EVERYMAN'S SCIENCE

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COVER PHOTOGRAPHS

Past General Presidents of ISCA

1. Dr. Atma Ram	**(1968)**
2. Dr. A. C. Joshi	**(1969)**
2. Prof. A. C. Banerjee (died pre-maturely)	**(1969)**
3. Prof. L. C. Verman	**(1970)**
4. Prof. B. P. Pal	**(1971)**
5. Prof. W. D. West	**(1972)**
6. Dr. S. Bhagavantam	**(1973)**

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EDITORIAL

JUDICIAL ACTIVISM IN INDIA

Judicial activism is a buzzword various of legal and political discourses in the 21st Century India. Although defined in several ways, it refers to increasing role of judiciary in defining law, a role which was to be played by the parliament earlier. Growth of judicial activism implies that judiciary is usurping the rights of the other two institutions- the parliament and the executive. Judiciary was supposed to be only one of the three pillars of Indian democracy and judiciary, parliament and executive were considered to have an autonomous place of their own. All the three institutions of state are supposed to enjoy freedom within limitations prescribed by the Constitution of India. Thus while the parliament is free to enact new Acts and laws it is not completely free to do so. At least in two cases, in Golaknath's case in 1967, and in Keshavanand Bharati case in 1973, the Supreme Court of India clarified that the parliament cannot amend the Constitution when it comes to fundamental rights or the basic structure of the constitution of India. Depending on one's perspective this new condition may have something to be celebrated or something to be condemned. Accordingly one may have a positive or a negative view of judicial activism. This essay explores the historical reasons behind judicial activism, limits of judicial activism and presents a few hypotheses for the future.

India is a democratic country and democracy implies the rule of law. This assumes that laws are well defined, understood by people, accepted by people, respected by people and most commonly obeyed by people. The case of India is interesting. The history of law in India is closely linked with the history of national movement. Politically speaking, India has never been a single nation with one monolithic culture. Whatever be one's reading of the ancient history of India one thing that cannot be denied is that the people of India have always been highly diverse in terms of economy, society and culture. British crown brought them under one state, of course with grant of freedom for many princely states and tribal regions. The dream behind nationalistic movement was to develop the state into a developed nation by breaking the chain of exploitation in the world system. However, for many freedom fighters from the subaltern groups this also implied breaking the chain of exploitation within the nation and removal of inequality and exploitation based on caste, community, class, urban-rural areas, etc. Soon after independence India adopted a Constitution which was to provide the framework of law in all matters pertaining to man and society. It was expected that the parliament would articulate the value system of Indian people and make policies, within the Constitutional framework; executives would implement these policies; and in perceived cases of injustice judiciary will provide justice to the aggrieved party. It was too utopian a thought. Indian elite, who carried a feudal mindset, and were not prepared for equality and justice, were to implement the ideas enshrined in the new Constitution. If one reads the writings of Prem Chand and other contemporary writers it becomes obvious that those who were to exercise power or give direction on behalf of society had absolutely no faith in the Constitutional ideas of equality, liberty and fraternity. Indian society was poor, backward, unstable and religious. Indian people were highly divided along diverse and strong identities. For most people the language of religion was the language of justice and they communicated their thoughts and meanings in locally interpreted religious concepts of diverse nature. Thus it was a

horrendous task to evolve a common civic and criminal code for Indian people that will guide the actions of individuals, groups and institutions.

After independence, especially after the death of Pt. Jawaharlal Nehru, in the background of continued poverty, inequality and rigid social stratification the unifying nationalist, developmentalist sentiments were soon replaced by ethnic and divisive sentiments. The subsequent social and political developments in the country produced several conditions, many of which were expected by certain scholars even at the time of Constitution making. Some significant ones are :

- Dedifferentiation and lack of clear distinction between politics, administration and law
- Weakening of state due to pressure from the top as well as the bottom
- Rise of identity politics (i.e., politics based on caste, community, gender, region and urban-rural distinction)
- Poor governance and widespread perjury and venality
- Double standards in politics and administration
- High degree of litigancy

In this environment the parliament appeared to be slow, occasionally unfair and ineffective. On several occasions it failed to project that its decisions were right on the grounds of social integration, fairness and national development. Administration too was found to be failing in redressing public grievances and meeting various democratic and modernistic needs of the people. In this context, judicial activism leads to some hope. If parliament and executives were effective judiciary would not have to tell them to provide mid day meals to school children. Judicial activism has produced very many significant results.

However, judicial activism does not exist in vacuum. It is closely connected with the social environment. Here one can visualize two scenarios : one in which due to various movements, in which civil society action has to play an important role, there is a change in the value orientation of Indian people, establishing equality and justice as two cardinal values; and second, in which there is no change in the value framework and more and more people rely on law, lawyers and judiciary for seeking justice. For various historical reasons most Indians suffer from a lack of a social sensitivity and empathy. For them equality is a value in individual's striving for success but not with regard to their relations with those who are less fortunate than them. If there is a strong movement for equality in all its ramifications then the whole set of institutions comprising state will work effectively and efficiently. But this appears to be too idle to expect in the near future. The other scenario is that without a change in the value framework of India we keep a check on inertial and/or excesses of the elected representatives of people forming the government. Judicial activism appears as one possibility. In this scenario, to use a phrase from N. A. Palkhivala (1994) we are looking for a backward constitution for a backward nation in which the judiciary is uneducated, slow, equally corrupt and unrepresentative.

Ex-Chief Justice of India, P.M. Bhagwati (u.d.) justifies judicial activism on a number of grounds. To quote: "... law cannot anticipate the endless permutations of circumstance and situation. There is bound to be a gap between the generalities of law and the specifics of life. This gap in our system of administration of justice is filled by the judge." Legal aid movement intended to produce legal awareness, promotion of voluntary mediation agencies called Lok Adalat, fostering and supporting social action-groups, development of Public Interest Litigation (PIL) to provide justice to the poor and underprivileged sections of society, and development of a new normative regime of rights (to life and liberty) have all produced judicial activism in India. Bhagwati claims that judges may adhere to

"photographic theory of the judicial function" whereby law exists independent of judges and they only have to find it, because it is a convenient one. It saves them from public criticism of their decisions and may often help them to escape accountability. In 1990s and 2000s there have several developments along these lines. Thus while in 1980s the law sanctioned that any man from the public or any social action group could approach courts on behalf of the poor and the deprived, in 1990s it was sanctioned that the judges themselves could take note of certain issues on the basis of newspaper reports or their own information.

The rise of judicial activism draws attention towards a number of issues, however. Some important ones are :

1. Education of judiciary
2. Representativeness of judiciary
3. Watch on judiciary

First of all, there is a need to attract the bright candidates for legal education. Also the judicial education should not only include technical knowledge on the subject but also ethical and moral concerns of society. Secondly, for judicial activism to succeed, judiciary must also represent all sections of society : SCs and STs, OBCs, women, minorities, and rural and backward areas. Thirdly, there is also the issue of keeping a watch on judiciary. Judiciary is not known for having an unblemished record in delivery of justice. The most difficult issue in all this is how representativeness and inclusiveness of judiciary can be combined with the impartial spirit of the Indian constitution. Judicial activism demands that the lawyers, legal institutions and judiciary represent the Indian spirit in case the techno-bureaucratic and political systems fail. The question is: are the causes of failure of techno-bureaucratic and political systems, for example perjury, double standard, self seeking, nepotism, favors, regionalism, casteism such that they will not touch judiciary, and how free the judges are from consciousness of primordial identities?

In sum, judicial activism is welcome but is not a panacea for complex problems of India. Along with judicial activism the country needs a mosaic of social movements on various issues underlining commitment to equality, secularism, harmony and social integration. These movements (on the farmers' issues, on corruption, mobilizations of various castes and communities, ecological movements, movements for saving rivers, swadeshi movement, various religious reform movements, etc.) may or may not succeed in achieving their intended and most articulated goals but they can influence the value system of society and sensitize people to need for change - in the broader framework of human values and professional ethics. They have potential to touch all institutions of state - government, elected representatives, bureaucracy and judiciary - and will make them more democratic, more responsible. Another possibility is that the judiciary itself decides to become more reflexive and frames such laws which influence the judiciary to act in the wider interests of Indian masses. Thus judicial activism goes beyond influencing the state policies and seeks to reform itself also, even in absence of pressure from outside. This becomes an essential ingredient of judicial activism.

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PRESIDENTIAL ADDRESS

SIXTY YEARS OF SCIENCE IN INDIA

DR. S. BHAGAVANTAM, D.Sc., F.N.A.

Let me commence my address by stating that I am grateful to the members of the Indian Science Congress Association for electing me as the President of this sixtieth session. I regard it as a special honour and a great privilege. The task of giving an address which is worthy of an occasion like this and at the same time acceptable as a reasonable one to the different sections of the scientific community in India is a severe one for me. The fifty-nine annual sessions that were held in the past had on many occasions such eminent scientists to address them that one feels it a difficult task to follow the traditions that had been set up. Further, as much has already been said on those occasions about Science in general and Science in India in particular that one wonders if there is anything very much more or very much new to be said. In such a context and knowing my own limitations, I fear that I will be a poor sixtieth in that distinguished sequence. Moreover, I will probably annoy you by restating some that has been said before or stating what many of you know. I seek your indulgence on both these counts and hope for the best.

I wish to express our gratitude to you, Madam Prime Minister, for your gracious presence. It is not easy for one in your position to spare time for anything other than matters of great National concern and if you are here with us today, it is indicative of the importance you attach to the Indian Science Congress Association. Let me hope that we shall deserve it in the years to come.

I cannot proceed further, without making a reference and paying homage to the memory of Shri Jawaharlal Nehru, who had been the General President of one of the sessions. He accelerated the pace of scientific progress in this country. He was accessible to practically all the scientists, both in the Government and outside the Government. He used to speak repeatedly about the scientific temper of the people, the need to take Science to the people and use Science for the removal of hunger and poverty in this country. In fact, he did more than any other single individual, to elevate Science in our country to the place which it occupies today. The Indian Science Congress Association, looking back over the past sixty years of its existence, should express its deep sense of gratitude to him and I beg leave of you all to do so on this special occasion of our Diamond Jubilee Session.

I have chosen "Sixty years of Science in India" as the title for my address. I owe an apology to my colleagues for this choice as the title sounds like one, more appropriate in history than in Science. The only saving feature is that whatever is history in my address is history of Science in India and not of anything else. It seems to me that now is not a bad time to take stock of our objectives, our achievements and our shortfalls. One may recall the fact that at its first session in 1914, when the membership was 105, 35 papers were presented before the Congress ; while the membership today

* General President, Sixtieth Indian Science Congress held during January, 1973 at Chandigarh.

is around 6,000 and the papers presented are around 2,000. Thus, quantitative progress is unquestionably evident. Of course, quantity is concrete and can be seen by everyone. Quality is abstract and can only be perceived and assessed by those who have the competence to do so. Progress in quality is also undoubtedly there, though not so evident. There are bound to be critics who look at this growth as a self-defeating load that the organisation has gathered. They ask the question that had been asked earlier "When shall this monstrous bubble burst?" On the other hand, there are an equal number, if not more, who see in this growth a healthy sign, because the Indian Science Congress, unlike other high-brow organisations in the country, has a responsibility of drawing the people at large into this great adventure of using Science for the benefit of man. In any case, the temper in the country today is such that if need be, one may not hesitate to express doubts about the correctness of the existing organisational structure of an Association in the context of its objectives, even if it is only for the purpose of stimulating critical analysis. In all humility, I seek your permission to do so and venture to ask the General Body to give some thought to this aspect. A wise oriental proverb says, "when you can see a reason for doubting, at a point where people have not hitherto doubted, then you are making progress."

In attempting a review in retrospect of the growth of Science in India during the past sixty years, one would like to recall that originally in the western world, Science had a specific connotation. The word Science comes from the latin word meaning "to know". The basic meaning of Science is thus simply knowledge. The idea of utilising such knowledge to control nature and thereby use her for man's benefit is comparatively recent. For instance, the character that was granted by King Charles II to the Royal Society of London on 15th July, 1662, lays down one of its objective as "to further promoting by the authority of experiments the Science of natural things and of useful arts to the glory of God, the Creator, and the advantage of the human race." Such efforts which speak also of the advantage to the human race have over the years given birth to that branch of Science which we now describe as technology. Thus, through the centuries that have gone behind us, some people looked at Science as a benevolent goddess, to be worshipped and cultivated by the Seeker of knowledge whereas the others looked at it as a milch-cow, to be used as the giver of butter and milk, by those who need to use Science in that manner. Any review relating to recent times has to pay attention to both these aspects. The technological aspect concerns the growth of Science in India, primarily in the context of our National problems. There are overtones of a secondary nature when we project this aspect into the International sphere. The second aspect of Science, which requires us to look at it more as knowledge of natural things, also concerns its growth in India but not in isolation. This aspect has close links with the shape and strides which Science has taken and is taking at the International level.

In our country, in the early years, scientific education was an important aspect of the progress of Science and we naturally had to depend on universities for that. There were only a few universities in pre-independence India and not many of them had the resources to support strong schools of Science. The surveys like the Geological, Botanical and Zoological Surveys and a small number of other Government departments did contribute in the direction of providing a general mapped picture of this large country and its resources. All this, however, did not amount to very much, especially when assessed as contributions at the frontiers of knowledge and in juxtaposition to the vastness of the country. One good thing that stands out prominently when we look back on the achievements of those days was the emergence of individuals, though a small

number, with outstanding achievements in selected fields like Mathematics and Physics. Srinivasa Ramanujan for instance, will be remembered as a mathematician from India, long after many of his noisy contemporaries would have been forgotten. Similarly, the fact that Chandrasekhara Venkata Raman was awarded the Noble Prize for a discovery of his, named after him and made when the facilities for scientific work in India were so poor that all the tools he used for that purpose did not cost more than about three hundred rupees, will remain for a long time to come without a parallel in the history of contemporary science.

These and other similar individual achievements apart, Science and technology in their broader and more recent aspects, particularly as aide to industry and as instruments of economic development and affecting the lives and outlook of the people in general are features largely of Independent India. That modern Science and technology are items of high priority in the process of socio-economic development in a developing country like ours is now a universally accepted concept. It therefore follows that the recognition of such a concept constitutes the foundation on which to build a sound National science structure. That in Independent India we did start very well in this regard is evident from the fact that no one perceived the significance of such an instrumentality more clearly than the late Jawaharlal Nehru. I wish to quote from one of his speeches, even if it is a repetition of what was done on earlier occasions and by others when preceded me.

"It is Science alone that can solve the problem of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, of a rich country inhabited by starving people. Who indeed can afford to ignore Science today? At every turn we have to seek its aid. The future belongs to Science and to those who make friends with Science."

Thus, the place of Science in tackling India's basic national problem was fully recognised. It was during the tenure of office of Shri Jawaharlal Nehru as Prime Minister that the Indian Parliament adopted the now widely known Scientific Policy Resolution, which declares that the aim of the scientific policy of the Government of India, amongst other things is in general, to secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge. This is an excellent background, as good as any developing country can look for against which Independent India had set out her sail for the purpose of participating in the world's greatest enterprise of today, namely pursuit of Science for the good and well-being of mankind and to ultimately provide for our citizens a quality and standard of life which every individual hopes for.

