was well appreciated by the Government of Kerala.
    7. Mega projects on development of tissue culture saplings of Banana (under RashtriyaKrishiVikasYogna), development of R&D centre for sustainable utilization of fibre yielding plants (funded by KSIDC) and development of compost from garden wastes (funded by NABARD) were successfully implemented.
    8. JNTBGRI received State Biodiversity Award 2015 for the work on conservation of Biodiversity of State.
    9. Published 313 international and national research articles, 18 books, submitted 450 gene sequences in GenBank; received 9 patents; 34 researchers were awarded with Ph.D. degree
    10. About 800 farmers from various parts of the state were given training on nursery management as part of the programme of Kerala State Agricultural Department; 50 students and teachers were trained on Herbarium techniques and Plant taxonomy; 45 researchers and Scientists were trained on Molecular Biology

11. About 3 lakhs people visited the garden during the plan period and gained knowledge on plant wealth of Western Ghats and awareness on conservation and sustainable utilization of plant wealth.
12. About 10,000 B. SC and M. SC students from various parts of the country had visited the herbarium and the various laboratories and familiarized the research work of the Institute.
13. Supported the workshop of BGCI held at JNTBGRI on seed Banking; five brainstorming sections of DBT, DST, CSIR and MoEFCC.
14. Supported KSCSTE in the active implementation of 25th and 26th Kerala Science Congress, held at Thiruvananthapuram and Wayanad respectively.
15. Panchayat level awareness programmes on medicinal plant cultivation and sustainable utilization were regularly conducted throughout the Grama Panchayats of Kerala as part of documentation of traditional and indigenous knowledge.

National Transportation Planning and Research Centre (NATPAC)

19. National Transportation Planning and Research Centre (NATPAC) was established in 1976 as a Division of Kerala State Electronics Development Corporation (KELTRON), a Public Sector Enterprise under the Government of Kerala. In 1982, NATPAC was reconstituted as an R&D institution under the Department of Science, Technology and Environment, Government of Kerala. NATPAC became a part of KSCSTE in 2002. The Centre is undertaking research and consultancy works in the fields of traffic engineering and transportation planning, highway engineering, public transport system, alternate options for transport system, transport energy, inland water transport, tourism planning andrural roads. The activities of NATPAC range from surveying to preparation of technoeconomic studies, feasibility analysis, detailed project reports for infrastructure development projects involving multi-modal system of transportation covering road, rail, water, ports/harbours and airports. Currently, NATPAC has 7 scientific divisions.

Table 6 *Financial Performance during 12thFive-Year Plan Period* rupees in lakh

Year	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
Amount	808.00	738.35	550.00	621.00	900.00
Financial Achievement	450.00	408.30	474.15	414.00	621.00

20. Major achievements during 12thFive-Year Plan
    1. NATPAC has won the contract for implementation of CSR programmes of M/s. MarutiUdyog Limited worth Rs. 67 lakhs at Haryana recently and actions are going on for its implementation.
    2. Prepared the Transport Policy, Road Safety Policy and Guidelines for outdoor advertisement for the State.
    3. National Level Certificate of Appreciation from Maruthi -Times now Road Safety award in the institution category for 2015.
    4. Prepared the Comprehensive Mobility Plan for Thiruvananthapuram and Kozhikkode which is a prerequisite for implementation of MRTS for the cities.

5. Government has authorized NATPAC as the Centre for conducting mandatory training to drivers carrying hazardous goods
6. NATPAC successfully organized 27th Kerala Science Congress at Alappuzha from 27-29 January 2015 in association with KSCSTE and other partner organizations.
7. Office building constructed at Aakkulam
8. Made 245 road safety publications; 74 seminar presentations; 313 road safety programmes, organized 72 seminars/conferences.

Srinivasa Ramanujan Institute for Basic Sciences (SRIBS)

21. Srinivasa Ramanujan Institute for Basic Sciences (SRIBS) is a capacity building Institute envisaged for Research, Teaching and Learning in Basic Sciences. SRIBS was established by the Govt. of Kerala in 2013. The main objective of the institute is to formulate and implement programmes for capacity building for young faculty members, researchers and post graduate students in contemporary areas of sciences. The institute has organized several colloquia, seminars, workshops and symposia with the support of over 200 internationally acclaimed scientists from about 100 premier institutions around the world, benefitting over 1500 students, teachers and researchers in various areas of science.

Table 7 *Financial Performance during 12th Five-Year Plan Period*rupees in lakh

Year	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
Amount		332	862	1078	909
Financial Achievement		107	122	92	

22. Major achievements during 12th Five-Year Plan
    1. A draft BILL for establishing the institute as an autonomous body by an act of legislature has been prepared and clearance of the Law Department has been obtained.This is pending with the Government.
    2. DPR was prepared and submitted to Government for approval.
    3. 3 Nobel laureate lecture series were conducted:
        1. Prof. Ada Yonath (Nobel Laureate in Chemistry)
        2. Prof.Ferid Murad (Nobel Laureate in Physiology or Medicine)
        3. Prof. Eiichi Negishi (Nobel Laureate In Chemistry)
    4. 10 acres of land has been obtained from Government of Kerala for the construction of the building, and preliminary steps for the construction has been started
    5. Organized three international and 30 national seminars

Malabar Botanical Garden and Institute for Plant Sciences (MBGIPS)

23. The Malabar Botanical Garden & Institute for Plant Sciences (MBGIPS) is an institution of KSCSTE dedicated to the conservation and research on aquatic plant diversity, lower group plants, endangered plants of the erstwhile Malabar Region, as well as disseminating knowledge on various facets of plant sciences. MBGIPS is situated adjacent to Pokkunnu at

Olavanna village in Kozhikode District. The Garden is spread over an area of about 40 acres of which about 15 acres is marshy land and the remaining part is a hilly terrain providing diverse habitats for varieties of plants. The Malabar Botanical Garden and Institute for Plant Sciences is unique for ex situ conservation of aquatic/wetland plants and for undertaking research on them.A Systematics Garden, Aqua-conservatory, *HortusMalabaricus* Garden, RET species conservation, lower group conservatory are the highlights of the Garden. The Garden is open to students for eco-education and to general public as part of promoting scientific tourism in the region. The educational value of the Garden lies with the descriptive labels displayed for the different sections and plants This institute is also a Research Centre in Plant Sciences (Botany) recognized by the University of Calicut.

Table 8 *Financial Performance during 12thFive-Year Plan Period*

Year	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
Amount (Rs.)	66,67,000	93,33,000	66,65,000	1,96,68,000	*16,66,000
Financial Achievement	100% utilization				Under utilization

24. Major achievements during 12thFive-Year Plan
    1. Conservatories for Bryophytes, Pteridophytes, Lichens, Victoria plants, Spices of Malabar, Xerophytes
    2. In-vitro Gene bank established.
    3. Lead Garden in Aquatic Plant Diversity
    4. First phase of Systematic Garden – a garden for Plant classification based on Benthem and Hooker classification – completed.
    5. New Fern House – A four tier conservatory for aquatic, marsh, terrestrial and epiphytic Pteridophytes (3rd Conservatory for Lower plant groups) –completed
    6. Published 6 books, 7 book chapters, 19 research papers in international journals, 17 in national journals, submitted 15 gene sequences in GenBank; 8 students registered for Ph.D. and their work is progressing.
    7. Supported one international and 3 national seminars
    8. Other Major achievements:

25. Fellowship Titles of National Academy of Biological Sciences (NABS 2012.), Leadership Award of NABS 2015, Gregor Mendel Foundation 2016, Eminent Scientist of the Year 2015 Award in the International Conference on Ecology & Environment 2016, Life Time Achievement Award 2014, Indian Fern Society, Best Microbiologist Award 2015 (SERS) etc to the researchers of MBGIPS.
    1. *New Species Reported – One (Oldenlandiadineshii) – Rubiaceae*
    2. *New Report – Two (Dipcadimontanum&Enydrafluctuans)*
    3. *Isolated and identified 3 strains of oil degrading bacteria and 6 strains of plastic degrading bacteria*
    4. *Isolated Usnic acid from lichens and Acridine from Lunularia (Bryophyte)*
    5. *Established an in vitro Genbank of Nymphoideskrishnakesara, Bacopamoneirri, Linderniamanilaliana and Heliotropiumkeralense.*

Schemes and Programmes of KSCSTE

26. Apart from coordinating the R & D activities of the Centres, the council is also directly implementing the following schemes and programmes:

Human Resources Development in S&T

1. Science Research Scheme SRS
2. Emeritus Scientist Scheme
3. Student Project
4. Scheme for promotion of young talents in Science (SPYTiS)
5. KSCSTE Research Fellowship
6. KSCSTE Post-Doctoral Fellowship
7. Training for Science, Technology Management

Ecology & Environment Programme

1. Ecology and Environment Programme and Environmental Education
2. Eco-clubs in Govt. Aided Schools
3. Environment Management Training
4. Environment Early Career Research Award Scheme
5. Wet Land Conservation
6. Outstanding Environment Award
7. Botanical Garden at Munnar
8. **Science Popularization**
9. Science Popularization Programmes
10. National Science Day Activities
11. National Technology Day Activities
12. Support for Seminar, Symposia, Workshop (SSW)
13. Technology Festival (TechFest)
14. Rural Innovators meet (RIM)
15. Kerala Science congress
16. National Children's Science Congress
17. Science Literature Awards
18. Kerala Sastrapuraskaram
19. Kerala State Young Scientist Award (KSYSA)
20. Science, Media Support, Documentation and Publication

Infra-Structure Development in S & T

1. Selective Augmentation of R & D activities (SARD)
2. Sastraposhini& Nurturing Excellence in Science Teaching (NEST)

Technology Development Programme

1. Patent Information Centre (PIC)
2. Engineering and Technology Programme (ETP)
3. Technology Development and Adaptation Programme (TDAP)
4. Rural Technology Programme (RTP)

Women Empowerment in S & T

1. Programme for women in Science
2. STARS

Kerala Biotechnology Commission (KBC)

27. Government of Kerala had announced its Biotechnology Policy in 2003. The BT policy for Kerala is designed to catalyze the development and application of BT, taking advantage of the State's resources and emphasizing its specific needs while meeting global requirements. The policy is aimed to ensure the rapid exploitation of pipeline technologies and opportunities available in the State to products and processes and to promote the sustained build-up of an elite knowledge cadre and knowledge base through the strengthening and creation of educational and R&D institutions, establishing infrastructure and putting in place administrative, regulatory, legal and financial framework conducive for investment and growth of BT enterprises, for the economic development and human welfare.

28. To achieve the vision in Biotechnology, to ensure hazzle-free implementation and to provide sustained leadership and resources, two major initiatives, Kerala Biotechnology Board and Kerala Biotechnology Commission were made in 2003. The Biotechnology Board will take all top level administrative and financial decisions to create the best environment in the state for growth of BT.The Kerala Biotechnology Commission is responsible for the implementation of the BT policy and other guidelines laid down by the Biotechnology Board

29. The **Kerala Biotechnology Commission** (KBC) is responsible for the implementation of the Biotechnology policy and other guidelines laid down by the Biotechnology Board. The Biotechnology Board will take all top level administrative and financial decisions to create the best environment in the state for the growth of BT. Currently KBC is serviced by KSCSTE.

30. The various programmes taken up for promoting biotechnology development include:
    1. Young Investigators Programme in Biotechnology (YIPB)
    2. Industry Linked Biotechnology Research Scheme (IBRS)
    3. Biotechnology Innovation for Rural Development (BIRD)
    4. Biotechnology Training and Workshop Programme (BTW)
    5. Post- Doctoral Fellowship (PDF).
    6. Biotechnology Young Entrepreneur (BYE) Award
    7. Kerala BiotechnologyRe-entry Fellowship (K-BIREF)
    8. Biotechnology Education Programme

Special Programmes of KSCSTE

Kerala State Centre for Assistive Technology

Centre for Assistive Technologies for Blind- S&T-based skill development programmes.

31. The KSCAT is currently under special programmes of KSCTE The Centre will be developed into a full-fledged R&D institution to address the problems of physically challenged.

Other Major achievements

1. A full-fledged training centre is established in the Farook College Campus, Kozhikode for the training of visually challenged students. Both Career Centric Computer Training and Basic Computer Training will be imparted through the centre.
2. KSCAT is currently developing Malayalam speaking web software application for converting Malayalam PDF and image file to text file and further transferring to audio. This will be useful for those who have visual impairment.

Trainee Scientist Programme

32. The Trainee Scientist Programme is primarily meant to provide temporary placement to highly qualified scientists, engineers, and technologists who possess good academic record and have not been able to secure regular employment. It's a sort of Research Associateship.The total number offered limited to 10. The Trainee Scientist Programme is not a regular appointment, but is a temporary facility to enable the Associate to do research/teaching while looking for a regular position. The Associateship is for a period of three years only. There is no provision for extension beyond three years.

Creating Science Talents for motivating Research (CREST)

33. It is an innovative programme proposed by the KSCSTE for attracting fresh talents to pursue Science as a career. The basic objective of CREST is to communicate to the youth of the State the exciting opportunities and career options that are open to them and to learn study of scientific facts at an early age and thus build the required critical human resource pool for strengthening and expanding the Science & Technology system and R&D base in Kerala. It is proposed to utilise the benefits of ICT, especially Virtual Classroom Technology to impart real-time and offline training to Students Researchers, Teachers and identified target groups.As part of this Core infrastructure will be developed, which can be utilised as a common facility by Kerala State Council for Science, Technology and Environment and its R & D Centres for disseminating Scientific Knowledge.

Dr. A. P. J. Abdul Kalam Youth Challenge Programme

34. This programme is introduced in memory of late Dr.A. P. J. Abdul Kalam. This programme targets the youth in the State for taking up challenges in specialized sectors. This is aimed to

encourage them to propose their innovative ideas to solve the issues faced by the society. Any youth below 30 years of age and a permanent resident of Kerala can apply for the programme. Educational Qualification is not a barrier for applying for this programme. After different levels of evaluation, maximum up to 10 proposals will be given up to Rs. 5 lakh to develop the prototype/working model, which shall be completed within 1 year. After the development of proto, the best Innovation will be selected and awarded with Rs. 50 lakh, along with technical support and guidance in developing the technology based on the proposal.The programme was initiated during the financial year 2016-17.

Scientific Management of Karamana River (Pilot Project)

35. The Karamana River Scientific Management Projectwas initiated as pilot program of Twelfth Five-Year Plan (2012-17) under the Head of Account 3425-60-200-63(P). The objective of the project is to develop and implement a Comprehensive Action Plan for Scientific Management of Karamana River Basin.This special Project was conceived andbeing implemented by the S&T Department in co-ordination with TRIDA, Kerala State Biodiversity Board & Irrigation Department under the guidance of a "River Restoration Co-ordination Committee" comprising of KSCSTE, Trivandrum Development Authority (TRIDA), Biodiversity Board, Irrigation Department, Revenue Department, Environment Department, Thiruvananthapuram Corporation, GramaPanchayaths through which the river passes, Environmental Experts, FRAT, MPs, MLAs and Councillors.

CHAPTER 3
PROGRAMMES OF 13THFIVE-YEAR PLAN

Kerala State Council for Science, Technology and Environment (KSCSTE)

Schemes and Programmes of Council Headquarters

Infrastructure Strengthening of KSCSTE

37. The Kerala State Council for Scientific Technology and Environment (KSCSTE) is responsible for steering the development of scientific research in Kerala and for financing research and development projects in the scientific domain in the State. One of the barriers to high-quality research and education is the lack of an adequate Information and Communication Technology (ICT) infrastructure. Development of the infrastructure for information technology and computing facilities within the scientific communities ranks very high among the KSCSTE priorities. This includes improving the means of information exchange, accessibility of information resources and broadband connectivity, as well as building up of better computing capabilities. The quality of scientific research can be improved with suitable IT interventions. Since IT field is constantly undergoing rapid developmental changes, in order to keep abreast with the pace of development else where we have to constantly upgrade our IT infrastructure and also should have financial provision to meet the operational expenses of ICT infrastructure which has already been deployed. Other subcomponents are as follows.

AMC of Equipments

38. Annual Maintenance Contract and Preventive maintenance is a set of planned maintenance activities aimed at prevention of breakdowns and failure of ICT and other physical infrastructure. KSCSTE houses a large number of equipment, elevator, Fire-alarms, and other electronic infrastructure including ICT that requires AMC. Untimely and unforeseen breakdown of any of those components may upset the whole management and administration process.So AMC is very much essential.

Maintenance of Building

39. SasthraBhavan houses three important offices viz., KSCSTE HQ, S&T Department, and NATPAC. The building is more than a decade old and requires replacement of electrical and plumbing fittings, replacement of rubber beadings of glass panels, periodic maintenance like painting and incorporating safety features to the building, occupants, furniture, equipment and other office documents. Therefore it is essential to carry-out proper up-keep and maintenance of the building and occupants (Surveillance CCD cameras and CCTV).

