Keynote address of

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"SCIENCE AND TECHNOLOGY CHALLENGES OF 21ST CENTURY- NATIONAL PERSPECTIVE"
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at

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Dr Manmohan Singh, Hon'ble Prime Minister of India; Shri R.S.Gawai, Hon'ble Governor of Kerala; Shri V.S. Achuthanandan, Hon'ble Chief Minister of Kerala; Shri Vayalar Ravi, Hon'ble Union Minister for Overseas Affairs; Shri M.A. Baby, Hon'ble Education Minister, Government of Kerala; Shri Shashi Tharoor, Hon'ble Minister of State for External Affairs; Dr G. Madhavan Nair, the President of Indian Science Congress Association, Professor C.N.R.Rao, Chairman, PM's Scientific Advisory Council; Dr T.Ramasami, Secretary, Department of Science & Technology; other distinguished dignitaries on the dais, awardees, delegates, guests, representatives of the media, ladies and gentlemen….

A very good morning to all of you. Let me also wish you and your families a very happy new year in 2010.

1. The Indian Science Congress has been convened for the 97th time, here at Thiruvananthapuram. Let me congratulate Dr Nair, the Indian Space Research Organization, University of Kerala and the Indian Science Congress Association for organizing the annual session at this venue. The annual session provides an opportunity for the scientists, policy makers and the political leaders to meet at a common platform, review and plan the way forward for the Indian science sector. We met last time in the Himalayan setting of Shillong. We are now meeting at

the shores of Arabian Sea here at Thiruvananthapuram.

2. Although the Indian economy has done reasonably well in spite of the global recessionary trends, these are challenging times for the world as a whole and the Indian science sector is no exception. The world leadership is also seized of the issues related to the impact of global warming and looks upon the scientific community to help understand the phenomenon and to find solutions.

3. Since the last meeting in Shillong, there have been some important developments in the country. Our Government has been re-elected with a more decisive mandate and carries a burden of enlarged expectations from people. These pose new challenges which we must face. But let us first take stock of few new initiatives taken in some key areas of science and technology in recent years and also where we stand globally in terms of S&T outputs.

4. Last annual session of the Indian science congress had its focal theme as “Science Education and Attraction of Talent for Excellence in Research”. The session had discussed India's plan in addressing the challenge of attracting best brain to science. Department of Science & Technology's initiative to

attract best students known as INSPIRE (Innovation in Science Pursuit for Inspired Research), launched by the Hon'ble Prime Minister in December 2008, has been received with enthusiasm by the educational system and the youth. Early indications are highly favorable. We will accelerate the implementation of this programme.

Number of candidates receiving NET (National Eligibility Test) Fellowship has been doubled during the last two years. Special schemes to attract talent to science have been mounted by almost all departments of science and technology in their respective knowledge domains. Scientific departments have embarked upon plans to pool their resources and work towards a target of increasing the combined annual PhD output in science, engineering, technology, medicine, agriculture and veterinary sciences to 10,000 within the next four years. Our science ministries have been able to establish as many as 12 new research institutions and set up seven types of new fellowship schemes during the last few years.

5. Synergy has been built between Government research institutions and the universities with a focus on rejuvenation of research in the academic sector. FIST (Fund for Infrastructure Strengthening)

programme has been reoriented and a large percentage of investments have been made to support research in three major initiatives viz., (a) Special packages for J&K and North Eastern Region, (b) PURSE (Promotion of University Research and Scientific Excellence) and (c) CURIE (Consolidation of University Research and Innovation and Excellence) for women. Department of Biotechnology and Department of Atomic Energy have initiated special flagship programmes for rejuvenating research in the universities. Department of Space has established a Space university and CSIR has made a proposal to establish an Academy to award post graduate and PhD degrees. These initiatives will go a long way in enhancing the engagement of academic sector in frontline research.