In some ways, we seem to have done reasonably well thereafter. India was the first country in Asia, outside the U.S.S.R., to produce fuel elements for atomic reactors. India's first nuclear reactor, Apsara, went into operation as long ago as 1956. Other reactors, with other but less fascinating names, followed in quick succession. There is a growing aircraft industry which, besides producing under license, batches of British and Russian aircraft, the Gnats and the Migs of which even the man in the street would have heard during the past few years, has also brought into service an Indian designed Jet fighter, the HF-24. Although there has been a continuous struggle in the field of electronics, between those who advocate taking risk with indigenous designs and those who support license production for one reason or another, Indian designed radars and sophisticated electronic communication and other equipments are now in production in India. I have stated these facts to convey my assessment that not only did we set our sail against an excellent background of governmental understanding at the highest level

but we also have achieved a few creditable bright spots in regard to which we can all be proud to a degree—though I would caution the technical people to pause for a while and ask the irritating questions, what is the present position and what are the prospects for the future? How do our achievements compare with what obtains in other countries and are we keeping pace with the fast moving world technology ?

In the context of the strong political patronage that we have had, as outlined by me in the preceding paragraphs, I believe that Science in India should have grown qualitatively and quantitatively to large proportions. I also believe that it should have discharged on of its desirable functions of penetrating into our industries much better, thus helping to modernise them and make them contribute to the economic growth of the country at a faster rate than what they have been doing. That this is not an unreasonable expectation will be evident if we look at what the state of Science in some of the economically affluent Nations of the world is today and what it was say. Forty to fifty years ago, the Soviet Union was a backward country, poor, illiterate and largely agricultural. Today she is identified with prodigious feats of Science and technology. It used to be publicised at that time by those interested in publicising such facts, that whereas the ten millionth car came off the assembly lines at Detroit, the majority of Russians were still travelling by ox-cart over unmade roads. Since then, the Soviets have had several firsts to their credit in the field of Science and technology. I, like some of you in this gathering, had the opportunity of visiting their laboratories and factories from time to time and of noticing, the gradual disappearance therefrom of all their imported equipment, all the disabled instruments and all the unoccupied space. Forty to fifty years ago, we too were in a large measure travelling by ox-cart over unmade roads. Many of us continue to do so even now, although great changes have been brought about in some areas. Our laboratories still contain a lot of imported equipment and in some places, instruments which do not work at all.

Looking again at another affluent country, the United States of America, we may get a picture of what Science was in that country about fifty years ago and what it is today. I have heard it said that when the American Chemical Society offered to aid the war effort in the USA at the start of world war I — sometime during the year 1914 — the'old war department of that country declined the offer with cordial regrets. This was on the ground that the ward department already had an army officer on their staff, who was once a chemist and who, in his spare time, had been thinking about their scientific problems, and therefore no additional scientific help was needed from the American Chemical Society. The narration is perhaps a little on the side of exaggeration but it is clear that the event enables us to conclude that countries, which today are very advanced were not far ahead of us, say sixty years ago, at least so far as the position occupied by Science in the heirarchy of National priorities was concerned. It is a coincidence that the year of 1914, during which the cited incident is said to have occurred, also happens to be the year when the first annual session of the Indian Science Congress Association was held. The situation currently is admittedly very different. While the two countries mentioned as examples are known to have successfully harnessed modern Science to raise the standard of living of their citizens, perhaps a little too rapidly, we are still in the process of talking and discussing how to go along those lines.

Quite a few thinking men have noticed these shortfalls in the National scene and have drawn attention to it at different times in different ways. For instance, out of a total expenditure on scientific and technical research of about Rs. 150/- crores a year at the present time, the Central and State Governments account for a major portion whereas the industrial sector's input into this is of the order

of only Rs. 10 crores. This means that research by the industry or for the industry, whether in the public or the private sector, is still in its very early stages. Taking another example from the field of education, from some 20 universities with a student enrollment in Science in the neighbourhood of 1 lakh at the time of independence, we have moved on to having nearly a 100 universities and institutions "deemed to be universities", with the student enrollment in Science having become many fold. Despite this growth and not withstanding the generally accepted importance of the place which Science should have in the universities in comparison with all other aspects of a country's scientific endeavour, our investment both in funds and in manpower in teaching and research in the universities has been very much below par in relation to India's total scientific effort.

These short-comings are well-known and there is no need to cite examples from other areas of National activity. A whole spectrum of views from one extreme end of outright condemnation of the structural details, obsolete policies and massive buildings to the other extreme end of a sympathetic defence of inherent difficulties, social barriers and inadequate leadership have been voiced from time to time. However, facts are more important than theories. Looking at the future with an analytical mind is more important than digging up the past with a view to find fault. It is my earnest appeal to the scientific community of India and the Indian Science Congress Association, while they look at the sixty years of past in retrospect, to undertake an exercise of evaluation in the right spirit. Behind what I had stated in the past few minutes is implied a feeling of mine, may be right or may be wrong, that while the scientists had the opportunity of building a strong superstructure on the good foundations and the extremely good environment which the political leadership in independent India had provided, they did not do so. In so saying, I am having in mind the ineffectiveness of the areas where science and politics meet. These indeed are the dark areas on which wise men, both in India and abroad have commented many times. In science, as in most other things, all that glitters is not gold. The leaders of a country should ignore the slogans and look through the outside glitter. Unfortunately, this is often possible only the hard way.

That takes me to an aspect of Science in India which enjoins on us the need to assess its growth in the context and as a part of the International endeavour. In this phase, the picture is more complex and we come across difficult situations. For instance, our population problem cannot be viewed in isolation. If an expert in demography points out that this National problem should be tackled with the best of means available to the rest of the world, that we have an unacceptably high growth rate and that every year we are adding twelve to thirteen millions to ourselves, we are inclined to view the suggestions with suspicion. Twelve to thirteen millions is as much as the entire population of a vast country like Australia or a small country like Hungary. Even so, we are sure to find one amongst us justifying the situation and extolling ourselves by saying that we are a great Nation and indeed we may even be proud of the fact that we are giving birth to an Australia or a Hungary every year. Taking another example, if someone points out that our aeronautical industry is in doldrums and that it is limping far behind the world trends in aeronautics and therefore cannot stand competition with the rest of the world, immediately we are sure to find one amongst us justifying the situation and asking the question, how does it matter? After all, our ancients knew all about flight sciences and there is evidence that they even used flying machines. Similarly, if someone points out that our contributions to modern Science are not in keeping with the shape which Science is taking at the International level, we at once satisfy ourselves by constituting a National Commission to delve into the History of Science in

India. A Commission of that kind will in due course discover that we did make significant contributions at one time to the progress of world Science. I do not like to multiply examples of this kind, particularly because the irony of it is that several of them are facts and cannot be contradicted on that score. They only reflect a National trait of ours by which we prefer to judge our capacities in isolation and not as a part of the contemporary world community. Indeed, I am very much one of those who believe in and always feel proud of the achievements of our ancestors. In a lighter vein, I comfort myself by saying that they had done everything great, the only exception perhaps being that they did not bring about a decent progeny. That does not mean that we should be ungrateful to our ancestors. It only means that we should learn to look at ourselves and our surroundings with a critical and discerning eye.

In the International context, we must recognise that Science has taken some wonderful strides. On the side of economic growth, it has been proved that at the stage at which most developing countries are and certainly our own country is and before reaching saturation, research can effectively increase the Gross National Product. On the side of human welfare, it has been proved that problems like the average duration of life being too low and the need to provide minimal requirements to each and every citizen can be successfulfy tackled, where they need to be tackled. It will be a repetition on my part to state that these aspects should receive the highest priority in our Science plan when we look at Science in its broader aspects. Alas, in spite of what all of us had done in this regard during the past few decades, a large percentage of our people in this country die prematurely of malnutrition because they have not enough to eat and what little they eat is ineffective. Even the rest, a small percentage of our people, also die prematurely because they have so much to eat and they overeat. The fact that Science has today acquired the ability to control and exploit energy, to manipulate materials and fabricate new composites, has drastically affected the life of man and has completely altered the fundamental economic realities.

Again, taking Science in its original ethos, namely pushing the frontiers of knowledge further and further, our contributions will naturally be judged in the context of frontiers as set by the world community of scientists. We should strain our utmost to bring into existence and promote such schools of Science as can fulfil this task. In this matter, capacity to judge, assess and distinguish the right ones from the wrong ones on the part of the leaders as well as the capacity to continually up-date, refine and improve themselves on the part of the individuals are very essential. There is no room for being imitative and second grade. Originality and excellence are the only criteria. No one who has himself not participated in this exciting venture of scientific research can ever comprehend how difficult it is to set up high standards as well as objective mechanisms by which to assess such standards. X-rays were not discovered at the behest of any industrialist who wanted to provide machines to surgeons for facilitating their task of looking through human flesh. The electron and the thermionic valve were not discovered at the behest of any politician who wanted to communicate more effectively with his clientele through radio and television. There is an old story that Emperor Napoleon, when told that there were no good poets in France at his time, turned round and demanded to know what the minister for interior was doing about it. Science too, in its original ethos, like Art, Culture and Poetry, does not fluorish and may even tend to fade by withdrawing from the glare of flambuoyant bureaucratic attention. Alas, we cannot plan to produce Ramans and Ramanujans in our laboratories as we can plan to produce rifles and rockets in our factories. If one takes on oneself the task of planning such research in advance, the only

thing that he may achieve is to delay or prevent fundamental discoveries being made. The tragedy of it all is that no one will know how much damage he has done, because no one knows in advance what basic aspects of Nature yet remain undisclosed to us. Progress in many cases could be retarded if assessment of such work is attempted during contemporary times.

Scientificially advanced and economically affluent countries today talk of global problems in another context. Their scientists and decision makers talk of environmental deterioration, depletion of natural resources, pollution control technology, irreversible metabolic changes effecting man's mental make up, nuclear armaments and biological and chemical weapons pointing to a possible mass destruction of the human race and so on. The less advanced and economically poorer countries like ours are bewildered. The now well-recognised fact that while a low GNP leads to poverty, squalor and suffering, an unlimited growth of GNP leads to crime, drugs and suicide adds a great deal to the prevailing confusion. In our bewilderment, we seem to forget what is good for us and what is needed most by us. However, somehow and somewhere, the decisions are made and have to be made, for time and tide do not wait for anyone. Thus, we too have begun to talk in this country of exactly the same problems as listed by me a little while ago, unmindful of the fact that we are at a different rung of the ladder and even on a different ladder itself. We have a proverb in my part of the country which says that as soon as Lord Siva starts his cosmic dance, all the lesser gods, the nymphs, the angels, the attendants and even the devils begin the same dance, unmindful of the ruggedness of the floor under their feet and of the status on the chain of evolution in which each of them is. Political pressures and personal considerations, which are far from scientific realities to say the least, are brought to influence the decision making processes. It is of some relevance here to point out that human behaviour, alas, does not lend itself to be described by simple or even complicated physical laws. It abounds in dichotomies, exceptions, contradictions and uncertainties. Science has no doubt, tried to extend its sphere of analysis to such areas by talking of statistical methods, probability laws and Gaussian functions but the major problems of today are beset with too many parameters, some of which are simple and some complex, to permit of quick and correct decisions being reached. Thus, in this age of Science, decision-making has become an art, and a difficult art at that. In this context, we certainly need a group of people who are well-versed in the art of decision-making and who will lay down our priorities in Science. Science has become a dominant feature of our lives. It is a dynamic element in the social structure of our times, both at the National and International levels. A major result is that the world has rapidly shrunk in size. I am quoting below a well-spelt out comment on the consequences of such a drastic reduction in the distances that used to separate different parts of the world in the past.

"In this age of Science which every day brings countries and nations closer, with political consciousness stirring the vast masses who until now had accepted poverty and hunger as preordained, against the background of unprecedented population growth which threatens even the present meagre supplies of the necessities of life, man everywhere to live in dignity can no longer be left to be dealt with by each nation on its own. International resources must be mobilized to assist the under-developed countries. We must be warned that in the present situation lie the seeds of unlimited progress or unlimited disaster, not only for individual nations but for the whole world."

I wish to recall that Thomas Carlyle had said, when he wrote the History of the French Revolution, that "The frightfullest Births of Time are never the loudspeaking ones, for these soon die; they are the silent ones, which can live from century to century."

Carlyle had France of those days and the hungry men and women of France of those times in mind. Today, in the context of coexistence having acquired a world coverage this statement applies to the world as a whole—a shrunken world indeed.

The needs of its inhabitants and therefore the needs of all of us have doubled themselves. Man has, in this process, emerged as a trustee of an inheritance dominated by Science and technology with an obligation to bequeath the trust to his children with increased benefits. Everyone wants food. Everyone wants clothing and a house to live in. We need to have drinking water in as many places as possible before we talk of pollution of water, because there must be some water that can be further polluted. We have a situation in our country without a parallel in the rest of the world in that there is a staggering number of 386 million people who do not know how to read and write, coexisting with the rest of our population. The only consolation is that the Indian Science Congress, by sheer accident, is today meeting in the Union territory of Chandigarh which, according to the recent census, happens to show up the highest percentage of literacy in the whole of India. In all this confusion, our universities seem to be working hard to produce large numbers of unemployable graduates. With these large numbers on our hand, not knowing what else to do, we talk of making plans as will find employment for all the unemployable graduates. These are surely examples of putting the cart before the horse. I fail to see the logic behind our establishing scores of new universities while the already established ones are facing serious financial deficits and do not have facilities for technical education worth its name. How can educational standards be maintained with ill-equipped laboratories? How can teachers who are drawn from amongst sub-standard degree holders contribute to inventivse development and throw away imitative research? How can the leaders in Science set right the ills that have crept into their programs, given such material to build their structures with?

Occasionally and particularly while looking at ourselves, our countrymen and our problems, one feels that all countries of the world do not have to talk about the same problems and in the same manner and all of them at the same time and on the same platform. I have an interesting statement here which I like to quote. "It has been estimated that a child born in the United States today will consume during his lifetime at least twenty times as much as one born in India, and contribute about fifty times as much pollution to the environment. In terms of environmental impact, therefore, the most industrialized countries are also the most densely populated." One feels like sitting up and saying to oneself that India is not the same as the USA or the USSR. After all, we sleep when many of them work and we work when many of them sleep. Our problems and our priorities are different. Our resources and our traditions too are different. Perhaps we can afford to be a little more Indian in identifying solutions to our problems using the resources we have at hand.

We certainly need to use Science and technology for pomoting our economic development. Our laboratories have to be modernised. Our libraries should endeavour to replace their stocks of obsolete books by more recent ones. Our teachers should bring themselves to be up-to-date by becoming students for a while. Our scientific programs should be looked at by someone who has a feel for their relevance and who is not so busy as those who actually handle them often are, and so on and so on. This is an unending chain and has irritating links in it. It is not right that I should misuse your indulgence. I should now conclude. I apologise for the rambling thoughts that have crept into my address and once again thank you for the honour you have done me by the patient hearing you have given me.

SANITATION, WASTE AND WASTE MANAGEMENT

K. P. Agrawal

Sanitation, waste and waste management are inter-related. India is considered one of the dirtiest country in the world. Our country does not have an integrated waste management policy. We do not understand basic principles of hygiene and sanitation. The issues related to sanitation and waste management particularly in Delhi, the national capital of the country have been highlighted in this communication.