Strengthening of the Council Library

40. Science and Technology is a fast developing field and in order to keep abreast with the development, an organization should have a good referral library with books and research journals on scientific domain.Hence the Library needs to be strengthened with adequate books, journals, periodicals, and other literature and electronic referral library. Similarly adequate furniture, cupboards, book racks, journal racks, etc., are also needed for the library.

Enhancing and Electronic Referral Library

41. KSCSTE has already developed a digital library using Dspace and houses 34000+ bibliographic records of S&T related publications that has emanated from the state since 1996.Full Text of the available and Copy-left bibliographic items are scanned to digitalise the publications of erstwhile STEC and KSCSTE and regularly added to the digital collections.Digital libraries are the latest trend and offer various advantages to the users, in addition to 24 X **7** accessibility. Membership to the digital library consortiums is planned to be availed so as to enable the academics and researchers to retrieve and share information. It is also proposed to develop a consortium of S&T Libraries under the Council and also to interlink with other major R&D Organisations like CSIR, ICAR, DST NKN etc. which would include necessary IT infrastructure like servers, data storage, electronic data processing, etc.

New Office Premises for KSCSTE Head Quarters

42. KSCSTE Headquarters, Sastrabhavan, is located at Pattom, Thiruvananthapuram on the main road Pattom - Kesavadasapuram.The building is placed among other major office buildings viz LIC, Bishop House, and Planning Board, KV Pattom, PSC Office and many other commercial establishments. A part of NATPAC unit is also functioning in this building.Though it is located at the prime location, lack of space in and around the building causes congestion. The office has very limited parking space too.

43. The construction of this building has not followed the concepts of Green building.Green building (also known as green construction or sustainable building) refers to both a structure and the using of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition.Since KSCSTE and its associated R & D Institutions are promoting good science and stand as models for conservation and sustainable utilisation, the KSCSTE Headquarters must be a model for all these.Now huge amount is being spent for conducting academic meetings like seminars/workshops/brain storming sessions etc because of the lack of space in the current building. The invited guests are accommodated in hotels, which are too expensive.

44. All these difficulties prompt for a new building for KSCSTE.The new building, which follows all the concepts of green building, can house the KSCSTE HQ, seminar complexes, quarters, dormitories, guest houses and will have adequate parking space and greenery.The

building will be utilising non-conventional energy sources and rain water harvesting facilities.When the proposed building is materialised, KSCSTE can save a lot of money, energy and time for conducting various academic programmes which could be run in the campus itself. The affiliated institutes can also utilise these facilities paying a nominal charges and these facilities can also be rented out for decent functions (to be categorised later), thus helping to defray the running costs.When the new building is materialised, the current building can be rented out for suitable purposes also.

Partnering Academic Industrial Research (PAIR)

45. KSCSTE proposes to launch a new programme 'Partnering Academic Industrial Research (PAIR)' for developing industrial partnership.The Scheme will emulate research personnel trained for industrial requirement ensuring career prospects and placement through a well-articulated tripartite agreement between KSCSTE, Academic Institution and industry. This industrial partnership in terms of sponsored research programmes shall encourage translational research leading to the development of a process or product beneficial to the State of Kerala. The industrial partner shall provide the fellowship for the candidate who shall execute a project relevant to the sponsoring industry.The institution wherein the candidate pursues the research shall have a mentor for guiding the candidate and KSCSTE shall provide research support. Industries willing to participate in the Scheme will be identified and the candidates will be selected through a rigorous screening by an Expert Committee.An Advisory Committee comprising eminent Academicians, Industrialists and Scientists will meet periodically and provide guidance for the successful implementation of the Programme. The candidate shall register for Ph.D during the Scheme with a Mentor from the Academic/Research Institution as per the research requirement of the Industry.An amount of Rs. 310 lakh is allocated towards this during the 13thFive-Year plan.

46. Expected Outcome: The Scheme is very unique and will emulate research personnel trained for industrial requirement ensuring career prospects and placement. This industrial partnership in terms of sponsored research programmes through tripartite agreement between KSCSTE, Academic Institution and industry shall encourage translational research leading to the development of a process or product beneficial to the State of Kerala.

KSCSTE - CRYSTAL programme

"Mould Them Young and Watch Them Grow"

47. Today, India is going through a phase of dynamic transformation in the field of science and technology. Fortunately, we are equipped with potential youth power to address the rising challenges. Studies have predicted that by 2020, India will become the world's youngest country with nearly 64% of its population in the working age group. Further, the State of Kerala is projected to be one among the major States with large share of youth power with formal skills. Hence, it is necessary to frame a programme to nurture our budding talents and provide them exposure to the state of the art research facilities at early stage.

48. KSCSTE –CRYSTAL [Crafting Young Scientists of Tomorrow] programme is aimed at creating a platform to mould the budding scientists of the nation. Behind every successful person, there is always a person who has inspired him/her at an early stage of his/her life. S/he can be a teacher, a scientist who delivered an inspiring talk or could be the parent itself. The age between 13 to 15 is ideal for moulding a student as s/he not only steps into teenage but also into high school, where s/he begins to identify her/his realm of interest.

Mode of implementation

1. Every year a group of 10 students (maximum) studying in Class IX will be selected from the State through a rigorous screening process comprising of online test, GD and interview.
2. A group of experts comprising of reputed teachers, senior scientists and renowned academicians will be identified to form a **Mentor Group**. Each student will be attached to a mentor for a specific period of time. The mentors guide the students to identify their interest area of interest at an early stage and pursue a career according to their talents.
3. The selected students will be awarded annual scholarships from Class IX to XII as follows, based on their performance evaluation:
    1. Rs. 10,000/- during first year
    2. Rs. 15,000/- during second year
    3. Rs. 20,000/- during third year
    4. Rs. 25,000/- during fourth year
4. An MoU may be signed with selected State and National research institutes and the students will be given opportunity to participate in regular or customized training programmes including summer camps every year till Class XII.
5. A meritorious student from a batch will be selected and sponsored to attend a training programme at a reputed institute abroad
6. The scholarship will be terminated once the student completes Class XII and chose a career of her/his choice

Unique features

1. annual scholarship to purchase books, travel and attend training classes
2. regular mentoring by reputed scientists and academicians
3. opportunity for interdisciplinary training at leading science and technology research institutes of India and abroad
4. intensive trainings to prepare for national/international competitions including science Olympiads with the help of institutes like HomiBhabha Centre for Science Education (TIFR)
5. career guidance by experts in the field of S&T

Science Education Centre

49. One of the main mandates of the Kerala State Council for Science, Technology and Environment is to develop a high quality science education system in state. The education system in Kerala is with good academic achievements in 100% literacy including female

literacy, maximum women participation in teaching sector. For the last one decade, the number of educational institutions has increased drastically especially in the unaided sector. This has created a backslash in the quality of science education, especially in the Government sector in rural Kerala. This is mainly because of the lack of good laboratories for science teaching, lack of proper orientation/in-service training for the teachers, lack of updating of the modern methodology and lack of proper monitoring.

50. Realising the importance of a Training Centre for Science Teachers and Students, this centre is in tune with the Centre for Science in Society (CsiS), CUSAT. The proposed centres will be at Trivandrum and Kannur.

Objectives

1. To stimulate interest in science at the school level by performance of experiments in Physics, Chemistry and Biology by the students
2. To provide hands on experiments to students for observation, inference, interaction and self-designing of experiments
3. Motivation of students as well as teachers in the basic research experiments
4. Revitalization of a science culture and establishment of a good teacher student relationship
5. Organising training programme for teachers for demonstrating scientific experiments
6. Fostering of innovations in science teaching, especially laboratory experiments in schools

Special Programmes of KSCSTE

Kerala State Open Data Cell

51. Government of India in order to increase the transparency of the Government Systems and processes and for engaging citizens in governance reforms has decided to place non-strategic data in public domain as part the provision of RTI Act 2005 – (Pro-active Disclosure). This is being done for empowering the citizens to provide secure access to information under the control of public authority leading to the transparency and accountability in the working of every public authority. Accordingly a National Data Sharing and Accessibility Policy (NSDAP) enacted in 2012 and Department of Science and Technology, GoI have been entrusted to coordinate and implement the same with Technical support from National Informatics Centre, New Delhi. The National Policy will increase the accessibility and easier sharing of non-sensitive data amongst the registered users and their availability for scientific, economic and social developmental purposes.

52. There have been a surge in large volumes and different types of data, including some of scientific and technical relevance are generated and compiled by various arms of Government of Kerala, in multifarious forms for meeting their specific requirements. Scientific organization generates data and develops scientific data bases deploying huge public funds. Since such data are not generated under any standardized format, inter-operability of both scientific and technical data poses a serious challenge. And global

experience has demonstrated convincingly that access to data leads to breakthroughs in scientific understanding as well as to economic and public good, in addition to Transparency and Accountability. It is in this context The National Open Data portals have been developed and states have to enrol themselves and coordinate with the state departments, collate datasets and contribute to the National Portal on a regular basis. The Open data is also a critical component of the emerging concept of Smart Cities and will complement the dashboard and data visualisation components of the smart cities that are coming in Kerala.

Proposal

53. Department of Science and Technology, GOI, New Delhi as part of implementation process and to operationalize the same has directed to form state specific Open data cells at the Science and Technology Councils to coordinate the activities envisaged under NDSAP and also to handle data collection, collation, conversion and uploading the state specific components in the National Open Data Portal, it is suggested that within 3-6 months at least 5 high value data sets must be contributed. To fulfil this, a cell with dedicated team members is proposed to be created.

54. The Department of Science & Technology, GOI has mandated state councils to establish a permanent setup with minimal staffing consisting of a project scientist, who is experienced in handling web based application development, content management framework and database management systems and has a flair in technical writing, handling big data and analytics and a Technical assistant to handle the digitisation and conversion of data formats, posted to generate metadata (data about data), metadata tagging to enable data discovery and its exploration for the developmental activities etc.

Sophisticated Analytical Instrumentation Centre (SAIF)

55. KSCSTE intends to establish an Instrumentation Centre in Northern part of Kerala, preferably in Kannur or Kasaragod. This Centre is conceptualized as an active analytical and Diagnostic Centre as well as a facilitation centre for outsourcing sophisticated instruments for the Research and Development needs of the Institutions in the northern part of Kerala, wherein such a facility is not available. The Centre will have all modern analytical and diagnostic equipment with well-trained technical staff to cater to the needs of the researchers from the academic and research institutions. Resources from the State and the Centre shall be mobilized to establish the Centre. In order to begin with, the Centre shall be established in an appropriate institution in the area before moving to an independent establishment.

56. In addition to this major objective of acting as a research facilitation Centre, the Centre will also take up research and development programmes which shall focus on the region-wise specific needs.

Solid Waste Management and Bioenergy Research Centre

57. The Centre shall be established at Puthenthoppe, Trivandrum. The Centre is conceptualized to take up active research in solid waste recycling and utilization through well-defined methodologies available as well as take up active research in collaboration with NIIST or other Institutions engaged in similar kind of research. Bioenergy production through conversion of bio-wastes into bioethanol/biodiesel to meet the increasing demands of alternate sources of energy shall be taken up in the Centre through high end research programmes

Molecular Diagnostics and DNA finger Printing Centre

58. As there are no centres in the northern part of the State which looks into both diagnostics development and DNA Fingerprinting facility, it is essential to have a centre which shall develop diagnostic kits, both immunogenic and molecular based, fully equipped to take up challenges on emerging and re-emerging diseases. The Facility also shall act as an outsourcing facility for diagnosis using high end technology and instrumentation to cater to the needs of the people of the mid and northern part of Kerala. State-of the art laboratory with most modern sophisticated instrumentation and expertise shall be established either in Kasaragod or Wayanad.

Translational Research Incubation Centre (TRIC)

59. Basic and applied research are complementary, with basic science uncovering promising new ideas for use in applied research and applied research raising new questions for basic scientists to answer.The general view is that the two are completely separate entities, with basic science as a generator of basic ideas on one end and applied research as a conveyor belt to the market on the opposite end. However, they are the two sides of the same coin and dependent on each other. In order to nurture a culture of applied research and need-oriented (societal or industry) innovation among researchers and to catch them young, provide professional mentoring and support needed, it is imperative that there be a focus on fostering local ecosystems.

60. It is therefore necessary to bridge them and find the best out of the complementary approach and define area which has potential Industrial application. The translational Research in the Centre would include refining all potential programmes through rigorous experimentation and analysis and sort out the best ones which have potential for entrepreneurial development and establish start up programmes through the Incubation facility

61. The Incubation Facility shall coordinate and leverage the synergies in various strands of excellence driving innovation and entrepreneurship, consisting of cutting edge research, industrial interactions and a stellar record of incubation in rural, social and industrial technologies. TRIC shall function as a Technology Business Incubator in association with National Science & Technology Entrepreneurship Development Board (NSTEDB); and

BIRAC, Department of Science & Technology (or R&D partners like RGCB, IISR, IISER, CSIR-NIIST and the Universities in the State) in creating successful Technology ventures**,** establishing industries thereby translating benefits to the society at large. TRIC will leverage these experiences and give entrepreneurship a stronger push as well as serve to coordinate and promote innovation-driven activities at the institute.

62. TRIC seeks to nurture technology and knowledge based ventures through their start-up phases by providing the necessary support to help entrepreneurs survive in the competitive market and reach a stage where they can scale-up their ventures further. The Incubation Centre aims to build and share resources including space and infrastructure, access to business support services, mentoring, training programmes to enhance the skills of entrepreneurs and help mobilizing seed funds. The scope of support is broad-based, and covers technologies/IP developed wholly at the TRIC or partly through collaborations with NABARD and KSIDC as well as by associating experts as consultants or mentors to foresee and monitor the success of each ventures

63. High class state of the art facility shall be created at the Centre. The establishment of TRIC may be taken up as a joint initiative of the Industries Department (KSIDC) at the Life Sciences Park at Thonnakkal, Trivandrum wherein enough land is available and start-up initiatives also can be established there so as to make it as a "Life Science Park" aimed at both high end research in Life Science and a start-up hub.

Centre for Nutraceuticals and Herbal Product Development

64. As the World demand is high for herbal products and nutraceuticals owing to the richness of both traditional/indigenous systems of medicine and medicinal plant wealth, the division shall focus on the development and marketing of herbal products and nutraceuticals for the benefit of the State. The products developed shall have quality assurance and labelling. The Facility shall be established at the JNTBGRI extension Centre at Puthenthoppe in the CARC Centre already established by KBC in the premises.

Food Technology, Development and Testing Centre

65. The facility shall focus on value addition of food, food preservation as well as testing in the wake of pesticide loads in the vegetables and food products. The testing facility shall be made ISO certified and NABL accredited so that it can act as a public sector, reliable establishment to address the problems faced in this sector. The facility shall be established in Kerala Agricultural University, Thrissur/or in the SAIF premises.

R & D Centres of KSCSTE

Kerala Forest Research Institute (KFRI)

66. The forestry sector has been undergoing significant changes largely in response to a number of developments outside the sector.These changes can be broadly grouped as economic,

institutional, socio-political and technological. In the absence of a clear understanding of the nature of the changes and their implications on forestry, the sector has not been able to respond effectively and adapt to the changes. In the coming years these changes are expected to accelerate, and it will be critical for the forestry sector to identify the driving forces and the scenarios that are emerging, the major changes with regard to forest resources, the demand for goods and services and the options available considering probable alternative scenarios. The State of World's Forest highlights the potential of well managed forest in contributing to sustainable development and food security, global climate change mitigation, conservation of soil and water in fragile ecosystem, poverty alleviation through employment generation from forest goods and services. Creation of a low carbon economy has already begun as part of the climate change mitigation activity through activities like private and public investment with well-defined policies, laws and regulations to ensure sustainable economic and social benefits. KFRI has a pivotal role in long term monitoring of the major changes, identify the driving forces and to articulate strategies for development of the sector, including the priority areas for investment, the nature of policy and institutional changes required, how technological capability has to be upgradedgiven the experience and expertise developed over 4 decades.