6. With rapid increase in number of Institutions of higher education in the country, we are facing serious shortage of faculty. We need creative solutions for addressing this challenge. We could encourage re-entry programmes for our women scientists and return of Indian Diaspora. Global partnerships could be another method to increase our capacity to meet the faculty shortage.

7. There has been considerable improvement in quantitative output of the Indian science research due

to initiatives taken in recent years. 'Global Research Report-India' by Thompson Reuters released in October, 2009, indicates positive trends with respect to scientific publications. India's research output has increased substantially since 1998. Annual growth rate of scientific publications in the world is currently about 4% while the average Indian growth rate during the last five years is about 12%. Our ranking in output of scientific publications has improved from 15th position in 2002 to 10th position in 2008. According to Scopus data base, India will emerge as the ninth important country in scientific publications by 2010 ahead of Spain. With increase in number of PhDs in science, there will be further improvement in the growth rate of scientific publications.

8. Relative ranking of India as source of IPR in terms of patents filed and granted in the USA has improved from 25 in 2000 to 19 in 2006. However, there is still a room for significant improvement in the generation of intellectual property. Although there are positive trends in patenting culture in the country, the significance of a large share of patents filed by foreign nationals in India needs to be understood. Currently, the ratio of patents filed and granted in India to foreign nationals as compared to Indian nationals is about 2:1. This is an indication of India emerging as a market for products manufactured through IPR

protected technologies in competitive global economy. Engagement of private sector in generation of intellectual property will be essential for improving the global competitiveness of India. I am happy to inform that the TKDL (Traditional Knowledge Digital Library) developed by our scientists will not only protect our traditional knowledge but it will be used by the European Patent Office and the US Patent and Trade Organisation for prevention of grant of patents based on traditional Indian knowledge.

9. CSIR with a large network of 37 labs, has spearheaded industrial research in India. Development of technologies in aero space sector as well as R&D on photovoltaics and solar energy has been strengthened. Prototypes for several pro-poor innovations have started flowing from our laboratories. Technologies for biomedical devices and Nanotechnology based ceramic filters for safe drinking water have gained acceptance for commercialization. We are proud of the achievement of our young scientists who have placed India in the Global Genome Map by fully sequencing genome of an Indian.

National Biotechnology Development Strategy was approved by the Government in 2007. Department of Biotechnology has already put in place 90% of the

deliverables laid down in the strategy well ahead of time. This is expected to ensure a sustained growth rate of 20-30% in bio-technology industry which would provide favorable environment for promoting research-industry collaborations in the future. Research in Agro-biotechnology sector has important implications for India's food security. Initiatives in health sector have resulted in India becoming a global hub for development and manufacturing of affordable vaccines.

Several initiatives to promote translational research and innovations in biotechnology and life science areas have been taken. BIPP (Biotechnology Industry Partnership Programme), BIRAC (Biotechnology Industry Research Advisory Council), SIBRI (Small Business Research Innovation) and NMITLI (New Millennium Indian Technology Leadership Initiative) are some major schemes promoting R&D in Biotechnology Sector, which have become very popular in industry.

Ministry of Earth Sciences has been making concerted efforts to modernize earth observation system in the country. Establishment of a state of art “Tsunami Warning Centre”, Ocean observation system, weather observation and modeling capabilities, and Atmospheric Physics are some of

our priorities. A Multi parametric seismological observation capability has been developed. Possibility of earthquake prediction is being seriously explored.

10. International Cooperation in the field of S&T of India has grown several fold during the last few years. Large projects developed on the principle of shared objectives, co-investments for co-generation of values, built on reciprocity and parity, are being jointly funded. We have cooperation agreements with over 80 countries. Technology focused initiatives like Science Bridges with UK have opened up new possibilities and mechanisms to forge academy-industry alliances and partnerships.