SANITATION

Status of sanitation in our country particularly in metro cities is poor. The situation in Delhi becomes worst during rainy season. The reasons are blockage of drains due to silt accumulation, debris at construction sites and potholes on the roads. The government wakes up when more than half of Delhi is flooded. The incidence of dengue, malaria and other communicable diseases increased during rains. Flood Control Order invariably issued in July to address water logging problems like repair of damaged roads, lifting of silts near drains and completion of desilting work proves a futile exercise and mere wastage of public money.

Our habits about sanitation and hygiene are selfish oriented and uncivilized. We forget everything about hygiene and sanitation once we are out of our houses. We do not hesitate to litter on the road, urinating, defecating, spitting and blowing the nose in the open. Probably our understanding of sanitation is very poor. According to a web-based survey by Trip Advisor's India in February 2009, based on 20 million traveller's response on the ratings of hotels around the world, eight of India's ten dirtiest hotels were located in Delhi. A few comments by the guests about these hotels were "It is better to live on the street than the hotel rooms". Mounds of garbage, stagnant water, choked drains and polluted Yamuna water also depict sanitation level in Delhi. Getting drain water into supply line is common. Drain water containing cow dung from a local dairy got into supply line in one of the posh area (Vasant Kunj) in South Delhi is a glaring example.

SANITATION AND HEALTH

Sanitation is the cornerstone of good health. It brings dignity, self-esteem and safety. Sanitation has a direct relationship with clean air, clean water, clean food and quality of life style. Clean water, sanitation and hygiene are also important for poverty alleviation and sustainable development. Lack of sanitation pollutes the environment. Polluted air, dirty water and poor sanitation are responsible for millions of deaths world-wide, Children and infants in slums are more prone for health hazards. There is close link with open defecation and community ill health. Huge mounds of garbage and stagnant water become breeding ground for organisms responsible for diseases like cholera, jaundice, typhoid, tuberculosis, diarrhea, dysentery and several other diseases. Onset of monsoon that creates humid environment is conducive to breeding of organisms. Lapse on safety measures and

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mismanagement of sanitation work related to sewage clearance sometimes lead to death toll of sewage workers. Six sewage workers died in March, 2009 in Delhi because of not following the requisite safety precautions by the concerned agency. The workers were not provided with protective gazettes.

REASONS FOR POOR SANITATION

Different types of wastes, sewage and industrial effluents, drainage, un-safe food and water and lack of personal hygiene are main reasons of poor sanitation. Increase in population, poor civic services, changing life styles, ineffective policies and lack of awareness contribute to the problems. Mounds of solid wastes generated every day if not managed properly can create havoc. Poor and uneven deployment of sanitation staff in several unauthorized colonies of Delhi add to the problem. Poor drainage, open urination and defecation, poor quality Water and stray animals are other reasons of poor sanitation.

Poor Drainage, Water Stagnation and Potholes on Roads : Open drains are main source of pollution and cause of contagious diseases. Using drains for garbage disposal is a common practice. Choked drains may lead to over flow of sewerage and becomes a breeding ground for mosquitoes, flies and insects. The situation in Delhi becomes chaotic in rainy season. Except VIP areas, Delhi is full of dirt, open and choked drains with water flowing freely on the road, fully encroached footpaths where it is difficult for pedestrians to move. During rains, more than 50 percent roads of Delhi are flooded. Potholes on roads is another problem that makes roads prone for accidents and in rainy season, it becomes a place of water stagnation and mosquito breeding. Yamuna pollution is a cause of several health problems in Delhi. Delhi which forms only 2 percent catchment area of the Yamuna basin, contributes roughly 80 percent of the pollution load on the river.

Open Urination and Defecation : Urinating and defecating in open places is prevalent in most parts of the country. Half of India defecates in the open. Open defecation is also a big challenge to millions of urban poor including metropolitan poor. No toilets are available for those who live in Jhuggi-Jhoparis. Another class of poor who use footpaths, roads, streets and parks for shelter during night also go for open defecation. This group contributes significantly to urban pollution. In absence of toilets, urban women of this class undergo more traumatic experience as there are practically no secluded places. Sometimes defecating in open becomes a compulsion as no public toilet is available. But why do people use open spaces even if public toilets are available? The reasons are: (1) charging for using public toilets, (2) public toilets are mostly dirty and stinky, (3) about 20-30 percent toilets are non-functional and (4) last but not the least, our mindset that refuses to let go of an age old vice. Lack of urinals also compel people urinating in public places. 3000-4000 urinals in Delhi are not sufficient. Many are not functional, others are invisible. Poor maintenance of the urinals is another reason for preferring open places. Non-availability of toilets in public schools is the determining factor particularly for girls whether to stay in school or drop out. According to a report on 959 community toilet complexes constructed in Delhi in 2002-03 as part of Yamuna Action Plan-I in order to stop open defecation with a loan of Rs. 170 crore from Japan Bank of International Cooperation (JBIC), about 350 of the 959 toilets found un-used within 3 years of construction. Many were used as stores and/or pigsty and a cattle shed. Mismanagement is rampant. Most of the toilets raise terrible stink. Government of India in its "Total Sanitation Campaign - 2012" targeted 100 percent coverage by 2012. With the current pace of work and lack of political will, it won't be possible to meet the target.

The problem of defecating and urinating in open is complex. If you charge for using public conveniences, people object to it and say it is the duty of the government to provide such facilities free. On the contrary, free to use toilets are not well maintained, stinky, choked and emit foul smell as a result no one wants to use them. Options to address nature's call for women are limited. Existing toilets are not well maintained, stinky, un-manned and without light. Woman do not dare to use them in late nights. Action points to address the menace are: 1) The number of public conveniences should be increased, the facility should be well maintained and made available free, 2) Signboards giving directions to reach the nearest public convenience should be displayed, 3) All lavatories should be manned both by male and female attendants to avoid vandalism, 4) A system of monitoring for maintaining public conveniences should be put in place, 5) In many countries, urinating, defecating, littering and spitting in public places are considered public nuisance and offence and is violation of law. Such law should also be framed in our country and 6) Delhi government may introduce toilets with soak pit device like the one developed by Rekha, a landless labourer in Bishangarh village of Kurukhetra district in Haryana. Such toilets are good for people who do not have access to toilet and go for open defecation. The toilet is simple in design, easy to maintain and does not pollute the water table. The cost of a toilet comes to about Rs. 1200/- only.

Poor Quality of Water : Lack of water quality standards and their poor implementation is responsible for the poor quality of water in our country. Seepage from the sewage system and sewer overflowing are main sources of water contamination. The agencies like Central Pollution Control Board and Central Ground Water Board do not have clear action plan, time bound programme and accountability. The steps suggested to improve the situation are : (1) Supply of one standard of drinking water throughout the country as in developed countries should be ensured, (2) The urban and industrial effluents should not be allowed in rivers, (3) Municipal wastes should not be dumped in open, (4) Laboratory facilities and manpower required for water quality control particularly in the metropolitans should be assessed and their availability be assured (5) Regular monitoring of the quality of ground water is essential to identify the source of contaminants, (6) Public Awareness Programmes and Street Plays on importance of quality water should be organized and (7) Industrialists and slum dwellers, who play a large role in polluting the rivers should be part of decision making process in quality control programmers.

Stray Animals : Menace caused by stray cattle to city dwellers is known to every body. They not only obstruct the smooth trafficking but also make roads, streets, footpaths and parks dirty with frequent defecation and urination. Stray dog menace on Delhi's streets is equally serious. Every year 30-40 thousand dog bite cases are reported from Delhi alone. Dogs litter the streets and parks also. High Court's directives like cash rewards to cattle catchers, threats to send concerned people to jail and putting microchips to cattle did not curve cattle menace in the capital. Relocating dairies from different parts of the city to identified areas has also been a failure.

Strategies for Sustainable Sanitation

Poor sanitation particularly in metro cities is a serious problem in the country. Efforts made so far have been a failure. Recurrence of disease epidemics due to poor sanitation and hygiene is common. Half of the households are without toilets as per 2006 figure. Tackling the sanitation problem was one of the Millennium Development Goals of the

Indian Government. Total sanitation was targeted by 2012 under Eight Flagship Programmes of the Union Government. Other programmes like Jawahar Lal Nehru National Urban Renewal Mission (JNNURM) was aimed at 100 percent sanitation coverage in the urban areas. Keeping in view the importance of sanitation, South Asian Conference on Sanitation (SACOSAN-III) was organized in Delhi in November, 2008. The theme was "Sanitation for Dignity and Health" where-in papers by experts on different aspects of sanitation were presented. During International Year of Sanitation (2008), country targeted for "NIRMAL BHARAT" and plan to construct 492 lakh individual household latrines, 7.29 lakh school toilet units, 4.29 lakh Anganwadi units and 15 thousand community complexes by 2012. National Urban Sanitation Policy (NUSP) approved in October, 2008 was focused on awareness generation and behavioral changes on issues relating to sanitation, open defecation free cities and safe disposal of wastes including human excreta and liquid waste. As per NUSP, all states were to prepare state sanitation strategies and cities to prepare model city sanitation plan along with state level apex body to develop monitoring and implementation plan. The policy also included an initiative called the "NIRMAL SHAHAR PURUSKAR" to achieve total sanitation through a rating system where cities would be color coded as red -symbolizing very bad; black-needs improvement; blue-recovering and green-healthy. Coding was based on parameters like no open defecation , waste disposal process and quality of water etc. Accordingly states and cities were asked to submit sanitation plan to the government within 2 years. No progress has been noticed so far and people have forgotten that there was any such movement in the country.

In spite of several programmes/schemes with time bound targets, improvement in sanitation is a far cry. Of the 100 toilets constructed in any metropolis, hardly 20 percent remain functional after a year. Even today, 5 crore people in the cities defecate in the open. We have several institutes on hygiene and sanitation in the country. There are full-fledged courses on hygiene and sanitation offered by medical and veterinary faculties. Opening of India's first university for sanitation at Gurgaon is on cards. We are good in proposing the schemes/ programmes and fix the targets and then forget. There is absolute lack of sensibility on the part of concerned people. An incinerator-cum-power generation plant installed at Timarpur in Delhi in 1985 at the cost of Rs. 20 crore did not work even for a day. No responsibility was fixed in this case and all concerned got scot-free. Wonderful excuses are given when system fails. In Delhi, when the system failed to prevent water logging and over flowing of drains, the bandicoot rats were blamed for over flowing of drains. Defaulters often escaped with such excuses. Politicians and industrialists have no interest in sanitation. They consider sanitation a petty matter. It does not affect the development neither their vote bank. There is need to improve hygiene and to create a favourable political environment. Our strategies should focus on safe and sustainable sanitation. Hygienic practices are required at different levels; at household, at school and at public places. Handling of waste, drainage, sewage, drinking water and eatables scientifically and develop short-term and long-term strategies for developing good hygiene and sanitation practices is important. It is high time for Delhi Government to initiate action and frame/modify rules (if necessary) to make Delhi neat and clean.

WASTE

According to a survey conducted in 25 cities by the Federation of Indian Chambers of Commerce and Industry (FICCI), all the four metropolitan cities produce 20,500 metric tonnes of waste per day. Delhi alone generates 7000 metric tonnes

every day and is running short of space to dump it. In Delhi alone more than 500 hectares land is utilized to stock waste. The three landfill sites at Okhala, Ghazipur and Bhalswa are fully packed. With no other alternative available, continued dumping of waste at these sites has resulted in overflowing. Delhi spends huge budget on waste management i.e. per capita expenditure on solid waste management comes to Rs. 431 which is highest as compared to other cities. With such a huge expenditure, the situation is not improving and becoming grave over the years. Privatization of garbage collection services has not met with the desired results.

Traditionally, waste in India is disposed off in crude landfills or deposited in the open outside the main city. According to a survey conducted in Delhi in 2007, garbage collection was ill managed in most of the places. The bins overflowing and stray cattle feeding on the rotten garbage near the dhalaos, is common. All the three landfills in Delhi are completely filled, overflowing and garbage heaps on these sites have reached to a height of 18 - 20 meters.

About three years back, MCD outsourced the task of garbage removal to a private firm. In-spite of outsourcing the task of garbage removal, things did not improve. The country has not yet established a scientific infrastructure as per Municipal Solid Waste Management Rules (MSW), 2000. The entire system needs to be streamlined. There is a need for institutionalization of the recycling sector which not only recovers valuable resources from the waste but is also a source of livelihood.

Types of Wastes : Wastes can be classified in different ways: (1) solid waste and liquid waste, (2) bio-degradable and non-degradable, (3) hazardous and non-hazardous and (4) domestic and industrial waste. Delhi alone produces 7,000 metric tonne waste every day of which 50-60 percent is domestic. The system of collecting and disposing of the domestic waste in our country is very poor. Lack of concern of households in waste disposal is another reason. The domestic waste (mostly kitchen waste) if left unattended or dumped on streets/ residential premises may be hazardous. We all have experience of Surat plague due to garbage dump. The bulk quantity of plastic mainly polythene bags generated every day causes serious health hazards and environmental pollution. Plastic bags choke anything from the sewage system to the stomach of a cow. The plastic bags along with other garbage obstruct the drains, lead to water stagnation and provide good breeding place for flies and mosquitoes. Stray cattle are main victims of plastic bag menace in the vicinity of urban areas. You can see mounds of bio-medical waste strewn all around including vicinity of hospitals. Hospitals generate two types of wastes: liquid and solid. The liquid waste is mostly discharged in the drains and solid waste is dumped in and around hospital premises. The existing disposal system of both solid and liquid waste is not healthy. Different kinds of waste, their source of generation, collection, segregation, recycling and/ or re-use and disposal strategies have been highlighted below.

Domestic Waste

Delhi alone produces 7,000 metric tonne waste every day of which about 50 percent is biodegradable (mostly kitchen waste). Sources of kitchen waste are hotels, hospital canteens, hostels, housing complexes, restaurants, institutional campuses, fruit and vegetable markets, temples and residents welfare associations. Domestic waste may be hazardous if left unattended or dumped on streets/ residential premises.

Delhi government introduced dust bins of different colors for bio-degradable and non-degradable waste but it did not work. Delhi government also organized training programmes to

public and garbage pickers. Delhi State Environment Department issued notification to all institutions generating kitchen waste to convert bio-degradable waste into organic manure. The department also suggested to install organic waste converter which can convert bio-degradable waste into pre-compost in 15 minutes which ultimately becomes organic manure in next 10 days. The technique helps in overcoming the space shortage required for dumping the waste in keeping city neat, clean and green. An average sized colony of 200 to 300 households can easily compost and vermi-compost its bio-degradable waste. The system may produce enough gas for a couple of hours and about 100 kg of compost each month. Unfortunately all these good ideas could not make much dent in improving the waste management.

Electronic Waste

About 8 lakh tonne e-waste is generated in India every year. Sixty five cities in India generate more than 60 percent of the total e-waste generated in the country. Mumbai is the top e-waste generator followed by Delhi, Bangalore, Chennai, and Kolkata, India also gets huge amount of e-waste from Europe, America and other countries.