Thematic area: 1. Forest Resources Assessment and Conservation

1. Long-term monitoring and assessment of forest ecosystems in Kerala- phase 1
2. Conservation genetics of rare, endangered and threatened (RET) species
3. Eco restoration of degraded landscapes in the Western Ghats of Kerala
4. Conservation and Management of endemic and RET tree species as part of Species recovery programme of the Western Ghats
5. Species specific restoration of degraded forest ecosystem with site specific tree species under Natural Forest improvement programme
6. DNA barcoding and fingerprinting for precise identification of forest trees, medicinal plantsand wildlife and curbing illegal trade.
7. Conservation of rare and threatened biodiversity in Kerala.
8. Strategies to mitigate human-wildlife conflict in various parts of Kerala
9. Sacred Grove Network for the State
10. Ecosystem service Assessment of major ecosystems in Kerala
11. Developing Automated Weather Station Net Work for Kerala

Thematic area: 2. Climate change and Forests

67. Specific programmes:
    1. Initiating climate change mitigation and adaptation program
    2. Assessing phenology and seed dispersal mechanism of woody plants in different forest types and developing a tree phenology network for Kerala State
    3. Research on mitigation of the impact of climate change through conservation and harnessing of adaptive diversity in forestry species using molecular methods
    4. Soil carbon monitoring in forest ecosystems

5. Study of Keystone/ Resource allocating potential tree species and their respective forest ecosystems under the climate change scenario.
6. Natural Forest improvement programme through restoration of degraded ecosystems with site specific tree species
7. Conservation and Management of endemic and RET tree speciesas part ofSpecies Recovery programme
8. Capacity building through Nursery and Seed technological inputs of NTFP tree resources for the livelyhood enhancement of tribal peopleof the State
9. Inventory and large scale multiplication and planting stock development of lesser known natural plant resources of the WesternGhats.

Thematic area: 3. Forest Information System

68. Specific programmes
    1. Developing a Field robotics center
    2. Lab for advanced remote sensing and GIS computations for forest measurements
    3. Establishing a Tree clinic at the State
    4. Establishment of Nodal Centre of Alien Invasive Species Research and Management
        1. To undertake research towards evolving management methods for already occurred alien species invasions in Kerala.
        2. To establish a monitoring system to detect alien species invasions at the earliest so as to contain them.
    5. Nanotechnologies for forestry sector

Thematic area: 4. Agroforestry and Livelihood Development programmes

69. SpecificProgrammes
    8. Five tree campaign in the urban and semi - urban areas of Kerala
    9. Strengthening of Bamboo and cane research for development of resources as means of sustaining livelihood for marginalized groups and indigenous people as well as for meeting the increasingindustrial uses.
    10. Long term programme of monitoring forest quality and the condition of forest dwellers
    11. Production, quality evaluation and popularization of organic manures
    12. Developing green space in Urban and rural areas of Kerala
    13. Inventory and Large scale multiplication and planting stock development of lesser known natural plant resources of the Western Ghats viz. flower, fruit, seed, medicine for distribution, popularization and planting in the forest and non forested areas.
    14. Environmental quality assessment in human dominated landscapes

Thematic area: 5. Capacity development, Awareness programmes and Knowledge dissemination

1. Establishing Eco-awareness cum Refreshment-Transit Centres along the Highways
2. Capacity Building and Rural Infrastructure Development for Restocking Home Gardens of Palakkad District for Climate Mitigation with Participation of Students.
3. Mangrove Conservation and Extension Centre (M-Care) at Kannur District
4. A Forestry information Cum Teak information Centre at Konni, Pathanamthitta
5. Developing a web based information system for forestry and environment
6. Upgradation of soil museum
7. Developing facility for Centre of Plant Molecular taxonomy and evolutionary biology Lab
8. Development of Forest Museum

Thematic area: 6. Plantation and production forestry

70. Specificprogrammes
    1. Productivity improvement of teak using functional markers (transcriptomics)linked to adaptive wood characteristic traits
    2. Selection of superior trees of indigenous species suitable for plantations based on molecular markers for wood quality traits
    3. Clonal forestry of importantforest trees forrapid improvement of productivity
    4. Capacity building through Nursery and Seed technological inputs of NTFP tree resources for the lively hood enhancement of tribal people of the State.
    5. Enhancing productivity of timber tree species in Kerala

Thematic area: 7. Forest Policy

71. Specific programmes
    1. Developing a centre for Policy Research in Forests and Forestry

72. The specific objectives of the proposal are:
    1. To open an exclusive forest policy research centre in forests and forestry at KFRI 29ocusing on the issues of biodiversity conservation and sustainable use of natural resources
    2. To build institutional capabilities of KFRI as a think tank in forest policy research
    3. To function as a national level repository of information for forest and forestry related decision making

73. The functions of the centre will include:
    1. Policy directed research
    2. Research on Socio-historical and political evolution of specific policy areas which are crucial but often neglected due to lack of involvement of concerned agencies:
    3. Set up a repository on forest policy– this should ideally include oral history document-action and archiving of important documents

4. Commission special researches on the progress in policy implementation
    1. Appraisal of the implementation of Forest Rights Act
    2. Revisit the PFM and eco-development in Kerala to evaluate their performance in the changing socio-economic and policy environment

    Expected budget (Five-Years): 1.5 crore

Centre for Water Resources Development and Management (CWRDM)

74. Centre for Water Resources Development and Management (CWRDM) was established in the year 1978 to cater to the R&D demands of Kerala in all spheres of water management. The Centre was established with the following vision and mission:

75. VISION: CWRDM shall be a centre of Excellence catering to the Research and Development demands in all spheres of water management

76. MISSION: *Our mission is to enhance the quality of life by ensuring water security for all by providing necessary Research and Development inputs, with special emphasis on the humid tropics.*

77. With eight scientific divisions, four central facilities and three sub-centres, the Centre provides research inputs for water resources development and management, especially in the humid tropics in the humid tropics. The priority areas of research at CWRDM are:
    1. Surface water potential estimation
    2. Groundwater potential estimation
    3. Drainage basin / Watershed studies
    4. Groundwater development
    5. Crop water requirement
    6. Irrigation and drainage
    7. Water and environment
    8. Action Research and Transfer of Technology
    9. Wetland studies
    10. Isotope hydrology
    11. Water quality studies
    12. Water supply and sanitation
    13. Water treatment/ recycling
    14. Sedimentation studies
    15. Forest hydrology
    16. Urban hydrology
    17. Integrated river basin management
    18. Environmental impact assessment
    19. Systems studies and Mathematical modelling
    20. Remote sensing application
    21. Water-related Natural Disaster Management Studies
    22. Development of Water resources information networks
    23. Data management systems
    24. Systematic and operational hydrology

25. Estuarine and Coastal dynamics
26. Climate Change
27. Dam Rehabilitation
28. Soil Nutrient Assessment
29. Integrated Water Resources Management
30. Participatory Irrigation Management

78. CWRDM also plays the role of Water and Land Management Institute (WALMI) in Kerala. Government officials and farmers are being trained under the Water Resources Management Training Programme (WRMTP). The Centre also provides training and research opportunities for students and research scholars from Universities and other Academic Institutions. Several consultancy projects have been taken up within and outside the State by CWRDM, mainly on the request of the government departments, corporate clients, and national and international agencies. A brief description of various programs proposed for the 13thFive-Year Plan is given below:

Programmes

Physical Infrastructure.

79. It is provided for the creation/modernization of the physical infrastructure facilities for carrying out various R&D activities in the Head Quarters and Sub Centres of CWRDM.
    1. Trainees' hostel & Guest house with associated facilities
    2. AuditoriumComplex with a seating capacity of 500, with all modern amenities
    3. Infrastructure & Library facilities at CWRDM and its Sub-centres and Modernization oflibrary
    4. Establishing Water Science Gallery and building
    5. Renovation of Exhibition Hall
    6. Vehicle parking sheds
    7. Maintenance of the existing infrastructural facilities, etc

Scientific Infrastructure:

80. It is provided for the procurement of new scientific equipment/ instrument and maintenance of the existing scientific equipment/instrument for carrying out various R&D activities in the Head Quarters and Sub Centres of CWRDM.
    1. Getting all the labs accredited by NABL
    2. Computers andaccessories to augment existing facilities and upgradation of training facilities
    3. sophisticated equipmentfor Isotope and water quality Labs
    4. Sophisticated equipment for Water Management Lab
    5. Up-gradation of computational facilities & LAN
    6. Modern survey equipments like total station, auto-level, GPS & DGPS and GPR
    7. Repairs and AMC for equipmentsetc

Plan Schemes:

81. CWRDM has been carrying out R&D projects under plan and externally funded programmes in different areas of water sector under the following broad major themes:
    1. Investigations on hydrology of watersheds
    2. Studies on urban hydrology
    3. Wetland management studies
    4. Studies related to coastal hydrology
    5. Studies on groundwater hydrology
    6. Water resources Information System
    7. Integrated water resources management (IWRM)
    8. Isotope hydrology
    9. Studies on Water-related Natural Disasters like drought, flood, landslides, salinity intrusion etc
    10. Climate change and its impact on Water Resources of Kerala
    11. Land and Water Management
    12. Crop water requirement and irrigation scheduling
    13. Cropping systems and water use efficiency
    14. Crop-weather modelling studies
    15. Drainage design and developments
    16. Dam rehabilitation
    17. Participatory Irrigation Management
    18. Environment and Water Quality
    19. Water treatment technologies
    20. Hydro meteorological and Hydrological Data generation and analysis
    21. Investigations on sand mining and its impact on water resources
    22. Public Private Partnership (PPP) in different areas ofwater resources
    23. Transfer of Technology and Action Research

82. The research findings of various R&D schemes under various broad themes will contribute to the sustainable management of Water Resources and livelihood Security of people in Kerala

Manpower component towards personnel attached:

83. This component has been provided towards scientific & technical man power involved in plan projects

Special Assistance (WRMTP):

84. CWRDM has been regularly conducting about 25-30 training programmes under Water Resources Management Training Programme (WRMTP) every year on various water related topics to Officers, Managers, Planners etc of various user Departments, Universities, commodity Boards etc. Action Research and farmers' training programmes are also being conducted. Scientists of CWRDM serve as the faculty for these training programmes.

During the 13thFive-Year Plan period also it is envisaged to conduct Training programmes under WRMTP, for which an annual special assistance of Rs 25 lakhs is required.

Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI)

85. Consequent upon the enforcement of the Convention of Biological Diversity and other impending patent/IPR regimes, it is imperative that means and mechanisms for practical conservation and sustainable utilization of India's biodiversity, especially indigenous biodiversity, are worked out without further loss of time. Both Central and State governments had already initiated several measures in this direction. Jawaharlal Nehru Tropical Botanic Garden and Research Institute, a premier autonomous R & D Centre of the Government of Kerala, with its major mandate on the conservation, evaluation and sustainable utilization of tropical plant resources has made significant contributions in this direction. In accordance with this recognition, the Institute proposes to work on a mission mode in the following thrust areas viz., Establishment of *ex situ* conservatories and Garden Development, Integrated Taxonomy and Conservation Biology, Sustainable Utilization, Biotechnology and Bioinformatics, Capacity Building and Training, each with its prioritized and multidisciplinary components of research during the 13th PlanPeriod (2017-22). A brief technical programme of the respective thrust area along with budget requirements for the next Five-Year plan is enclosed.

Thrust Areas and Prioritization of Activities (2017-22)

86. For the proposed Action Plan for the next Five-Year period thrust areas and prioritized activities are identified.

Thrust Areas 1: Establishment ofEx Site Conservatories and Garden Development

87. Activities proposed in this area will be confined to the botanic garden largely aimed at developing suitable conservatories and lending support sources to the R & D system, eco-education and training programmes, production and supply of planting materials whenever necessary and restoration of RET species back in the forest habits.

88. Priorities*:*
    1. To house the national *ex situ* collection of selected wild, economic plant resources of tropical India.
    2. To sample and conserve the maximum possible genetic diversity of the endemic plant species.
    3. To prepare distribution maps of each endemic species in the Western Ghats with GIS data marking and collect all basic data on their conservation biology contributory to *ex situ* conservation.
    4. To develop conservatories for the endemics in the botanic garden and to resort to conventional and *in vitro* multiplication and reintroduction to augment the resource base in native habitats; to standardize *ex situ* conservation packages.

5. To study seed biology of the endemics and other rare and endangered species for purposes of conservation and utilization.

Thrust Area 2: Integrated Taxonomy and Conservation Biology

89. The 'Jaipur Declaration Taxonomy' which materialized largely due to the efforts of the Ministry of Environment and Forests, recognizes taxonomy as a thrust area of conservation research. JNTBGRI is in the vanguard of taxonomic research from its very inception. The vast herbarium, live collections of tropical plants and culture collections of microbes are a store house of information on biodiversity. However, until recently, morphotaxonomy based mainly on morphological characters was followed for systematic classification of plants. As against the fast emergence of Molecular Taxonomy in the rest of the world and occurrence of innumerable chemo and genetic variants within the species, taxonomy has become an interdisciplinary subject. Therefore, an integrated taxonomy programme with appropriate inputs from morphotaxonomy, phytochemistry, biochemistry, cytology and molecular biology will be developed during the period.

90. Priorities*:*
    1. To develop a vibrant integrated taxonomic programme to delineate phytogenetic relationship and solve taxonomic disputes.
    2. To focus detailed taxonomic work on economically important groups like legumes, grasses, bamboos, orchids, aroids, aromatic and oil yielding plants.
    3. To develop expertise on molecular taxonomy and monographic work in taxonomy.
    4. To focus taxonomic work on local endemics of the Western Ghats region.
    5. To focus attention on consumer friendly approaches for describing species following descriptor type of germplasm.
    6. To establish modern herbarium with electronic data processing facility for herbarium and taxonomic research including multipurpose database and automated mapping.
    7. To evolve a crash programme to carry out extensive surveys and mapping to identify areas that are ecologically sensitive.
    8. To do environment impact analysis to assist the Government or private sponsored projects in selected areas.
    9. To participate in tropical forest surveillance and monitoring programme and restoration ecology work in degraded forest and ecosystems.
    10. Study the plant-animal association and intricacies involved so as to evolve conservation strategies which also include appointment of entry level and middle level scientists.

Thrust Area 3: Evaluation and Sustainable Utilization of Tropical Plant Resources

91. Plant resources are the life-blood of any nation. Prosperity of a nation depends on its capability to utilize the available resource optimally through the application of science and technology. The tropical flora of India offer unique opportunities for utilizing genes, resins, canes, reeds, biomolecules and aromatic oils of industrial importance. Technology could be

developed for sustainably utilizing these resources for the promotion of location-oriented and plant-based microindustries that convert the plant raw materials into value-added products thereby giving employment and income generation opportunities to the local communities. With technology mediation it is also possible to convert every household into a plant nursery with plants which could be networked and interlinked with marketing agencies for the off take of the products at regular intervals.

92. Priorities*:*
    1. To bio prospect (phytochemical and drug prospecting) the medicinal and aromatic plants and mushrooms with the objective of bringing out phytochemicals, biochemical and drug precursors of greater economic value.
    2. To evaluate the wild horticultural (fruits, vegetables, pulses, fiber, latex, biofuel, ornamentals etc.) plants and identify useful genotypes that could be developed as cultivars to release new plant types for cultivation through appropriate integration of horticultural techniques.
    3. To get involved in breeding and plant improvement programmes.
    4. To share the benefit of technology development and sustainable use of plant/microbial resources with local/ethnic communities and user industries.

Thrust Area 4: Biotechnology and Bioinformatics

93. Biotechnology has emerged as a 'biological razor' to solve many a problems both applied and basic in all spheres of activity including environment, medicine, agriculture and pharmaceuticals. This is the hottest area of research where global investments are steadily galloping year after year. Biotechnology together with bioinformatics has revolutionized the areas of gene structure elucidation, determination of three dimensional structure and conformational changes of biomolecules under different situations, drug design and action, and molecular interactions. The rich phytodiversity of India forms the feed stock for a variety of products produced through judicious application of the biotechnology and bioinformatics tools. The derivative products include isolated gene sequences, reconstructed genetic molecules, transgenic organisms, value-added drugs of plant origin, biomolecules, databases and conservation biotechnology leading to developing the molecular markers. JNTBGRI has already established good facilities, manpower and processes and products in plant biotechnology. Keeping these as the basis, selected programmes are proposed for the 13th Plan.

Thrust Area 5: Infrastructure Development, Capacity Building through Training

94. JNTBGRI intends to develop high end infrastructure facilities and equipments to augment the research activities in the sustainable utilization of plant resources component. Towards this, we propose Central Instrumentation Facility, Animal House and other facilities for advanced research in the 13thFive-Year Plan. JNTBGRI has approached biodiversity on lab to land basis with a view to develop practical skills as part of human resource development. Training of the interested groups and local people in field cultivation and horticultural

techniques is an important step to improve horticultural production. Training in advanced propagation (micropropagation) technique is offered to students and nurserymen from all over the country. Since taxonomy is the main instrument for biodiversity monitoring and evaluation, training in taxonomy with modern tools and techniques is important for biodiversity capacity building. Besides, as against the realities of today, viz., biodiversity loss, habitat, fragmentation and genetic erosion, training courses on conservation biology and taxonomy would help biologists and foresters in preserving our scarce resources.