11. But there is no room to be complacent. Challenges are enormous. Science of the 19th century was primarily scholarship driven and focused on understanding nature and natural phenomena. Passion, curiosity and pursuit of knowledge were driving factors of global science. During the 20th Century, market forces started to influence science. Technology is now mostly market driven. GERD (Gross Expenditure on Research and Development) has emerged as one of the important parameters for assessing the technology and innovation status of Nations. During the last quarter of the 20th century,

global investments into R&D scaled new heights reaching more than a trillion dollars. Share of technology-led growth in GDP increased to as much as 25-50% in several countries.

12. World wars propelled large investments into science and technology which enabled United States of America and USSR to emerge as major global powers during the middle of twentieth century. Their capacity to dominate the world was strongly related to their strength in science and technology. However, during the twenty first century, resurgence of major Asian economies will usher into a new world order. It is widely believed that 21st century will belong to China and India on account of strength of their economies and human resources. Since the next wealth creation opportunity will undoubtedly depend on science, technology and innovation, a major challenge in 21st century will be in relating the knowledge to economic outcomes and ability of science and technology system to innovate at affordable costs. Governance systems for promotion of innovations will face hitherto unknown challenges and would require new approaches.

13. The science, technology and innovation has to play a key role in two distinct areas. These are: (a) to provide improved quality of life and opportunities to each

citizen of the country and (b) to step up achievements in different pursuits of science which can take India to leadership position in world science.

The objective of providing improved quality of life and opportunities to every citizen of the country would entail addressing the following grand challenges:

- Energy security
- Food security
- Water
- Affordable Healthcare for all
- Terrorism and Internal security .

14. There is congruence between the global concern for climate change and India's concern for energy security. Answers to both lie in building capacities for alternate energy sources like solar, wind and nuclear. A PAN-IIT initiative in solar energy research and joint network programme with EPSRC (Engineering and Physical Sciences Research Council) of UK on Solar PV has been set up. National laboratories under CSIR have stepped up R&D for solar energy based technologies. As India has abundant supply of coal, it is not possible to give up coal based option for energy production in the near future. Therefore, research on clean coal technology would remain crucial for the country.

15. To address the challenges of food security, geospatial data inputs for crop planning and monitoring using special algorithms have been developed and made available to several states. New cultivars, prototypes for a low cost tractor (*Krishi Shakti*) and several other agriculture implements, indigenous technologies for potash, seed quality assessment systems and agro-biotechnology initiatives for increasing the crop productivity are some important leads from the Ministry of Science and Technology. Ministry of Earth Sciences has launched a major modernization programme for enhancing the capabilities for weather forecasting. Also a district-level agro-meteorological advisory service started last year, is now being expanded to reach out to farmers at sub-district levels. The service helps the farmers to increase productivity in the face of uncertain weather.

16. Science ministries have taken up several initiatives to address the challenge of water security. A Technology Mission on "Winning, Augmentation and Renovation" for Water has been mounted by the Department of Science and Technology with an outlay of Rs 145 crore over 2 year period. Ministry of Earth Sciences has set up two desalination plants one for producing 1 lakh litre per day and the other for 1 million litre per day of clean drinking water using Low Temperature Thermal Desalination Technology in Lakshadeep and

Chennai respectively. CSIR has developed Thin Film Composite (TFC) reverse osmosis (RO) high flux membrane which helps to recover process water from domestic sewage through tertiary treatment. A one million liters/day capacity plant has been successfully operating at Chennai for over three years. Arsenic/iron removal technology based on ceramic membrane for the production of safe drinking water (conforms to WHO standards) from contaminated ground water has been transferred to industry.

17. Our NAPCC (National Action Plan on Climate Change) has enunciated eight national missions. These missions require affordable solutions to problems of water, efficient energy use, transportation, green agriculture, sustainable habitats, strategic knowledge and sustaining Himalayan ecosystem including glaciers. The Indian S&T sector should gear itself to engage in the research dimensions of NAPCC.