E-waste management in our country is mostly unorganized. It goes through a chain of steps. Obsolete goods from households are either dumped or sold to kabadis, who pick up all useful material, sell it to local scrap dealers, local scrap dealers after dismantling and separating crude components sell to specialized dealers who through specialized process extract metals like gold, silver, aluminum, copper, iron, brass, platinum etc. Metals are sold to respective metal dealers and leftover solid waste then dumped at the dumping place. It is then dumped in landfill sites. This system is responsible for processing about 80 percent of India's e-waste. The remaining 20 percent is dumped and end up in landfills. This is the mode of disposal in metro cities. In Delhi, the places where e-waste is dumped and recycled are Turkman Gate, Mayapuri, Old Seemapuri, Lajpat Nagar and Kirti Nagar. E-waste from most of the states in our country finds its way into garbage dumps from where rag pickers collect them for recycling.

There is lack of legislative framework in our country to address the issue of electronic waste management. In the West, there are specific rules on how to dump household e-waste. Either the companies take back the e-waste or specialized vehicles pick up e-waste and dump in recycling units. Most of the organizations in India do not have any policy on disposal of obsolete e-waste. Only 40 percent of e-waste enters the recycling stream; the rest remains in warehouses/ store houses. Expended Producers' Responsibility Approach (EPRA) wherein the producers be made responsible for their products even after the consumer has bought, a successful system of e-waste disposal in various countries of the world, can be thought of to be introduced in the country. The guidelines with legislative backing for e-waste disposal should include: 1) the electronics industry should encourage re-use/ re-cycle of obsolete electronic items, 2) the products produced in the country should last longer to minimize fresh purchases, 3) all manufacturers to come up with a take-back policy for used electronic and electrical goods, 4) institutional users must mandatorily put in place a policy on e-waste management and disposal and 5) the government should explicitly identify and define the role of each stakeholder -manufacturer, user, vendor, segregator, recycler and regulator.

India Turning into Global E-waste Dump

The Indian e-waste re-cycling system is neither technically and economically equipped nor hazard free even to handle in-house generated e-waste. More than 70 percent of e-waste collected in Delhi's

recycling units is actually dumped by developed countries. This waste when subjected to primitive and highly polluting recycling operations, contaminates air, water and harms the health of workers. Developed countries are wise and prefer to dispose off their e-waste by paying for its export instead of actually investing in developing recycling infrastructure which is very expensive. They find India a cheaper place to recycle e-waste. As a policy, the government should take steps to control import of hazardous wastes in the country. Why should India be the waste-bin of the developed countries.

Compact Fluorescent Lamps and their Disposal

The use of compact fluorescent lamps (CFLs) particularly in cities is increasing over the years. Its consumption would increase many fold because its use is economical. The government has made mandatory use of CFLs in official buildings including hospitals. Mercury being one of its important component may cause serious health hazard. It can contaminate food and underground water. Therefore safe disposal of used CFLs is important.

Disposal plan for CFLs differs. Instead of going to landfill sites, CFLs should be dumped in an incinerator where mercury is removed. Delhi government has installed an incinerator in Mohali area of Delhi. Installing a machine and extracting mercury from used CFLs covering a small area does not serve any purpose. There is need for holistic approach that includes public awareness, collection from households, their segregation and transport to the site of processing and finally proper extraction. A scheme introduced by a private power distribution company (distcom) which suggests payment of Rs. 8 for every damaged CFL is very encouraging. Under the scheme, the damaged CFLs are collected by kiosks of the area from where CFLs are carried to the company for disposal. Mercury present inside the CFLs is safely recovered. According to a figure released by an NGO Greenpeace, approximately 12.5 crore CFLs are used in Delhi. Mercury content in these bulbs is about 500 kgs. 500 kgs mercury can create havoc if not extracted properly before it contaminates soil and ground water and goes in the food chain. The use of CFLs is economically viable if total mercury from CFLs is extracted before dumping.

Plastic Waste

Plastic is a wonderful invention. Its use has become indispensable because it is convenient, comparatively cheap and easily available. India produces 2 million metric tonnes of plastic waste daily of which plastic bags constitute the bulk. The main reason of plastic menace is because of its non-degradable nature. Food packed in plastic container on heating releases chemicals/ toxins which are leached into the food. Dioxin is one such toxin which is known to damage immune system of the body. Phthalates, which are used to make plastic are known to disrupt the development of male babies' reproductive organs if mother during her pregnancy is heavy user of low grade plastic. Bis Phenol A (BPA), a common constituent of feeding bottles and plastic based diapers may lead to reproductive problems including cancer in adults and changes in hormonal profile in children. Most of us come across plastic being burnt at common places/ dumping sites, poisonous fumes released in the air and the foul odour emitted. Mundka, a village near the Delhi - Haryana border where all the plastic waste churned out from Delhi dumped, is Asia's biggest market for recyclable plastic waste. The process of sorting, shredding, grinding and recycling is poisoning the village air with plastic dust and toxic fumes and most of the workers engaged here suffer from one or the other ailment.

The bulk quantity of plastic waste is becoming unmanageable. The need is for safe recycling process to dispose it of. One possible way to dispose of plastic bags is to shred it and mix (melt not burn) it with tar and use it for layering the roads. Use of plastic in road construction particularly in temperate region has been found very successful. In 2005, NDMC imposed ban on use of plastic bags at certain tourist spots in Delhi and planned to fine anyone found littering. The punishment was imposed even on vendors who found using plastic bags. Delhi government had a regulation in the past stating that plastic bags thinner than 20 microns must not be used and/ or produced. But system did not work for long and had hardly reduced the menace.

Bio-Medical Waste

You can see mounds of bio-medical waste strewn all around including vicinity of hospitals. You will finds dogs, cats, mice, squirrels and other animals roaming around for search of food. Rag pickers who are also regular features of these bio-medical waste sites are prone for several diseases. Health institutions like hospitals, nursing homes, doctors' clinics, pathology laboratories are main sources of bio-medical waste. Delhi alone generates about 65 tonnes of bio-medical waste every day.

Hospitals generate two types of wastes: liquid and solid. The liquid waste mostly consists of vomit, urine, drugs, chemicals, radioactive materials, organic chemicals and fluid from pathology laboratories and chemical developers and fixer solutions from radiology department. The liquid waste is discharged into the drains without detoxifying in spite of the fact that hospitals have been issued clear directions to treat the liquid waste before discharging it into the drains. Solid waste is dumped in most irrational way. Majority of hospitals do not have incinerators, neither bio-medical waste disposal arrangement nor an agency who has expertise in bio-medical waste disposal. Part of the solid waste like disposable syringes, empty plastic pouches of blood, empty bottles of glucose and other drugs are sold to scrap dealers who sell it to factories for recycling of which about 20 -30 percent disposables after cleaning are returned back to hospitals for reuse. Such disposables once recycled are responsible for serious health hazards and environmental pollution.

Existing system of bio-medical waste disposal in most of the hospitals is not healthy. The bio-medical waste management and handling rules framed as early as in 1998 are not followed. Hospital waste without segregation if burnt in incinerators may result in toxic fumes in air. Non-incinerable materials, like plastic and other infectious material should be segregated and most ideally autoclaved. The guidelines developed for bio-medical waste disposal, namely i) destroying all medical waste by incinerator or through a system similar to incinerator, ii) no leakage of toxic gases during incineration and iii) destroying dangerous medical waste after freeing of hazardous microbes should be strictly followed. According to guidelines developed by Delhi government, all medical wastes should be disposed of through incinerator only. Delhi government has established a centralized bio-medical waste treatment facility in Okhala and every hospital has been issued the guidelines to make use of it. As per guidelines, medical waste should go nowhere other than the incinerator. Most of the time the guidelines are flouted. Items like bandages, soiled cotton, globes, syringes etc. find their way back to hospitals or houses for re-use.

Construction Waste

Construction waste (Malba) mostly includes concrete, wood and iron. There are two sources of construction waste. One is left-over/ un-utilized goods after the construction/ renovation is over and

second is debris resulting from demolition of old and/ or unauthorized construction. From Delhi alone it is about 2500 metric tonne per day. Presently, all the construction waste along with other waste like vegetable, plastic etc. is being dumped in sanitary landfill sites. Since construction waste is the largest component of the total waste generated, Delhi government has decided to set up a Construction and Demolition Waste Treatment Plant at Burari under public-private partnership to treat construction waste as a profit making venture. Using the concrete and rubble after the treatment as a filling for footpath in road construction is an innovative approach.

Littering Common Places

Throwing garbage at common places is natural instinct of people in our country. Littering place may be road, street, school premises, residential colony, market, industrial establishments, government offices, stairwell, corridors, backyard gardens and community parks. Even people with palaceous houses and travel in expensive cars do not mind littering outside their houses. It is a peculiar Indian trait and is not restricted within the boundaries of our country. Even Indians who visit abroad or settled as NRIs are blamed for throwing rubbish out of the window and littering the streets. We lack sensitivity to take care of common places, to keep them clean and do not litter. Even parks are not untouched of littering and sometimes it is difficult to distinguish between park and garbage dump site. Common areas in residential and commercial complexes look like garbage dumps. People throwing banana skins, empty disposables and other sundry wastes on the street is a common sight. People do not make use of dustbins. Public spitting is common. Paan chewers consider the corridors, common places and public urinals, a place for fine art. Many of us when drive down the road have had the experience to be attacked by an empty coke can/ bottle/ waste paper etc., flung out of an open window of a neighboring car.

Delhi, the capital of India is not untouched of littering the public places. Stall owners are the biggest source of littering the streets/ roads. Most of them do not have even bins as a result, people dispose of left-overs on the roads. Even posh areas like Connaught Place, Nehru Place, South Extension have open rubbish heaps swarming with flies and stray dogs, sometimes cattle who gulp everything even the plastic bags. In many developed countries if a person dumps domestic refuse into a street litter bin, he or she is penalized as it is an offence under section 87 of the Environmental Protection Act 1990. Littering in India is given a free pass. It is high time, Delhi government must initiate action, frame rules against littering and execute strictly.

Sewage and Industrial Effluents

Population growth with increasing industrialization and urbanization in India has created major problem of disposal of sewage and industrial effluents. Both sewage and industrial effluents are dangerously toxic and a source of infection if discharged untreated. They pollute not only air and soil but also pollute surface and ground water aquifers. The situation is worst in Delhi particularly in areas inhabiting near the drain. You will find drains filled with stagnant water and heaps of garbage at every nook and corner of the city. 1 or 2 hours rain brings the city to a grinding halt. Water collected once takes hours to recede. Kilometers of road are immersed in knee-deep water at several places every year. Delhi government develops an action plan every year to complete desilting work by June 30 but it never happens. There is lack of synchrony in working of different departments (Municipal Corporation of Delhi, Delhi Development Authority, Delhi Jal Board) responsible for sewage collection, treatment and disposal. Each one adds confusion rather than finding solution.

Sewage and industrial effluents being rich in N, P and organic matter is widely used for peri-urban agriculture. According to an estimate, sewage water can annually irrigate about 1.5 mha of land area. Sewage and industrial effluents contribute about one million tonnes of nutrients. Present sewage irrigation practices being primitive, and more of disposable oriented, their use results in progressive and irreversible accumulation of salts, toxic materials and heavy metals in soil and ground water. Industrial effluents contain high Total Solids (TS), Total Volatile Solids (TVS) and high Chemical Oxygen Demand (COD) in comparison to the sewage water which contain high Biological Oxygen Demand (BOD), chemicals and organisms, rich in nutrients, as well as organic carbon. These effluents have heavy bacterial load and pesticide contamination.

There is a need to make use of these effluents effectively. One best way to make use of such water is in peri-urban agriculture. Sewage and sludge because of organically rich content is good for vegetable cultivation. Growth is luxurious but presence of heavy metal contents make it un-suitable for agricultural use. The treatment of sewage would be much easier if industrial waste was separated from sewage. Conventional treatment technology to make effluent less risky is cost prohibitive. There is a need to develop low cost techniques to get rid of impurities from the waste water. Biological treatment techniques like use of aquatic micro-phytes, faster decomposing bacterial cultures and bio-filters can be efficacious to remediate waste waters. Disposal in tree plantations for creating green belts around urban areas and in non-edible crops such as flowers and aromatic plants, provides viable alternatives. According to a study in Kanpur, no adverse effects were found on plants raised on tannery, textile or dairy effluents.

Role of Rag Pickers in Waste Management : Delhi alone produces about 7000 metric tonnes of waste of which about 2000 metric tonnes is disposed of by rag pickers. Rag pickers are known as kabaris in common parlance. They do wonderful job of collection, sorting and recycling and help in eco cleaning. There are about 2 lakh rag pickers in Delhi alone. They save the Municipal Corporation of Delhi (MCD) Rs 6 – 8 lakh a day for doing difficult and arduous work of segregating and disposing of the waste. After MCD privatized the collection of garbage, there has been a big blow to this society . These contracts are awarded for huge sums of money. Under the contract the MCD has signed an agreement that the private company is to involve rag pickers working in the area for garbage collection but it has not happened. Segregation and recycling, two important aspects of waste disposal are not looked at as per the contract.

Role of Manual Scavenging in Waste Management : Manual scavenging, a social evil continues in the country even after six decades of independence. According to a survey by Delhi University's Delhi School of Social Work, Delhi alone has more than thousand manual scavengers of which 80 percent are women. In 86 percent cases, the scavengers use bare hands to clean colony drains. Delhi has 25,000 families who use dry latrines. The practice of manual scavenging is rampant in East Delhi and is continuing in several other parts even after 15 years, Delhi government initiated steps for rehabilitation of manual scavengers under National Scheme of Liberation and Rehabilitation of Scavengers (NSLRS) launched in March 1992 by the Ministry of Social Justice and Empowerment. Since then the scheme is toying between ministries/ governments without any visible impact to eliminate the scourge.

WASTE MANAGEMENT

Waste management practices differ from country to country, for urban and rural areas, for metropolitan cities to towns, for domestic and

industrial waste, for hazardous and non-hazardous waste and for bio-degradable and non-degradable wastes. Irrespective of the source and type of waste, there is a need for proper and integrated waste management at all stages-collection, transportation, segregation, treatment, recycling and disposal. Waste management policy is centered around 3 Rs-reduce, reuse and recycle in addition to take care of environment, health and aesthetics. Broad strategies worked out mainly for Delhi and can be replicated in other cities including metropolitans have been described below.

1. People's proactive participation in waste management is essential and for that clean city campaign involving non-government organizations, private companies and consumer federations be organized. Area specific approach should be identified. The role of bodies like Municipal Corporation should be restricted to work as a link between government and private concerns. "Clean-up Mumbai" campaign launched by Bombay Municipal Corporation (BMC) in November, 2007 to make the city cleaner and people aware about the merit of cleanliness and hygiene with the help of private security forces achieved significant success. It can be tried in other places. Delhi which fares badly in cleanliness and waste management may try BMC model of waste management.
2. Delhi may introduce dhalao free system of garbage disposal, i.e. garbage "ON WHEELS" like the one very successful in Bangalore. In mis approach, garbage is collected right from the place it is generated and dumped at the landfills.
3. Landfills in Delhi and other metropolitan cities are not landfills in true sense but are dumping ground which cause health and environmental hazards. They should be replaced with sanitary landfills where garbage is properly disposed of and used effectively for production of resources like gas, electricity, manure etc.
4. Three landfills-Gajipur, Okhala and Bhalaswa in Delhi which are good sources of gases like methane and carbon dioxide can be utilized using technology from Japan for which Japan government has agreed. About 750 tonne gas released daily from existing three landfills can be a good source of income @ 4 to 10 US$ per tonne from the group of developed countries to safeguard the environment.
5. Segregation is an important step of waste disposal and if this process starts right from the individual household level, at least segregating biodegradable and non-degradable waste and composting of bio degradable waste at the site, may reduce the total waste for further processing at least by 50 percent.
6. Plastic can be a good source of fuel in cement industries where furnaces are used at high temperature of about 1200°C. The technology is cost effective and environment friendly.
7. Use of plastic bags is rampant. Blanket ban on its use may not be feasible. Plastic bags thinner than 20 micron which creates problem of collection and also of health hazards should be banned and strictly executed. Buy-back system of used plastic bags (thicker then 20 microns) at the rate of fresh plastic bags with involvement of rag pickers be introduced. The difference in cost of fresh and used plastic bags should be borne by the government. Overall the approach would be cost effective, generate employment opportunity and livelihood security to rag pickers who feel insecured with introduction of recent garbage collection approach at household level.