95. Priorities*:*
    1. Development of advanced infrastructure facilities towards sustainable utilization of plant resources.
    2. Training in basic horticulture involving seed collection, seed propagation, vegetative propagation, field cultivation and disease and pest control.
    3. Training in mushroom cultivation and value addition.
    4. Training in integrated taxonomy.
    5. Training in conservation biology.
    6. Recruitment of trained human resources (scientists and technical staff) at entry and middle level in garden/research divisions.

Anticipated Outcome

1. Development of a major conservatory botanic garden with vast living plant collections including most of the endemics of the Western Ghats with their natural variations.
2. Publication of a status report on the endemics of the Western Ghats comprising such details as their distribution, population, habitat analysis, physico-chemical factors affecting them, bottlenecks if any with biological processes of pollination, seed set, seed dispersal, seed germination etc., responses of the species under captive cultivation and horticultural conditions, their performance, micropropagation, reintroduction, restoration etc.
3. Authentic information on the economically important plant resources of the Western Ghats including taxonomic characters, utilization values, useful genotypes for upgradation and development as cultivars.
4. First hand report on the floristic components, population biology, quantification of species straits, vegetation structure, function and dynamics, nutrient cycling, sustainability of the ecosystem on medium to long term scale and other related biotic and abiotic components on phytodiversity rich and fragile areas..
5. Phytochemical/drug prospecting and gene prospecting leading to identification of useful plant molecules, genes and drug precursors.
6. Identification/formulation of plant based and microbial value-added products for sustainable utilization.
7. Organization of regular multidisciplinary training programmes on bioresource conservation and utilization benefiting the scientific as well as the local communities.

National Transportation Planning and Research Centre (Natpac)

Transport Infrastructure Development

96. Since transport is the lifeline of the society, planning of all-weather roads to rural habitats and service centres, traffic planning and management of small and medium sized towns, developing methodology for integrated development of transport system in urban areas and studies on public transport are to be scientifically done and hence all the related studies are given priority.

97. New Projects which will be carried out in this area are:
    1. Preparation of GIS based road network database, accident black spot identification and shortest path identification for emergency vehicles.
    2. Evaluation of the mobility needs of marginalized communities who are socially and economically backward and are residing in hilly and mountainous terrains.
    3. Evaluation of pedestrian facilities for cities
    4. Preparation of strategic development plan for National Highways in Kerala
    5. Preparation of Comprehensive Mobility Plan for Corporations
    6. Functional and structural performance of highways
    7. Preparation of GIS based Road Information System and Accident Information System

98. NATPAC will develop up to date, reliable and scientific data base (digitized spatial maps in GIS format along with road inventory and location of socio economic infrastructure facilities that determine the travel pattern) of roads under the control of various Departments/Agencies.The data base will provide the inputs required for the preparation of development plans with reference to roads, settlements and location of facilities etc.The studies will benefit the entire societies who are living in the inaccessible areas of Northern Kerala.The study will help to establish travel demand model for communities with similar background.A methodology for pavement condition index and suitable maintenance strategies of roads will be evolved.

99. A Critical evaluation of the highway development projects will result in obtaining a realistic data base on the structural and functional performance of the project roads along with the traffic data.This will be helpful in finding out the success/failure indicators for the projects funded externally or from other sources.This could be a guideline for future planning of road projects.

Traffic Safety

100. Improvement of accident prone locations, creating awareness to all cross sections of public, preparation of scientifically designed publications to cater to different types of road users are some of the activities which need attention. Safety on roads is a social need and hence the area requires top most priority for a safe society.

101. The major heads under which projects will be carried out in this area are:
    1. Safety Auditing of Public Transport System in Kerala
    2. Identification of accident prone locations and improvement measures
    3. Evaluation of Accident Black Spots on Roads
    4. Effect of speed restriction measures on road safety
    5. Evaluation of the road safety activities of the State
    6. Awareness Programmes

102. The safety record of public transport system is not found satisfactory. Safety Auditing of Public Transport System will give suggestions to improve the safety of Public Transport. This will benefit the entire society who uses public transport.This will also analyse the causes of accident relating to public transport system and device methodology to improve the safety of public transport system in Kerala.

103. No improvement measures have been adopted to counter the problems related to increasing traffic in the highways. This also leads to more number of road accidents in the highways.The study on Identification of accident prone locations and improvement measures will benefit the entire society who use public transport on the National Highway stretches.Evaluation of Accident Black Spots on Roads Using Geographical Information System will portray the condition of roads using dynamic segmentation method in GIS environment.The study will locate accident spots in the study area and recommend preventive measures to reduce accidents in these zones.

104. The effect of speed restriction measures on road safety will evaluate the impact of speed management measures on road accidents, level of service and vehicle operating cost in the selected roads and suggest appropriate guidelines on speed control measures in Kerala.

Inland Water Transport System & Coastal Shipping

105. Kerala is gifted with waterways, which can be effectively used for transport and tourism. Development of the waterways with proper support for the users will reduce the congestion on roads and thereby lead to savings in economy in addition to reducing the adverse environmental effects of road transport. The area is of utmost importance and hence to be continued.

106. The major heads under which projects will be carried out in this area are:
    1. Development of model canals
    2. Route network planning of feeder canals and its connectivity to NW3
    3. Environmental Impact studies
    4. Accessibility studies
    5. Safety Audit of roads on canal banks and development of Safety Standards
    6. Preparation of GIS based database for Waterway Systems in Kerala

107. An efficient route network for waterways will be planned which can be integrated with road and rail transport.Optimal use of Waterways for transport and tourism will be highly

beneficial to the state. At least 20% of the cargo moving on the road can be shifted to the Waterways which would result in considerable savings in terms of fuel consumption, reductionof congestion, reduction of accidents, employment generation etc.Integration of this mode with other modes like rail, road and air is to be planned and this will help in increasing the utilization of the water bodies.This study is most relevant to the state.

108. The development of Waterways will be helpful for the State in many ways i.e., as a supplementary mode of transport to decongest the roads, reduce fuel consumption, improved tourism activities and better environment.The study will be beneficial to the society also.The Alapuzha-Changanassery canal which is lying side by side of the Alapuzha - Changanassery (AC) road is one of the main modes of transport of Kuttanadu area. The canal is now in defunct stage due to human intervention and remains as a threat to the environment.The canal, if developed will be highly useful for tourism development, fishing activities, duck farming etc. This canal enroute the National Waterway No. three and hence acts as a feeder canal to NW3.The study on completion will benefit the entire society who uses water transport.

109. The canals of Kerala which were the primary mode of transport in earlier days are now used for other purposes.These canals were constructed to connect the rivers and back waters to get a through waterway from Trivandrum to Kasargode. But most of them are not navigable now due to lack of maintenance and misuse. There is an urgent need to clean up these canals for which a detailed study is required. The canal banks are now thickly populated and the access to these residents needs to be evaluated in terms of safety in the light of the accidents reported recently.

110. Hence evaluation of the water quality of the canals, measures to improve the water quality and navigation and safety audit of the canal banks are to be done urgently. Since the situation exists in most part of the state, this is proposed to be done in phases.

111. A model canal will be developed with side protection using geo-synthetic materials in Thiuvananthapuram city. The study on completion will benefit the city by developing a model canal protecting the frequent flooding during the rainy season.

Road Construction Materials and Pavement Evaluation Studies

112. Since the expenditure required for construction and maintenance of roads is very high, proper planning and scientific studies are required to optimize the same. Use of locally available materials, modifiers for bitumen which can retard the distress, proper design of mixes using the materials which conform to specifications etc. are to be adopted for reducing the cost and increasing the life of roads. Hence research in this line is very important and to be continued.

113. Projects which will be carried out in this area are:
    1. Use of industrial waste like jarofix and steel slag
    2. Use of Reclaimed Asphalt

3. Use of Stone Matrix Asphalt
4. Use of Geo-Synthetic materials in road construction
5. Use of plastic waste and construction waste for road construction and to study its suitability to Kerala conditions

114. Use of coir geo textiles which is available in Kerala will improve the condition of the road and slow down the deterioration of the road.This study will help in confirming the advantages of using coir geo textiles for road construction and embankment construction. This will also help in utilizing the states own resource as well as reducing the fuel consumption and wear and tear (Vehicle operating costs) of the vehicles.The project will be of beneficial to the society.The results will be published in Indian Road Congress Publications.

115. A Comparative study of different types of modified bitumen available in the market (Polymer Modified Bitumen (PMB), Crumb Rubber Modified Bitumen (CRMB), Natural Rubber Modified Bitumen (NRMB) etc.) will help in using the appropriate modifiers suitable to Kerala conditions.Test stretches using the modified bitumen will be laid in a homogeneous road section and the comparative performance will be assessed.This will help in identifying the modifier which is suitable to the climatic condition of the state and thus help in keeping the road within the desired level of service for longer time.Use of Waste Plastic in road construction has been widely studied in NATPAC. The project is most relevant to the state as it can provide prolonged quality of the road. This will result in mass consumption of the Waste Plastic without any detrimental effect to the environment.The project helps to add value to the Waste Plastic and thus help the Self Help Groups like Kudumbasree.

Innovative Projects and Policies

116. Research and application programmes on intelligent transport system, low cost traffic solutions, mass transit systems, freight transport management and accident information systems will be given priority in the next Five-Year plan period, since these are the areas to be harnessed to reduce the congestion on roads and minimize accidents. Post implementation studies also will be carried out.

117. Studies on Periodic Updation of Price Indices for Stage Carriage Operation (PISCO) and Auto-Taxi Operation (PIATO) will be continued on regular basis.Studies on air pollution and climate change due to transportation will also be taken up. For reducing the problem of traffic congestion, it is proposed to take up the study of congestion pricing.It has been found that the role of women is remarkably less in service sector operations like public transport. Inorder to improve the women participation, a research study on participation of women in public transport and institutional bus operations in Kerala with particular research in the field of bus and auto rickshaw operations will be carried out.

Kerala School of Mathematics (KSOM)

Regular academic programmes:

Fellowship -JRF & PDF

118. Junior fellowships for PhD students in mathematics offering an amount equivalent to the UGC-CSIR fellowships based on screening test and interview by an expert committee including mathematicians from other national institutes.M.Sc. with NET exam cleared students interested in research and higher studies will be able to apply for the program. The research activity at KSoM will be benefited by this program.

119. Post-doctoral fellowships for candidates who have completed all formalities of their PhD degree in mathematics from universities or research institutes are eligible. Young PhD holders will benefit from this program by making use of the facilities and activities at KSoM and engage in independent work or collaborative research work with faculty at KSoM. This program will benefit KSoM in its aim to grow as a institute for independent and collaborative research work.

International visitors programme

120. Mathematicians from research institutes and universities abroad whose area of research and expertise are related to those of researchers and faculty in KSoM are to be invited to spend short periods of time at KSoM for collaborative work and interaction. This program will expose the institute to a wider international research community in mathematics. This will lead to possible formal collaborative research programs between KSoM and other international research institutes.

National visitors programme.

121. Visitors from well-established national level research institutes are to be invited to interact and collaborate with KSoM faculty and research scholars.The experience of these well-established research institutes they bring will benefit the research scholars at KSoM and KSOM as a whole as an institute aiming to establish itself at the national level.

Discussion meeting

122. Short term discussion meeting on their area of research organised by KSoM faculty involving invited researchers working in same, similar or related areas from India and abroad.These meetings aim to bring together researchers working in specialized related areas for interaction and collaboration. This program will help KSoM faculty to make contact with a wider research community. This also will aid the visibility of KSoM as a centre for mathematical research in the research areas of the faculty of KSoM.

National level workshops and seminars

123. These meetings with two components of workshop and seminar aim to bring together established mathematicians and young researchers in specialized areas. In the workshop component senior mathematicians will give instructional classes to young researchers and introduce them to the ongoing research problems in the area. In the seminar component the mathematicians will share their latest work with others and possibly come up with new ideas and problems for collaboration. These programs will help establishing KSoM as a meeting place for mathematicians and research students for discussions and interactions.

International conferences

124. In these meetings, mathematicians form both India and abroad working in related areas will present their latest work. Senior research scholars also will be invited to benefit from these interactions. These programs aim to establish research level contacts with a wider international community leading to collaborative work and also project KSoM as a platform to present and discuss original research work at international level.

Visitingprofessorship.

125. Senior professors from other national level institutes will be offered visiting professorships for a period of one year with a possible extension of the visiting period. KSoM will benefit immensely from the experience and expertise of these senior academicians.

Adjunct faculty

126. Mathematicians from India and abroad drawn from a panel are to be appointed as adjunct faculty of KSoM. These mathematicians will visit KSoM often to give short term courses for research scholars and to interact with KSoM faculty.The visits of these academicians with expertise other than those of the existing KSoM faculty can be arranged and announced to colleges, universities and institutes for arranging short term courses for the benefit of students.

Lecture series in Mathematics

127. Mathematicians will be invited to give a series of lectures at KSoM in a selected area. These programs will be intimated to colleges and universities in Kerala so that faculty and researchers from these places will be benefited. These lecture series can expose the research oriented post graduate students to active areas of research through introductory and expository talks.

Outreach programs:

Long term refresher courses for college teachers/students in Kerala

128. Refresher courses for college teachers in Kerala for a period of 3 to 4 weeks on advanced topics closely related to the topics they teach for M.Sc. classes. The instructors for these courses are to be drawn from academicians in various national level research institutes in India.The resource persons for these programs will be drawn from KSoM faculty and faculty of national research institutes. The teaching community in Kerala will benefit by updating and refreshing the topics they teach in colleges. These programs will establish KSoM as a resource centre for college teachers in Kerala.

Outreach program for college students.

129. Workshops on fundamental areas of mathematics consisting of classroom lectures and tutorials will be conducted for college students. The students will be exposed to the learning atmosphere and facilities at KSoM. This will help in attracting students to research in mathematics.

Mathematical Olympiadtraining.

130. Selected school students from Kerala will be given training in problem solving through classes and tutorial enabling them to take part in mathematical olympiad at various levels: regional, state level and national level leading to international mathematical olympiad. Experts from NBHM (National Board for Higher Mathematics) resource centre for mathematical olympiad will be the resource persons. This program will inspire interest in mathematics among school students and kindle their interest in mathematical competitions.

Scientific Infrastructure Development Schemes – Library

131. Library is a key department in any research organization that contributes significantly to the knowledge acquisition process of both students and faculty. Library collection has a wide variety of educational and research materials of all levels of academic programs. Research libraries play a vital role in promoting educational research. The success of any research organization is directly proportional to the adequacy of literature available and the state of the art infrastructure in the Library. Unlike conventional Libraries, the modern digital library reaches out to its patrons anywhere in the world at his/her finger tips. By keeping this fact in mind, Kerala School of Mathematics is aiming to set a state of the art digital library to its users which could enable them to access from anywhere in the world. Kerala School of Mathematics has always believed in providing the best available resources to its scholars and faculty members. The ultimate aim of KSOM Library is to become the regional mathematical depository library to serve both research scholars and faculty to support all kinds of research activities in the field of mathematics and its allied subjects. At present KSoM library provides access to Electronic versions of periodicals and other online reference materials covering the disciplines of Mathematics and Statistics. In addition to that

Library aims to maintain a vast collection of conventional materials to support the research activity of its patrons and keep on additions to its resource every year.A significant sum is being budgeted for the overall development of the Library including procurement of printed resources, e-resources and other supplementary needs which is essential for a modern digital library. Major concern has been given to literature collection in order to build adequate materials in terms of conventional as well as online resources. Allocations are being utilized for the collection development of the library both in hardcopies and online resources, subscribing online resources and for hardcopies of periodicals and journals. Catering to the growing needs and effective utilization of the library facility additions and extension of facility and its furnishing are being taken up then and there on need basis.

Scientific Infrastructure Development Schemes – Computational & Networking

132. High performance computing facility is highly needed in any research and scientific organization. Computation and Networking facilities provides an array of IT infrastructure and scientific computing services for Faculties, Research Scholars, technical and administrative staff at KSOM.These include networking, email distribution and gatewaying, file and print services, domain name service, data backup, high-end printing support and WiFi facility.Current facilities at KSOM include IBM Server with Xeon Quad Core processor with Windows 2008 Server operating system, DELL Server with Xeon processor and Linux operating system, desktop computers for each staff members, laptop systems, multi function printers, color and mono laser printers, projectors, an array of thin client systems at Library, UPS backup etc. The open source Library software KOHA is used in the Library and Web OPAC is enabled for the use of researchers and mathematicians. This year we are planning to setup a MatLab class room containing 12 computers. As critical infrastructure, KSOM has made important advances in internetworking its campus; connecting to the outside world via the Internet. A 24 Mbps Internet bandwidth is available for the users for round the clock Internet access.Entire network is protected via a hardware firewall and antivirus software. WiFi facility is provided atKSOM campus and Hostels.It is expected that more faculties and students will join KSOM in the coming years. Hence more computers, laptops, printers and software's are to be procured as the number of faculties, administrative staff members and students increases. More UPS systems are to be purchased to provide enough backup to these systems.Networking and WiFi facilities also need to be expanded. A smart class room and expansion of computing facility at library is also proposed in the next Five-Year plan.