18. In the area of affordable health care for all, CSIR has mounted OSDD (Open Source Drug Discovery) for infectious diseases with global participation which has identified new molecular entities for a number of therapeutic targets. A new anti- Tuberculosis drug based on CSIR technology has now been launched.

Number of new initiatives and programmes on affordable health care have been mounted by the Government of India. Ministry of Earth Sciences has strengthened research on drugs from Sea and polar region. Research on low cost biomedical devices are being actively supported

19. India enjoys significant advantage of high return per dollar invested into research and development. This could be leveraged by the Indian science and Technology sector as an opportunity at a time when the global economic crisis has diminished the Global Gross Expenditure on Research and Development. The comparative strength of the Indian R&D sector could be converted into competitive advantage through strategic actions and timely investments into R&D.

20. The Government of India has unambiguously stated national priorities through the address of the President of India to the Houses of Parliament. A "Decade of Innovations" has been articulated as the National policy. The Indian R&D sector should gear itself to fulfill the promise and deliver innovative technology solutions rather than technologies. Private sector would have to play a major role in this endeavour.

21. Technology solutions complete with business and revenue models for applications in enterprises as well as community based interventions offer vast opportunities on account of growing market for consumer goods and developmental requirements. Indian market is a highly differentiated market. "Reaching the un-reached" itself demands innovations of marketing. Whereas the majority of the global innovation systems are focused primarily on process of innovations, there is a unique opportunity for the Indian R&D sector to address the challenges of innovations for inclusive growth.

22. In the global assessment of innovation index, Indian position is not favorable. There is a need to develop a suitable Science, Technology and Innovation policy framework since India's current Science and Technology policy was enunciated in 2003.

23. Global Economic crisis has affected the global investments into science, technology and innovations. With slowing down of the Global economic growth rates, importance and essentiality of International S&T cooperation are being widely recognized. Thompson Reuters's report on India specifically comments about the need for G8 countries to invest in building S&T relationship with India. India must therefore develop appropriate global strategic alliances.

24. Successful implementation of the Eleventh Plan for Science and Technology will result in :

a. Larger investment into R&D as a percentage of GDP,
b. Enlarged R&D base,
c. Larger enrollment of youth into scientific careers,
d. Improved competitiveness of India as evidenced by S&T outputs indicators,
e. Improved participation of Indian industry into R&D and
f. An enabling innovation ecosystem which connects knowledge to wealth creation.

25. At the end of the eleventh plan, India might need a strategy to assess and measure the economic impact of R&D and technology-led GDP growth and prepare a road map for adequate investments into the Science, Technology and Innovation during the Twelfth Plan. It is known that Gross Investments into Research and Development form an important indicator of global competitiveness. Past investments have laid the foundation for further strengthening the R&D base of the country. Directions of growth are in the right direction. Hon'ble Prime Minister has expressed his commitment to increase the National outlay for Research and Development to 2% of Gross Domestic Product from current level of about 1%. This

would require an increase of R&D expenditure by at least 20-25% annually. It is now equally important that we increase the ability of the sector to absorb the additional resources.

26. Our future strategy should serve to a) enhance synergy among academy, research and industry, b) build new strategies for development of private-public partnerships in R&D and c) step-up global alliances developed during the Eleventh Plan and d) aim at acceleration of the pace of conversion of scientific outputs to targeted socio-economic and developmental outcomes.

27. In conclusion, I must say that Global challenges of 21st century for science and technology are tougher than those of earlier centuries. Technologies and lifestyles of 19th and 20th centuries may have caused global warming problems. Technologies of 21st century should find solutions and enable reversal of the problem. National Decade of Innovation having been enunciated, the Indian science and technology sector must emerge as the innovation hub of the world. We would need a new policy framework and new approaches to planning and implementation. We should work with cohesion and synergy. We should seek collaborative rather than competitive excellence. Our goals must focus on India of the 21st

century. There is an opportunity waiting for us to make a difference to the life of the common man. Let us live upto his expectations.

Jai Hind!

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