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Scientists protest against the attack on the Theory of Evolution

On 19th January this year, speaking in a seminar organized by the All India Vedic Samiti, the Union Minister of State for Human Resource Development Dr. Satyapal Singh claimed that Charles Darwin's theory of evolution was 'scientifically wrong' – because nobody has seen an ape turning into a man – and proposed to drop it from school and college curricula. Scientists responded to it by sending an open letter to him, signed by more than 5000 scientists and scientific workers. The India March for Science organizing committees and the Breakthrough Science Society chapters in different states decided to observe the week from 12 to 18th February as the 'Darwin Week', during which popular talks, seminars and film shows on Darwin's theory of evolution were organized in schools and colleges all over the country.

Following is a report of the events.

Scientists' Letter to Dr. Satyapal Singh

To,
Dr. Satyapal Singh
Union Minister of State
Ministry of Human Resource Development
Government of India

20th January 2018

On Saturday 20th January 2018, several news outlets have reported your speech made in the city of Aurangabad on the previous day. You have been quoted saying, "Darwin's theory of evolution is wrong. It has already been rejected by scientists some 30-35 years back. It is wrong to say that humans evolved from monkeys and such references should be removed from the science and history school textbooks." The news report also included several other questionable statements attributed to you. However, for the purpose of this letter we would focus on this particular claim.

We, the scientists, science communicators and scientifically oriented members of public, are deeply pained by your claim. It is factually incorrect to state that the evolutionary principle has been rejected by the scientific community. On the contrary, every new discovery adds support to Darwin's insights. One should also note that it is no longer merely a mechanism for organic evolution, but several other evolutionary phenomena in nature. Statements such as 'humans did / did not evolve from monkeys' is an overly simplistic and misleading representation of evolution. There is plentiful and undeniable scientific evidence to the fact that humans and the other great apes and monkeys had a common ancestor.

You have also supposedly claimed that Vedas contain answers to all questions. Such an exaggerated claim cannot be substantiated with the evidence available and is an insult to the genuine research work on history of Indian scientific traditions. Vedic traditions through the *Mimansa* discipline, teach us ways of analysing Vedas through rationality and logical reasoning. Your

claims are at odds with the very traditions you claim to uphold.

When a minister working for Human Resource Development in the country makes such claims, it harms the scientific community's efforts to propagate scientific thoughts and rationality through critical education and modern scientific research. It also diminishes the image of the country at the global level and reduces faith of the international historical research community in the genuine research by the Indian researchers.

Therefore, we urge you to retract the reported speech at the All India Vedic Sammelan with immediate effect and issue a clarification about the Ministry's policy towards teaching the theory of evolution.

Yours Sincerely,

(Signed by over 5000 scientists and technologists including Parvin Sinclair, Professor & Former Director (NCERT), Subhra Priyadarshini, Chief Editor, Nature India, C.N.R. Rao Honorary President JNCASR Bengaluru, Rajaram Nityananda, Professor & Former Centre Director (NCRA-TIFR), Rajesh Gopakumar, Centre Director, ICTS (TIFR) Bengaluru, Satyajit Mayor Centre Director and Professor, NCBS, Bengaluru)

Darwin Week Celebration

As a positive way of protesting, the India March for Science Organizing Committees in all the cities in India decided to commemorate the week from 12 February to 18 February as the 'Darwin Week' (12 February was Darwins birthday).

During this week a series of programmes were organized in schools and colleges, where scientists and educators delivered popular talks on the theory of evolution. The objective was to show with evidence that evolution does happen, that humans did evolve from apes, that Darwin's theory of evolution offers the correct explanation of the observed evolution in nature and is no longer a subject of debate within the scientific community.

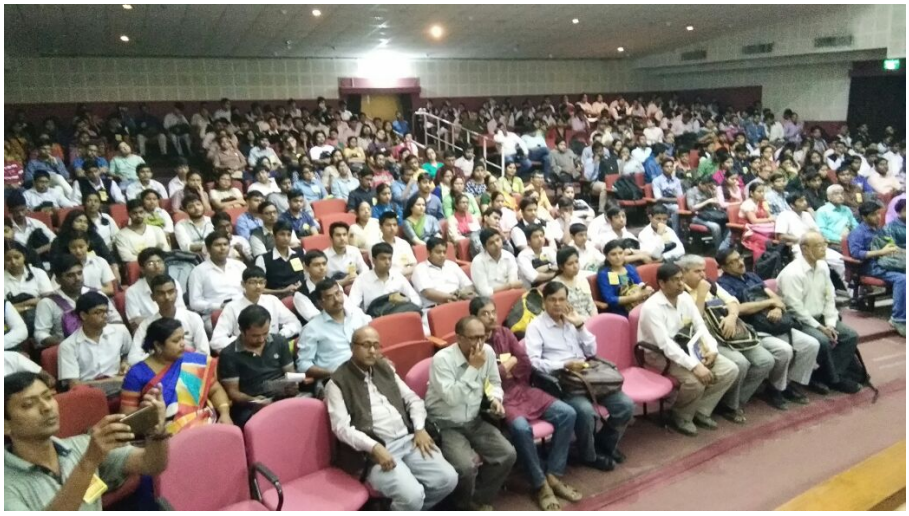
West Bengal

The Darwin Week saw a grand beginning through a seminar held on Darwin's birthday, 12 February, at the Gandhi Bhavan, Jadavpur University. The speakers were Prof. Shilanjan Bhattacharyya of West Bengal State University and Prof. Partha Pratim Majumdar, Ex-Director of National Institute of Bio-medical Genomics. Around 700 students, teachers, and science loving people attended the programme.

During the course of the week from 12 to 18 February, many programmes were organized in schools and colleges. Many scientists and professors from universities and colleges volunteered to deliver the talks. Here we provide a list of the schools / colleges and the speakers.

Kolkata:

- Behala Girls School (speaker: Prof. Asutosh Mukherjee of Vivekananda College),
- Barisha Uchchabalika Vidyamandir (speaker: Amit Mukherjee, Research scholar of ISI),
- Hindu School (speaker: Prof. Sabyasachi Bhattacharyya of ISI),
- Netajinagar Vidyamandir (speaker: Prof. Debopam Acharjya of Jogamaya Devi College),
- Jadavpur Vidyapith (speaker: Prof. Kantishree Goswami of Charuchandra College),
- Arjyakanya Vidyamandir (speaker: Dr. Barnali Bhattacharyya, Ramanujan Fellow, NIBMG),



A view of the audience at the seminar in Jadavpur University, Kolkata, marking the inaguration of the Darwin Week

- Jadavpur Girls' School (speaker: Prof. Mustafizur Rahaman of Ashutosh College),
- Naktala High School (speaker: Prof. Rahi Soren of Jogamaya Devi College),
- Kailash Vidyamandir (speaker: Sri Surajit Saha),
- New Alipore Multipurpose School (speaker: Prof. Arpita Bhattacharyya of Sarsusa College),
- Shibrampur Nanilal Vidyapith (speaker: Prof. Sunanda Roy of Vivekananda College for Women) and Prafulla Kanan,
- Deshapriya Vidyamandir (speaker: Prof. Sarifa Khatun of Jogamaya Devi College),
- Nafar Chandra Balika Vidyalaya (speakers: Nibedita Pradhan & Dr Subhra Prakash Kajli),
- Krishnapur Adarsha Vidyamandir (speaker: Arnab Ghosh, Research scholar of Bose Institute)

North 24 Parganas:

- Nibadhui High School and Dighara Haradayal Vidyapith, Dattapukur (speaker: Dr. Anindita Bhadra, IISER),
- Barasat Priyanath School (speaker Dr. Ayan Banerjee, IISER).

Purulia: Lakhanpur High School and P N Jha Institution Bandowan

Burdwan (West): Bidhannagar Govt. Sponsored Boys High school (speakers – Mr. Subhamoy Banerjee, DAV Model School and Prof. Tapan Kr. Pal of TDB college, Raniganj), Asansol Girls College

West Midnapur: Kespur College (speaker – Prof. Priyanka Halder Mallick of Vidyasagar University);

Coochbihar: Maharaja Nripendranarayan High School

Howrah: Shibpur Chittaranjan Adarsha Vidyamandir

Burdwan (East): Kashiram Das Institution, Katwa (speakers – Dr Subhra Prakash Kajli & Purnendu Ghosh)

Darwin Evening at Kochi on February 15

Hooghly: Right Track Coaching Centre, Tarakeshwar, Tinna High School

IISER Kolkata

A programme was organized on 16 February at IISER Kolkata with students from local schools. Dr. Partho Sarothi Ray and Dr. Anindita Bhadra presented Darwin's theory of evolution. A documentary film was also screened. Another programme was organized on 14 February for the students and faculty members of IISER Kolkata, in which the speakers were Prof. Soumitro Banerjee and Dr. Anidita Bhadra. This programe saw a very lively discussion on the evolution versus creationism debate.

IISER Mohali

The Department of Biological Sciences of IISER Mohali celebrates Darwin Week every year. This year on 15 February 2018, a student body named "Biology Discussion Forum" organized a discussion on Evolution focusing the comment made by union minister Dr Satyapal Singh. The discussion focused on the conflict between theory of evolution and creationism. The challenge to convince general public about the correctness of the idea of evolution was also discussed.

Kerala

Feb 9: A talk and discussion on 'Darwin and Theory of Evolution' was organized at Iswara Chandra Vidyasagar Cultural Center, Trivandrum. Mr G S Padmakumar, President, BSS Kerala chapter was the main speaker.

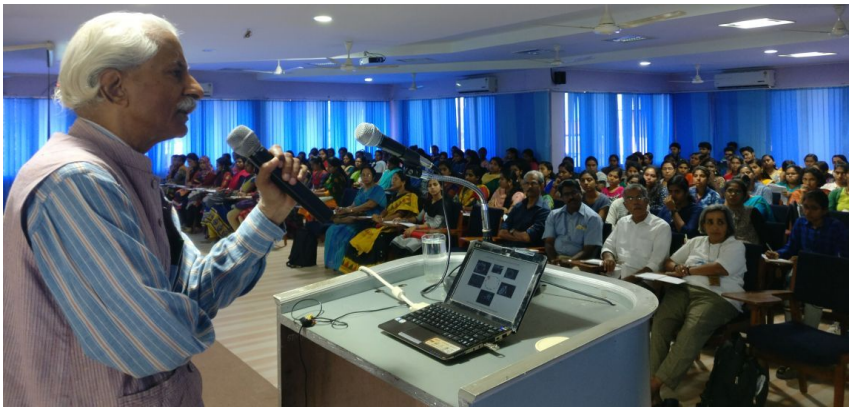
Feb 12: Darwin week meeting was held at Jawahar Navodaya School Kottayam. Prof P C Thomas (Retd) Dept. of Zoology CMS College, Kottayam and Amateur astronomer Mr K Thankappan spoke.

Feb 12: Science meet 'Sastra Sangamam' was organised in Kottayam town. Prof A P Thomas, Director, ACESSD, M G University inaugurated the program. Students and faculty from BCM College for women and C M S College participated in the program.

Feb 15: A public program 'Darwin Evening' was organised at Menaka, Kochi. Dr Liya of St.Teresa's college Ernakulam read out the pledge to uphold the values of science.

Feb 14: A public lecture titled 'The evolution of living matter' by Dr. Vidyanand Nanjundiah, retired Professor, Department of Molecular Reproduction, Development and Genetics, Indian Institute of Science, Bangalore was organized at the Kerala State Science and Technology Museum, Trivandrum. Prof. Nanjundiah in his lecture explained how life on earth has evolved from one or a small number of forms to give rise to the dazzling variety that we see around us based on Darwin's theory of evolution. Mr. P.Radhakrishnan, former Deputy Director, LPSC, ISRO and advisor BSS Kerala chapter inaugurated the program.

Feb 14: A seminar was organized in association with Kerala State Science and Technology Museum, at Priyadarsini Planetarium, Trivandrum. Dr Vidyanand Nanjundiah delivered a lecture titled 'From one to many: the evolution of multicellular



Dr Nanjundiah speaking at the programme in Trivandrum

organisms'. Mr G S Padmakumar, President, BSS Kerala chapter spoke on 'Life and contributions of Charles Darwin'. Mr. Arul Jerald Prakash, Director, Kerala State Science and Technology Museum, Trivandrum inaugurated the seminar.

Feb 18: BSS in association with Banner Film Society organized a science film festival – 'Great Scientists' at Lenin Balavadi, Thiruvananthapuram. The films screened were 'Creation' - a film on Charles Darwin, 'Louis Pasteur', 'Madame Curie' and 'The Man who knew Infinity'.