Physical Infrastructure Development Schemes

133. Campus of Kerala School of Mathematics houses two important blocks viz., Main Block and Hostel Block. The main block building accommodates the academic facilities, Library and administrative office is about 8 years old and requires regular maintenance which includes replacement of electrical and plumbing fittings, replacement of rubber beadings of glass panels, periodic maintenance like re painting and incorporating safety features to the building and its facilities, furniture, equipment and other office documents. Therefore it is essential to carry-out proper up-keep and maintenance of the building and its facilities.

Catering to the growing needs and effective utilization of the facilities of the main block and hostel, additions and extension of facilities and its furnishing have to be taken up then and there on need basis. Physical infrastructure need to be strengthened by adding facilities and extensions to present infrastructure, furnishing of the existing facilities to scale up to meet the increased needs when the activity level of the centre is going up.Annual Maintenance Contract and Preventive maintenance is a set of planned maintenance activities aimed at prevention of breakdowns and failure of scientific and other physical infrastructure. KSOM houses a large number of digital and electrical equipments and other electronic infrastructures which requires AMC.Untimely and unforeseen breakdown of any of those facilities may upset the whole management and administration process.So AMC is very much essential. Regular maintenance is also required for the campus which includes removing overgrowth of vegetation, maintenance of landscaping, repair and maintenance of irrigation systems and hygenic management to facilities of the centre. Engagement of manpower is required for the regular upkeep and maintenance of campus.Safety features like fire prevention and detection is critical to safeguarding the hostel facilities which hold critical in the activities of the centre. Facilities of the main block and hostel have changed significantly in past years which have placed increased demands for fire safety and other preventive safety systems. The facilities of the centre became increasingly important in housing and accommodating the participants of various academic activities of the centre and had electrical installations for its facilities which needs sufficient safeguarding system is required to be in place. Recreation facility is required for the inmates of hostel during their stay period. Most of the visitors to the centre will have short term stay at the hostel of the centre. Adding recreation facility like play courts to the present infrastructure found to be worth in the scenario of increased level activities of the centre and catering to the needs of the inmates of the hostel of the centre.

Malabar Botanical Garden and Institute for Plant Sciences (MBGIPS)

Introduction

134. As per GO (Ms) No.04/2015/S&TD dated 24th April 2015, the Government of Kerala has upgraded Malabar Botanical Garden Society into Malabar Botanical Garden and Institute for Plant Sciences (MBGIPS) as a research institution of the Kerala State Council for Science, Technology and Environment. The vision and goals of MBGIPS is as follows

Vision

135. Conservation of aquatic plant resources and lower groups of plants, their sustainable utilization, generation of knowledge through R&D activities anddissemination through training and education.

Goals and Objectives

1. To explore, map and document aquatic plant resources and lower group of plants of Western Ghats.

2. To conserve the plant resources documented through the establishment of conservatories and through restoration of degraded wetlands and their maintenance.
3. To establish and maintain living collections of economically important plant resources of Malabar region.
4. To undertake Research & Development studies on the taxonomy, biology (including reproduction) ecology and economic potential of the plant resources documented using conventional and modern tools.
5. Development of value-added products from these resources for the human well-being through bio-prospecting.
6. Conservation of RET species of aquatic and lower group of plants through *in-vitro* techniques such as cryopreservation of propagules, tissue culture and DNA libraries, besides traditional methods of multiplication and nursery techniques.
7. To promote environmental education through training and education and also skill development in horticulture, floriculture, hydroponics, nursery techniques and management of green houses, etc.

136. We have a major plan to strengthen the Garden, its live Conservatories and R&D for next Five-Years by adding major components as below.

137. Major components include;
    1. Strengthening the Terrestrial Garden
    2. Plant – Animal Interactive Biota (pollinators, feeders, butterfly, bats, birds etc)
    3. Aquatic Biopark
    4. Geology Garden
    5. Facility for Biodiversity and Environmental Awareness Training(F-BEAT)
    6. Facility for Climate change assessment (Climate change and vulnerability of the aquatic ecosystems in tropical India with special reference to Kerala).
    7. Facility for Community Agro Biotechnology Resources (F-CAR)
    8. Research & Development Unit

Strengthening the Terrestrial Garden

138. The present situations of the terrestrial area of the Malabar Botanical Garden and Institute for Plant Sciences is a western hillock slope with a gradient sprawling in an area of ca. 25 acres from the wetland (MSL) to the top (70 m alt.). Being a land of gradual gradient, this area provides diverse microhabitats for a variety of plants such as trees, shrubs, lianas, herbs and grassland. A well maintained road with avenue trees on either side spirals the hillock providing side paths to the star (zodiac) forest, Hortus Valley, Butterfly Garden, Palm grove, Bambusetum, Fernery and Bryophyte House and Orchidarium etc. The library, herbarium, laboratory, seminar hall complex and the poly house accommodating the lower group plants are situated on the half way of the track. Being situated at the low end of the midland of the geographical Kerala, the area is blessed with good rainfall (above 3000 mm/annum) and high humidity (80-90%) congenial for the luxuriant growth of tropical vegetation. The soil is lateritic loamy on the hill slope and clay-loamy adjacent to the wetland.

139. It is expected that an additional terrestrial area of 200 acres of land can be made available for the upgraded garden.Therefore the existing terrestrial garden of MBG can be concentrated for the conservation of the genetic resources of Malabar region as well as to the entire Western Ghats.

140. The components of the terrestrial garden initiated at MBG, on further strengthening would become a part of the upgraded MBGIPS which include
    1. Apushpi (Cryptogam Conservation - Bryophyte – Pteridophyte Conservatory)
    2. Janakiya (Medicinal Garden) RET Plants
    3. Gardenia (Ornamental Garden)
    4. Begonia and Jasmine (Shade loving-Sciophyte garden)
    5. Hortus Valley (Rheedea)
    6. Salabharamam (Butterfly Garden)
    7. Panathottam (Palm grove)
    8. Medicinal Plants (Sanjeevani)
    9. Carnivorous Plants (Pranipriya)
    10. Systematic Garden

141. For evoking interest among school children in Plant Taxonomy, plant species are arranged in family–wise according to the classification of Bentham and Hooker. Each family is represented by five different species of plants belonging to the family explaining the taxonomic position with distinguishing characters and a pictorial display explaining these details. This would be of immense educational value as seeing and learning would enhance the understanding of taxonomy.

Curiosity Garden

142. 'The Curiosity Garden' is an exhibition of artwork that attempts to put a contemporary modern slant on sculptures and art, adapting and mixing traditional designs with alternative twists and providing the opportunity for purchase at affordable, non egocentric prices.
    Kids Zone

143. This area at the Biodiversity Garden will be demonstrated to the kids to see and enjoy science around them.

Palynology Garden

144. Pollen grains and fungal spores being the reproductive units deserve much attention in the conservation and reproductive biology studies related to conservation biology. Therefore setting up of a pollen biology garden will deserve much attention both in the academic as well as R&D sector.

Xerophytes and Succulents Garden

145. Succulents are Xerophytes that have developed storage structure, in which they hold water, enabling them to survive the period of drought.

Palms and Rattan Garden

146. In the Palm Garden once strengthened in the MBGIPS, one could familiarize with rare and endangered palms like *Arengawightii* and *Pinangadicksonii* and rattans like *Calamusnagabettii* and *Calamusvattayila*.Many plants of great economic significance such as *Areca catectu, Phoenix sylvestris*, Borassus*flabellifer* and *Cocos nucifera* which are grown for their fruits, timber, spices, fibres, perfumes and medicines can also be assembled in this garden.In addition to these, a variety of palm species like Royal palm, Majesty palm, Table palm, Shampine palm etc could also be grown here.

Butterfly Garden

147. This garden attracts butterflies and enthuse them to live here.This is done by planting larval and adult host plants and subtle modification of the habitat.

Evolutionary House

148. This house would display the flora in graphics and in live display through a series of evolutionary plants. It can represent how geology and plants evolved through time, from 3.5 billion years ago to the present day.

Lichen House

149. Lichens survive in bare areas as they don't even have roots, instead preferring to absorb their food and water from the air around them.

Temperate House

150. Temperate House corresponds to forest concentrations formed in the northern and southern hemisphere. It is characterized by wide leaves, big and tall trees and non seasonal vegetation. The project proposes to construct a temperate garden in the proposed area.

Bryophyte Conservatory

151. The bryophytes are a heterogeneous assemblage of non-tracheophytes, generally grouped into liverworts, hornworts and mosses.

Pteridophyte Conservatory

152. Represent an ancient lineage which marked a major step in the evolution of the plants. The recent developments in the field of molecular taxonomy have resulted in looking into this group with a different perspective.

Orchidarium

153. Malabar Botanical Garden & Institute for Plant Sciences is planned to have a facility to train the local people, particularly the women citizen on floriculture and its scope as a livelihood option. Sikkim may be the only organic State of India that promotes floriculture (orchids, anthuriums, rose) as a major livelihood option for its citizen. The upgraded botanical garden may plan collaboration with Sikkim Government at its early stage of existence.

Canopy walkways

154. MBGIPS could get technical assistance from the Forest Research Institute Malaysia (FRIM) to set up a canopy facility as they are the pioneer in South Asia. If this cannot be materialized soon, MBGIPS may plan to have some single/ double rope canopy gears to access the canopies.

Eco-Voyage India to offer a coast to crest experience

155. The unique geographical position, long geological history, made our country being one of the diverse ecosystem on the world.

Plant – Animal Interactive Biota

Aquatic and amphibian bio resources unit

156. MBGIPS is planned to have a biotechnological facility to meet the constant requirement of fish/prawn/mussel seedlings for farmers and that required to maintain/recover wild populations of economically and ecologically important vulnerable/ threatened fishes and amphibians.

Apiary

157. The concept of moving large quantities of bee hives in trucks across the country for providing pollination service is a practice in North America, Europe and Australia. Recent studies in Sikkim, Himalayas have shown that indigenous bumble bees are the major pollinator of *Amomumsubulatum* (large cardamom of commercial importance).

Beewatch

158. Through this project, it is planned to give a different dimension for our effort to conserve indigenous bees. This will be a live and vibrant repository of bees that can be used by the researchers, amateurs and school-going students to know more about their taxonomy, biology, behaviour, ecology and eco social life. MBGIPS is planned to landscape some of its area bee-friendly by planting a range of native herbaceous and shrubby plants and trees to provide resources (pollen and nectar) around the year. Some non-invasive potted exotic species also would be maintained to secure the flowering days throughout year. Ample attention would be given to provide nesting sites for wild social and solitary bees by retaining the dead woods, mud surfaces, tree holes etc.

Bird and bat watch

159. MBGIPS is planned to have a facility for bird watching for amateurs and to do research on plant-animal interactions (frugivory, seed dispersal, and even pollination), avian biology for the researchers.

AquaticBiopark

Aquagene

160. The form and structure of aquatic plants always attract the curious minds. The very wet nature of them has marked its strong bearing in our culture. The symbolic and spiritual values of the aquatic plants had been recognized since long.

Malabar Aquatic Biopark

161. Facilities proposed to be established in the Malabar Aquatic Biopark include
    1. Establishment of a wetland Biopark in the 15 acres wetland of the Garden
    2. Conservatories for Aquatic biodiversity including aquatic plants
    3. Wetland Model interpretation Centres
    4. Reintroduction programme of Aquatic RET species including common Aquatic plants
    5. Setting up of Mangrove zone
    6. Setting up of Algal conservatory and also aquatic plant breeding stations.

Mangrove Zone

162. A separate section in the wetland area of the MBGIPS will be set apart for cultivating different forms of mangroves as well as its associates. This will be of benefit to the student as well as other communities in understanding the ecosystem interrelationships.

C. Geology Garden

Rock garden

163. The Rock garden will have various types of rocks that are seen in India and the native plants of each region will be planted. The name of the rock, its geological record, area from where it is collectedwill be engraved on the rock or it will be displayed on a board. The igneous, metamorphic and sedimentary rock will also be displayed.

Palaeontology Museum

164. The Garden will also house a museum with various plant and animal fossils that will help to understand the history of Life. This can be named as Palaeontology Museum.

Soil Museum

165. The museum will have displays of soil monoliths with accompanying data including a full profile description, soil chemical and physical data, and information on the landscape and land-use etc.

Srinivasa Ramanujan Institute for Basic Sciences (SRIBS)

166. The main objective of this institute is to formulate and implement programmes for capacity building for young faculty members, researchers and Post graduate students in contemporary areas of sciences. Since its inception the Institute has organized several colloquia, workshops, training sessions etc. with the support of internationally acclaimed scientists from various premiere institutes benefitting around 2350 students, Researchers, and teachers in science. This included programmes in all areas of Basic Sciences including Mathematics. At least 12 programmes are conducted every year.

International seminars/lectures

167. Joint Research Programme of SRIBS and RGCB at RGCB Bioinnovation Centre KinfraFilim and Video Park , Kazhakkoottam

168. In Accordance with this programme, 5 Technical Officers and 5 Technical Assistants were posted at the Bioinnovation centre. They are given specific task and placed under the supervision and control of senior scientists from RGCB. As per the MOU RGCB has to provide the entire infrastructure needed for the project and SRIBS has to meet the entire running expenditure. The running expenditure for the Five-Year period was estimated to be Rs.6.07 Cr. Out of this an amount of Rs. 40 lakhs has been released to RGCB so far.

169. At a joint meeting of RGCB and SRIBS held on 04/05/2016 a suggestion came to post a few scientists specialised in Computational Biotechnology from SRIBS side to this programme, so that the research work can be made more effective.

Construction of Building

Progress of building Construction

170. Govt. of Kerala vide GO (Ms) No. 311/Rev/2015dated 07/07/2015 gave ten acres of land at RIT CampusPampady, Kottayam to SRIBS. There were about 1000 rubber trees on the land and these trees were cleared by Revenue Dep. by March 2016. After this Soil testing was done by RIT Pampady Kottayam.

171. Ms. Vasthusilpalaya Consultancy Pvt. Ltd. Tvm. was selected as Architect for the project and they completed the drawings and prepared estimate for the work. Total area of the buildings is 180000 Sq. Ft and the cost including land development, roads, compound wall, solar energy tapping and rain water harvesting is estimated to be 77.82 Crs. Since Administrative sanction for the work has not been received the tender process has not yet been started. Around Rs. 30 lakhs has been spent so far for initial work and architectural charges.

172. The DPR was submitted to the 44th Executive Committee Meeting held on 02/03/2016. The Committee approved the DPR and forwarded it to the Science and Technology Department for Administrative sanction. The total cost is estimated at Rs.100 crores.

State-Centre Resource Institute for Partnerships in Technology (SCRIPT)

173. State-Centre Resource Institute for Partnership in Technology (SCRIPT) is an institute established in the Kerala State Council for Science, Technology and Environment (KSCSTE) by the Government of Kerala in 2013, initially as Centre-State Technology Partnership Institute (CSTPI) which was later re-named as SCRIPT in 2014. The main mandate of the institute is to foster building partnership between investors and technologists in order to overcome barriers in technology adaptation. In other words, SCRIPT is an institution meant for competitively positioning Kerala in the Global Science, Research and Innovation Space. The institute aims to liaison transfer and adaptation of technologies from National/International level institutions through partnership with Industries for the benefit of the State of Kerala.