8. MCD's recent plan to distribute 2 dustbins (green for bio-degradable and white for non-degradable) to each house owner for garbage segregation at household level has failed. It needs full proof monitoring and implementation plan for long term sustainability
9. The other segment where garbage disposal deserves immediate attention is waste generated from markets. The amount of waste generated from markets is in bulk. Market associations on their part must introduce decentralized garbage management schemes.
10. Incineration is considered suitable for disposal of bio-medical waste. In this process, garbage is burnt at 600°C. Toxic gases produced during the incineration process are treated before released in atmosphere.
11. Putting sufficient number of dustbins at common places to avoid road side littering is another approach to keep cities clean.
12. A workable model (modus operandi) of waste management on the pattern developed by a NGO (Vatavaran) should be attempted. For the success of the scheme, one needs to work and generate information on i) study the quantum and type of garbage produced, ii) decide the financial contribution each house should make every month, iii) select a patch of waste land within the colony to convert bio-degradable waste into compost, iv) train local rag pickers and unemployed youth to collect, transport and segregate garbage in an organized way, v) organize meetings to create awareness and make people more responsible towards garbage , vi) bio-degradable garbage is composted and non-degradable material after sorting is sold, vii) money earned by sale and monthly contribution from the residents is distributed as pay to functionaries in the scheme. The scheme is eco friendly, almost a zero investment scheme rather an income generator and does not require landfill sites for garbage disposal.
13. The Municipal Corporation of Delhi (MCD) recently received a proposal from electricity distributing company, BSES who claims to convert garbage into an ambitious power plant capable of meeting almost half of the capital's present electricity demand. Rs 5,600 crore project is gas based, will make use of sewage water after treatment and will generate 1,400 MW of electricity. It is a mega scheme and involve huge funds. The scheme needs strategic planning, responsibility with accountability, monitoring and concurrent evaluation of work progress and funds utilization for fruitful results.
14. The technology which can convert bio-degradable wastes like putrefied and rotting vegetables, fruits, food wastes from houses, hotels, restaurants and carcass left overs from butcheries into organic manure should be promoted. The technology is simple wherein garbage is first heaped in a yard and spread with bacterial cultures to aid composting. Every 7-8 days, heap is turned over to oxygenate. The size of the heap is reduced as garbage is compost.
15. Eco-friendly technologies such as pelletisation, biomethanation and sanitary land filling should be used for waste disposal. Landfills should be scientifically constructed. The landfills should be lined with a layer of impermeable liners at its bottom, piping it to relieve gas pressure as well as to obtain leachate. When full it will be capped with an impermeable cover.

16. Educational programmes against littering, segregation and disposal of waste should be introduced.
17. Collection agency (mostly municipality) should designate days to collect different types of trash except kitchen waste which is to be collected on daily basis.
18. Municipal authorities should impose fine on irresponsible disposal by contractors, gardeners, sweepers and others who do not perform their duties. Provision of some award for clean colonies and neighborhoods as an incentive to encourage citizens' participation would be a good initiative.

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NANOPARTICLES AND ITS EFFECT ON ENVIRONMENT AND HEALTH

Sumita Singh***, Shruti Singh** and Siddharth*

Nanotechnology provides technological solutions to environmental problems. The darker side of the nanoscience is its toxic effect. Nanoparticles are often coated with a different material than the core but these coatings are expected to cause health issues. Carbon nanotubes cause a specific type of cancer called *mesothelioma.*

INTRODUCTION

Nanotechnology provides unprecedented technological solutions to many environmental problems and cleaner production and eventually reducing consumption of resources along improved chemical reactions. Nanotechnology delivers cleaner production (e.g. through green chemistry; synthesis and processing of nanoscale materials that reduces consumption of raw materials and natural resources such as water and energy, and improved chemical reactions and catalysis). Environmental nanotechnologies have the possibility to contribute to economic growth and innovation while at the same time allowing sustainable development and protecting the environment. As particles decrease in size, they acquire interesting and novel physical, chemical and electronic properties. Advantages include unique catalytic properties that can accelerate oxidation or reduction reactions with various pollutants for particle size less than 10 nm.

Nanoparticles can be used in soil remediation through the interaction of mineral strata, soil and resident micro-organisms, in order to engineer more efficient systems. For example, nickel that has leached into groundwater from industrial sites or natural pyrites can be absorbed by natural chalk or calcite. Similarly, different iron oxide minerals can be used to remove heavy metal and arsenic contaminants from groundwater. Nano-sized silver particles acting as bactericides. The cells of bacteria are damaged in the presence of nano-Ag, finally resulting in death of the organisms. And the interaction with the cells is size-dependent which seems to depend also on the shape of the particles. So we can say Nickel, SnO_2, ferric oxide based nanoparticles can be used for treating and remediating environmental contaminants. Nanoparticles made from zinc oxide can be used to extract unwanted agricultural by-products from soil and water using nanofiltration membranes which consist of a multilayer structure with coating in the top layer, which is ultrathin. Nanofiltration is one of the most recently developed processes, aiming at a compromise between a high product quality and low energy consumption[7].

Trends in nanotechnology can be utilized to clean up toxic waste sites. Researchers have developed sponge-like nanoporous materials that will mop up pollutants in air and water, and break

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down noxious wastes therefore reducing greenhouse gases. ZnO film-based nanosensors should be useful in applications such as monitoring the quality of drinking water, or assessing the contamination in undergroundwater[4]. These are used as conductometric gas sensors and also to destroy highly toxic and chemical contaminants by cleaning up waste streams of contaminants. In Nanosensors, Solar photocatalysis method is used to detect and track pathogens, nutrients and allergens and in agriculture the nanoparticle can improve the quality of production by detecting pesticides, fertilizers, and biological events. Similarly, some nanoparticles use sunlight to break down organic pollutants thus monitor biochemical threats harms. The photocatalysis method is an active method which harnesses Ultra Violet energy from the sun to degrade many different pollutants such as nitrous oxides (NOx) and volatile organic compounds. Titanium dioxide nanoparticles have shown significant efficacy in this respect and have already been incorporated in paints and cement for construction products. Combining solar light with photocatalysts can destroy a variety of dangerous pollutants in air[2]. The TiO_2 based photocatalysis is also being used for controlling indoor pollution. Moreover, they are now being adapted for drinking and groundwater remediation.

Titanium dioxide nanoparticles can be immobilised on substrates[6], through a number of processes or be applied as thin films. Titanium dioxide nanoparticles have been doped with boron to harness visible light and therefore can be effective remediators of indoor air. Combining solar light with photocatalysts can destroy a variety of dangerous pollutants in air.

Clear and adherent films of titania are being used in optical coatings, therefore, it is possible to use photocatalytically active films as self-cleaning windows and automotive windshields[9]. Also it is seen that doping TiO_2 with metal ions with radii larger than Ti^{4+} should primarily result in modifications of its surface properties. Along with these benefits which have been observed by using nanoparticles, the darker side of the nanoparticles is on health and environmental as the nanoparticles has toxic effect which has potential negative environmental impacts causing environmental risks. Within the past number of years several studies have indicated that exposure to specific nanoparticles, can lead to adverse effects in humans[3].

Chemicals required for nanoparticles are often highly toxic, as are many nanomaterials. Nano-Ag appears to be significantly more toxic than Ag-ions and the presence of light is a significant factor increasing the toxicity. Nanoparticles are often coated with a different material than the core. About 90% of TiO_2 nanoparticles which is used for photo-catalysis work are coated to radically alter the toxicological properties of nanoparticles but these coatings are expected to interact with the environment causing health issues.

Another widely used nanoparticle is carbon nanotube which was first observed in 1991 by SumioIijima. Carbon nanotubes are cylindrical single sheets of carbon atoms or molecules, typically a few nanometres in diameter. They are very strong, conduct heat efficiently and have unique electrical properties that make them potentially useful in many fields such as optics, electronics and architecture. They have been shown to be useful in hydrogen fuel cells because of their huge surface area and help to cause chemical reactions. Also, 'nanomedicines' allow more targeted therapy, where these tiny particles can be specifically sent to organs that are otherwise difficult to reach. Hence demand for carbon nanotubes are growing day by day.[1] They can be made either by laser ablation using graphite as a starting material or made from CH_4 or other carbon containing gases through chemical vapor deposition. Resulting carbon nanotubes may consist of a single layer of Carbon, single-walled carbon nanotubes, double layers, or multiple layers of Carbon. A specificity of carbon

nanotubes is that they are light and have high mechanical strength. Single-walled carbon nanotubes are believed to have superior mechanical strength, and thermal and electric conductivity. Also, they have conductive properties which depend on the symmetry of the C-C bonds.

Now the serious concerns about carbon nanotubes are health and environmental risks. In early studies researchers did not observe any cutaneous irritation in humans[5] but now it is seen that some carbon nanotubes can cause asbestos-like health harm if inhaled. Indicators of the harmful effects usually caused by asbestos were monitored when they get inhaled, such as inflammation and the production of scar-like structures or lesions. Hence, carbon nanotubes, which are proposed for super-capacitors and lightweight parts for planes, cause a specific type of cancer called *mesothelioma*[1] and damage D.N.A., resulting in serious health risks. Certain carbon nanotubes cause inflammation, granuloma development, fibrosis and artery 'plaque' responsible for heart attacks. When cultured human lung cells treated with the nanotubes and nanofibres, change in the DNA observed which indicates a direct link between the dose of carbon nanotubes and the amount of damage.

The amount of surface area of a substance affects the interaction of chemicals in that substance with the environment. Smaller particles, nanoparticles, would result in a great deal of surface area. Thus there will be a dramatic increase in the interaction between that substance and the environment if its particle size changes from macro to micro to nano. The results revealed damage to DNA from zinc oxide nanoparticles at higher concentrations 0.8 micrograms/ml after six hours of exposure. The data also demonstrated that the nanoparticles caused oxidative stress in the cells, even at low concentrations. Its findings also indicate that nanoparticles are likely to cause extensive lung disease if entered the lungs and move into fine blood vessels to accumulate in several organs. There is then the potential for the nanoparticles to translocate, or move through the cells lining the lungs, and cross into the fine blood vessels of the lungs. From there they could circulate throughout the body causing danger to human being.

Ecotoxicological studies show that nanoparticles are also toxic to aquatic organisms, both unicellular (e.g. bacteria or protozoa) and animals (e.g. fish). Carbon nanotube induced a dose-dependent growth inhibition in a protozoan and was found to be a respiratory toxicant in rainbow trout[10]. However the acute toxicity was only observed at the highest concentration only.

FUTURE ASPECTS OF NANOTECHNOLOGY

Nanotechnology is an area where research and development are growing fast and attract substantial funding, both from public and private sectors. According to Lux Research, a New York-based independent intelligence and technology research and advisory firm, investments in the nanotechnology industry grew from $13 billion in 2004 to $50 billion in 2006[11]. By 2010 the total world market for applications based on environmental nanotechnologies has been estimated to be $6.1 billion[8] and will reach $2.6 trillion by 2014[11]. This can be divided into four sectors: remediation, protection, maintenance, and enhancement, of which remediation is the fastest growing, maintenance and protection applications constitute the bulk of the remainder, while environmental enhancement represents the smallest sector. Numerous applications of remedial nanotechnologies are already close to market and, once performance and safety have been verified in field trials, these have potential for very rapid growth[8].

CONCLUSION

The knowledge about the toxic effects of nanoparticles is relatively low and to prevent the toxic effect of nanoparticles we need better governance of technological innovations, key industrial and research policies. Seeing around the

potential benefits of developments in nanotechnology, we overlook some serious and chronic potential negative impacts. Thus the concept of "Safety by design" is an illusion.

Before a product is applied or comes to market, it must be tested for safety. That is the rule for all products - drugs, chemicals, materials, etc. It is no different for nano-products and processes. So if a product is properly and thoroughly tested, the potential risks will have been identified. When applying established toxicity tests to nanoparticles the results should always be interpreted with great care especially to avoid the reporting of false positive results. Currently the introduction of strict preventive procedures is the only way to prevent any risk of occupational disease.

We can also introduce regulations to protect human health from the risks of inhaling nanoparticles and exploring the extent to which current regulations cover risks of nanomaterials and also case by case approach for the risk assessment of nanomaterials.

Technology must operate in the service of society, which means that it needs to be operated and headed by societal structures. Public debate on its progress and acceptable development is needed, and on obligation for damage done. Key industrial and research policies should include elaborated sustainability objectives which include reduced environmental impact and further, using sustainability assessment of technologies as a tool to identify more acceptable technological developments which must have positive impact on environment. So we can say, with better governance of the technology we can reduce the side effect of this precious technology which has the capability to cure many human health and environmental ailments.

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NATURAL POLYSACCHARIDES FOR DRUG DELIVERY IN TISSUE ENGINEERING APPLICATIONS

Amit Kumar Nayak[1] and Dilip Kumar Pal[2*]

Natural polysaccharides have got its importance for drug delivery in tissue engineering applications due to their ready availability, similarities with the extracellular matrix, chemical versatility, good biological performances and low processing cost. The present communication deals with various natural polysaccharides that found applications for drug delivery in tissue engineering.

INTRODUCTION

During past few decades, considerable research efforts have been directed towards the development of drug delivery in tissue engineering applications. Tissue engineering is the promising therapeutic approach using biomaterials alone or in combination with cells or drug molecules to induce differentiation signals into surgically transplanted formats and proliferation towards the regeneration of tissues[1]. The ideal biomaterials used for this purpose must be safe, non-toxic, possess biodegradability and biocompatibility with adequate mechanical and physical properties. A variety of biomaterials have been investigated and proposed to be used in the development of drug delivery systems in tissue engineering applications, namely biodegradable polymers of both natural and synthetic origin and inorganic biomaterials[2].

At present, the socio-economic condition of the modern world has elevated the interest in using natural-origin biomaterials for various biomedical applications. Environmental concerns are also playing a considerable role, contributing to the growing interest in natural polymers due to their biocompatibility, good biodegradability, low toxicity, low processing and disposal cost. In the biomedical field, the degradation of natural polymers into physiological metabolites make them excellent candidates for a wide range of applications such as drug delivery.