Feb 26: A Seminar was organized at S N College, Chempazhanthy in association with the Dept of Zoology. Dr Shobi Veleri, Scientist, CSIR-National Institute for Interdisciplinary Science and Technology (NIIST), Thiruvananthapuram was the main speaker.

Feb 27: A Seminar on 'Darwin and Theory of Evolution' was organized at N.S.S College for Women, Neeramankara in association with the Department of Zoology. Mr. G.S. Padmakumar, President, BSS Kerala chapter was the main speaker.

Andhra Pradesh and Telengana

A press meet was held on Feb 12 at Hyderabad to take the message of the Darwin week to the general public. Dr Vishnupriya (Principal Scientist, CCMB, Dr Nathanial (Osmania University), Sri J P Sastry (Science communicator) addressed the meet.

Feb 12: A seminar was held at University College for Women, Begumpet. Shri P Sastry, CCMB retired PRO explained the contribution of Darwin in the field of zoology and botany and the how through the process of Natural selection, humans evolved

Feb 13: A seminar was held at Reddy College for Women. The main speaker Dr Vishnu Priya (Principal scientist, CCMB) explained about Darwin life, his voyage in HMS Beagle and the Theory of Evolution.

Feb 14: A seminar was held in New government degree college (Osmania University). Prof S Janibhasha, GITAM University was the main speaker.

Feb 14: A seminar was organised in K.V.R Govt Degree College for Women, Kurnool. Prof M Sarath Babu (Retd Principal) was the main speaker.

Dr M R Vishnu Priya addressing press meet at Hyderabad on 12 Februar

Feb 15: Darwin Week programs were held in Vasavi high school and Nirmala high school, Hyderabad

Feb 15: Mr Tabrej Khan (BSS Incharge, Anantapur) addressed a gathering of students in Viswabharathi School, Anantpur.

Feb 16: Mr Mallikdatt Addressed a gathering of students in V T High School, Hindupur, Anantapur.

Tamilnadu

Feb 9: The documentary 'Darwin and the Tree of Life' was screened and a discussion by Dr Ravikumar was held in the Dept of Plant Biology, Presidency College, Chennai.
Feb 14: Talk by Dr M Balasubramanyam, Senior Scientist, Madras Diabetes Research Foundation in the Dept of Zoology, Loyola College, Chennai. The documentary 'Darwin and the Tree of Life' was screened.
Feb 14: Talk program in Yadava College, Madurai. Dr Dhinakaran, Dept of Zoology, Madura College spoke on Darwin and the Theory of Evolution. An exhibition on the Theory of Evolution was also conducted.
Feb 16: Talk program and Darwin charts exhibition in Madura College, Madurai. Dr Dhinakaran and Prof Latha spoke.
Feb 22: Screening of the documentary 'Darwin and the Tree of Life' and discussion by Mr Balajibabu at Madhavaram, Chennai.

Gujarat

Feb 12: Screening of the Documentary "Charles Darwin and the Tree of life" and discussion at Narmad-Meghani Library, Ahmedabad. Dr. Durgesh Modi spoke on life of Darwin and the Theory of Evolution.
Feb 16: Photo exhibition on Charles Darwin and Theory of Evolution in Republican High School, Ahmedabad. Dr. Durgesh Modi and Shri Rafikbhai Kothariya (Principal of the School) spoke.

Karnataka

A study class was held at Bangalore office of BSS on the life and work of Charles Darwin on 10th Feb 2018. On 24th Feb 2018, a seminar was organized at the KLE College, Rajajinagar, in which about 100 students participated. Mr Kannan and Mr Bharath Kumar (Bengaluru district organizers of BSS) conducted the discussion. A chart exhibition on Darwin were also put on display.
Feb 20: In Gulbarga, a school level discussion was conducted on Darwin and the Theory of Evolution by Mr Abhaya Diwakar, Joint Secretary, BSS, Karnataka.
March 2: A discussion on Darwin's theory of evolution was organised at Oxford school, Rajajinagar, Bangalore. Mr. Anandraj and Ms Dipti.B conducted the discussion.

Madhya Pradesh

Gwalior: Discussions were organised in Padma School and Govt. Jiwaji Rao School in Gwalior
Guna: A seminar was organised in P C Rao Convent School, Aron. Discussions were conducted in Lions School, Ashok Nagar and by Madam Curie Club.

Scientists demand greater support for scientific research and education

The India March for Science Organizing Committees launched an online petition demanding greater financial support for scientific research and education, which was submitted, with more than 2000 signatures, to the Prime Minister (with copies to the Finance Minister, Minister of Human Resource Development, and the Minister of Science & Technology) before the Union budget. The text of the petition is given below.

However, the scientific community was disappointed when the budget was announced on 1st February. A statement by the Breakthrough Science Society containing an analysis of the budget provisions for science and technology is also reproduced.

Petition

To
The Prime Minister,
Government of India

Sir,

You would be aware that on 9th August 2017, scientists all over the country staged an 'India March for Science', in 40 cities across the country, urging adequate funding for science, technology, and education, without which the dream of propelling India forward as a scientifically advanced nation is likely to remain unfulfilled.

Today, the Indian economy is the third largest in the world in terms of its GDP (purchasing power parity). However this advancement is not reflected in the fields of science and education because of the poor support received from the government. India ranks 40th in terms of support for science as the R&D expenditure is only around 0.85% of GDP (PPP). Developing countries like Mexico, Malaysia, Brazil, and Turkey are ahead of India in R&D spending and seven countries in the world spend 3% or more of GDP on R&D.

The support for education presents an even more dismal picture. It is indeed a matter of regret that currently India stands 134th in terms of the expenditure on education as percentage of GDP. In 2012, it was 3.2%, and today it is further down to 2.9%. Around 40 countries including developing countries like Tunisia, Jamaica, Vietnam, Kenya and Venezuela spend more than 6% of their GDP on education.

Due to India's inadequate funding for education, the school, college and university systems are failing to produce high-quality scientific and technological manpower in the country. Talented students are choosing careers abroad because of the inadequacy of facilities available in the scientific institutions and the limited number of career opportunities available in scientific research inside the country. None of our universities ranks among the top 100 in the world.

Even out of the paltry sum provided for R&D, only 7.5% is allotted to the DST and 7% for the CSIR which account for the

greater part of scientific and technological work done in India. These science funding agencies are reeling under acute financial crisis and are unable to provide necessary support to S&T projects. A country that is home to one sixth of the world population is contributing rather minimally to the generation of knowledge in today's world. On the other hand, the success of India in the space sector has also shown that, with adequate assured funding, mission orientation and freedom to innovate, Indian science can deliver laudable results. Replicating that success in many fields requires major investment in S&T research and education. Technology development cannot happen without investment in science.

The situation is crying out for urgent redressal. We would like to emphasize that India's need for support to education should not be compared with that of those countries which have already built up infrastructure to a very large extent and are mainly spending on sustenance, expansion and advancement today. Therefore we urge you to kindly ensure allocation of at least 10% of GDP (PPP) to education and 3% of GDP (PPP) to scientific and technological research in the relevant ministries, from the next budget onwards. We also request firm governmental steps for the streamlining of administration, eradication of bureaucratic practices, ensuring greater academic and financial autonomy for universities and academic institutions, and strict accountability at every level.

Let us try to ensure that India achieves a position of eminence in scientific research within the next decade.

Sincerely,

(*Signed by more than 2000 scientists and scientific workers*)

Statement of Breakthrough Science Society on the Union Budget 2017-18

For a long time the scientific community of India has been demanding greater financial support for science, technology, and education. On 9th August 2017, scientists all over the country staged an India March for Science in more than 40 cities across the country with the same demand. Just before the Union budget, more than 2000 scientists, technologists and educators submitted a petition to the Prime Minister urging the government to increase the financial support to S&T to 3% and that to education to 10% of the nations GDP, without which the dream of propelling India forward as a scientifically advanced nation is likely to remain unfulfilled.

The scientific community of India feels let down by the Union Budget presented on 1st February as none of the real necessities has been addressed. The R&D expenditure in the country in 2017-18 was only around 0.85% of GDP and the spending on educating the future generations was only 3% of the countrys GDP, while most advanced countries spend in excess of 3% on R&D and 6% on education.

We find that in the budget of 2018-19 there have been only marginal increases in the outlays in science, technology, and education sectors.

The figures are as follows:

Science and Technology

- Dept. of Scientific & Industrial Research budget has been increased from 4629.70 Cr to 4795.97 Cr = 3.4% increase
- Dept. of Science & Technology budget has been increased from 4726.71 Cr to 5114.78 = 7.5% increase
- Dept. of Biotechnology budget has been

increased from 2260.11 Cr. to 2411.53 = 6.2% increase

- Dept of Atomic Energy budget has been increased from 13209.94 Cr to 13971.41 = 5.4%

Education:

- Higher education budget has been increased from 34862.46 Cr to 35010.29 Cr. = 4.2% increase
- School education budget has been increased from 47006.25 Cr to 50000.00 Cr. = 5.9% increase

(The figures of 2017-18 are from the revised budget)

The inflation rate (consumer price index) is now around 5%. This means that the budget outlays barely offset the effects of inflation. If we take into account the increase in salary of government servants as a result of the 7th pay commission recommendations, we find that the spending on scientific research (infrastructure, equipment, etc.) has actually gone down.

In India a major part of scientific research is supported by the Department of Science & Technology (DST), Science & Engineering Research Board (SERB), Council for Scientific & Industrial Research (CSIR), Dept. of Biotechnology (DBT), etc. These research funding organizations have been badly hit over the past few years. The last year the DG of CSIR had declared financial emergency because it had no money to fund research after paying salaries and pensions. The DST was unable to support the research projects that were approved by expert committees. This crisis situation cannot be overcome with the level of funding provided in the 2018-19 budget.

Notable is the fact that the Ministry of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) has got 1626.37 Cr., which is about 30% of the budget of DST and 71% of the budget of DBT. Probably much of this will be spent on pursuing research on personal beliefs like Panchgavya, which have no relation with advancement of medical science.

India's GDP growth rate is around 6.75%, which is more than the percentage increase in the budgets of most S&T related departments and of MHRD. Therefore, it seems the financial support for science, technology and education has seen no real increase when expressed in terms of percentage of GDP. □

Responsibility of Scientists towards Building Scientific Temper in Society

Aniket Sule *

WHEN WE TALK ABOUT science communication, we generally discuss "How should we communicate science?" But today, I am going to talk about "What kind of science should we be communicating?"

Typically, masses are excited about development of science and hence newspapers' science sections (wherever it exists) are dominated by news about latest discoveries and futuristic technologies. Some of those news also find some space in private news channels. This is one kind of science communication. Many educationists would like to say primary purpose of science communication is to make the curricular science interesting for students. So one can develop some simple hands on experiments, make youtube videos, run a Q&A column in a magazine, develop a mobile app, there are many ways to go about it. That's second kind of science communication. When I was a student, the highlight of our weekly television schedule used to be a show called 'Turning Point'. If my memory serves right, I have seen it being hosted by Prof. Jayant Narlikar, Prof. Yash Pal and few episodes by Mr. Girish Karnad. This show had a nice blend of two kinds of science communication I just mentioned.

But there is also a third kind of science communication. To explain that, first we have to ask ourselves a seemingly simple question, "what is science? What do you mean when you say you have learnt science? Is it just a body of facts? Is it some abstract thought which manifests itself in form of new technology? Or is it something more?" I believe science is a process which is less about the end result, but more about the journey in itself. The rigour of scientific method is the most important lesson one should take home from your science classes. Once you have done that, you realise that science is not just another subject from school, but science can be your philosophy of life. Scientific temper is just realisation of this one simple fact.

One cannot keep science confined to our school textbooks. We should learn to apply it in every action in our life. "I do something, because I have seen it gives results" may seem like a good practical approach, but it is certainly not a scientific one. Unless you try to investigate "why it seems to give results?' you will not know if it really works or is it some kind of spurious correlation or is your brain playing tricks on you, by only selectively recalling favourable data. If you want to know how spurious correlations can trick you, I recommend website of Tyler Vigen and to know how selective memory works, or what psychologists call as confirmation bias, watch YouTube videos of James Randi, a well known US based debunker of psychic powers.