Strategic Partnership

174. The Institute shall liaison with National and International agencies like Department of Science & Technology, State Planning Board, GITA (Global Innovation & Technology Alliance), Major Industries in India, R& D Institutions and major Academic Institutions. Once functional, SCRIPT shall be the nodal agency to facilitate resurgence ofKerala as the national leader in the transfer of technology from research to the field for enhancing the socio-economic well-being of the state as well asto foster the development of professional capacity within the S&T institutions in the State to enhance the effectiveness and efficiency

of technology and knowledge transfer and commercialization for improving resource use efficiency. The following themes are envisaged:-

1. serve as aninstitutional mechanism for accomplishing Centre- State collaborativeeffortsfortransfer and adaption of technologies to suit societal needs
2. equip the S&T sector of Kerala for making a visible impact on the economic, social and environmental aspects of development
3. provide a forum for networking and exchanging technology innovations and bestpractices
4. assist and encourage technology transfer and commercialization
5. promote public awareness on technology transfer for enhancing resource use efficiency and promoting sustainable development

Project Implementation Plan

1. Assessment of Technology Demand/Gap/Availability/Utility
    1. Inventory of development issues through expert consultations
    2. Inventory of practicing technologies
    3. Evaluation of efficiency and appropriateness
    4. Identification of technology gaps
2. Assessment of Technology Needs/Priorities of the State
3. Scouting suitable technologies/expertise available in National R&D Institutions
   Launching a technology portal listing available technologies
4. Assessing the level of technology development availble with R&D Institutes
   Facilitate adaptation of selected technologies for local deployment
5. Enrolling deployment – ready technologies
    1. Defining the scales of applicability
    2. Preparing standards & specification for different scales
    3. Assessment of capital cost for different bands
    4. Preparing O & M protocols and cost requirement
    5. Drafting field deployment manual
    6. Drafting contract conditions
6. Preparation of Technology Deployment Feasibility Report
7. Launching Technology Portal & Publishing Technology Compendium
    1. Compile a book containing the details of technologies and institutions concerned
    2. Design a Technology Portal with ready to use guidelines
8. Building Public- Private Partnership models
    1. Conceiving small business innovations
    2. Conceptualizing industry partnership/collaborations
    3. Drafting contract conditions for different partnership scenarios
9. Developing State Level Technology Park
    1. Concept test beds & incubation centre for technology deployment
    2. Preparation of guidelines for accessing appropriate technologies
    3. Formulate a mechanism for standardization / adaption support
    4. Compile protocol for technology transfer/ adaption
    5. Institute a facility for technology vetting and costing support

6. Constitute a facilitation centre for technology propagation

10. Developing a Technology Up-gradation Facility
    1. Perpetual search mechanism for technology updates
    2. Assessing the R & D requirements for technology adaption
    3. Providing technology forecasting support mechanism
    4. Preparation of technology deployment protocols
    5. Establish a facility for technology evaluation and validation
    6. Establish training facility for technology managers and technicians

175. In order to define the activities and priority road-maps, SCRIPT had conducted the following programmes
    1. A Workshop on Technologies on Demand Requiring Support/Refinement(Agriculture, Forestry, Fisheries & Livestock)was conducted onMay 25, 2011 wherein experts in the subjects debated and made suggestions in all the above areas which was made into a recommendation document for facilitating SCRIPT to define its road map of activities
    2. A. Workshop on "Technologies for Transfer and Adaptation in Kerala" was conducted on November 4, 2013. Experts from planning, IT, industries and scientists from reputed institutions participated. The deliberations were documented and made into a future road map of activities
    3. A meeting of the First Project Management Committee constituted by the Government was held on October 5, 2013. The Experts suggested several action plans for SCRIPT
    4. Technical Expert Committee Meeting was held on November 16, 2013
    5. In order to strengthen bilateral cooperation an MoU was signed with Department of Science & Technologyon March 4, 2014

Grant-In-Aid Institutions under KSCSTE

Sophisticated Test and Instrumentation CENTRE (STIC)

176. In the calibration division facility is available to calibrate various types of instruments in the Electrical, Thermal and mechanical areas and are accredited by NABL. Most of the existing calibrators are obsolete models and suitable replacements needs to be procured to meet the technical requirements. This facility is now widely used by industries in private as well as in public sector to meet their quality assurance needs. As per the proposed plan, new calibrators and other accessories will be installed based on the industry requirements.

177. The existing analytical division which is supported by DST, Govt. of India, mainly caters to the need of academic community and is being well utilized by various categories of customers.There is also scope for testing in other areas, which include food testing, building material testing and led lamps and fittings testing, which are quite relevant in the present scenario.In the food testing laboratory, water testing and testing for nonperishable food items are proposed in the initial phase. Various types of materials used for construction field also need quality evaluation. Hence in the building material testing, facilities will be installed

for testing of cement cubes, steel rods etc. The led lamps are now commonly used and are now replacing CFL and incandescent lamps. Hence there is ample scope for this testing.

178. The present building space is not sufficient to accommodate the proposed testing activities. Hence a new building is proposed with around 3000 sq.meter plinth area.

Integrated Rural Technology Centre (IRTC)

179. Programme for developing and promoting rural technologies for the support of sustainable livelihood and local economy.

180. Integrated Rural Technology Centre (IRTC), Mundur, Palakkad is a knowledge based technology dissemination Institution established by the *Kerala SasthraSahithyaParisheth* (KSSP) in the year 1986. It is a grant-in-aid Institution and has been receiving support grant from the State Government through the Kerala State Council for Science Technology and Environment from 1995 onwards. The proposal is for availing grant –in- aid support during the 13thFive-Year Plan and is intended to further strengthen the Research and Development Activities in Technology Adaptation and Modification so that IRTC can customize and deliver Appropriate Technologies suitable for drudgery reduction, livelihood enhancement, improvement in theproduction process and value addition.

Objective of the Proposal

1. To undertake and promote Technology Adaptation and Modification through Research and Development for supporting sustainable local economy.
2. To customize and deliver Appropriate Technologies for improving the livelihood options of people particularly marginalized groups and women.

Output and Achievements Anticipated during the 13thFive-Year Plan Period

181. It is proposed to conduct R&D activities in areas such as (1) Green Energy harvesting (2) Natural Resource Development and Management (3) Eco-Agriculture (4) Recirculation Aquaculture (5) Waste management, and (6) Technology options for livelihood support. The specific outputs anticipated are listed below
    1. Establishing and maintaining Systems for harnessing thermal energy for the processing and storage of agro produces and cooking in selected villages.
    2. Establishing and maintaining household Solar DC Systems in rural areas.
    3. Establishing and maintaining Plug and Play Model Pico Hydro Power Systems utilizing small heads of stream falls in suitable areas.
    4. Preparation and promotion of Natural Resource Management Plans, GIS software based Monitoring Systems for water budgeting, soil health surveillance and water harvesting in selected waster shed areas.
    5. Production, value addition and marketing of 'Safe to Eat' agricultural products by promoting entrepreneurships, linkages and market potential through Farmer Producer Companies and Good Agricultural Practices.

6. Establishing decentralized units for low cost production and distribution of bio-control agents, EM-Composting Accelerators, post- harvest technologies and packing materials. recirculation aquaculture
7. Promotion of toilet linked biogas technology.
8. Training support and technical service delivery for sustaining the dissemination process of customized rural technologies.

182. Expected Outcome/Implication of the Proposal

1. The green energy application would encourage fire wood replacement which in turn helps to reduce emission of CO2.
2. Solar DC Systems would save grid energy during day time.
3. Pico hydal stations would benefit people living in remote areas.
4. NRDM Holistic Plans would support decentralization andSustainable DevelopmentGoals
5. Eco-Agriculture would popularize Good Agricultural Practices in a big way.
6. Recirculation Aquaculture would ensure availability of safe to eat protein.
7. Toilet linked biogas plants would be an answer to the problem of septic tank sludge disposal.

CHAPTER4
REGIONAL CANCER CENTRE

183. Regional Cancer Centre, Thiruvananthapuram (RCC), is an autonomous scientific institution sponsored jointly by the Government of Kerala and Government of India. The centre was established in the year 1980 as a tertiary referral centre for the diagnosis and treatment of cancer. RCC rated amongst the top three of the 28 Regional Cancer Centres in the country. It is the only comprehensive, dedicated centre for diagnosis, treatment and control of cancer in Kerala. On an average 60,000 new patients occur every year in the state and out of this nearly one third comes to RCC for treatment.

Cancer Scenario in Kerala – Alarming Trends

1. Cancer incidence is around 156/100,000 population (CR)
2. Over 150,000 prevalent cancers at any point of time
3. 60,000 new cancer patients every year
4. Incidence of cancer likely to increase by 30% in the next decade
5. Approximately 50% of cancers occur in women
6. 35% of cancers present in early stages of the disease (at RCC) and are curable if treated promptly

Major Achievements during 12thFive-Year Plan Period

1. Constructed a new 10 storied Building to accommodate the increase in patient activity. The building has accommodated all Outpatient Departments, chemotherapy wards, Director's Office, Accounts and Administrative Sections, Cancer Research etc.
2. Renovated existing Fire fighting systems - Rs. 25 Lakhs.
3. Renovated existing Auditorium - Rs. 84 Lakhs.
4. Renovated Two oldOperation Theatres with latest technologies – Rs. 1.5 Crores
5. Construction ofadditional CSSD Block – Rs. 1 Crores
6. Installation of new two generators and upgradation of electrical systems with latest PLC and SCADA System – Rs. 3.59 Crores
7. Replacement of AHU - Rs. 2.70 Crs.
8. Purchased and installed PET/CT scanner – Rs. 11.44 Crores
9. Purchased one Elekta Linear Accelerator - Rs. 6 Crores
10. Upgraded two Linear Accelerators– Rs 2.80 Crores
11. Purchased CT Simulator (4D) – Rs 3.15 Crores
12. Purchased two Flow Cytometer – Rs. 1.17 Crores
13. Purchased Colour Doppler Ultra Sound Scanner – Rs. 86 Lakhs
14. Purchased Digital Radiography System – Rs. 1.40 Crores
15. Installed Mini Data Center – Rs. 1.50 Crores
16. Upgraded the RDBMS Software Licence – Rs. 1 Crore
17. Implemented Passive Network – Rs. 50 Lakhs
18. Implemented Barcoding Technology – Rs. 35 Lakhs
19. Installed Active Networking components – Rs. 50 Lakhs

20. Implemented IT-Hardware Infrastructure – Rs. 1.10 Crores
21. Installed Digital Display System- Rs. 70 Lakhs
22. Implemented e-Office– Rs. 13 Lakhs

Clinical Services

1. Radiation Oncology
2. Medical Oncology
3. Surgical Oncology
4. Paediatric Oncology
5. Pathology
6. Imageology
7. Nuclear Medicine
8. Pain and Palliative Care

Social Services

1. RCC has implemented several schemes for providing economic assistance, free food, free drugs and various rehabilitation facilities for patients and their families through governmental and non-governmental support programmes.
2. Both the Central and State Governments have initiated several generous schemes to ensure free or subsidized treatment for patients.
3. These schemes include Sukrutham, Cancer Suraksha Scheme, Chis Plus, Karunya Benevolent Fund, Thalolam, Scheduled Tribe Patient Fund, Snehasanthwanam for Endosulfan Victims, Prime Minister's Relief Fund, Health Minister's RashtriyaArogya Nidhi (RAN) and Health Minister's Discretionary Fund.

Clinical Output

1. Evolved as one of the top Cancer Centres in the country offering State-of-the-Art comprehensive cancer care.
2. Prompt and appropriate treatment for all in spite of the increasing patient load.
3. Specialised treatment such as Bone Marrow transplantation Limp Salvage Surgery minimally invasive surgery 3 DCRT, IMRT, IGRT, SRS at affordable costs.
4. Enhanced early detection methods facilitated detection of breast cancers and oral cancers in earlier stages thus leading to more conservative surgeries, improved treatment results and reduction in mortality with good quality of life.
5. Better care of female cancers using Dedicated MRI, Digital Mammography, and Digital Prone Biopsy Table.
6. Four advanced radiotherapy machines added during the Plan period offering more precise treatment for more number of patients at lowest possible cost.
7. Commissioned PET CT Scanner, Elekta Linear Accelerator, CT Simulator, Digital Radiography System.

Training & Research Output

1. MCI approval & National Board Accreditation to conduct postgraduate course in various specialities in Oncology.
2. Approval for specialized Paramedical Programmes related to oncology.
3. Research Collaborations with prestigious National and International Institutions.
4. Approved PhD programmes.
5. Over 1500 articles (80% in indexed peer reviewed journals) and 570 chapters in books.
6. 304 articles (235 in indexed peer reviewed journals) and 71 chapters in books in the last 3 years.
7. 51 PhDs over the last Five-Years (25 in the last 3 years).

Work Pattern in RCC

1. 16,042 new cancer patients in 2015-16
2. 2,16,156 patients were reviewed in 2015-16
3. 6886 patients were treated with external radiotherapy and 1646 patients with brachytherapy in 2015-16
4. 5547 surgical and 1830 endoscopic procedures in 2015-16
5. 10,089 patients were administered chemotherapy in 2015-16
6. Regular research activities and publications

Table 9 *District Wise Patient Registration during Last 2 Plan Period And Expected Future Increase at RCC Thiruvananthapuram*

District	2007-12 11thPlan	2012-17 12thPlan	2017-22 13thPlan (projection)
Thiruvananthapuram	14542	17507	21008
Kollam	11281	13199	15839
Pathanamthitta	3476	4171	5005
Alappuzha	3661	4360	5232
Kottayam	1698	2432	2918
Idukki	900	1288	1546
Ernakulam	2800	2890	3468
Trissur	2817	4404	5285
Palakkad	3085	4667	5600
Kozhikode	2186	2358	2830
Malappuram	3914	5406	6487
Wayanad	420	556	667
Kasaragod	869	994	1193
Kannur	2381	1756	2107
Others	9490	11070	13284

Table 10 *Major achievements during the TwelfthFive-Year Plan Grant-In-Aid 2012*-2017 rupees in lakh

Twelfth Five-Year plan (2012-17) - outlay & expenditure			
F.Y	Agreed Outlay	Budget Provision	Expenditure
2012-13	3400	3400	3400
2013-14	4217	4217	4217
2014-15	4040	2000	1103
2015-16	5350	3850	267
2016-17	5936	5936	NIL

RCC: Challenges Ahead 13thFive-Year Plan

1. Construction of 14 storied Building in RCC at an estimate cost of Rs.180 crores
2. Upgradation of RCC as State Cancer Institute at an estimated cost of 120 crores under the Centrally Sponsored Scheme.
3. Construction of Building in newly sanctioned 15 Acres of Land at Pulayanarkotta.
4. Create more space by expansion of Physical Infrastructure
5. Virtualization of IT hardware infrastructure
6. Hyper convergedIT infrastructure
7. Secondary server site Up gradation-Disaster Recovery site –Replacement
8. DC-Site Replacement
9. Tobacco related cancers in Kerala state are still high. The Community Oncology Division intends to scale up tobacco control measures to reduce the burden of tobacco related cancers in collaboration with various departments in the state.
10. Training of doctors and nurses in State Health Services Department - The intention is based on the fact that more than 60% of common cancers occurring in the community are diagnosed in advanced stages.To counter this it is essential to give prime importance for early cancer detection for which doctors of primary and community health centres have a major role to play.
11. Community based research activities in primary and secondary prevention of cancers

CHAPTER 5
RECOMMENDATIONS

Research Needs of Kerala in Science and Technology Kerala's Changing Scenarios

1. Demographic Changes
2. Land Use Changes
3. Changes in educational opportunities & increase in educated population
4. Changes in mindset and attitude of people
5. Influx of consumerism and Life Style Changes
6. Global warming & Climate Change

The Approach

184. The approach towards the science and technology development in the next Five-Years shall be focused on the real developmental needs of Kerala. The present approach of funding to individual projects in the random order, of course on some general major theme, shall be replaced by funding to integrated collaborative and multidisciplinary science and technology research by bringing all the R&D centres to specific goals. I will explain it in another way – if we plan to address the water scarcity, there are more than a dozen college/University/institutes and more than 100 researchers who are working on different aspects of water management working on a scattered manner. Let us bring together all these institutes and researchers under one project umbrella with an integrated approach. We had a real experience to these collective efforts in the preparation of the biodiversity register in Ernakulam district in which all the botany and zoology departments were involved.

185. To identify the research needs of Kerala, first of all the present status has to be properly examined and stated. The broad themes where serious attention has to be given are listed below:

Water Security

186. Though Kerala had a sumptuous supply of rain water, and is rich in rivers/streams/ponds/wetland systems most of the parts of Kerala are fast advancing towards a desertification in terms of non-availability of quality water.

187. The major reasons are
    1. Declining rainfall
    2. Increasing temperature
    3. Increased incidences ofdroughts and floods
    4. Decreasing river flows and drying up of water bodies
    5. Uncontrolled exploitation ofgroundwater
    6. Water pollution
    7. Rapid urbanization

188. The research approach to this issue should be on identification of water resources, quality and quantity, storage and replenishment, etc. with due consideration of the geo physical setting of the state. A uniform approach cannot give required results and so research plans after dividing the state into different zones is essential. The work shall be shared with the institutions available in the different zones.