Polysaccharides are a class of high molecular weight biopolymers constituted by various simple sugar monomers. The monomers are linked together by O-glycosidic bonds that can be made to any of the hydroxyl group of a monosaccharide, conferring polysaccharides the ability to form both linear and branched polymer. In nature, polysaccharides have various resources from algal origin (e.g., alginate), plant origin (e.g., pectin, guar gum), microbial origin (e.g., dextran, xanthan gum), and animal origin (chitosan). Natural polysaccharides, in particular, have several excellent properties, which make them widest biomedical application experience: non-toxic, high swelling ability by simple chemical modification, stability in wide pH variations and a broad variety of chemical structures. These versatility of natural polysaccharides able to overcome some disadvantages like low mechanical, thermal and chemical stability, proneness to microbial and enzymatic degradation, which in

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some cases, can be considered as an advantage. In this communication, different natural polysaccharides, which are widely proposed as scaffold materials to use in for drug delivery in tissue engineering applications, will be overviewed.

VARIOUS NATURAL POLYSACCHARIDES USED FOR DRUG DELIVERY IN TISSUE ENGINEERING APPLICATIONS

CELLULOSE

Cellulose is another naturally occurring polysaccharide produced by plants, as well as by microorganisms. It is the β $(1 \rightarrow 4)$ polymer of anhydroglucose (Fig. 1). In nature, it is the primary structural component of plant cell walls. The ease in which it can be converted to various derivatives makes it a smart raw material for biomedical applications. Cellulose is poorly biodegradable *in vivo*, but it can be made hydrolysable by changing its higher order structure[3]. Several investigations have done on the use of cellulose for bone and cartilage tissue regenerations[4]. The incorporation of various bioactive molecules like antibiotics, growth factors, proteins etc., into this material can display desirable enhancement of various tissue regenerations.

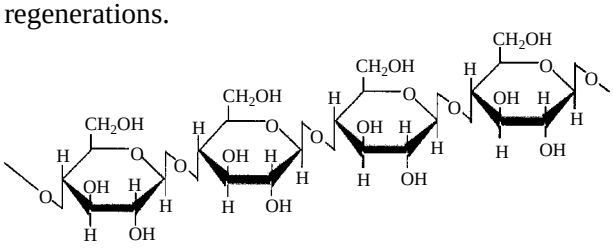

Fig. 1 : Structure of cellulose

To fabricate improved cellulose-based scaffolds for tissue engineering, several modifications have been done to produce cellulose derivatives like cellulose phosphate (CP), cellulose sulphate (CS) etc. The applicability of CP as a biomaterial for orthopaedic applications was investigated to improve osseointegration of cellulose. Due to its capability of binding with various growth factors, CP can be used as a promising alternative biomaterial able to promoting an adequate tissue regeneration. The *in vitro* studies showed that the regenerated cellulose promotes bone cell attachment and proliferation. On the other hand, CP has shown an opposite performance by inducing formation of calcium phosphate layer in simulated physiological conditions, but behaving as a poor substrate for bone cells attachment and proliferation[5]. Cellulose sponge has been evaluated in rats femur for its permissibility in bone regeneration field and it was found to need more time to regenerate new bone tissues than the control. Pulkkinen *et. al.* have developed this and Cellulose viscous sponges have also been proposed as connective tissue regeneration matrices[4].

ALGINATES

Alginates are the most studied naturally occurring polysaccharide and are found as structural components of brown marine algae. These include *Laminaria hyperborean, Ascophullum nodosum* and *Macrocystis pyrifera.* Alginate, the monovalent form of alginic acid, belong to a family of linear copolymers composed of β-D-mannuronic acid monomers (M–block), regions of ∝ - L- guluronic acid residues (G–block), and regions of interspersed M and G units (Fig. 2).

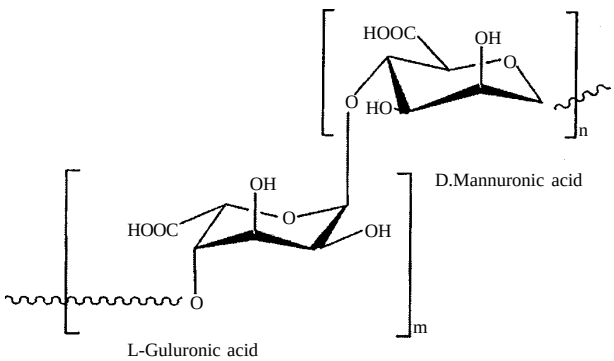

Fig. 2 : Structure of alginic acid

Alginates undergoes ionotropic gelation in aqueous solution in the presence of divalent cations such as Ca^{2+}, Mg^{2+}, Sr^{+}, Br^{2+}, etc. The cross-linking process can be carried out under mild conditions at normal room temperature excluding

any use of organic solvents and in this way hydrogels of different shapes can be prepared. Several therapeutic agents including antibiotics, enzymes, growth factors, and DNA have already been successfully incorporated in alginate hydrogels[6]. Moreover, alginate-based hydrogels have been extensively studied for bone and cartilage tissue engineering applications as scaffolds and vehicles for biologically active molecules[7]. When tricalcium phosphate (TCP) is used to promote gelation, it additionally promotes osteoconduction that can facilitate cell-attachment[7]. The enhanced adhesion of osteoblast-like cells to calcium phosphate-alginate microspheres of different compositions loaded with the recombinant enzyme, glucocerebrocidase (OCR) in comparison with their polymeric counterparts have been investigated.[8]

CHITIN AND CHITOSAN

Chitin is the prime structural component of exoskeletons of invertebrates, such as crustaceans, cuticles of insects and cell walls of most fungi and algae. It is a homopolymer of β $(1 \rightarrow 4)$-linked N-acetyl-D-glucosamine residue (Fig. 3). Chitin is almost solely used as a raw material for the production of chitosan. Chitin can be converted into soluble derivatives of carboxymethyl chitin, chitosan and glycochitin. Chitosan, the fully or partially deacetylated form of chitin, due to its properties has attracted much attention in tissue engineering and drug delivery fields with a wide variety of applications ranging from bone, skin, cartilages etc. It has been proved to be biologically renewable, biodegradable, biocompatible, non-toxic and non-antigenic.

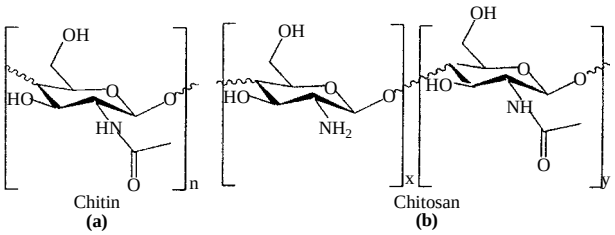

Fig. 3 : Structure of chitin (a) and chitosan (b)

Porous chitosan matrix may be suggested as a potential candidates for bone regeneration due its proper biological and physical properties. The biological activity of chitosan for bone generation has already been reported[9]. Incorporation of active molecules such as growth factors has been used as a strategy to induce improved bone tissue regeneration rapidly.

In cartilage tissue engineering, use of chitosan is highly beneficial due to having structural similarity with glycosaminoglycans, which is found in extracellular matrices as in native articular cartilage and is very important in playing a key role in modulating chondrocytes morphology, differentiation and function[2]. Chitosan was found to enhance blood coagulation accelerating wound healing, thus it can act as an ideal wound dressing as it exhibits a positive charge, film forming capacity, mild gelation characteristics and strong tissue adhesive property. In a research, Okamoto *et. al.*, have found that chitosan was able to enhance the functions of inflammatory cells such as polymorph nuclear leukocytes, macrophages and fibrinoblast promoting granulation and organization.[10] In addition, it has bacteriostatic and fungistatic properties, which are particularly important for wound management.

STARCH

Starch is the carbohydrate reserve in plants and usually isolated from corn, wheat, potato and rice. It is stored in choloroplasts of plant cells as insoluble granules composed of ∝-amylose (20-30 %) and amylopectin (70-80 %) (Fig. 4).

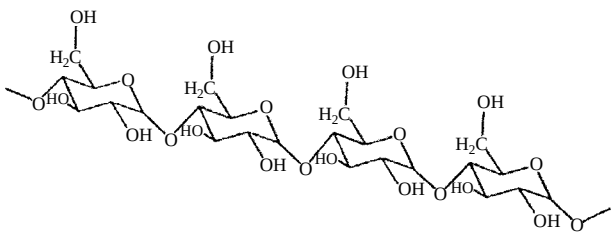

Fig. 4 : Structure of starch

Starch has been extensively used for biomedical drug delivery applications. Recently, scientists and researchers have focused on making various novel starch-based scaffolds for drug delivery and tissue engineering applications. Most of these materials have been shown to be biocompatible *in vitro*[11] and *in vivo*[12] performances.

HYALURONIC ACID

Hyaluronic acid is most frequently referred to as hyaluronan due to the fact that it exists *in vivo* as a polyanion, not in the protonated acid form. Hyaluronan is a naturally occurring non-sulphated glycosaminoglycan and a major macromolecular component of the intercellular matrix in most connective tissues such as articular cartilage, vitreous of the human eye and synovial fluid (the fluid that lubricates joints). Hyaluronic acid is a linear polysaccharide that chemically composed of alternating disaccharide units of ∝-l, 4-D-glucuronic acid and (β-1, 3-N-acetyl-D-glucosamine, linked by β $(1 \rightarrow 3)$ bonds, (Fig. 5). The disaccharide units of hyaluronic acid are extended forming a rigid molecule, whose numerous repelling anionic groups bind cations and water molecules. Hyaluronic acid possesses several important properties that make it a candidate for wound dressing applications[13]. It has capacity to act as scavenger free radicals in wound sites, thereby modulating inflammation and can interact with a variety of biomolecules. In addition, it has bacteriostatic property. Hyaluronic acid can be recognized by receptors on a variety of cells associated with tissue repair. The use of hyaluronic acid for drug delivery in tissue engineering applications has been focused on articular cartilage, bone and osteochondral applications[2].

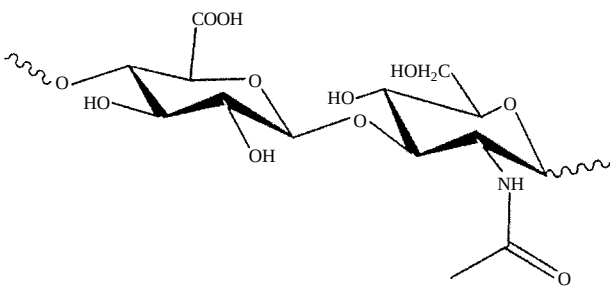

Fig. 5 : Structure of hyaluronic acid

DEXTRAN

Dextran is a high molecular weight polymers of D-glucose. It is produced by different bacterial strains from sucrose via the action of enzyme dextran sucrase. Dextran is a branched bacterial polysaccharide consisting of ∝ $(1 \rightarrow 6)$-linked D-glucose residues with some degree of branching via ∝ $(1 \rightarrow 3)$-linkages. The biodegradability and biocompatibility of dextran make it suitable for wide range of biomedical applications. It is used in drug delivery and has been shown to be a bone healing promoter and also has capacity of dermal and subcutaneous augmentation.

GELLAN GUM

Gellan gum is a high molecular weight bacterial exopolysaccharide produced by *Pseudomonas elodea.* It is a linear anionic heteropolysaccharide composed of the tetrasaccharide $(1 \rightarrow 4)$-L-rhamnose ∝ $(1 \rightarrow 3)$-D-glucose-β $(1 \rightarrow 4)$-D-glucuronic acid -β $(1 \rightarrow 4)$- D-glucose as a repeating unit. Gellan gum has been studied both as adjuvant and as vehicle for drug delivery systems[14]. Suri and Banerjee[25] has first explained its use in tissue engineering applications, where it is used a gellan gum gel as a substitute of the vitreous of the eye, and its properties were comparable to the commonly used material (silicone).

Some relevant applications of natural polysaccharide-based matrices/scaffolds for drug delivery in different tissue engineering fields have been summarized in Table 1.

Table : 1

Natural polysaccharide-based matrices for drug delivery in various tissue engineering field[3].

Natural polysaccharide based matrices	Drugs	Animal model	Tissue engineering model applications
Starch-based microparticles	NSAIDs	—	Bone
Starch-based microparticles	Corticosteroids	—	Bone
Alginate beads	TGF-β	Rabbit knee Osteochondral defects	Cartilage
Alginate beads	BDNF	Rat sciatic nerve	Peripheral nerve regeneration
Alginate beads	bFGF, VEGF, EFG	Rat myocardial infarction	Vascularization
Alginate hydrogel	bFGF, VEGF	Nude mice subcutaneous implantation	Vascularization
Chitosan hydrogel	FGF-2	Rabbit myocardial Infarction	Vascularization
Chitosan hydrogel	EGF	Rat burn wounds	Skin
Chitosan hydrogel	FGF-2	Mice full-thickness skin incision	Skin
Chitosan granules in a TCP/chitosan hydrogel	PGDF	Rat femur defect	Bone
Hyaluronic acid gel	bFGF	Nude mice subcutaneous implantation	Vascularization
Hyaluronan-alginate scaffold	bFGF	—	Not defined
Carboxymethyl-Dextran hydrogel membranes	Lysozyme	—	Not defined
Dextran beads (in Ca-P porous scaffolds)	rhBMP-2	Dog class III furcation defect	Bone
Dextran/gelatin hydrogel microspheres	IGF-I	Periodontal defect	Periodontal tissue
Gellan gum (Gelrite*R)	Antibiotic	Rabbit bacterial conjunctivitis	Ophthalmology

Abbreviations: NSAIDs: Non-Steroidal Anti-Inflammatory Drugs; PDGF-BB: Recombinant Human Platelet-Derived Growth Factor-BB; TGF-β: Transforming Growth Factor-β; BDNF: Brain-Derived Neutrophic Factor; bFGF: Basic Fibrinoblast Growth Factor; VEGF: Vascular Endothelial Growth Factor; EFG: Epidermal Growth Factor; FGF-2: Fibrinoblast Growth Factor-2; PGDF: Platelet-Derived Growth Factor; rhBMP-2: Recombinant Human Bone Morphogenetic Protein-2; IGF-I: Insulin Growth Factor-I.

CONCLUSION

Natural polysaccharides have received a considerable interest and importance in drug delivery and tissue engineering applications. Many attempts have been made to produce various smart systems using various natural polysaccharides and drug molecules like antibiotics, proteins, growth factors, etc in tissue engineering application. Although, natural polysaccharides present some limitations such as difficulties in controlling the variability from batch to batch, mechanical properties or limited processability; still their degradability, biocompatibility, similarity with extracellular matrices, low cost and availability makes them attractive candidates for various biomedical applications, in aspects of tissue engineering applications as described above.

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99TH INDIAN SCIENCE CONGRESS MAJOR RECOMMENDATIONS

Overall impression of all the participants and public was that the 99th congress was a grand success with respect to the scientific deliberations as well as logistic arrangements.

A major highlight of the 99th ISC was addressing important issues highly relevant for India, not dealt with in the earlier sessions of science congresses such as "Maternal and Child Health Care – Nutrition Security, Health Care without Borders – The Telemedicine Way, NBC Technologies for Armed Forces and Civilians, Green Building Technologies, Rural livelihood and Livestock Management, Assistive Technologies for the Differently abled" to mention a few. Panel discussions held on equally important issues evinced keen interest amongst delegates as well as the general public.