The point I am trying to make here is

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that there is need for third kind of science communication. The science communication targeted towards masses which tells them that science they learnt in their school / college should be applied in their daily life with proper rigour. We are seeing a society around us where a large number of people complete the degrees in science / engineering / medicine, but never internalise the process of science. Due to their paper qualifications, masses (and in most cases those people themselves) believe that they have proper understanding of what is science and they can separate chalk from cheese, when they encounter some new seemingly scientific information. Sadly, the reality is very different. I don't have hard data to prove it, but my own experience in science outreach has led me to believe that an overwhelming majority of people who fall prey to pseudo-scientific nonsense are people with science / technology degrees. Many of them are also practicing scientists. Although it may seem counter intuitive, the logic behind it is probably not too difficult. Those who have studied other disciplines, readily accept that they have poor understanding of science and when a scientist or science communicator tells them that their beliefs are pseudo-scientific, they readily believe the 'expert'. However, in case of those with science degrees, it is much harder for them to accept that they were fooled by meaningless jargon and hence when experts tell them that they are wrong, their natural reaction is to either question the authority of experts or to invent more convoluted, meaningless explanations to cling on to their beliefs.

As a result, we have a society where educated people believe astrology is real. The horoscopes are matched for marriages, news channels spend mornings on astrology related programming and so on. In Indian context, astrology is the most overt kind of pseudo-scientific nonsense, but it is hardly the only one. There is palmistry, feng shui, reiki, numerology and so on. But beyond these there is a new kind of monster which is raising its ugly head in recent years. In one short phrase one can call it "great ancient past". In last few years, there is rising tendency to ascribe some seemingly scientific meaning to every cultural tradition and belief. Some of these explanations are so convoluted that they may seem unbelievable even in a satire on the subject, but still there are people who propose it and there are much greater number of people who actually believe it.

We have seen our prime minister telling a conference of doctors that Ganesha's head is an example of plastic surgery. We have seen MoS of HRD telling that airplanes were invented in India by one Shivram Bapuji Talpade. We have seen Indian Science Congress accepting a 'paper' about health benefits of konch blowing. We have seen the famous Sadhguru Jaggi Vasudev, who was conferred Padma Vibhushan this year, telling why it makes scientific sense to not eat anything during eclipses or why his ashram on the 11th parallel is at the best location on the Earth, where gravity is most wonderful. We have seen IIT Kharagpur including Vaastu in its architectural curriculum or Junagarh Agricultural University claiming to find gold in cow urine. We have seen a 2 day circus (which was named as a scientific conference) sponsored by MP government, which declared that cow dung can save you from all kinds of radiation and cancer. The list is endless.

I am not making a case that everything which is ancient is bad. Our ancestors had developed a number of scientific theories which were ahead of their times. If you want to know more about it just talk to Prof. Ramsubramaniam from HSS department of IIT Bombay or Prof. Mayank Vahia

in TIFR. But the key part here is "ahead of their time". If you start finding 21st century science in ancient literature, it becomes embarrassing. Not just embarrassing, it also eclipses genuine research on scientific development in ancient India and makes non-Indian researchers more skeptical about any claim coming out of India.

In such a situation, scientists bear responsibility of holding the torch of reason. About 16 years back, when Dr. M. M. Joshi, then HRD minister, tried pressurising UGC into introducing Astrology as a curricular subject in all universities, Prof. Jayant Narlikar, Prof. Yash Pal and Prof. P. M. Bhargava led the signature campaign of scientists against that move and forced UGC to back down. Even before that, the conference on scientific temper organised by Prof. P. M. Bhargava and Prof. Obaid Siddiqi in 1970s, with the help from Nehru Centre in Mumbai, first brought idea of scientific temper in public discourse and it eventually led to introduction of article 51(1)h of Indian constitution which stipulates that it is fundamental duty of every Indian citizen to adhere to scientific temper.

However, in present time, we the scientists seem to be failing in our duty. No doubt we had our March for Science on 9th August 2017, but I will remember the march for the fact that very small fraction of scientists from mainstream institutes bothered to show up for it. I don't understand, if not now, then when? In last four years, we have seen Dabholkar, Pansare, Kulburgi, Gauri Lankesh murdered for propagating rationalist thought. Still we think it is not a pressing issue? Worse, we see members of scientific community encouraging pseudo-science. A so called 'spiritual organisation' destroys flood-plains of a river in the name of a 'culture festival' and has audacity to tell the National Green Tribunal that they cannot be held accountable because it was responsibility of government to stop them. Even after that many scientific institutes have thriving chapters of this Art of Living foundation? Why?

One may hold any irrational belief in your own personal life and do any pooja in confines of your own home, but if as a chair of a scientific organisation, you take replicas of satellite to Tirupati as offering before every launch, what message are you sending to the masses? It is bad enough that ministers who lack scientific training, think it is desirable to have a Committee and special source of funding for research on cow urine and cow dung, but do we have to make it even worse by chairing such a preposterous committee and lending it credibility through our endorsement?

Time has come for scientists to say 'enough is enough'. Last decade it was turn of Prof. Bhargava, Prof. Yash Pal and Prof. Narlikar to lead the charge. Now, sadly two of them are not amongst us and Prof. Narlikar has reduced his public engagements. This is the time for scientific stalwarts of next generation to step in their shoes and make voice of scientists heard. If they cannot do that, they are failing not just fellow scientists but the progress of science itself. □

Funding for Education in India : The Rationale Behind the Demand of 10% of GDP for Education

Arghya Das*

The 'India March for Science' that happened on 9th August last year was a huge success, and is being seen as a landmark event initiating a much awaited and much needed concerted effort by the concerned academic community with a view to save the spirit of science and education. It also gave rise to several points of discussion. The scientific spirit of the whole endeavour, and the seriousness and urgency of the matter demand a thorough discussion.

This is particularly relevant after the announcement of union budget for the financial year 2018-19. After so much effort, the budget for science and research has seen only a marginal increase in absolute monetary terms. When inflation is taken into consideration, and when the outlay is calculated as percentage of GDP, it shows a downward trend! "Funding for education has come down from 0.49 per cent of the GDP in 2017-18 to 0.45 per cent of the GDP in the coming year. Central government's spending on school education as a proportion of GDP has been cut from 0.28 per cent to 0.27 per cent. Higher education has suffered similar fund cuts, from 0.21 per cent of the GDP to 0.19 per cent." [1]. Among other things, it demonstrates that we have a long way to go after the great initiation through the March for Science.

Therefore it becomes very important to have a patient look at what we are demanding, whether the demands are tenable when compared to necessities as well as viability, and where and by what amount the policies conform or contradict. In a scientific manner we need to understand the context, the cause-and-effect relations, which would indicate the direction to proceed. The purpose of this article is to form the basis for a detailed discussion within the concerned community.

Almost all agree that whatever fund is allotted, the demands of proper distribution, autonomy, accountability etc., as raised in the recent petition by India March for Science (IMFS), are crucial. However, on the issue of funding, two important questions came up:

1. While we all agree that funding in education as a whole, and research in particular, must be increased substantially, what should be the amount needed? What is the rationale behind the numbers 10% of GDP for education and or 3% of GDP on research?

2. With best of intentions, is it really possible to allot the needed funds in a country like India?

Before going into these issues, I think

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[1] https://newsclick.in/union-budget-2018-19-conjob-health-cutbacks-education-contractionary-thrust-economy

quoting a line from the recent petition launched by IMFS is relevant: "··· India's need for support to education should not be compared with that of those countries which have already built up infrastructure to a very large extent and are mainly spending on sustenance, expansion and advancement today."

We shall focus on the overall situation and funding requirement of India's education as a whole. The inference thus obtained will hold for sub-sectors like higher education and research. In view of the above two questions, the rest of the article is divided into two sections. Section I deals with the questions of necessity in current context and the rationale behind the numbers. In Section II. we discuss the questions related to the economic viability of the demands given many other pressing needs like health care, food security, job for youth etc. We shall argue that though the demands are more than viable in a resource rich country like ours, the policy orientation emerging out of the financial practices and mechanisms not only stands in the path of education, but actually greatly hampers the redressal of all the aforementioned pressing human needs.

Necessity : Why 10%

Let us set a minimum target: Within a reasonable time period, say two decades, *all* children should be taught till class 12, and as many as possible should be provided education up to the Bachelors degree. Remember that it is a long-standing goal of governments to build a new India which will be among the top five countries in the world.

In view of the national and international data one can draw a firm conclusion. We take the following approach. First we will have a look at the government's take on this matter. In this process we shall briefly encounter the percentage of GDP spent in many advanced and not-so-advanced countries. Thereafter we will compare the relevant demographic as well as educational parameters of India and few of the nations we want to surpass. Based on it and in view of the aforementioned minimum target, we will make a comparative study of the resource requirements, and will try to sketch its reflection in financial terms.

6% of GDP is too little

The policymakers seem to agree upon allocation of 6% of GDP for educating India. The Government itself acknowledged for decades that, at least 6% of GDP is the minimum requirement, and all policies after 1968, including the upcoming "New Education Policy" proposal envision the same. (Source : Section 4.21, pages 40-41 of "Some Inputs for Draft National Education Policy 2016" published by MHRD[2]).

However, the proposed ways of raising the required funds through privatisation, hike in fees, education loans etc. (ibid. point 4.21.4) are themselves matters of concern, may be in a separate discussion. Note that, in this 6% setting up of new institutions/infrastructure is restrained (ibid. point 4.21.3).

Let us have a look at section 5.7 (pages 57-60), particularly section 5.7.2, of the full 2017 TSR Subramaniam committee recommendation for New education Policy 2016. It makes two cases: firstly, the committee strongly advocated for 6%, and secondly they clearly stated that this 6% is not even a minimum: "Just for comparison, the corresponding level of expenditure in OECD countries[3] is at an average of 5.3%

[2]http://mhrd.gov.in/sites/upload_files/mhrd/files/nep/Inputs_Draft_NEP_2016.pdf

[3]The countries that are members of the Organisation for Economic Co-operation and Development

of the GDP of those countries; indeed 11 OECD countries exceed 6%. Note that these are highly developed countries, where income levels are high; the governments consider such expenditure as investment in their people. In India's current state of development, a minimum of 6% of GDP, if not at much higher level, should be essential expenditure in the education sector."[4] At the bottom of page 176 (ibid., section 9.4) it states: "Most OECD countries spend more than 6%, and many progressive countries have managed to cross the 6% benchmark" (Cuba spends 18%, global average is near 5% – ibid., pg 59)[5].

With these inputs, let us go back to the part of the petition quoted at the beginning. The OECD countries had already built the infrastructure; the income level is also much higher, still they need 6% to maintain and advance it. Then have a look at the relevant parameters for India: the population density, poverty, immense educational backwardness, and, as a very important factor, the fraction of young demography — all of which are way greater in India.

It is imperative to note that, the TSRS committee consulted 107 documents – surveys, census, and relevant reports, before preparing their report with recommendation (ibid., section 2.5, page 9). The report reached an 'inescapable conclusion' that, not only the standard 6% "must be attained almost immediately if there is to be any realistic hope of meeting the needs of the sector", but there is "imperative need to maintain at least 6% expenditure of GDP on education" (ibid., pg 59-60). And in fact, it recommended several other areas related to education where additional financing outside the 6% needs to be provided (ibid.). Such repeated assertions only indicate the reality on the ground: that 6% of GDP is way too less. But the actual spending on education today stands at 3% of the GDP!!

Needs

Now we shall analyse the parameters. Let us compare with France. While France has youth population (below 15) around 1.2 crores only[6], India's count is 30 *times* more – a huge 36 crores[7]. Then our 'minimum target' is to educate all till the age of 18, and as many as possible till 20. According to 2011 census data, below 20 population was 41%, i.e., around 50 crores[8]. This would be increasing, as a characteristic of a 'young' population.

The last but one para of the Firstpost report also gives a picture of education in 2011, after 65 years of freedom: "··· only 4.5 percent of the population in the country is educated up to the level of graduate or above while a majority of 32.6 percent population is not even educated up to the primary school level". These in coming decades to be elevated respectively such that, after say 20 years, most of youths below 40 are graduates and almost all have completed school. By the way, our 2011 demography contained 74% of population[9] below 40.