189. Research is required on the following themes
    1. Fresh assessment of water resources availability and demand in the State at river basin level and district level under changing scenarios of land use and climate
    2. Long-term monitoring of hydrologic and climatic parameters in all river basins and real-time forecast of floods and droughts and their mitigation measures
    3. Groundwater dynamics in different physiographic regions of the State including recharge treatments
    4. Development of cost-effective materials for water purification, especially using nanotechnology
    5. Development of sensor-based devices for water quality testing, and Surveillance and monitoring of water quality through public participation
    6. Evaluation of water saving irrigation techniques and water management practices
    7. Soil and water conservation measures

Coastal Protection

190. Kerala has a very dynamic and productive coastal belt running to about 600km. Major part of the economic activity of the state is at this coastal belt which also houses more than 10% of the population. It is the most vulnerable part of the state also. The sea wall, the hard engineering with rocks, is still the technology which is used for the coastal protection, which is not of much use for coastal protection. In almost all developing and developed nations the sea wall has been replaced by Geo textile covering and bio fencing. The coir is a stable Geo textile and the use of coir for this purpose will promote the traditional coir industry thereby contributing to the economic advancement.

191. Present status
    1. Wide Spread coastal erosion
    2. Sea Wall restricting the fishing operations
    3. low socioeconomic condition

192. Research requirements
    1. Identification of stable geo textiles and potential bio-fencing plants
    2. geo textile covering options
    3. socio economic survey to identify issues
    4. Dependency of coastal erosion on other influencing factors

Health Security (Other Than Water Security)

193. The Health security, other than water security, has three components – Retention of Hygienic Environment, Preventive treatment of epidemics and Clinical disease treatment. The first two are part of the public health and includes waste management, availability of quality water and food and abatement of environmental contamination.

194. The major issues are:
    1. Atmospheric, soil and water pollution from different sources
    2. Indiscriminate waste disposal
    3. Indiscriminate sand mining, laterite & granite quarrying, clay mining, soil removal, etc.
    4. Reclamation of wetlands, paddy fields, mangroves, etc.
    5. Lack of awareness
    6. Food adulteration
    7. Poor quality control
    8. Poor sanitation and hygiene

195. The research shall be focused on:
    1. Enactment / amendment and strict enforcement of environment laws strongly supported by scientific data.
    2. Development of management techniques of wastes from different sources
    3. Phyto and Microbial remediation of soil and water
    4. Development of recycling options of wastes
    5. Biocontrol of disease vectors
    6. Development of biotoilets for public places
    7. Use of Geographic Information Systems

Energy Security

196. It is clear that the support of the heavy hydroelectric projects are approaching its final run and it is high time that we divert our research on alternate renewable energy. Though there are various alternate renewable energy sources such as solar, biological, ocean, no serious effort was directed towards taping this alternate energy. No energy auditing is done for any institution nor for the state of Kerala.

197. Present status
    1. No energy auditing in any area
    2. High cost of non-conventional energy sources
    3. PoorR&D in energy sector
    4. Low importance given to development of energy-efficienttechnologies forrural sectors

198. Research requirements
    1. Energy auditing of the state
    2. Development of energy-efficienttechnologies for urban and rural sectors
    3. Development of less expensive non-conventional energy installations

4. Options of DC grid

S&T Status in Universities and Colleges

Present Status: Strength and Weakness

199. Over the last 5 years, the scientific infrastructures in all the major Universities have improved substantially. There are four major State Universities (Kerala, MG, CUSAT and Calicut) in the state having regular research departments in the area of science and technology. The fifth one is in the process of development. The Kerala Agricultural University has a major share in the area of agricultural research. There is a Central University in Kasargode which has also developed considerable research facilities in this period. In addition, the IIT in Palakkad is in its initial stages of development. Some of the divisions of the National Institute of Technology (NIT), Calicut has some share in research and development.Research is also being carried out in a number of research centres in affiliated colleges. Another addition from the State Government is the introduction of several Inter University Centres in the state Universities. There are about 400 science faculty members in the University departments in the state. Nearly around 450 faculty members are in Agricultural University. In addition to this, there are nearly about 200 approved science research guides in affiliated colleges in the state.

200. It is, noteworthy, that many of the research centres in the above categories contributed substantially to the science and technology in the state. The Department of Science and Technology (DST) identified three major universities of the state (Kerala, MG and CUSAT) under the PURSE programme based on the H-index and citations. There are about 2800 scientific publications in indexed journals from the five major Universities in the last 5 years. There are several existing MoUs and linkages with many reputed Universities and research organizations abroad.Many of the Science departments of these Universities have obtained FIST programme from DST and SARD programme fromKSCSTE. In addition, research is also being supported by BRNS, DRDO, UGC, DBT etc. Some of the major funding includes DST-PURSE, FIST, DBT Builder programme, DST-nanoinitiative etc. KSCSTE support for University/college research is substantial. A reasonable amount of plan fund given to University departments by the state government is utilised for research.The main mandate of the Inter University Centres set up in different Universities is to build up common facilities for all the researchers in the state. The STIC in CUSAT, Kochi, the Inter University Instrumentation Centre (IUIC) and Sophisticated Analytical Instrument Facility (SAIF-DST) (both in Mahatma Gandhi University) are presently functioning as reputed centres for providing state-of-art facilities for common use. In brief, the infrastructure facilities available in the state for advanced level research are in a reasonable magnitude.

201. While the above is a reality, there are many issues in the state Universities and colleges which require serious attention in order to tap the potential in full scale. The very first issue is the lack of information on many of the common centres, particularly recent ones, for research. Although, massive amount of money is spent on setting up highly sophisticated equipments, paucity of manpower (mainly technicians) is the main blockade of up-keeping

these machines. Sufficient fund for maintenance is another issue. Most of the Universities are struggling to have enough scientific staff/faculty members. Scaling up of a laboratory scale process is always an issue due to the lack of coordination between scientists and technologists. Although many of the colleges receive funds from DST and KSCSTE as FIST and SARD programmes, respectively, they find it difficult to maintain the scientific infrastructure after the project period.

202. In the above context, it is necessary that KSCSTE may further strengthen the research in this sector by playing a bigger role. At the moment, the programmes of KSCSTE specified in the preceding pages relevant to the Universities and colleges are of significance.

203. The following points are put forth as recommendations.

204. *Efficient utilisation of common centres of research: connecting colleges, Universities and research organizations*. It is necessary to fully utilise the existing research facilities in Universities and other research institutions in the state including KSCSTE institution. KSCSSTE may connect all the needy researchers in the state with these centres by way of signing an MoU with them for a fixed period (3-5 years). In this way, the special facility will be available for the researchers of the programme and fund may be provided to the researchers as analysis charge/travel grant. Short term fellowship can also be given to post-graduate students for carrying out their project work in these centres. We may prioritise and fund research that proposes to make use of existing equipments and centres.This could be done by funding/paying for the use of existing facilities than creating more facilities. A large number of researchers in the state, particularly from colleges will be benefitted from this programme. Unless and otherwise essential, no new centres may be created. In some of the research centres, the equipment remains either unutilised or underutilised. The first priority shall be to take steps to utilise it in an optimum level.

205. In order to make use of the facilities available at Central Government Institutions, KSCSTE may preferably fund projects involving collaboration with these institutions.The investigator from the central institution could be funded for consumables and contingencies while the main investigator (should be from a state government funded organization)be given travel and minor equipment support apart from consumables and contingency grant.

206. *Support programme for common centres for better performance.*There are number of common centres which provide equipment support to researchers of the state and other parts of the country. A major issue with all these centres are shortage of manpower (technicians and research scientists). A model implemented already by KSCSTE in STIC, CUSAT, Kochi (or similar) may be continued and extended to other centres. The funding period could be 5 years in the initial stage which may be extended after assessing the output. Govt. may fund initial infrastructure and part of the salary of the technical staff at these centres directly and allow use of fund generated by the centres to make up the rest. In order to get good technical staff, they may be allowed to carry out their own research, but for getting external funds, part of the equipment time at the centre could be reserved for the particular project. The council also may consider identifying issues which requires a multi institutional and

interdisciplinary research approach on burning issues of the state such as water security, waste management etc.

207. *Support programme for maintaining the existing scientific infrastructure.* It is generally seen that that after a particular project period, many centres in colleges and Universities struggle to maintain the facilities they have already developed. The reference is mainly to FIST programme from DST and SARD from KSCSTE in addition to many similar programmes from various funding agencies. It is necessary to maintain these facilities for the best interest of the state. A large number of scientific personnel can be trained with these facilities. Therefore a support programme is proposed for maintaining the scientific infrastructure even after the project period. A period of 5 years may be selected in the initial stage which can be extended based on their performance.

208. *Identifying theexpertise of common centres and promotes them as Centres of Excellence.*A number of centres, presently performing well in Universities and other research organizations in the state, need to be further strengthened. Identifying the strength and expertise of these centres in specific areas of research is important. In this context, a programme for promoting these centres as "centre of excellence" is proposed. Partial financial support for this programme may be extended for applying to central funding agencies for full funding.

209. *Consortium for research and eco-friendly technologies.*Scientific research demands high level of interdisciplinary approach and involvement of research groups from more than one institution having diversified expertise and sophisticated analytical equipments. This is the generally accepted principle, both nationally and internationally.A coordinated effort in various interdisciplinary scientific areas involving researchers from different institutions is still lacking in our country. At the same time, there is encouragement and support from many national agencies for carrying out research in emerging areas using multi institutional expertise in recent years. The major advantage of this kind of approach is that many researchers can share not only the expertise but many highly advanced sophisticated analytical types of equipment for high level research as well. In this context, bringing in the idea of a consortium for advanced research in selected emerging areas is very important. It is therefore proposed to set up a Consortium for need-based research and technology in interdisciplinary areas such as water purification, phytochemistry, energy, waste management etc for state's need. This will be set up with the participation of active research groups in various research Institutes and Universities within Kerala. This is also expected to bring in a new culture of scientific collaboration among experts from various disciplines and organizations. This set-up may be utilized for developing a special product, a workable technology or solving an advanced level scientific problem.

Research in Colleges

210. Among the Government Colleges and Arts and Science Colleges 172 science departments are recognised as research centres by the 4 affiliating Universities. Some of these have been research centres for decades and have contributed both in terms of research output and in terms of human resource produced.

Table 11 *Research Departments in Colleges - University wise statistics*

Sl. No	Affiliating University	No. of science departments in affiliated colleges recognized as research centres.
1	Kerala University, Thiruvananthapuram	37
2	Mahatma Gandhi University, Kottayam	73
3	Calicut University, Malapppuram	47
4	Kannur University	15
	Total	**172**

Table 12 *Research departments in colleges - subject wise statistics*

Sl. No	Area of Research	No. of departments in affiliated colleges recognized as research departments
1	Bioscience	9
2	Botany	27
3	Zoology	33
4	Chemistry	41
5	Physics	36
6	Geology	3
7	Mathematics	16
8	Statistics	5
9	Others	2
	Total	**172**

211. In these research centres in colleges in different branches of science alone there are nearly 500 research guides and 1250 scholars working towards their Ph.D. At present, UGC and the affiliating universities have adopted a regulatory approach towards research in colleges. They should change and take the role of facilitators. It is necessary toestablish connection between colleges and premier institutions of research.

Suggestions

212. *Establish regional instrumentation facilities in public funded Institutions/Colleges* These should give opportunity to BSc and MSc students to do advanced experiments handle sophisticated instruments. The facility can be used for training teachers in schools and colleges in new methods of teaching theory and experiment and in trying out new ideas in pedagogy

213. *Help in establishing and maintaining research labs.*At present there is no maintenance staff employed for the research labs and it is very difficult to maintain and repair lab equipment. Some fund should be allocated for the maintenance of equipment. Researchers should be encouraged to repair/ fabricate simple research equipment. The existing workshops in colleges should be strengthened.

214. *To develop scientific temper among students and teachers* Encourage discussions/ debates on the subject. Fund NGOs, Schools and Colleges to organise activities such as poster exhibitions, meetings etc on the subject. Help in organising talent search exam for BSc students.

215. *Providing scholarships and other assistance.*At present very many students work towards their Ph.D. without any kind of scholarship or financial assistance. One suggestion is to increase the number of available scholarships. There should be more flexibility in the utilization of the scholarship schemes.

216. *Initiatives by the KSCSTE* All the present schemes of KSCSTE to promote research in colleges should continue. SARD (Selective Augmentation of Research and Development) scheme is very good and should be continued with enhanced amount and wider reach. Funding student projects is an excellent scheme and very cost effective and that should continue. Providing funds for research projects (minor and major) should be continued.

217. *To strengthen experimental science.*There should be advanced laboratory facilities in select public institutions. These will be used by students from different colleges. Funds may be given for say 10 day stay for a group of students from I year BScto do experiments. The experiments need not use sophisticated instruments, but should lead to better understanding of the subject and certain skills.

218. *How R&D centres can help Colleges?* R&D Centres can do several things such as a) Opening their doors to teachers and students. b) Organising refresher courses for teachers c) Hosting students during vacations d) Workshops for Board of Studies members e)Facilitate student projects f) Mentoring students g) Writing textbooks and reference books.

Initiatives for Strengthening Translational Research

219. The gap between research in campuses and practice in all areas of science, technology and engineering is to be bridged to enable more outputs for the real world solutions. Translational Research holds its place between research and practice of all areas of science, technology and engineering translating between the abstractions of research and practice. As an activity, Translational **Research** is existing around the R&D institutions and clinical research. So, effort would be needed to provide the proper and adequate infrastructure for the academic institutions and universities to support the translation of the technology know how and product designs into actual full-fledged products. This should be more than an academic exercise. Such programmes should ideally be not in traditional style, but should be built around problem solving and even futuristic in the outlook. This will be more suitable where vibrant business incubation is present.

220. The conventional approach for translational research could be setting up fabrication facilities such as ProtoLabs and Fablab to develop prototypes translating research findings into applications.Example of such a scheme is setting up model research lab or translational research labour in the vicinity of the academic campus or on campus. The objective is to provide the second level R&D support for the companies who have successfully graduated

from the Incubators and are in the path of scaling up their S&T inputs to the products for innovation and improvisation. Small and tiny S& T based industries cannot have the R&D in-house. Example is the Research park of IIT Madras. The feeding of the problems and the user base for the Research Lab is the Technology Business Incubator, as in the case of IIT Madras. Setting up technology business incubators might be the second or the final step after translational research whether the original idea is translated into a business. Setting up of innovation lab in the campus would link the academic research to fruitful developmental research and is a good idea for nurturing innovation especially among the students to translate ideas into applications. There need to support for handholding the young innovators and prospective entrepreneurs. So, a mentor system can be supported with financial compensation. The intellectual property can be protected to sustain interest in the innovation and research and translate the output to revenue earning propositions.

221. Similar to theTen grand challenges have been proposed by the National Academy of Engineering a few years ago which are the problems for us to solve.The Technology Vision 2035 of the Technology Information Forecasting and Assessment Council (TIFAC) outlined grand challenges of our country, there can be a S&T challenge thrown by the S&T Department to solve the problems faced by the State and funding can be given for proposals invited to solve the challenges. Specific suggestions are given below

222. *Setting up Model Research Lab or Translational Research Lab in Institutions where Technology Business Incubation is vibrant.*State may fund the setting up of Model Research Lab or Translational Research Laboratories with high end research facilities for translating the results of fundamental research to usable clinical, industrial, agricultural or social technology and also for providing R& D support for tiny and micro S&T entrepreneurs. This Laboratories can be sanctioned to Science & Technology educational institutions with proven track records, both state funded and central funded.

223. *Setting/Scaling up Technology Business Incubator.*It is seen that the Department of Science & Technology of Central Government is giving only for equipment and seed funds. State may help in the setting up of Technology Business Incubators by creating the building and basic infrastructure. The incubators will help the students and fresh graduates to seek a path of entrepreneurship. State may create 5000/10,000 sqft space for incubation in State and Central funded institutions. During 13th Plan the target could be 2,00,000sqft with adequate budget. Attach Electronic Fabrication Facility with each TBI. Seed fund and working capital can be sought from Government of India and the industries through the CSR funding.

224. *Setting up Innovation Laboratories and Clubs.* Each Central funded institution/Engineering College/Arts & Science Collegeand University may be provided recurring support for running Innovation club, which will organize ideation camps, entrepreneurship awareness programmes, interaction with successful scientists and entrepreneurs, etc. It can also set up small scale dedicated labs for development of new designs and solving challenging issues.

225. *Consortium of Institutions/Joint Research*. Government may promote joint research and joint organization of conferences. Institutions may be encouraged to collaborate and address social issues and create a win-win situation for all stakeholders.

226. *Appointment of Mentors- Emeritus status/consultant*. State may provide funding for appointing mentors for the institutions having research labs for helping them to translate the research into possible uses. These mentors can be drawn from industries.

227. *Exhibitions & Awareness Programmes/Conferences*. State may provide funding for organizing exhibitions ona regional basisfor the institutions having research findings to showcase their technology or knowhow for helping them to disseminate knowledge for possible uses.

228. *Supporting Patent/IP Rights*. State may support national as well as international patenting for the inventors in academic and

Science Popularisation

Suggestions

229. *Online science channel for children*. To begin with create 1000 short videos under creative common licensing. Selected school/colleges may be given basic studio facilities for production of the programmes. These could be uploaded in Youtube, shown through Victors channel etc.The coordination of the work could be entrusted to C-DIT (Centre for Development of Imaging Technology) or SIET (State Institute of Educational Technology).