Some of the ideas generated and recommendations made during the 99th ISC were as follows :

1.1 RECOMMENDATIONS FROM THE ADDRESS OF HON'BLE PRIME MINISTER OF INDIA, DR MANMOHAN SINGH

- There is a need to strengthen the supply chain of the science sector. There is a need to motivate talented youth to pursue education and career in science.
- Must ensure a major increase in investment in R & D including by industry and strategic sectors. There is a need to incentivize private R & D investment under Indian Conditions. The public sector undertakings especially in the energy sector should play a major role in this expansion.
- Must achieve greater alignment of the Science and Technology sector with the inclusive development needs of the nation.
- There is a need to expand the basic science infrastructure.
- Greater research collaboration among universities and national laboratories must be encouraged.
- International collaboration needs to be expanded.
- There is a need to make scientific output more relevant to the basic needs of our society. Research should be directed towards providing 'frugal' solutions to our problems of providing food, energy and water security.
- Must ensure creation of a new innovation ecosystem. The knowledge generated by research should be used productively for social benefit through innovation.
- It is necessary to explore and rejuvenate traditional knowledge systems found all over the country such as agriculture, architecture, handicrafts and textiles.
- Public private partnerships must increase.
- Gender budget audits should be practiced and steps must be taken to promote participation of women in science.

1.2 RECOMMENDATIONS FROM THE ADDRESS OF HON'BLE MINISTER OF SCIENCE AND TECHNOLOGY AND EARTH SCIENCES, SRI VILASRAO DESHMUKH

- There is need to look at alternate models of innovation to address the societal issues like health care.
- The science and Technology policy was enunciated in 2003. There is a need to frame a new and well enunciated science, Technology and Innovation policy.

- Both Innovation and gender equality on which poverty reduction and human development are dependent, require "out of the box" thinking and acting beyond existing predefined parameters and traditional interventions.
- Identify a well-defined pathway that connects innovation to empowerment of women.
- Use the pathway to assess powerful innovations that can change women's lives in technology use, social norm change and economic resilience.
- Identify the core levers that are essential for innovation to empower women and transform gender relations.

1.3. RECOMMENDATIONS FROM THE PRESIDENTIAL ADDRESS OF PROF. GEETHA BALI ON THE FOCAL THEME "SCIENCE AND TECHNOLOGY FOR INCLUSIVE INNOVATION–ROLE OF WOMEN"

- There is a need to integrate science with social sciences to achieve inclusive development.
- Promote innovation driven research to bridge the divide that exists in various forms.
- Design and effectively implement special skill training and educational programmes for honing agricultural skills in women who share most of the burden in agriculture.
- Involve women in the design, testing and use of agricultural technologies and innovations.
- Encourage development, manufacture, accessibility and affordability and adoption of drudgery reducing agricultural implements in order to enable women to engage themselves in farming independently.
- Take steps to transform agriculture as an entrepreneurship for women rather than labour.
- Support women in agriculture and women entrepreneurs through innovative policies.
- Redesign selection criteria to facilitate entry of women into premier institutions in the country.
- Extend Tele-education and virtual class room teaching throughout the country specially focusing on rural and remote areas to promote universal education taking the benefit of India's capabilities in IT and Space Technology.
- Establish Free ICT training centres in all villages for the benefit of rural schools and colleges, making ICT training compulsory in secondary and college education.
- Incorporate training in rehabilitation of the disabled, developing equipment and machinery for the disabled in the curriculum for professional courses that are training architects, urban planners, engineers, public health and medical personnel.
- Establish a number of women's only educational and technical training institutions to promote their active participation as administrators, trainers and trainees and enable adoption of special policies including incentives and positive discrimination to bridge gender divide.
- Improve linkage between technology development and technology application by strengthening the ties between basic research and business.
- Encourage and harness innovative capabilities of communities at the grass root level by establishing linkage between marginalized population and industries.

- Convert traditional knowledge into value added products or technologies which are also likely to be more acceptable in order to achieve inclusive development.
- Liberally support research in energy producing and saving technologies with a focus on improving energy availability in rural areas.
- Encourage every R& D Institution, private or government, every educational institution and every organization in the country to design its own policy to achieve inclusive development.

1.4 RECOMMENDATIONS FROM SOME OF THE PUBLIC LECTURES

- Year of Science should focus on traditional knowledge for health care and conservation and on transformational technologies.
- Encourage participatory research with local communities as primary stakeholders as well as partners in order to benefit from traditional knowledge.
- Encourage, provide support and incentives to local communities in various parts of the country which have been conserving indigenous knowledge at their own cost.
- India's science and technology programme must balance basic and applied research with innovation, commercialization and societal reach since the nation is witnessing rapid changes with its technology needs ranging from nuclear to rural.
- Encourage innovation in high-technology enterprises requiring strong Research and Development inputs and intensive academia industry interactions.
- Adopt policy to encourage early introduction of new advanced technologies.
- Enhance academia-industry interactions for industrial development and improve systems for technology delivery for rural development in order to achieve inclusive growth.
- Encourage the highest intellects to work on fundamental problems of their choice pursuing what can be called 'Directed Basic Research'.
- Utilize the National Knowledge Network effectively for linking country's knowledge institutions, promoting national and international collaboration for promoting research and innovation and strengthening our own initiatives.
- There is a need to look differently at our priorities in food and this is an opportune time to re-think about the food production and research methods system. Maintenance of the system can be carried out at the village level itself.
- Strengthen Information systems in rural areas such as Kisan Mobile Sandesh and Agropedia which can also create indirect employment.
- Promote consultancy services in the fields of education, research, training and dissemination of information in Agriculture, Agro-forestry, Animal husbandry, Fisheries, Home Science and allied sciences in order to focus on broader issues of rural development.
- Rejuvenate technology transfer programmes in rural areas.
- Facilitate participation of people in designing and implementing Science policy.
- Further strengthen the capabilities developed in India for drought accessing monitoring, which will be upgraded for drought proofing agriculture, improved productivity in dry land farming, bio-engineering measures for

soil-conservation, integrated nutrient management, integrated farming system and water budgeting to address the basic needs of people and to transform India into food-secured nation.

- Land ownership should be vested with rural women who are actively involved in farming.
- Gender experts may be included in all the technical committees of the Government.
- Gender data base should be generated and documented at all levels.
- Enhance recruitment of Women Extension personnel/ Researchers.
- Provide better facilities/incentives to Rural Women field workers.
- Implement equal wages for men and women who are working in rural development programmes.
- Revise labour wages rules to take into consideration percent human capacity also rather than quantity of work carried alone while fixing wages.
- Establish Rural Women centres in State Agricultural Universities (SAUs) to undertake R&D activities.
- Strengthen budgetary support to Women studies.
- Assess farm technologies, progarmme, institutions and policies with gender perspective.
- Evaluate Gender role in different agro-ecological and production systems and its linkage with agricultural production.
- Develop women friendly drudgery reducing farm tools to strengthen women's participation in agriculture and allied activities.
- Identify income generating subsidiary enterprises for different agro-ecological regions.
- Adopt Women-centric IFS models for farms managed by women, integration of enterprises that can be taken care by women to ensure sustainable income.
- Establish Incubation and processing units for agricultural and allied sectors in villages particularly for rural women and Organize a number of women entrepreneurial programme at taluk level.
- Set up small production units at community level to Promote health based traditional foods with good shelf life. Establish small agro based enterprises complex utilizing locally available grains, fruits and vegetables and developing linkages with Khadi village industries, sales counter of State Government institutes, food bazaars etc.
- Promote research on topics addressing nutritional and health security to women, Impact of climate change on women in agriculture, occupational health hazards of farm women etc in order to design and adopt appropriate policies and mechanisms to face the challenges.
- Conduct extensive off-campus outreach programmes keeping in mind the convenient time of rural women, employing agricultural universities and R & D institutions in the sector.
- Provide assistance for women agricultural graduates for setting up agri-clinics, agri-business centres and food processing centres.
- Patronize and Institutionalize women farmer producers associations.

- Strengthen Self Help Groups by providing technical training, marketing advices and opportunities.

1.5 RECOMMENDATIONS FROM WOMEN'S SCIENCE CONGRESS

It was unanimously accepted that no society can claim to be a part of modern civilization unless it provides an enabling environment for empowering women and gives them equal opportunities. Hence, all efforts must be made for bridging the gender divide and facilitating participation of women in nation building and encouraging women to pursue science. A number of recommendations were generated in various sessions some of which are as follows :

- There should be more women-oriented programmes to encourage women to take up science as a career.
- There is a need to increase mid-career opportunities for women scientists who quit their jobs after marriage and provide self-employment opportunities for women.
- Wide spread discrimination at basic education level and lack of opportunities for pursuing higher studies being major contributors for gender divide, appropriate policies must be adopted to ensure basic education for girls.
- Accessibility to and affordability of education including higher education must be promoted immediately by establishing dedicated institutions for females especially in rural areas and also in urban areas providing basic education, technical and professional training at subsidized cost.
- Education about health, nutrition, communicable diseases, personality development and such topics especially significant for women must be part of training in all institutions dedicated for women.
- Empowerment and welfare of rural women must be achieved with integrated approach involving various departments of the Government.
- Industries, R & D institutions and private organizations must be encouraged to promote training and employment of women by suitable policies that provide government incentives.
- Empowerment of rural women should be aimed towards bridging rural-urban divide.
- A well defined positive discrimination for women in education and opportunities is necessary for reducing the wide gender divide that exists and to resist the increasing insecurity of women in modern times.
- Gender auditing must be made compulsory in all S & T institutions encompassing recruitment, promotion in addition to taking other gender enabling measures.
- Gender budgeting must be effectively implemented across the country.
- One of the members should be a trained Gender expert (not limited to women) in all selection committees.

1.6 RECOMMENDATIONS FROM PLENARY SESSIONS AND PANEL DISCUSSIONS

- There is a need to integrate Science and Technology with Social Sciences.
- Social Scientists must be taken on board right from the beginning of science policy making in order to be able to address factors that inhibit success when implemented.

- Match strategies of S & T for public social and strategic good and more gainful use of Public and Private Partnership for R & D.
- Create programs nurturing students to pursue science as carrier. Consolidate the gain achieved under INSPIRE program and such other programs implemented during the last five-year plan in this direction.
- Initiate grand challenge programs and launch Pan India missions to address national priorities in various developmental sectors through bottom-up approach, particularly in the areas of health, energy, water, food through a consortia of multi-institutional and multi-agency, cutting across public and private sectors.
- Build technology partnership with states through new models of technological solutions, design, development and delivery. Invigorate state S & T councils to contribute in this direction.
- Increase R& D expenditure to 2% of the GDP from the current level of 0.9%. Significantly increase corporate sector's R & D expenditure to at least 1% of GDP by encouragement of investment and engage corporate sector in R & D through policies and profound approaches.
- Encourage large Indian Industries to establish their R & D centers and support technologies to provide a mission means to leap frog to contribute to inclusive growth.
- Develop and deploy and integrate innovative technologies in strategic and non-strategic sectors for social good.
- Increase full time researchers and scientists by two times in both volume and quality to pursue basic research, achieving an increase at least by a factor of three.
- Create a set of new inter-university and inter-institutional research centers with state of the art facilities to create a vibrant academic ambience in the universities and institutions.
- Bring in structural reforms in science sector for matching national aspirations through creating new appraisal and audit mechanisms and personal practices with best practices and seamless mobility of S & T personnel. Create graphical representations of institutions and support systems.
- Evolve effective implementation strategy along with the new policy, adopt good and, transparent mechanisms to enhance quality nation is looking for.
- Educate and involve public extensively in implementing policies in order to achieve transformation at grass root level.
- Synergize various technologies developed.
- Strengthen infrastructure in medical colleges to promote translation of technologies.
- Employ state systems to reach the developments in health sector to people with special focus on tribal and other marginalized communities.
- Science policy should be encompassing and overlapping with interdepartmental involvement since any issue has multiple facets of influence.
- Create Interdepartmental platforms to adopt holistic approach in addressing an issue.
- Install agri-incubators that could be made use of by young researchers who would turn into agriculturists rather than migrate to cities.

- Youth to be kept in focus while making science policy.
- Initiate necessary steps to improve the currently existing governance procedures to facilitate implementation of new policies effectively.
- Established Institutes of policy making on the lines of IIT and IIM providing a platform for young scientists and social scientists as well as beurocrats to work collectively and undertake highly focused, sustained advanced research at the grass root level, examining important issues from various angles and from all perspectives and gaining expertise on region specific problems and environment – social, cultural and economical and monitoring them in space and time. The information so generated can be invaluable for policy makers at all levels in designing policies, developing strategies for implementation as well as monitoring and evaluating societal impact.
- Collate, analyse and use biodiversity information effectively.
- Employ 'e-science infrastructure' in the country for conservation and promotion of biodiversity.
- Carry out a "Biodiversity Foresight Analyses" in India to predict components of biodiversities that must be preserved while recognizing the inevitable demands of technological development.
- Identify, incubate, adopt technologies relevant to biodiversity, focussing on issues of access to resource and benefit sharing.
- Involve local communities closely in activities related to eco-development and eco-tourism.
- Involve coastal communities in conservation and sustainable management of coastal biodiversity.
- Provide special protection and management of sacred groves and explore the possibility of declaring such sacred groves as Biodiversity Heritage Sites under the Act.
- Evolve appropriate policies to link local action to national and global policy making in securing coastal and marine biodiversity for development purposes and adopt society based approaches.
- Encourage participation of women in conservation of biodiversity since women play a vital role in preserving and protecting which is a part of biodiversity conservation.
- Strategic resource mobilization for promoting biodiversity activities integrating women's participation.
- Teaching and training in rural areas must focus on achieving socio-economic development of the rural population by adopting the following objectives :

  (a) Gainful employment

  (b) Individual emancipation

  (c) Socio-cultural well being

  (d) Environment protection

  (e) Biodiversity conservation
- Right to Education should focus on rural areas.
- Establish common schools admitting everyone in the neighbourhood.
- Invest liberally in creating necessary infrastructure for teaching science in rural educational institutions.

- Link rural schools, colleges and post-graduate institutions in a given rural area through policies which can be followed up with district, state and national level networking in a phase-wise manner.
- Ensure stable and reliable electric power supply for 20 hours a day throughout the year to academic institutions in rural areas.
- Science education must also focus on teaching applications of science.
- Prioritize teaching of women.
- Provide primary education in mother tongue/ regional language.
- Incorporate health education, education on the environment and ecosystem in the curriculum at all levels.
- Initiate a drive to educate 0.8 million panchayat body elected women members through adult science education programmes to make them technically literate.
- Establish primary health centres in the proximity of schools in rural areas.
- The National Innovation Council should focus on rural problems of education.
- A village education officer, preferably a woman should create, train master teachers exclusively for rural areas for teaching science.
- Set up Community colleges in rural areas based on IGNOU model.
- Link different Taluk hospitals/Community Health centres in each district to the District Hospital and different District hospitals to Specialty Hospitals in the major cities for prioritizing rural and semi-rural health care to the masses.
- Involve medical graduates/PG's in tele-medicine programme during their internship for providing clinical support for the local Telemedicine centres.
- Adopt cost effective technologies including Mobile Phone Technology for enhancing Telemedicine service and to make it affordable.
- Acquire a dedicated Communication Satellite for the country for Health and Medical education/Training for telemedicine service covering the whole country.
- Make budgetary provision for implementing Telemedicine programme country wide in the 12th five year plan.
- Telemedicince thematic session should be a part of a public lecture/panel discussion or a plenary session in all the Indian Science Congress sessions in order to provide a forum to popularize this programme, strengthen participation of people and draw attention of scientists, policy makers and public.
- The 3Rs (Reduction, Refinement and Replacement) principle, must be given recognition, emphasis, and importance in national scientific deliberations, funding and planning.
- Create awareness that the science of alternatives to animals besides being a progressive and better science and pedagogically superior, is legally binding on the Indian scientific/teaching community, bureaucrats and policy makers as enunciated in the Prevention of Cruelty to Animals Act 1960 section 17(d).
- "The Bologna Declaration" of 1999 should be the guiding criterion in all scientific

planning and funding in India. All national and central institutes and university portals should display the declaration.