The nature of India's educational need is thus three fold compared to many other countries:

[4] http://www.nuepa.org/New/download/NEP2016/ReportNEP.pdf

[5] 2013 country-wise data: http://hdr.undp.org/en/content/expenditure-education-public-gdp
2016 data :
http://data.uis.unesco.org/index.aspx?queryid=181
and a world bank link for global government expenditure: https://data.worldbank.org/indicator/SE.XPD.TOTL.GD.ZS

[6] https://www.statista.com/statistics/464032/distribution-population-age-group-france/

[7] https://en.wikipedia.org/wiki/Demographics_of_India

[8] http://www.firstpost.com/india/latest-census-data-shows-youth-surge-nearly-41-of-indias-population- is-below-the-age-of-20-2581730.html

[9] http://www.deccanherald.com/content/355994/74-per-cent-indians-below.html

1. To include a population many times larger (where 'inclusion' encompasses not mere enrollment but providing all facilities and requisites to keep them in school till class 12, as well as to place as many in colleges);

2. To upgrade the whole body to a minimum standard, and then

3. To maintain and expand.

One need not be an economist to claim that these colossal 3-fold needs will count, in a persistent manner for coming decades, *many times* the 'resource' than used in many developed countries primarily for sustenance and expansion only.

The memorandum submitted by the India March for Science to the Prime Minister points out that "In India the education system has been seriously neglected, resulting in a large section remaining illiterate or semi-literate even after 70 years of independence. The public school system, where a majority of Indian children get their education, is in a very bad shape, as many schools are without proper buildings, toilets, and playgrounds, have overcrowded classrooms, face acute shortage of teachers and are without laboratory facilities. As a result, a majority of children are deprived of the opportunity of being a part of the scientific manpower of the country. The college and university system is also reeling under acute shortages of infrastructure, teaching and non-teaching staff, and funds for carrying out research resulting in a lack of atmosphere for pursuit of excellence and in falling standards in the quality of education."

If this is the real situation of education in India, in absolute monetary terms, the manifold need of resources will translate to several times the spending in the countries mentioned above.

Now, of course the GDPs of different countries are different. So when we want to express the monetary requirements as the fraction of India's quite large GDP, where does the percentage stand? Before answering this, we take note of the argument that, the cost of living is also much lower in India, so that the same resource can be availed at a lesser monetary cost.

To make comparison with respect to a compatible benchmark, we need to correct the scales for the differing prices in different countries. Then the right quantity becomes GDP-PPP (PPP – purchasing power parity). While India's total GDP is 7th in the world and is more or less comparable to that of many advanced countries[10], our nation stands near the top, on the 3rd position in terms of GDP (PPP)[11].

With scales now correctly fixed, let us compare. Our GDP(PPP) is 3.2 times that of France, and 2.2 times that of Germany. Now spending for education in these two countries are around 5.5% and 5% of their own GDPs respectively, which as fraction of India's GDP(PPP) stand around 1.7% and 2.3%.

Now let us go back to the paragraphs where we have compared the demography of India with other countries and mentioned the three-fold needs for Indian education. These two highly developed and wealthy countries with much higher per capita income and much lesser poverty level[12], who also contribute highly to the world's knowledge and culture, spends money amounting to 1.7% and 2.3% of India's GDP(PPP), to cater only to the sustenance and expansion of the educational needs of a 30-35 times

[10] https://en.wikipedia.org/wiki/List_of_countries_by_GDP_(nominal)

[11] https://en.wikipedia.org/wiki/List_of_countries_by_GDP_(PPP)

[12] Though inequality is rising: http://money.cnn.com/2017/09/20/news/economy/germany-election-inequality-income/index.html

lesser demography. Then it is left to the reader to decide whether the fraction of India's GDP needed for educating Indians is many many times higher of this 1.7 or 2.3%, or not. Remembering that creation of new requisite infrastructure is sidelined in calculating the 6% figure, it goes without saying that 10% is really too small to ask for.

India's pressing needs and economic ability, and the policy orientation of the state

"There can be no better investment than in the future of India's children" said the TSRS committee recommendation 2017 (page 60). Although we oppose the idea of viewing education as an 'investment', the spirit is acknowledged by the Committee. Based on last section's discussions, there could be no excuses before the persons in responsible positions to deny the urgent needs.

But if we spend 10% on education, what will be left for the other essential sectors like health, food security, social welfare schemes, infrastructure expansion like electricity, road, etc., expansion of scopes for employment, and so on?

It is a well known myth that India is a poor country. We should rather say India is 'poor' because it cannot utilise of the immense natural and human potential. In the subsequent discussion, we will mainly focus on the funding features and the associated policy orientation in relation to the broad economic scenario. Before going into it, we note that a large share of the country's GDP come from private revenue, which, in a corporate monopoly, do not have any serious social responsibility. So we shall focus on government spending that will also clarify the policies. By the way we must remember that, the corporate share which is nothing but profit accumulated over time also comes from the people.

While tax revenue accounts for 7% of India's GDP, government spending stands at 17% of total GDP[13] as of 2014. The 2018 budgetary provision is estimated to be 13.5% of the GDP. Of course India's GDP is increasing, but total public spending is not increasing compatibly. Anyway, while we expect that at least government spending is solely for people's purpose, it will be instructive to see how the government budget is allocated, and spent.

The public funding scenario

Not only education, but there are a set of internationally acknowledged quantities that measure human and social well being. Main three of them – life expectancy, education, and income per capita – are collectively known as Human Development Index (HDI).

The Wikipedia link[14] gives India's latest HDI status. The latest report shows that India's rank has actually declined; it is ranked 7th on total GDP (3rd on GDP-PPP), but its HDI rank[15] is 131.

The share of education in the GDP is around 3%. In health[16] it is worse – only 1.4% in 2014. Two important sectors – health and education – together are allotted less than 5% of GDP!!

Now let us look at the share of government spending for public welfare. In 2016 the proposed total expenditure for public welfare and related matters was barely

[13] https://en.wikipedia.org/wiki/Government_spending

[14] https://en.wikipedia.org/wiki/List_of_countries_by_Human_Development_Index

[15] http://www.thehindu.com/news/national/india-slips-in-human-development-index/article17566555.ece

[16] https://data.worldbank.org/indicator/SH.XPD.PUBL.ZS (also compare with world average)

2016	2017	2018
15%	$\sim 15\%$	13.5%

Table 1: Share, in % GDP, of total expenditure for public welfare and related matters (*Govt. spending* for public welfare).

around 15% of total budget estimate[17]. In 2017, the alloted fraction for social welfare was around the same[18] (ignoring the amount for rail budget that was newly merged).

What is the scenario in 2018? Excluding rail budget, the total budgetary outlay in 2018 is Rs. 22.94 lakh crores (13.5% of India's GDP estimate of 2017-18)[19]. Considering the three prime sectors of social welfare, "the Budget 2018, outlay on health, education and social protection will be 1.38 lakh crore"[20] – mere 6% of the public spending, that is, 0.81% of the GDP estimate!

Looking into the figures sectorwise and comparing them to India's GPD estimate, we see that the numbers are actually decreasing. "The actual allocation for health in the coming year is Rs. 54,600 crore. This would amount to 0.29 per cent of the GDP, down from 0.32 per cent of the GDP during the previous year. Allocation for the National Rural Health Mission has been cut from Rs. 25,458.61 crore to Rs. 24,279.61 crore, with the total outlay for the National Health Mission being reduced from Rs. 30,801.56 crore to Rs. 30,129.61 crore... Funding for education has come down from 0.49 per cent of the GDP in 2017-18 to 0.45 per cent of the GDP in the coming year. Central government spending on school education as a proportion of GDP has been cut from 0.28 per cent to 0.27 per cent. Higher education has suffered similar fund cuts, from 0.21 per cent of the GDP to 0.19 per cent"[21]. Therefore the government spending on education and other 'public-service' sectors, has really gone down in the last budget. Public life is already privatised.

Policy orientation

Then, where exactly is the public expenditure going? The military grabs almost 13% of government allocation. But the real sink has a nice name – "Revenue Foregone". Recently it has been renamed as "Revenue impact of tax incentives under the Central Tax System" and its measurement has been diluted significantly. "Tax concessions and relaxations on customs duty and excise – collectively known as revenue foregone – are meanwhile a large and growing amount, up to Rs 5.89 lakh crore in 2014-15. Exemptions on diamonds and gold are the biggest contributors to revenue foregone"[22]. In that year, and for preceding as well as subsequent years, it consistently constituted almost 30% of central budget !! How much is the impact? The same reference points out: "$\cdots$ put that number in perspective, the total revenue foregone by India in tax exemptions in 2014-15 was more than the amount the Indian government needed to borrow from the market in this last year to be able to fully fund its budget." Is it not strange that, when farmers' loans are written off, or subsidies given (the

[17] www.thehindu.com/business/budget/Budget-2016-Where-the-money-comes-from-and-where-it-goes/article14130547.ece

[18] http://www.ideasforindia.in/article.aspx?article_id=1770

[19] http://www.livemint.com/Industry/710i08pNKRjJiUBDXtpYIO/Budget-2018-Defence-budget-increased-by-a-mere-781-to-Rs2.html

[20] https://www.ndtv.com/education/budget-2018-finance-minister-arun-jaitley-announces-eklavya-schools-medical-colleges-prime-minister-1807215

[21] https://newsclick.in/union-budget-2018-19-con-job-health-cutbacks-education-contractionary-thrust-economy

[22] http://www.thehindu.com/business/budget/budget-201516-in-seven-charts/article6948182.ece

amount being minuscule in comparison), industry and media houses burst into tears citing the grave burden this poor nation's economy has to bear due to what they consider as 'doles' to India's own people?

The total such depletion announced through the budget speeches in 2013-16 was more than 17 lakh crores[23], which in fact amounts to the total budget estimate for 2015-16. And this is more than 10% of India's present GDP estimate!

By the way, if the readers search for latest figures, including the budget placed on 1st February 2018, it would show that only around Rs. 3.1 lakh crores (1.9% of India's GDP estimate) is foregone[24]. That is only around half compared to average budgetary doles to the corporates given in the last few years. The reason is only some change in 'definition' adopted by the govt[25].

This is one direct officially announced facet of the corporate absorptions of public money. We need to add to it the depletions through non-performing assets, crony businesses, petrolium and gas prices and myth of under recovery, the PPPs[26], public insurance system, and so on. While the nation is set to see world's largest public health insurance system, given India's health infrastruture and the state's policy outlook, this will but end up as another mechanism for siphoning huge public money to the coffers of private insurance companies and hospitals.

Thus we see that a sum, much larger than the demanded 10% of GDP for education, is siphoned off to unproductive avenues that do not contribute to the welfare of the people. It is therefore not true that India is a poor country that does not have the necessary resources. What is absent is the government's will to allocate the available money for education.

Future of India's youth pool

After so many freebies in so many ways, still the profit-sharks are shouting that the government should be more 'courageous' to make India more investment friendly. The last and highly useful excuse for feeding us this market oriented and arguably corporate controlled public policy is that, companies give jobs. The myth of jobs was busted most loudly when the ex-President of India could not avoid expressing his concern in 2015. The year 2015 saw a 7 year low in permanent job creation. Only 1.35 lakhs jobs were created while the number of jobless youths stood at 70 crores. The then President said, if things continue this way, it might spell disaster[27]. The job creation level has not improved since then. It could not, simply because the purchasing power of Indian populace has reduced over the years resulting in crisis in the market. With a shrinking commodity market, job market cannot expand. In addition, technology-intensive automation in a profit-oriented system has rendered much of the manpower redundant.

The suppression of these facts, which are seldom discussed and almost never appears in the front page or as breaking news,

[23]http://indianexpress.com/article/business/economy/govt-forgoes-rs-17-15-lakh-crore-revenue-due-to-tax-incentives-in-the-last-three-financial-years-2923820/

[24]https://thewire.in/220093/budget-2018-numbers-need-evaluated/

[25]http://www.thehindubusinessline.com/economy/why-revenue-foregone-has-fallen-a-massive-70/article9530269.ece

[26]Public Private Partnership, which in practise stands as private profit based upon public infrastructure. Here the profiteer is actually relieved from the primary investment. Then the public infrastructure – bank, hospital, school, electricity, govt industries, real estate – are being privatised directly, or indirectly through gradual defunctioning.

[27]https://timesofindia.indiatimes.com/india/Job-creation-seven-year-low-need-for-more-jobs-President-Pranab-Mukherjee/articleshow/55458325.cms

	Education	School education	Higher education	Health
2017	0.49%	0.28%	0.21 %	0.32 %
2018	0.45%	0.27%	0.19 %	0.29 %

Table 2: Shares in % of GDP.

helps maintain a feeling that there is no job because there is not enough investment due to corruption, tedious procedures, red tapes etc. Often the news of intakes in companies – this hundred here, that thousand there – appears in the news. All these intensify the notion that corporates need to be supported and strengthened to bring happiness.

But sometimes the news of sustained job losses, closures and lay-offs, downsizing, etc., come into discussion. A clear enough picture appeared last year, when the great Indian IT sector was reported to have laid-off 56,000 professionals in one go. Actually the number is 4-fold (almost 200,000) and the industry expects such annual lay-offs to continue for next few years[28]. The recruitment in government schools, colleges, other sectors is also stagnant. Recently the central government abolished thousands of posts[29].