230. *Online Encyclopaedia of Science*. Utilize the resources available with the, The State Institute of Encyclopaedic Publications (SIEP). Make it accessible through different platforms. Add multimedia content. C-DIT and SIET will be able to help.

231. *Help publishing of Science literature in Malayalam*. Promote scientific publishing in Malayalam. Help setting up science corners in library. Organise workshops for writing for science in regional languages.

232. *Promote Popular Science Magazines*. KSCSTE should have a scheme to support popular science magazine. This could be through financing subscription to say all schools/ libraries.

233. *Interactive books, pop-up books, flipbooks*. This is aimed for small children. The Kerala State Institute of Children's Literature (KSICL) can produce these.

234. *Help establish Science parks/ museums*. Some districts in Kerala such as Thiruvananthapuram, Ernakulum and Calicut have science parks/ museums. Help other districts to establish the same. These should provide facility for children and others to conduct experimentation and should have interactive exhibits.

235. *Innovation clubs*.Support innovationand initiatives in innovation.

236. *Project Darwin*. A project to make sure that the new generation learns and understands the basics of theory of evolution. Emphasis will be in presenting science as a process and not as a product. Thrust will be on communicating the method of science and cultivating a rational attitude.

237. It is proposed that a good book/set of books be prepared for high school students and one copy be supplied to each student as additional reading material. There should be some innovative evaluation to make sure that the students read it. It could be made available in online form also.

238. The book is to be printed attractively and carefully edited. The task may be given to The Kerala State Institute of Children's Literature (KSICL).

239. *Project Galileo*. A project to make sure that everyone gets an opportunity to look at the sky through a telescope. For this every school/public library will be provided with a low power telescope. Local resource persons will be trained for usage of telescope. The task may be given to State Council for Education Research and Training(SCERT) or KSSP.

240. *Project Micro World*. To introduce people to the world of micro-organisms. Let everyone have a look through a microscope. Procure foldscope (microscope that folds like origami developed by the Stanford scientist Manu Prakash).

Gender Related Issues in Kerala

241. In Kerala, despite highest literacy rates amongst women in the country, their representation in science research is poor similar to most other states. As per the latest All India Survey on Higher Education for 2013-14 published by Ministry of Human Resources, Government of India (2015), it is seen that in Kerala, the enrolment levels of women at Ph. D, Post-graduate and Undergraduate Degree are 58%, 64% & 57% respectively. However, in six R&D institutions under KSCSTE the frequency is less than 20%, highlighting a major loss of trained woman-power. Based on these data it is apparent that despite large proportions of women obtaining post-graduate and doctoral degrees, frequencies of women in jobs in science and technology are very low. Thus, there is a need to provide support system to attract and retain women; and to encourage girls to take up science as a career. This will also boost their self-esteem and societal recognition.

242. The existing programmes targeted towards women scientists and women in science of KSCSTE are excellent and have made strong footholds in strengthening the gender based promotion of science and technology in the state of Kerala.

243. The following points are suggested to reinforce the programmes of KSCSTE

'Back-to-Lab' programme

244. The growing trend of an increase in the number of applications clearly indicates that the programme is gaining popularity and the need is felt by women who had moved out of their career. It is recommended that the programme should be continued in the 13th plan period with possibility of more publicity and better use of funds.

Awareness Programme on 'Technological Advances in transforming women's lives'

245. The programme is very much beneficial in making women in remote and rural areas aware of S&T inputs in makingtheir lives better, and hence need to be continued in the 13th Plan.

VSORT

246. During 12th plan period the programme has reached women prisoners and it is recommended that its reach may be expanded in the 13th Plan so as to include under privileged women in other women's prisons, tribal hamlets, poor homes, orphanages etc.

Database of women in science in Kerala

247. During 12th five-year plan data on 2500 women have been collected which highlights a high frequency and numbers of trained but unemployed women (~900) indicative of wastage of funding and other resources provided by the State for their training. Continuing the Scheme for the 13th Plan will help in enriching the database with more data that will assist planners and policy makers in evolving appropriate strategy for ensuring gender parity in Science and Technology and utilising women's potential for societal upliftment. It is necessary to expand this work of data collection more actively by publicising the effort and, if needed, by providing additional workforce. Further, as mentioned below under 'newer initiatives' the next step needs to be addressed that is to curtail losses of trained woman-power in the State.

Research Methodology Workshop

248. Improving the quality of the trained woman-power so that their future input in the S&T sector becomes more beneficial is the need of the hour and hence this small effort may be continued.

The PrathibhaScholarship Programme and SPEED Scheme

249. The twin programmes of Prathibha Scholarship and SPEED Camps under the scheme 'STARS' have tremendous positive impact among bright science aspirants in the State. Under these schemes it is encouraging to note that more than 85% of the beneficiaries of STARS programme are girl students. Continuing the scheme in the 13th Plan period will definitely contribute to better standard of academics and research in the State and also help to identify and mould the young generation in fulfilling their scientific pursuits.

Suggested NewInitiatives

Career Advancement Programme for Women Brought Back to S&T Arena

250. The State-run Back-to-lab, programme as well as similar programmes implemented by the Department of Science and Technology and Department of Biotechnology, Government of India have brought back to the labs certain number of women. However, with a three-year support provided under various schemes many women, despite re-entry, find it very difficult to get further funding to stay in research. A long-term career path needs to be chalked out for career advancement for these women and also not to lose the investment of funds and efforts made by the State on them.

251. In this context it is recommended that a formal career path may be introduced. This can consist of firstly a transition from a post-doctoral position to young faculty/scientist position with the same or a new mentor, gaining experience for a few more years to become independent researcher and thereafter continuing to work independently with opportunity to seek funding from extramural sources. However, for this an assurance of a job with a respectable salary is needed. If positions are available in the existing institutions, these women can be considered against these posts as 'successful' products of 'Back-to-lab' scheme. If their expertise and available openings do not match, they may be offered a contract career path as a faculty. This would consist of salaried position, with regular increments and opportunity for promotion to the next grade at the end of 5-7 years, as appropriate, based on rigorous evaluation as is followed for regular employees. Alternatively a consolidated amount, but linked with inflation index, can be offered for a 5-7 year term as appropriate, followed by review and promotion to the revised consolidated amount. Details of this scheme can be worked out.

Women-Friendly Workplace

252. Younger trained women tend to drop out because of child-bearing and child-rearing responsibilities, and once out, it is not easy for them to come back in competitive manner. Hence possibilities for them to continue while fulfilling the family responsibilities need to be provided. Firstly, women in this phase of life should be offered **flexible working hours** or **part-time** jobs. It must be ensured that when they wish to become full-timers, the option is available. In order to help in this endeavour, good **quality crèche** facility must be made mandatory at workplace.

253. It is recommended that provision of good quality crèche facility may be implemented as a policy first at R&D institutions of KSCSTE, followed by the other institutions – universities, colleges etc.

254. Other facilities which also need to be in place to encourage women to work for 8 hours a day are **campus housing**, **transpor**t to and from the place of work, **day-care centre for the elderly**, **proper toilets** and **ladies rooms**.

Co-Location Posting Policy of Husband and Wife and Age Relaxation in Recruitment for Married Woman

255. Another reason why trained women do not get job opportunity is an informal policy of discouraging employment of husband and wife in the same institute. It is recommended that employment of husband and wife in the same place, or at least in the same city, be encouraged to overcome loss of woman-power from the trained work-force. Further an age-relaxation in recruitment may also be provided especially to married women with/without young children.

Fellowships for Girls from Rural and Remote Areas

256. Young girls from rural/remote areas in the State may be specially provided fellowships and accommodation to work in state-of-the-art research institutions for a period of a few months which will provide exposure and may kindle interest in science research.

Adoption of Child-Care Leave Policy

257. Central government employees are eligible for child care leave since the implementation of sixth pay-commission. Employees of S&T institutions funded by the Government of India are also eligible for this benefit. This entails a maximum period of 730 days of leave during their entire service for taking care of up to two children. It is recommended that this policy may be adopted

Strengthening the Women Scientists Division at KSCSTE in terms Of Better Workforce and Funding

258. In order to take up the above programmes proactively at the State level, the Women Scientists Division needs to be strengthened with adequate workforce and enhanced funding.

ANNEXURE 1

PROCEEDINGS OF THE MEMBER SECRETARY
STATE PLANNING BOARD
(Present: Sri. V. S. Senthil IAS)

Sub: Formulation of XIII Five Year Plan (2017-2022) – Constitution of Working Group – **Science and Technology-** reg.

Ref: Note No. 260/2016/PCD/SPB dated 06.09.2016 of the Chief (i/c),PCD, SPB

ORDER No.SPB/295/2016/I&I (WG-10) Dated: 20.09.2016

As part of formulation of XIII Five Year Plan, the State Planning Board has decided to constitute Working Groups to formulate draft proposals in the various major development sectors and sub sectors.Resources persons including Professionals, Administrators and experts connected with the sectors were identified as members of the Working Groups. Accordingly, the **Working Group Science and Technology** is hereby constituted with the following members.

Co – Chairpersons

1. Prof. D. Balasubramanian, Director of Research, LV Prasad Eye Institute (LVPEI), Hyderabad
2. Dr. Suresh Das, Principal Secretary and Executive Vice President, Kerala State Council for Science, Technology and Environment, Shasthra Bhavan, Pattom, Thiruvananthapuram

Members

1. Prof. C. T. Aravindkumar, Director, School of Environmental Sciences, MG University, Kottayam
2. Director, Kerala Forest Research Institute, Peechi
3. Director, Centre for Water Resources Development and Management (CWRDM), Kozhikode
4. Dr. A Ajayaghosh, Director, National Institute for Interdisciplinary Science and Technology (NIIST), Thiruvananthapuram
5. Dr. Abraham T Mathew, Dean, Research Consultancy, National Institute of Technology, Kozhikode
6. Prof. (Dr.) Kuncheria P. Isaac,Vice Chancellor, APJ Abdul Kalam Technological University, Thiruvananthapuram
7. Dr. K.K Seethalakshmi, Scientist (Retd.), Kerala Forest Research Institute, Peechi
8. Prof. Vineeta Bal, National Institute of Immunology, Delhi.

9. Prof. Chandramohan Kumar, Department of Chemical Oceanography, Cochin University of Science and Technology
10. Prof. Achutha Shankara S. Nair, Head of Biology and Bioinformatics, Kerala University, Karyavattom
11. Dr. N. Shahji, Professor in Physics, Maharaja's College, Kochi
12. Prof. R. Ramanujam, Institute of Mathematical Sciences, Chennai
13. Dr. Asha Kishore,Director, SCIMST, Thiruvananthapuram
14. Prof. P. B. Sukumaran, Director, Indian Institute of Technology (IIT) Palakkad
15. Dr. Sunil Mani, Professor, Centre for Development Studies, Thiruvananthapuram

Convener

Er. Joy N.R., Chief, Industry& Infrastructure Division, State Planning Board

Co-Convener

Research Officer (S&T Sector),Industry and Infrastructure Division,State Planning Board

Terms of Reference

1. To review the development of the Science and Technology sector with emphasis as to progress, achievements, present status and problems under its jurisdiction during the 11th and 12th Five Year Plan periods.
2. To evaluate achievements with regard to the plan projects launched in the Science and Technology sector, both by the State Government and by the Central Government in the State during these plan periods.
3. To list the different sources of data in regard to the Science and Technology sector and provide a critical evaluation of these data sources, including measures for improvement.
4. To identify and formulate a set of output and outcome indicators (preferably measurable) for Science and Technology sector and base the analysis of the previous plans on these indicators.
5. In particular the Group may deal with the following issues
    a) Measures to further encourage a widespread culture of quality research in institutions of higher learning in Kerala based on the experience and performance of schemes undertaken in the 12^{th} Plan period.
    b) Measures to actively promote a culture of industrial innovation in institutions ofhigher learning in technology and identify specific focus areas in technology for the same.
    c) Measures for the popularisation of science and the development of scientific temper based on the experience and performance of programs in the 12^{th} Plan period.
    d) Strategy for creating a knowledge advantage for Kerala in specific select areas based on university-industry-government linkages through specific schemes under S&T

e) Suitable sustainable innovation strategies to steer Kerala's economy out of economic, social and environmental challenges it faces and to create a platform that encourages the public/cooperative/private sector to compete on the basis of its innovative products, services and technologies.

6. To suggest, in particular, a set of projects which can be undertaken during the 13th Plan period in the Science and Technology sector

Terms of Reference (General)

1. The Chairperson is authorised to modify Terms of Reference with the approval of State Planning Board. The Chairperson is authorised to invite, on behalf of the Working Group, experts to advice the Group on its subject matter. These invitees are eligible for TA and DA as appropriate.
2. The Working Group will submit its draft report by 1st December 2016 to the StatePlanning Board
3. The non- official members of the Working Group will be entitled to travelling allowances as per existing government norms. The Class I Officers of GOI will be entitled to travelling allowances as per rules if reimbursement is not allowed from Departments

Sd/-
MEMBER SECRETARY

To

The Members concerned

Copy to:-

The Accountant General, Kerala (A&E) with C/L
The Sub Treasury Officer, Vellayambalam.
The PS to the Hon. Vice Chairman, State Planning Board.
PA to Member Secretary
CA to Member (TJ)
All Divisions, State Planning Board.
The Sr. Administrative Officer, State Planning Board.

Forwarded by Order
Sd/-
Chief
(Industry & Infrastructure Division)

ANNEXURE 2

PROCEEDINGS OF THE MEMBER SECRETARY, STATE PLANNING BOARD
(Present: Sri. V S Senthil IAS)

Sub: - Formulation of 13Five-Year Plan (2017-2022) –Working Group on Science and Technology-Re-constituted – orders issued - reg.
Ref: - This office order of even no. dated 20.09.2016

ORDER NO.SPB/295/2016/I&I (WG-10)DATED:04 .10.2016

As part of formulation of 13Five-Year Plan, the Working Group on Science & Technology Sector has been constituted vide paper read above. The **Working Group on Science and Technology** is here by re-constituted by including one new member viz., Dr.A.D.Damodaran, Former Director, NIIST.

Sl.No	Name & Address	Designation
1	Prof. D. Balasubramania Director of Research LV Prasad Eye Institute (LVPEI) Hyderabad	**Co – Chairperson**
2	Dr. Suresh Das Principal Secretary and Executive Vice President, Kerala State Council for Science, Technology and Environment Shasthrabhavan, Pattom Thiruvananthapuram	**Co – Chairperson**
3	Prof. C. T.Aravindkumar Director, School of Environmental Sciences MG University, Kottayam	**Member**
4	Director, Kerala Forest Research Institute, Peechi	**Member**
5	Director, Centre for Water Resources Development and Management (CWRDM) Kozhikode	**Member**
6	Dr. A Ajayaghosh, Director National Institute for Interdisciplinary Science and Technology (NIIST), Thiruvananthapuram	**Member**
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8	Prof. (Dr.) Kuncheria P. Isaac, Vice Chancellor APJ Abdul Kalam TechnologicalUniversity, Thiruvananthapuram	**Member**
9	Dr. K.K Seethalakshmi Scientist (Retd) Kerala Forest Research Institute, Peechi	**Member**

10	Prof.Vineeta Bal National Institute of Immunology, Delhi.	**Member**
11	Prof.Chandramohan Kumar Department of Chemical Oceanography Cochin University of Science and Technology	**Member**
12	Prof.AchuthaShankara S. Nair – Head of Biology andBioinformatics, Kerala University, Karyavattom	**Member**
13	Dr. N. Shahji Professor in Physics, Maharaja's College, Kochi	**Member**
14	Prof. R. Ramanujam Institute of Mathematical Sciences, Chennai	**Member**
15	Dr. Asha Kishore, Director, SCIMST, Thiruvananthapuram	**Member**
16	Prof. P B Sunil Kumar Director, Indian Institute of Technology (IIT) Palakkad	**Member**
17	Dr. Sunil Mani Professor, Centre for Development Studies Thiruvananthapuram	**Member**
18	Dr.A.D.Damodaran, Former Director, National Institute for Interdisciplinary Science (NIIST), Thiruvananthapuram	**Member**
19	Er. Joy N.R. Chief Industry & Infrastructure Division State Planning Board	**Convenor**
20	Research Officer (S&T Sector), Industry and Infrastructure Division, State Planning Board	**Co-Convener**

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Sd/-
MEMBER SECRETARY

Forwarded/ By Order
Sd/-
Chief, Industry & Infrastructure Division

To

The Members concerned

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5. CA to Member (TJ)
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7. The Sr. Administrative Officer, State Planning Board.