The more general scenario is expressed in the United Nations Development Programme (UNDP) report which asserted that India will face severe job shortage in coming decades. This includes the huge unorganised sector too, which, consisting of half-employed and contract labourers, contributes 93% of the working pool. India would not be able to accommodate even half of the labour pool entering the job market in coming decades in any type of employment whatsoever, if the trend continues![30].

Then what is the solution? The PM of India forwarded the most novel solution, the 'pakoda' scheme of employment! While the assertion of 2 crores of jobs per annum turned out to be false, the honourable PM took the most apathetic stand and said "If someone opens a 'pakoda' shop in front of your office, does that not count as employment? The person's daily earning of Rs 200 will never come into any books or accounts. The truth is massive people are being employed"[31]. The more worrysome fact is, even such 'employment' schemes could not number more than 70 lakhs[32].

Economic viability revisited

India is growing, and its GDP is growing. Where is the growth? Let us note that – in 2014, top 10% wealthy Indians possessed 74% of the nation's wealth[33]; in 2017, a

[28]https://economictimes.indiatimes.com/tech/ites/it-to-layoff-up-to-2-lakh-engineers-annually-for-next-3-years-head-hunters-india/articleshow/58670563.cms

https://www.hindustantimes.com/education/layoffs-and-shrinking-job-market-is-this-the-end-of- india-s-engineering-dream/story-uWtw0E8PtslNzsfiXszMpL.html

http://www.thehindu.com/business/Industry/indian-it-companies-expect-layoffs-shrinking-job-market/article19833381.ece

[29]https://www.ndtv.com/jobs/government-planning-to-scrap-posts-lying-vacant-for-5-years-1806443

[30]http://www.livemint.com/Politics/Tpqlr4H1ILsusuBRJlizHI/India-to-see-severe-shortage-of-jobs-in-the-next-35-years.html

[31]http://www.dnaindia.com/india/report-pm-modi-interview-with-zee-news-top-10-key-takeaways-2576913

[32]http://www.firstpost.com/india/narendra-modis-7-million-jobs-speech-relying-on-epf-data-alone-paints-incorrect-picture-of-employment-in-india-4326779.html

[33]http://www.thehindu.com/data/indias-staggering-wealth-gap-in-five-charts/article10935670.ece

total of 58% of nation's wealth condensed in the coffers of top 1%[34]. Finally, in 2018, this elite 1% aggregated 73% of the nation's wealth. It further came out that, "According to the latest survey, the wealth of this elite group increased by over Rs 20.9 lakh crore during the period under review – an amount close to the total expenditure estimated in the Union Budget 2017"[35]. Rich gets richer, everyone knows. But at this pace! How is this accumulation of wealth possible?

All these data merely indicate that, the GDP and growth stories we hear incessantly actually represent an exponentially collapsing phase. It is actually a growing instability in the large-scale socio-economic structure, simaltenously fed by as well as controlling the government policies (in a feedback mechanism), which leads to such accumulation and consequently the devastating social depletion. The trend is alarming. It is not the demands, but actually the policies and the economic mechanisms that are not viable. These mechanisms and policies, that result today in a mere 6% of public funding (which is mere .81% of GDP) for the pressing social matters, are the ones that stands as the hindrance in the path of true social welfare.

The country is indeed rich in its resource. And if one can resist (if possible recover) the dissipation of the public exchequer, then finding the resource for coherently addressing all the pressing problems – including allocation of ample funds for science and education – will not be a problem, and in addition this will put a brake in the collapse we just referred. But yes, that demands a major shift in the policy orientation. And this is where the necessity of building mass opinion and mass movement lies. Beyond the academic exercise of establishing the requirement of at least 10% of GDP in education, this broader correlation constitutes the most crucial reason to voice for the same and taking initiatives to make the policy-makers hear.

Summary and Conclusion

We are now witnessing an era of snowballing collapse of the economy. In this background we have probed into the broad requirements of Indian education system and have examined the rationale behind the demand for 10% of GDP for education. We have examined if this requirement conforms to other pressing needs of society, and whether the nation has enough resourse for allocating 10% of the GDP to education.

The answers to these questions are in the affirmative. We have shown with hard data that India has enough resources to address all the needs of the society. But a lion's share of the resources are siphoned off to fill the coffers of the rich resulting in unfettered wealth accumulation in the hands of a few. That is the reason for the ever-deepening crisis that we are witnessing today. The government and the corporates together have squeezed the society to a tipping point where the purchasing power of the people has hit a rock bottom.

It is ironic that lack of resources is cited as a reason for not allocating enough funds for educating the next generation. The actual motive is to keep the next generation in dark. We hope this article will help in providing a basis for justifying the demand of allocation of at least 10% of the nation's GDP for education. □

[34] http://www.thehindu.com/business/Economy/Richest-1-own-58-of-total-wealth-in-India-Oxfam/article17044486.ece

[35] http://www.businesstoday.in/current/economy-politics/oxfam-india-wealth-report-income-inequality-richests-poor/story/268541.html

Stubble Burning in India —

Problems, Prospects, Management Options and Policy Needs

Safique Ul Alam*

Introduction

More than half of all absolutely dry matter in the global harvests of cereals, pulses, oilseeds, tuber, sugar and vegetable crops are phytomasses, inedible to human being (like straws, tops, stalks, leaves and shoots etc.). A large part of these residual harvests is handled inappropriately, in developing countries contributing to undesirable biospheric changes and environmental hazards. Inadequate amounts of residues are recycled there, while unacceptably large amounts of straws and stalks are burned, either in the fields or as household fuel.

India produces an estimated amount of about 500 -550 million tons of crop residues annually. Crop residue management and disposal after harvest of the previous crop is a common problem encountered by farmers of India. The surplus residues i.e., total residues generated minus residues used for various purposes, are typically burnt in farm.

The residues of rice, wheat, cotton, maize, millet, sugarcane, jute, rapeseed -mustard and ground nut are typically burnt in farm across different states of the country and it recurs every year. The problem is more severe in the irrigated agriculture, particularly in the mechanized rice-wheat system of the northwest India (Punjab and Haryana in particular) and also in some other states like Western Uttar Pradesh, HP, Rajasthan, MP etc. The residue burning on a larger scale also leads to severe atmospheric pollution in these states and adjoining regions including National Capital Region.

Each year, in Punjab and Haryana after kharif harvesting season, crop burning occurs. Pollutant concentrations in the air then increases, leading to massive winter pollution. It is aggravated by the massive usage of firecrackers in the region, during Diwali. After this, the weather patterns change, temperatures drops and the dispersion effects of pollutants are reduced. Burning of biomass (leaves, and other organic wastes) and garbage through thousands of small fires lit for warmth, along with fires in massive municipal solid waste landfill site, also contribute in making the air full of toxic pollutants and unfit for breathing in the region.

Traditional uses of crop residues and extent of stubble burning

The utilization of crop residues varies across different states of the country. Traditionally crop residues are used in making animal feed, fodder, fuel, roof thatching, packaging and composting etc. The residues remaining in field are left unused or burnt on-farm. In states like Punjab and Haryana, where crop residues of rice are not used as cattle feed (as the same is not easily digested by cattle), a large amount is burnt on-farm. Sugarcane tops are either used for feeding of dairy animals

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or burnt on-farm for growing a ratoon crop (crop grown from remains of previous crop) in most parts of the country. Residues of groundnut are burnt as fuel in brick kilns and lime kilns. The residues of cotton, chilli, pulses and oilseed crops are mainly used as fuel for household needs. The shells of coconut, stalks of rapeseed and mustard, pigeon pea and jute and mesta, and sunflower are used as domestic fuel. It is also a paradox that burning of crop residues and scarcity of fodder coexists in this country, leading to significant increase in prices of fodder in recent years.

A recent Punjab Government report has pointed out that of the total paddy straw, only 21.8 per cent is consumed in biomass-based projects, paper/cardboard mills and animal fodder/other uses, while a small portion is managed through other systems such as machinery and equipment. Farmers actually have little choice and ordinarily resort to stubble burning under present circumstances en masse.

Less time gap between harvesting of kharif paddy and sowing of subsequent wheat crop during October-November months, lack of requisite machinery for crop residue incorporation in the field and increased use of combine harvester to harvest wheat, leaves behind a large amount of unmanaged crop residue in the field. During wheat harvest season in April, also the similar situations arise and large quantities of wheat straws are burned.

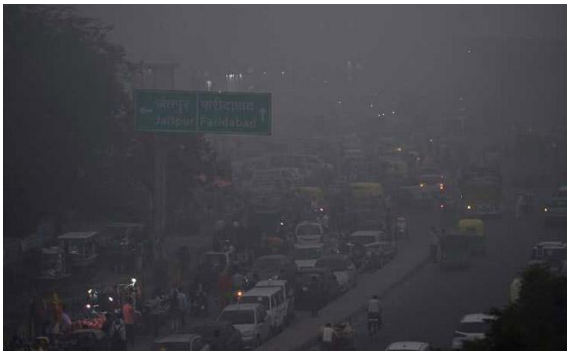
Presently rich farmers in Haryana and Punjab take recourse to increased mechanization and use combine harvesters, which leave about 80% of plant height (12-14 inches) as residue. It takes barely an hour and Rs 1,000-1,500 to cover an acre of paddy using combines. The same job through traditional sickle-harvesting and manual threshing-cum-cleaning requires about 10 men working a full day, and costing Rs 4,500 or upwards. So, farmers simply burn the leftover stubbles to get rid of them and assert "is not a hobby, but a necessity". The problem of on-farm burning of crop residues is intensifying in recent years due to shortage of human labour, high cost of removing the crop residues by conventional methods and use of combines for harvesting of crops.

Traditionally, farm labour in these states was in the form of seasonal, migrant workers from the states of Uttar Pradesh and Bihar. Since 2005, the demand for these workers has been reduced, and accordingly, the availability of assured income from farm labour has declined. The launch of an assured rural income scheme in the form of the NREGA further led to income opportunities in their home states. As a result, agricultural labour has become a scarce commodity in parts of Punjab and Haryana.

Punjab Remote Sensing Centre found that there were 40,510 fire incidents in Punjab alone, between September 27 and November 9, 2017. Rice is produced on about 28 lakh hectares and wheat in 35 lakh hectares in the state. About 75% of 20 million tonnes of rice straw is burned in the state. In Haryana about 2 million tonnes of rice residues are produced annually and as many as 2,955 cases of crop residue burning have come to light in Haryana during last harvesting season. In total, 236 FIRs have been registered against farmers in Haryana for stubble burning. In Punjab only 45 lakh tonnes of paddy straw including nearly 25 lakh tonnes of Basmati rice crop, which is used to make fodder, is being managed currently and remaining 152 lakh tonnes paddy straw is being burnt in fields.

Estimated total amount of crop residues surplus in India is 91-141 million tonnes (Mt). Cereals and fibre crops contribute

58% and 23%, respectively and remaining 19% is from sugarcane, pulses, oilseeds and other crops. Out of 82 Mt surplus residues from the cereal crops, 44 Mt is from rice followed by 24.5 Mt from wheat, which is mostly burnt on-farm. NASA images show biomass residue burning fires are concentrated in Punjab, Haryana, Uttar Pradesh, Rajasthan, Madhya Pradesh, Chhattisgarh, Odisha, Jharkhand, and a few pockets in southern India.



View of severe pollution in Delhi

An environmental hazard

The burning of crop residue can quickly clears a field at low costs, kills weeds and some other pests, but it also leads to loss of valuable plant nutrients, pollution of the ambient environment along with high SPM (suspended particulate matter) and sometimes risk of fires going out of control and damaging electrical and electronic equipments. Biomass burning is estimated as a major source for the global carbon budget and many trace gases such as carbon dioxide (CO2), carbon monoxide (CO), methane (CH4), nitrous oxide (N2O) and other reduced gases in the troposphere. Both CO2 and CH4 directly influence global warming on the Earth. Emissions from the burning of fossil fuels and biomass have led to the creation of atmospheric brown clouds of black carbon and aerosols in various parts of the world. These clouds reduce incoming surface radiation and rainfall, resulting in negative impact on growth and yield of crops. Emission of CO2 during burning of crop residues is considered neutral, as it is reabsorbed during the next growing season. However, biomass burning is one of the significant sources of atmospheric aerosols and trace gas emissions, which has also a major impact on human health.

During crop residue burning season, the SPM 2.5 levels reached up to 600 to 700 or more in some places of NCR in SAFAR (System of Air Quality and Weather Forecasting and Research) scale that runs from 1 (Good) to 500 (Severe). SPM10 (micrograms per cubic metre) levels also increased significantly. The thick smog that hung over Delhi last year during Diwali has been described as worse than the great smog of 1952 in London.

The IARI study estimates that in 2008-09, crop residue burning released 149.24 million tonnes of carbon dioxide (CO2), over 9 million tonnes of carbon monoxide (CO), 0.25 million tonnes of oxides of sulphur (SOX), 1.28 million tonnes of particulate matter and 0.07 million tonnes of black carbon in the country.

A study by the Institute for Social and Economic Change, Bengaluru, has estimated that people in rural Punjab spend Rs 7.6 crore every year on treatment for ailments caused by stubble burning. Moreover, climate scientists have already linked fine particulate matter in the haze to the melting of Himalayan glaciers.The study also shows that CO levels become critical in the areas surrounding a burning field – concentrations of 114.5 mg/m3 or more were observed at 30 m from burning fields and 20.6 mg/m3 at residences 150 m away. The permissible limit of CO in ambient air is 4.0 mg/m3.

Apart from humans and animals, residue

burning also adversely impacts the soil health. Heat from burning straw penetrates upper 1 cm into the soil, elevating the temperature to as high as 33.8-42.2 C. Soil in the burning fields also become hardened and burnt, thereby, soil health is also deteriorating. This kills the bacterial and fungal populations critical for maintaining soil fertility and physical, chemical and biological properties of top soils have also been getting deteriorated. The burning of one tonnes of paddy straws leads to loss of 5.5 Kg of nitrogen, 1.2 kg of sulphur, 2.3 kg of phosphorus, 25 kg of potash and 400 kg of organic carbon. The monetary cost of burning to Punjab farmers is around Rs 800-2,000 crore every year in terms of nutritional loss and Rs 500-1,500 crore in the form of government subsidies on nitrogen, phosphorus and potash fertilizers.

When the Delhi government implemented the second edition of the odd-even vehicle restriction during April 15-30, 2016 to fight air pollution, the Central Pollution Control Board, to everyone's surprise, found that the pollution levels had increased during the experiment. This put a question mark on the efficacy of the emergency measure. Even, coal fired power plants now have some sort of pollution control measures but residue burning causes uncontrolled pollution.

Crop residues management strategies in different countries

Some countries have developed strategies for successful management of crop residues for avoiding on-farm burning. In China, where about 700 Mt crop residues are generated annually, 31% of crop residues are left in the field, 31% are used for animal feed, 19% are used for bioenergy generation and 15% are used as fertilizer (Jiang et al., 2012).

In USA on farm burning has been regulated in some of the states. For example, in California farmers require a permit for crop residues burning, which can be carried out only on 'burn days' determined by the local authorities in consultation with the California Air Resource Board. The crop residues are also required to be shredded and piled where possible. The crop residues are used as a source of energy in some countries like Indonesia, Nepal, Thailand, Malaysia, Philippines, Indonesia and Nigeria; for composting in Philippines, Israel and China; as animal feed in Lebanon, Pakistan, Syria, Iraq, Israel, Tanzania, China and some countries in Africa; for mushroom cultivation in Vietnam and some quantity of residues are even burnt on-farm in China, USA, Philippines and Indonesia.

Measures taken to prevent residue burning

A major campaign has been launched to create awareness among the farmers about the ill-effects of stubble-burning. Crop residue burning was notified as an offence under the Air Act of 1981, the Code of Criminal Procedure, 1973 and various appropriate Acts. In addition, a penalty is being imposed on any offending farmer. Village and block-level administrative officials are being used for enforcement. The National Green Tribunal (NGT) had in 2015 asked Delhi, Punjab, Haryana, Uttar Pradesh and Rajasthan to curb this practice and later asked them to incentivize small farmers to manage the stubble. The NGT had also fixed the environment penalty amount per incident of crop burning to be paid by small land owners having less than two acres of land at Rs 2,500, medium land owners holding over two acres and less than five acres at Rs 5,000 and those owning over five acres at Rs 15,000.

FIR has been filed against farmers in cases caught by the Pollution Control

Board. Apart from this, many farmers were charged a fine. The NGT bench stated in its order that, all the member secretaries and District Magistrates (DM) of the five states would be held personally responsible for any crop-burning activity.

The DMs of these five states have also been asked to form district-level committees comprising members from panchayats to spread awareness about the hazards of crop burning and recycling the residue to make organic manure in those five states. The state governments have been asked to pay subsidy on machines such as paddy seeders and shredders based on the size of land holdings.

The NGT has also asked the state governments to find out ways to properly utilize crop residues. The tribunal said, if any state had already issued a notification in this regard, then it should ensure its compliance. Village panchayats have also been directed to pass resolutions that crop residue will not be burnt and in case of violation the person would not be eligible for auction of panchayat land the following year.

Lately, in a meeting convened by the Environment Pollution (Prevention and Control) Authority on how to control air pollution, representatives of the Punjab and Haryana governments said that the Centre had reduced the subsidy on farm equipment used for extracting crop residues by 90 per cent. This has led to farmers burning crop residues, they said. The representatives stated that subsidy to the tune of Rs 20 crore annually for Haryana and Rs 358 crore annually for Punjab for a period of three years were needed for purchasing farm equipments.

Outreach and public awareness campaigns are also going on. There are ongoing efforts to highlight the health effects of crop residue burning. It produces extremely high levels of toxic particulate matters, which affect the health of the people in the direct vicinity of the burning. In addition, efforts are also being made through kisan camps, trainings and workshops, apart from campaigns through various print media, televised shows and radio jingles, in informing farmers about the alternative usage of crop residue.

The alternative and modern ways of Stubble use

The excess crop residue biomasses may be utilized in a variety of alternative ways commercially, as summarized below.

Making use as Combustion Material: Rice straw can either be used alone or mixed with other biomass materials in direct combustion, whereby combustion boilers are used in combination with steam turbines to produce electricity and heat. The by-products are fly ash and bottom ash, which have an economic value and could be used in cement and/or brick manufacturing, construction of roads and embankments, etc.

Making Pellets: The biomass pellet mill machine uses stubbles as raw materials. After crushing, pressing, increasing density and forming, they become small solid pellets fuel. Biomass pellets can be used for civil heating fuel and cooking fuel. This kind of fuel has high efficiency and is easy to store. Biomass pellet fuel can be also used as main fuel for industrial boiler. It can replace coal and solve environment pollution problem.

Power Generation: Power production from rice straw is a promising way to meet the growing demand of energy. If enough biomass power plants are set up locally, it will provide a new source of income to farmers and also save the environment from stubble burning. Although there will be some emissions from combustion, the

project is eco-friendly and aims to earn substantial carbon credits. However use of stubbles as combustion fuel in large scale is not desirable.

Back in Soil: Composting is the decomposition of rice straw to enable recovery of portions of its nutrients and organic components. It can be done in open spaces or in an enclosed controlled environment. Best results are obtained when residue materials have a high nitrogen content to obtain a better carbon to nitrogen ratio. Factors affecting composting are oxygen availability, moisture content, pH, temperature, and the carbon/nitrogen ratio. Rice straw is slow to decompose and usually will take up to a year in open field with moisture content of the pile remaining high. Scientists have developed a simple and rapid composting technique to convert huge piles of rice straw into organically rich soil. It takes about 45 days to prepare this rice straw compost which helps conserve nitrogen and other nutrients contained in the straw. Use of compost in agriculture may help to improve crop yield by 4 to 9 per cent but the problem of making compost is also found to be labour-intensive. The problem with farmers is that they want quick solutions. That is why the rice straw compost was not adopted in Punjab and Haryana.

Mulching: Another use of rice straw is mulching. In this method, straw is spread across the soil surface and allowed to decompose naturally into the soil by the activity of worm and other organisms. But this environment-friendly agriculture asks for extra effort and time. With farming becoming less remunerative, farmers are looking for easy and quick solutions. This is perhaps the reason burning of rice straw continues unabated.

Making Paper, Packaging Material and Card Board: Straw is a competitive, alternative source of fiber for paper making to reduce the pressures on forests. Rice straw can be used not only to make paper (i.e., newsprint, copier paper, bond paper, etc.) and various paper products.

Packing Materials: A Chinese company has invented eco-friendly material – straw based plastic – made from rice and wheat stalks and can be used in 3D printing, without sacrificing price or performance. Company has developed a technology that can transfer crop straws into 3D printing material. The straw based plastic is made from dried crops straw, such as wheat straw, rice straw, and corn stalk etc., mixed with plastic and plastic additives, using company's patent pending technology.

Worm farming: Ground rice straw can be used as earth worm growing media for making vermi-compost. The most effective material is in the range of 1 to 3 millimeter (mm) particles produced by grinding through 3 mm screens.

Poultry litter: Chopped straw litter can be used for poultry kept on a built-up litter system. The used litter has a useful fertilizer value or can be utilized as cattle feed.

Growing substrate: Rice straw bales can be used for production of many crops such as cucumbers, tomatoes, and flower crops. The bales are soaked in water and impregnated with nitrogen in powder or other forms along with other fertilizers.

Erosion control and soil stabilization: Rice straw is an effective material both in commercial erosion control practices and in rice field erosion control. Bales of rice straw can be shredded on site and blown into roadside cuts and fills to provide soil stabilization.

Frost control: Layers of rice straw can be used for frost control in areas with low temperatures. These uses are usually closely allied with mulching and composting and it is difficult to determine which one of the

practices is dominant.

Sewage Sludge Mixing: Rice straw would be a suitable bulking agent for sewage sludge composting and disposal. It would appear that chopped or fiberized straw would increase both absorbency and acceleration of decomposition.

Fuel in Brick Kiln: A small amount of paddy straw is consumed as fuel by brick kilns.

Mushroom Cultivation: Paddy straw can also be used as sub-strata for mushroom cultivation, but practices of mushroom cultivation is limited to a few farms in a few districts in Punjab. They are yet to achieve the kind of scale at which they will consume the available crop residue.

Production of Ethanol, bio-CNG and Biofuel: These fuels can be produced by fermenting and gasification of straws.

Bio Char: Biochar is a fine-grained charcoal, used as a soil amendment and can potentially play a major role in the long-term storage of carbon in soil, i.e., Carbon sequestration and GHG mitigation. Biochar is a stable solid and can endure in soil for thousands of years. Like most charcoal, biochar is made from biomass via pyrolysis (heating in the absence of oxygen).

Recent Development of Straw Management Equipments

Several machineries as stated below have already been developed for managing crop stubbles.

Straw Reaper: The left over wheat stalks after cut by combine harvester are threshed and the cut straws are blown out to netted trolley attached which allows blowing of dust particles. Recovery of wheat straw after combine operation can be done at high capacity (0.4 ha/hour and straw recovery is about 55-60

Paddy Straw Chopper: This is a perfect machine for chopping all types of crop residue / straw such as wheat, Paddy, Maize, Sorghum, and Sunflower etc. In a single operation, it chops the left behind straw/ stubbles and spread it on the ground. The chopped and spread stubbles are easily buried in the soil by the use of rotavator or disc harrow. Subsequently, wheat sowing is done as usual by the use of no-till seed drill or traditional drill/other equipments. The fuel and labour costs for operation of the equipment is low.

Zero Till Seed Drill: Zero-till farming is a way of growing wheat / other crops without tillage or disturbing the soil in paddy /other crop harvested fields. The advantages of using this method are saving time, reduced labour usage, saving fuel, improving soil health, increased soil organic matter, trapping soil moisture, reduced erosion etc.

Happy Seeder: This machine is developed by the Punjab government in collaboration with CSIRO, the Australian government's scientific research agency. Happy Seeder allows planting of wheat through the residue without burning it. It may be expensive for small and medium farmers, but large farmers can afford it. Direct sowing with this machine reduces soil disturbance, enabling it to retain more nutrients, moisture and organic matter, saving money as less time is needed on carrying out field operations, which in turn reduces fuel and labour costs. In this machine a rotor unit is attached at front of seeding unit that and spread straw in between the rows, as mulch, majority of the residue is not disturbed and seed is sown in a single pass. This technology is eco-friendly with environment for the health of soil as well as it also saves water.

Mulcher Machine: It is used for mulching of straws of crops such as rice, maize, sunflower and tobacco residues easily. This machine also shreds the weeds and stalk of row crops in orchards. Cutting height is

adjustable by two wheels at the back of the machine.

Straw Baler: It is used to compress raked residues of rice, wheat, fodders, sugarcane, legumes etc. into compact bales that are easy to handle, transport, and store. Crop residues are turned into bales which are used for animal feeding as well as bio fuels, creates alternative business for farmers to sell bales to power plants.

Super Straw Management System (Super SMS): The Super SMS cuts the straw in small pieces and scatters it around behind the tail of the combine. An additional straw management system could be fitted to Self Propelled Combine harvesters. The Advantages are easy direct sowing of wheat with happy seeder. Scattered straw helps in conserving the soil moisture and avoids burning straw or removal of straw.

Measures required going forward

Market shall be created for paddy straw, along with a mechanism for commercial procurement of paddy straw for alternative uses as described above needs to be done in wide scale.

Establishment of bio-refineries, biomass based power projects for utilization of paddy straw are viable option. Punjab has nine projects in various stages of planning utilizing 1.5 million tonnes of paddy straw. There's need to expedite operational status and plan more projects. NTPC had already issued a tender to procure biomass pellets for a power plant in Uttar Pradesh in August, 2017.

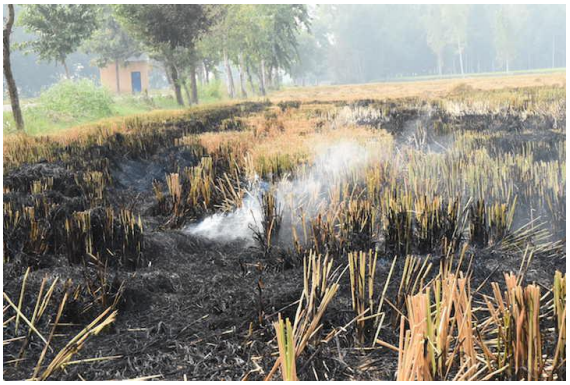
The State Governments, in collaboration with the Centre, has rolled out schemes for providing subsidy on mechanical implements stated earlier. However, the high cost of these implements means that in spite of subsidies, only a small number of farmers have access to these implements at the moment.

Punjab has a proposal to provide subsidy on 67,750 units of agricultural implements, and Haryana has notified a scheme in May, 2017 to subsidise 1810 units of agricultural implements. This is not sufficient, considering the production of 19-20 million and 2 million tonnes of paddy straw, respectively. One way ahead is to promote the co-ownership model.

There are more than 1700 existing cooperative and privately-run Agricultural Machinery Service Centers (AMSC) in Punjab, which can be the focus of such subsidies. It is important that the farmer understands the value of the crop residue and wants to use these implements for extraction and packaging.

There are various ongoing, long-term efforts at diversification of cropping techniques, such that crop residue burning can be effectively prevented. This is being attempted through cultivation of alternate crops (apart from rice/paddy and wheat) that produce less crop residue and have greater gap periods between cropping cycles. Punjab Govt. has expressed willingness to introduce maize in some summer (boro) rice area, but Central Govt. is not allowing diversification of crops in Punjab citing the endeavour will jeopardize food security of the country.

According to Sunita Narain, Director General of Centre for Science and Environment, New Delhi, "Farmers should be paid Rs 1,000 per acre under the Rashtriya



Krishi Vikas Yojana so they can shun the practice of burning paddy straw. They should be given subsidies for buying Rotavator machines that help cut and mix agricultural stubble with soil. We need to understand why the farmers burn stubble and then deal with the basic problem."

In another significant development this year, the Punjab government directed manufacturers to install a straw management system in combined harvester machines. The straw management system cuts and mulches the leftover crop into the same field. However, the manufacturers are considering going to NGT because the order, they say, would make their products expensive and unsellable.

Crop Residue Management with Conservation Agriculture

To manage the residues in a productive and profitable manner, conservation agriculture (CA) offers a good promise. With the adoption of conservation agriculture-based technologies, these residues can be used for improving soil health, increasing crop productivity, reducing pollution and enhancing sustainability and resilience of agriculture. The resource conserving technologies (RCTs) involving no or minimum tillage, direct seeding, bed planting and crop diversification with innovations in residues management are the possible alternatives to the conventional energy and input-intensive agriculture.

Conservation tillage practices are gradually gaining importance as effective mitigation options for changing climate conditions. Studies show that no tillage (NT) and reduced tillage (RT) have favourable effect on soil properties and crop performance. No-till management systems require specialized machinery for seeding under heavy residues. Due to inadequate machinery for NT in India, farmers prefer residue burning or removal, to residue incorporation in the field.

The RCTs with innovations in residue management avoid straw burning, improve soil organic carbon, enhance input efficiency and have the potential to reduce GHGs emissions. Permanent crop cover with recycling of crop residues is a prerequisite and integral part of conservation agriculture. However, sowing of a crop in the presence of residues of preceding crop is a problem. But new variants of zero-till seed-cum-fertilizer drill/planters such as Happy Seeder and rotary-disc drill have been developed for direct drilling of seeds even in the presence of surface residues (loose and anchored up to 10 tonnes per hectare). These machines are very useful for managing crop residues for conserving moisture and nutrients as well as controlling weeds in addition to moderating soil temperature. In the areas, eastern India for example, where crop residues have competing uses as animal feed, roof thatching and domestic fuel, at least some parts of the stubble should be left in the fields to contribute to soil organic carbon.

Yield response with residues management varies with soil characteristics, climate, cropping patterns, and level of management skills. Higher yields with crop residues application result from increased

infiltration and improved soil properties, increased soil organic matter and earthworm activity and improved soil structure and obtained normally after a period of 4-7 years.

A series of challenges exist in using crop residues in conservation agriculture. These include difficulties in sowing and application of fertilizers and pesticides, and problems of pest infestation. Therefore, integrated pest management (IPM) and other specified package of crop production practices should be adopted as a necessary component of a conservation agriculture system.

Research needs for efficient management of crop residues with conservation agriculture

Management of crop residues with conservation agriculture is vital for long-term sustainability of Agriculture in India. Burning of residues must be discouraged and the same be utilized gainfully for conservation agriculture, improving soil health and reducing environmental pollution. Several technologies are now available for efficient use of crop residues in conservation agriculture. However, they require substantial investment for large sale adoption by resource poor and low-skilled farmers. For example, Happy Seeder seems to be one of the potential technologies for managing crop residues. To facilitate adoption of Happy Seeder, farmers need subsidy for procuring the same and also clear guidelines for optimum irrigation, fertilizer management, pest management and long-term effects on soil health. Efforts are required to quantify the economic, social and environmental benefits of conservation agriculture-based practices under different situations.

These can then form a basis for policy level issues in relation to carbon sequestration, erosion control, fertilizer-use efficiency and incentives to retain crop residues. Some of the strategic and basic research areas which need immediate attention are stated below.

- Development of region-specific crop residues inventories including total production from different crops, their quality, utilization and amount burnt on-farm, for evolving management strategies. Satellite imageries should be used to estimate the amount of residues burnt on-farm.
- Assessing the quality of various crop residues and their suitability for off-farm (e.g. animal feed, composting, energy, biogas, biochar and biofuel production) and on-farm (e.g. conservation agriculture) purposes.
- Developing crop varieties with more root biomass to improve the natural soil resource base.
- Developing simulation models for prediction of impact of conservation agriculture on crop growth, oil properties, crop yield and farm income.
- Enhancing decomposition rate of residues for in-situ incorporation.
- Assessing life-cycle of residue-based conservation agriculture vis--vis conventional method of disposing crop residues by burning and other competing uses. Optimizing competing uses of crop residues
- Analysing the benefit, cost, socio-economic impact and technical feasibility of off and on-farm uses of crop residues.
- Assessing the suitability of residue retention/ incorporation in different soil and climatic situations.
- Quantifying the permissible amount of residues of different crops which can

be incorporated /retained, depending on the cropping systems, soil characteristics, and climate without creating operational problems for the next crop or chemical and biological imbalance.

- Assessing benefit cost and environmental impact of residue retention/incorporation in conservation agriculture vis--vis residue burning for short and long term time scales.
- Developing complete package of practices for conservation agriculture for prominent cropping systems in each agro-ecological region, particularly in rainfed and dryland eco-systems.
- Scheduling irrigation in conservation agriculture fields (i) with anchored residues, (ii) with surface carpet of residues and (iii) no residues. Developing soil test method, fertilizer recommendations and customized fertilizer application for conservation agriculture taking into account nutrient requirement of the cropping system.
- Assessing the role of legume residues in sustaining/ maintaining C-N-P-S (Carbon-Nitrogen-Phosphate-Sulphur) balance in the soil.
- Developing package of practices for integrated pest management (IPM) involving crops, tillage, residues, modified planting methods and pesticides in conservation agriculture to reduce use of pesticides and to minimize cost of production and environmental pollution.
- Evaluating weed dynamics (i.e., shift and virulence in weed flora, biology), their interference potential and suitable management practices with low-cost, environment-friendly herbicides in crop residue-based conservation agriculture.
- Developing technologies for termite control in order to enhance yield and the value of residues left on surface during long interval period between two crops.

- Development of appropriate farm machinery to facilitate collection, volume reduction, transportation and application of crop residues, and sowing of the succeeding crop under a layer of residues on soil surface.
- Modifying combine harvester to collect and remove crop residues from field. Twin cutter bar type combine harvester for harvesting of top portion of crop for grain recovery and a lower cutter bar for straw harvesting at a suitable height and windrowing should be developed for proper management of straw.

Future Actions Needed for Long Term Solutions

For long term solutions to stubble burnings across the country, effective steps on following aspects also need to be taken up –

- Agriculture scientists should develop rice/wheat varieties with short growing period and fast degradable straw but having good yield for specific regions
- Farmers should be encouraged for diversification of crops
- Cost effective, environmental friendly and user friendly chemicals and bio

agents should be developed which can make the compost of rice/wheat stubble at a faster rate

- To design rice/wheat harvesters such that minimum residue is leftover in the field just like cutting manually
- Bales of rice straw can be used as mulch for reseeding and erosion control
- Classifying crop residues as amendments (like lime or gypsum) and their use in agriculture should attract subsidy like any other mineral fertilizer or amendment.
- The emphasis should also be laid on recycling of other organic wastes along with crop residues. As the availability of such organic resources is site-specific, an inventory of the potentially available organic wastes should be developed for their use in the target regions in a systematic way.
- Rice straw can be used as the material in the construction of new non-concrete and environmental friendly homes. The bales of rice straw can be used as infill material in the walls of the structures where it provides excellent insulation and acoustical qualities. Straw bale houses, barns, community centers, and even commercial buildings are beginning to show up in many countries.

Future sound walls along highways could be constructed using stacked bales of straw covered with chicken wire and stucco (fine plaster). Whereas, concrete walls rebound noise into the highway, a straw bale absorbs noise and is expected to match a concrete barrier in terms of noise insulation outside the highway. The use of straw bales is inexpensive, sustainable, nontoxic, and environmentally friendly. Also, the construction using straw bales is more cost effective than traditional materials.

Conclusion

With farming becoming less remunerative, farmers are looking for easy and quick solutions. This is perhaps the reason for unabated burning of rice straw. In the current scenario, the farmer in Punjab has no incentive to spend the resources required to extract the crop residue from the field.

Some of the challenges to tackle stubble management are huge quantity, high cost of collection, transportation and storage (high labour requirement), creating awareness and dissemination of standardized technology, capacity building of technical manpower and farmers. Hence, cost effective mechanization and availability of appropriate machinery shall be ensured along with promotion of alternative uses of straws and adoption of conservation agriculture.

The problem of crop residue burning was also highlighted by the Food and Agriculture Organization in 2007, which said that lack of funds, more than anything else, had resulted in poor implementation of the programmes. Pollution from large scale residue burning doesn't recognize political boundary and ultimately affects the larger population, irrespective of whether they are in Punjab or Delhi or elsewhere. Experts say lack of adequate machinery makes strict implementation of "not burning fields" impossible. The gravity of the situation demands that an appropriate policy should be evolved to promote multiple uses of crop residues in the context of conservation agriculture and to prevent their on-farm burning.

Most farmers are not well off. They cannot adopt the scientific and technological methods being suggested as it costs money. Therefore, suggestions like making use of rice straw as fodder, fuel, building material, compost, storing etc. do not come cache with farmers and they have to clear

their fields for next crop showing and thus burn it. New environmental friendly, cost effective, less time consuming, viable and user friendly, and labour-free technologies have to be provided to the farmers in the fields to convert rice straw into useful end products. Companies can also collect the stubble from fields for further use and farmers will be happier if they get some income from this waste. Creation of a market for paddy straw, along with a mechanism for commercial procurement for alternative uses is needed. Lately, industrial demand for crop residues is also increasing.

Adequate subsidy may be given to farmers for procurement of machinery, and more custom hiring centres may be promoted for easy reach of costly equipments to small and marginal farmers at village level. Incentives should also be provided to farmers for adoption of various residue management operations. Adequate R&D activities for diversified use of stubbles shall also be taken up.

However, the farmers might become victims of the administrative rep-tape. The state governments and the court itself must ensure that farmers do not suffer in the end. Farmers should not be prosecuted or arrested for burning the crops. This is a livelihood issue for them. Govt. needs to create market for the residue so that farmers can get an economic value for the same.

India is going to be the most populous country by 2050 and it will be a challenging task to ensure food security for all of them, as the agricultural resource base is degrading gradually due to present unscientific practices in agricultural production activity and fluctuating crop yield due to climate change. Soil resource base must be strong and healthy for agriculture to be sustainable in short and also long run. Conservation agriculture with on farm management of crop residue can be an effective way forward for protecting natural resource base for sustainable agriculture. Location specific practices for conservation agriculture need to be standardized and translated into effective adoption by farming community.

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BSS observes National Science Day with the slogan "India Against Superstition and Pseudo-science"

Sir C V Raman discovered the celebrated Raman Effect on 28 February 1928 while working in a laboratory of the Indian Association for the Cultivation of Science, Kolkata. For his discovery, Raman was awarded the Nobel Prize in Physics in 1930. That day is observed as the National Science Day to commemorate the event.

In view of the cultural atmosphere prevailing in the country, this year the *Breakthrough Science Society* decided to observe the day with the slogan "India Against Superstition and Pseudo-science". Letters were sent out to schools and colleges, requesting them to observe the event in a solemn manner, through debates and discussions among students on various prevailing superstitions and unscientific ideas. The response was tremendous in terms of participation of the scientific community as well as the enthusiasm shown by students in taking part in such debates and discussions.

A decorative badge containing the slogan was distributed in institutes and in many public places to create awareness in the students and common people regarding the importance of National Science Day.

On that day, the students wore the badge and collectively read out a pledge:

> On the National Science Day I take pledge to be guided by scientific outlook and social responsibility. I shall try to inspire others around me, relatives and friends, to be free of unscientific beliefs and superstitions. I shall oppose the spread of pseudo-science, false claims, and religious bigotry in all possible ways.

We report here the programmes undertaken in various states.

West Bengal

In West Bengal the programme was conducted as part of an ongoing movement for the introduction of an 'Anti Black Magic Act' in the state assembly. Such a law banning fraudulent practices that utilize people superstitious beliefs has been enacted in Maharashtra and Karnataka. We are demanding enactment of a similar bill in the state of West Bengal. For that purpose a large scale signature campaign is being conducted. So in this state, along with the other programmes outlined above, the signature campaign was also conducted in schools and colleges as part of the observation of National Science Day.

The programmes in different districts were as follows.

Kolkata:

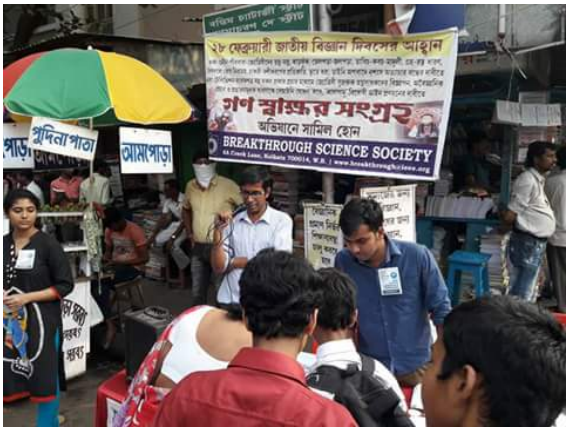
At the University College of Science and Technology (Calcutta University, Rajabazar Campus) 400 students wore the badge and a discussion program was held on "National

Science Day and Our Role". Programs were also held in

- Calcutta University Alipur Campus,
- Jogomayadevi College,
- Jadavpur University (Gate No 1 and 2),
- College Street,
- Behala,
- Baghajatin Boys' School,
- Jatiya High School, Belghoria,
- Bhrama Girls High School,
- Thakurpukur College,
- Jadavpur Girls High School,
- Jadavpur Vidyapith,
- Adarsha Balika Vidyalaya, Jadavpur,
- Prantapalli Girls High School,
- Prantapalli Boys High School,
- Baghajatin Girls High School,
- Taki Boys School,
- Victoria Institution,
- Prafulla Kanan Desapriya Vidyamandir,
- Sailendra Sarkar School Belghoria,
- Haradoyal School Belghoria,
- Ballygunge Govt. School,
- Mitra Institution, Bhawanipur,
- Barisha Uchcha Vidyamandir,
- Shibrampur Nanilal Vidyapitha

Purulia:

In Purulia the National Science Day was observed in the following schools, colleges and Universities: Sidho Kanho Birsha University Purulia, J K College, Kenda College, Santamoyee Girls High School, Kashipur Girls High School, Kashipur Nivedita Mission, Beko High School, Kenda M S Foundation, Lakhanpur High School, Rigudi High School, Gorada High School, Bodam High School, Sirkabad High School, Bandoyan Science Club, Nistarini Women's College



Signature campaign in West Bengal demanding introduction of 'Anti Black Magic Act'

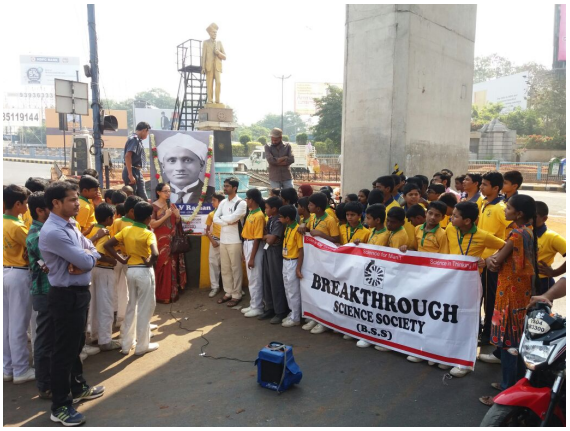
Midnapur (East):

The National Science Day programme was held in many schools and colleges. In each one the student participation was in the range of a few hundreds. In Nandigram Ashad Binod Vidyapith the participation was more than five hundred students. They also presented a drama "Against Superstition".

The list of places are: Barsundara High School, Haldia Chakdwipa High School, Haldia Kukrahati High School, Haldia Paranchak High School, Kanthi High School, Kanthi Kishore Nagar Sachindra Sikshasadan, Mahishadal Science Centre, Bajkul Balaichand High School, Panskura (in three schools), Moyna

South 24 Parganas:

The National Science Day was held at the following schools: Pathar Pratima Anandalala Adarsha Uchcha Vidyalaya, Debnagar High School, Dakshin Kashinagar High School, Raidighi Srifaltala Chandra Kanta Uchcha Vidyalaya, Dharapara High School, Mathurapur Balika Vidyalaya, Ghatiharaniya High School, Patpkur High School,



Dr. Krishna Kumari speaking at the garlanding program in Hyderabad

Jhapberia High School, Rangabeliaghata High School, Joynagar J M Training School, Public Badge wearing was held in Joynagar.

Burdwan (West):

The NSD was observed in the following schools: Searsole Raj High School, Raniganj, Durgapur T N High School, Durgapur Projects Boys High School, Bidhannagar Government Sponsored Boys High School

Dinajpur (South):

Balurghat Chetana Bigyan Sanstha organized a public program in the town.

Howrah:

Salap Science Club, Panchla Azeem Moazzam High School, Howrah Yogesh Chandra Balika Vidyalaya

Midnapore(West):

Basantapur Jhareswar Banibhaban, Benedighi Janakalyan High School, Tarrui Vidyabhaban (Dantan), Gangadhar Academy, Baipatna Uchcha Vidyalay(Dantan), Rohini C.R.D High School, Atulmoni Girls High School, Atulmoni Boys High School, Prionath High School, Arya Vidyapith, Vidyasagar Vidyapith Balika Vidyalay, Rangamati Kironmoyee High School, Vidyasagar University.

North Bengal:

Jalpaiguri: FDI School, Dhupguri; **Darjeeling:** North Bengal University, Siliguri Vidyasagar Free Coaching School, North Bengal Medical College; **Coochbehar:** Jenkins School

Andhra Pradesh and Telangana

A public program of garlanding the portrait of C V Raman was held on Feb 28 at Khairathabad. Children from four schools participated actively. Dr. Radhika, HoD, Dept of Physics, NGDC College spoke about the importance of the day.

A Convention was held at B.R Ambedkar College, Baglimgampally. The main speaker, Dr.P.V Nagendrakumar, GITAM University spoke about the life of C V Raman and how he was passionate about science. Mr R Gangadhar and the College Principal Shri Atmaram also spoke.

A seminar was organised at KSN Degree College, Anantapur on Feb 28.

National Science Day celebration was orgainsed at Jawaharlal Technological University, Anantapur on Feb 28. Prof B Raviprasad was the main speaker on the occasion.

Gujarat

A photo exhibition on life of Dr C V Raman and a book stall was organised from Feb 26 to March 1 at Gujarat Science City, Ahmedabad.

Photo Exhibitions on life of Dr C V Raman and Raman Effect were held in the following places: Charotar University, Changa, Anand district (Feb 25), M. G. Science

College, Ahmedabad (Feb 26), Chamunda Nagar, Naranpura Gam, Ahmedabad (Feb 28), K. K. Shah Maninagar Science College, Ahmedabad (March 1), Sharda Mandir Highschool, Ahmedabad (March 3).

Madhya Pradesh

A seminar was organised at MLB College, Bhopal on Feb 28. Dr Parimal Mishra was the main speaker. He discussed about the need to cultivate scientific outlook and the way to achieve it.

Tamilnadu

Feb 28: A whole day seminar was organised at Madurai in association with M.S.S WAKF Board College. Dr Daniel Barnabas, Dr Abdul Kadir, Principal, Wakf Board College, Prof Yogarajan and a few others spoke. There was a student presentations session. Students from seven colleges participated.

Feb 28: A public program was organised at Sivan park, KK Nagar, Chennai. Mr Ilango Subramanian, science communicator spoke about Raman Effect. Prof N Elangovan and student members of the Science Academy of India conducted science experiments demonstration for more than an hour that very much attracted the children.

Jharkhand

As part of celebration of National Science Day, science experiments demonstrations and discussions were conducted in different parts of Jharkhand: Shisu Vidya Mandir School, Chandrapura, Bokaro (23 Feb), Janta School, Bokaro (26 Feb), Higher Secondary School, Chaibasa (27 Feb), Chandil Degree College (28 Feb), Mahulia School, Ghatsila (28 Feb), Behra School, Ghatsila (28 Feb), UHS high school, Jamshedpur (28 Feb), Kanhu Siksha Niketan, Jamshedpur (28 Feb).

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Kerala

A meeting was organised at the Kerala Forest Research Institute (KFRI) on Feb 28. Mr G S Padmakumar, President, BSS Kerala chapter spoke. Dr Divakaran, Registrar, KFRI presided.

Sky watch programs were organised at the following places in Kottayam district: KE English medium School, Mannanam, Navajeevan Trust and Kendriya Vidyalaya, Kottayam. Amateur astronomer Mr K Thankappan and P G Sasikumar conducted the program.

A talk on Scientific temper was held on Feb 27 at CMS College Kottayam. Dr. K.P Satheesh, Retd. Principal of Govt. College, Nattakom and Dr. P.Rajagopal, HoD, Dept.of Physics spoke.

A two day astronomy exhibition was held at Govt. College Nattakom on Feb 27 and 28. The exhibition was part of the Sastrayan exhibition in the college. On the 27th a sky watch was also conducted under the guidance of Mr K Thankappan.

Feb 27: National Science Day celebration at Baker Vidyapeed, Kottayam. More than 125 Eco Club In-charge teachers from various schools in the district participated. Dr. B.K Bindu Associate Professor Dept. of Civil Engg and Prof. P.N.Thankachan made presentations.

Feb 28: National Science Day celebration at Henry Baker College Melukavumattom. Talk, quiz competition and Einstein exhibition were conducted. Prof Lisa George and Prof P.N.Thankachan spoke.

Feb 28: A talk was organised in Saikrishna Public School, Chenkal, Trivandrum. Mr Anand Justine, BSS organiser spoke about the need to cultivate scientific temper.