- National funding agencies must make it mandatory that in the allocation of funds for projects/schemes the investigators should exhaust all possible *in vitro* and *in silico* approaches before embarking on research using animal models and encourage research using *in vitro* and / or *in silico* methods by earmarking at least 50% of funds for such research.
- All life science, medical, and paramedical educational programmes should actively incorporate alternatives to use of animals for both pedagogical and ethical reasons. Alternatives foster better teaching, learning and empathy for life and our environment.
- Incorporate topics of animal ethics / science of alternatives / 3Rs in undergraduate as well as postgraduate life science / medical / paramedical courses.
- Establish *in vitro* and *in silico* facilities in all laboratories/institutions which use animals / animal models in research and/or testing providing appropriate funding for the same in the 12th Plan.
- Constitute a high level committee to review internationally validated alternative tests (for drugs, agro-chemicals, cosmetics and vaccines) and design new and more appropriate and efficient Indian test guidelines for drugs, cosmetics, agrochemicals, medical appliances, household products etc.
- The spirit *of AHIMSA*, which is the guiding principle of Indian culture and espoused by Mahatma Gandhi, the Father of our Nation, should percolate in our national policies and science planning.
- Propagate nanotechnology education at all levels.
- Establish industry-academia partnership in Nanotechnology.
- Facilitate capital investment in new nanotechnology ideas for start-up companies.
- Adopt National Policy for ensuring maternal care and fetal nutrition.
- Initiate a special drive to address anemia in women.
- Focus on Low Carbon Food Print Diet.
- Implement special programmes to create awareness amongst women especially those from lower socio-economic strata regarding maternal and fetal nutritional needs.
- Programmes involving subsidizing or free distribution of health foods for women and children must be compulsorily twinned with nutrition awareness creating programmes.
- Identify, recognize and promote innovations addressing empowerment of people with different and diverse abilities.
- Integrate various technologies in addressing the needs of differently abled.
- Incorporate Training in rehabilitation of the disabled, developing equipment/facilities for disabled in professional schools that are training medical personnel, engineers, architects, urban planners.
- Prioritize control of diseases that impact the livelihoods of poor farmers (eg : Swine fever, Peste des petites in ruminants, Foot and mouth disease).

- Implement programmes to Control of zoonotic diseases that predominately affect human health (Like Brucellosis, Anthrax) in rural areas.
- Evolve efficient vaccine delivery technologies specific to rural communities.
- Some of the New generation vaccines developed by various R&D institutes should be taken up by the Government of India for further validation and Initiatives should be made to convey these technologies from R&D labs to the poor farming community (Eg : FMD vaccine) for livestock management.
- Importance should be given for the development of multi-component vaccines targeting more than one disease.
- Development of advanced Diagnostic technologies like DIVA (Differentiation of Infected from Vaccinated Animals) has to be considered for disease monitoring.
- Steps should be taken towards the development of thermo-stable vaccines as maintenance of cold chain is a serious constraint in rural areas.
- For the control of PPR which is a very important disease in ruminants, pulse vaccination programme has to be initiated before the disease outbreak for effective sanitization of the virus.
- Importance has to be given for epidemio-logical studies that enable the planning of vaccination programmes for effective disease management.
- Regulatory issues have to complement the rapid and easy transfer of R&D efforts to the rural areas for their use/practice.
- Some of the disease-resistant animal breeds in rural areas have to be identified and special breeding programmes have to be initiated.
- Integrative management programmes that comprise disease diagnosis, control, prevention and eradication have to be implemented for important livestock diseases that impact livelihood of poor like FMD, Bovine Brucellosis, PPR, Classical swine fever, Ranikhet disease and Avian Influenza.

1.7 RECOMMENDATIONS OF SECTIONAL PROGRAMMES

(as received from Sectional Presidents)

1.7.1 ANIMAL, VETERINARY AND FISHERY SCIENCES

1. Along with the production of food grains through new technology, level of pharmaceutically produced proteins should be tested on human digestibility.
2. Promotion and protection should be given to small scale farmer (Agro and Aqua) for sustainable development in respective fields.
3. Production of animal and dairy products should be promoted through small scale farmers for sustainable development and food security.
4. Technologies should be developed in veterinary medicine for the sustainable development of livestock for food security.
5. Special program should be formulated for the development of riverine fisheries and freshwater aquaculture for food security.
6. New innovations are required to control different diseases in farming fisheries and other aquatic products for the sustainable development.
7. Public awareness should be made regarding "Genetically Modified Organism" (GMOs).
8. Fish production technology should be introduced at school level to create interest and enthusiasm amongst children.

9. Science awareness programs should be introduced at various schools and colleges.

1.7.2 ANTHROPOLOGICAL AND BEHAVIOURAL SCIENCES (INCLUDING ARCHAEOLOGY, PSYCHOLOGY, EDUCATIONAL SCIENCES AND MILITARY SCIENCES)

1. There should be networking of Psychological counseling and guidance centre to be totally managed and staffed by woman Psychologists.
2. It should be mandatory for secondary and higher secondary institutions to have service of counselors who are trained in the problems of adolescents especially girls.

1.7.3 ENGINEERING SCIENCES

Strategic and Long-term :

- An exclusive budget for technical education, like the budget for railways.
- The National Mission for Engineering Education to prepare Road Map.
- A new service cadre- Technical Education Service through UPSC and State PSCs.

Action Items for Immediate Implementation :

- There is an urgent need for a change to bring in a system that gives importance to students' capabilities. By creating such an environment, innovations and breakthroughs happen. The open labs concept be introduced and "tolerance for failure" culture be inculcated to promote experimental learning in students and young faculty in order to encourage innovation.
- Younger faculty should be given opportunities for research, while senior professors given undergraduate classes to improve quality of teaching.
- There is urgent need to make teaching and research a lucrative career option to address an acute shortage of faculty.
- Universities must be provided budgetary support for ICT-enabled teaching-learning.
- The ASSOCHAM, CH, MAIT, NASSCOM, TiE and others should take path-breaking initiatives to support academia and to network with community of practice.
- Early identification of entrepreneurs and establishment of industry supported project development and innovation centres could be the first steps in the right direction.
- To reduce learning curve and improve employment potential of students, industry-oriented extension programmes can be offered jointly by academia-industry-professional societies. The systems engineering and trans-disciplinary engineering design methodologies should find place in curricula.
- The acute shortage of faculty can be partially addressed by inviting experienced professionals from Govt./R&D and industry (not withstanding with their academic qualifications) to become an extended arm of academia.
- Faculty development institutes or centres should be established by universities or autonomous institutes for training new faculty.
- The recommendation of Knowledge Commission for establishing 1,500 universities should be acted upon to provide education opportunities to all strata of society. However, universities must be bench-marked/ assessed regularly. Regulatory agencies and professional societies should co-evolve quality standards.

- Industry - academia partnership in technical education should be institutionalized. Industry Faculty exchange programmes should be encouraged.
- Evaluation of the faculty by the students should be done for all the engineering colleges in the country as a matter of policy.
- Industries must spend part of their income to train faculty and students which may be compensated via tax incentives for any expenditure that may be incurred on this training.
- Acquisition of additional skills concerning the core professional value such as creativity, clean environmental sustainability - cum - development, societal benefits, etc. is essential for all engineering professionals before they can start practicing their profession. These aspects should find a place in the universities curricula.
- For award of Research projects by Government Institutions, preferences should be given for research grants to bright and budding engineers with research ideas irrespective of their affiliation to Government/ private organization.

1.7.4 ENVIRONMENTAL SCIENCES

- People's participation is the need of the hour for Conservation of Environment, Natural Resources and issues pertaining to Mitigation of the climate change. Added emphasis should be given to action oriented environmental awareness generation programmes.
- Waster water management is required to be given added emphasis particularly in areas of utilization of waster for increasing agricultural productivity.
- Research on Identification of Macrophytes and Microbes for Bioremediation of Industrial effluents needs to be promoted for removal of toxic substances from the human environment.
- Assessment of the impact of coal and black stone mining on the local environment needs to be done as scientific research on the topic is lacking.
- Measures are required to be undertaken to prepare an inventory and initiate actions to conserve the Fossils of Rajmahal.
- Assessment of the potential of biochar in increasing Carbon-sequestration in the soil needs to be made.
- Encourage studies on isolation of pesticide degrading microorganisms, their growth behavior and their potential in remediation.
- Invasive species are a threat to Biodiversity and Bio-resources. Steps must be taken to mitigate the threat.
- Large areas of country are affected with ground water contamination with toxic elements. There is need to mitigate the impact of toxic elements viz., cadmium, arsenic, fluoride etc. in order to ensure the availability of safe drinking water.
- Wetlands provide immense ecosystem services and are in great threat due to land use change and encroachment. There is an urgent need to take action for conservation of wetlands.
- For conservation of environment and biodiversity, the traditional and religious practices need to be scientifically assessed documented.
- Institutional arrangements of traditional societies can be used as model for building

of modern institutions for management and conservation of natural resources.

- Alternative sources of energy to be explored for reducing dependence on conventional sources of energy.
- Possible models to be developed to mitigate the ill impact of climatic change.

1.7.5 INFORMATION AND COMMUNICATION SCIENCE AND TECHNOLOGY (INCLUDING COMPUTER SCIENCE)

- Lack of consistent and affordable electricity is the single greatest challenge in designing a computing infrastructure for rural health informatics (or any other application for that matter). The vast majority of health -facilities in remote parts of the country have no mains power and, where available, such power is usually extremely unreliable or so unstable that it poses a threat to unprotected electronic equipment. Ending the decade's long process of extending stable, grid power to remote communities or the advent of an entirely new computing paradigm, the logical immediate answer to this challenge lies in low-power-consuming hardware. Fortunately, hardware now exists that is cost-effective to run on solar (or other renewable) or in partial-grid power.
- Just as in many other areas of development (e.g., agriculture, health, and education), women face enormous challenges to use ICT for their own economic empowerment. Using and benefiting from ICT requires learning, training, affordable access to the technology, information relevant to the user and a great amount of support (to create enabling environments).
- In addition to being used as effective ICT for development, radio and television should be considered and used as a means to educate populations on the benefits of using ICT for development.
- Language and content limitations: Lack of local and community related content as well as content in local languages continues to be a major barrier in women's use of ICT for economic empowerment. ICT can only be useful and meaningful, particularly to rural and poor women, if they provide relevant information and the tools needed to address women's needs and demands.
- Creating business and employment opportunities with women as owners and managers of ICT access projects, as well as employees of the new business ventures.
- Creating an environment where women feel welcome and comfortable learning with others, getting trained on using ICT and participating in community development activities, including community advocacy efforts.
- Developing ICT based programs that address women's specific needs and that are run by women (e.g., literacy programs, business planning courses, ICT training, access to health information and services, access to market and trading information services and e-commerce initiatives) and providing the skills necessary for members of the community to develop their own businesses and business applications.
- With the advancement of Communication and Computing Technology in the digital era there is a need to focus on Spiritual Science. There is a need to educate everybody about Computer Ethics and its impact on the Society, in our education systems to prevent misuse of Computer Technology.

- Science is perceived as a tool for promoting the well-being of humanity as well as planet, for Social and economic transformation and hence efforts must be made to connect Information, communication and Technology with Spiritual Sciences (cognition).
- We need to take concrete action while framing curricula and development and adaptation of innovative methods to inculcate values and ethics in children.

1.7.6 MATERIALS SCIENCE SECTION

- The following research areas in Materials Science have immense scope and potential and hence it is recommended that intense focused research be conducted in these areas :

  Materials for automotive applications, nano materials for various structural and functional applications, energy materials, bio materials advanced materials processing for developing engineered materials, materials modeling including materials genome and multi-scale modeling, materials characterization at the atomic scale for better understanding of the advanced materials. All these studies can lead to design of materials with better performance for the future.
- Funding agencies should support research in both top-down and bottom-up modes. The bottom-up mode is the usual way projects are funded, wherein a researcher approaches a funding agency with an idea. Such projects help in improving the research base in the country. However, the top-down approach, wherein the funding agencies identify certain focused areas and identify the groups that can work together in a mission mode from the design to the system development level and funds such mega networked projects with clear cut deliverables for each group with regular monitoring in order to make India a leader in certain specified areas.

1.7.7 MATHEMATICAL SCIENCES (INCLUDING STATISTICS)

- Multidisciplinary research must be enhanced for intra and inter academic institutions involving Mathematical Sciences to solve emerging issues of national importance and impact. Academic, Government and Private sectors should be encompassed in this effort.
- Specific workshops should be conducted to expose researchers to the techniques of applications of various tools from Methodical Sciences to target topics of real-life applications. Such applications should include health and work issues related specifically to women and to the sensitive sectors of our population, using scientifically and objectively collected data.
- In the Master's curricula for Mathematical Sciences at academic institutions, a "Project on Analyses of National Data" should be introduced. This project work will expose students to the difficulties, as well as methods to overcome those, for such data and implement their textbook knowledge for solving real-life problems. The outcome of this plan would be a new and young generation of "Problem Solvers" from Mathematical Sciences ready to face many practical challenging issues from our national scenario.

1.7.8 MEDICAL SCIENCE (INCLUDING PHYSIOLOGY)

- Adequate preventive measures should be advocated to prevent occupational hazards.

- Safety rules should be instituted to reduce the incidence of trauma.
- All medical, paramedical staff, ambulance drivers, police and school children should be trained for primary care to trauma victims.
- Chronic pain can be treated successfully, but people should be made aware about the options.
- More research in the field of nanotechnology may be helpful to treat cancer by creating nano particles of chemotherapeutic agents.
- More research related to genetics may help to identity persons prone to develop certain debilitating diseases such as diabetes. Young scientists should be encouraged to take up such studies.

1.7.9 NEW BIOLOGY (INCLUDING BIO-CHEMISTRY, BIOPHYSICS & MOLECULAR BIOLOGY AND BIOTECHNOLOGY)

- Natural products from the various diversified places in India needs to be explored for the treatment of genetic diseases prevalent in our country and diseases emanating from changed life style.
- Research involving isolation and characterization of microorganisms to identify newer bioactive compounds should be encouraged.
- Research on the use of new chemical entities for the inhibition of drugs targets for various types of diseases such as hypertension, cardiovascular diseases, Alzheimer's, diabetes, Asthma, obesity etc. should be augmented.
- Basic research on the understanding of the drug - drug interaction and use of nano technology for the betterment of human life and poverty alleviation should be given preference.
- Research on the bioactive compounds from natural products, microbes as well as chemically synthesized ones for combating disease may be accelerated for the betterment of human life.

1.7.10 PHYSICAL SCIENCES

Universities should have a substantial component of research so that they become centers of knowledge generation along with knowledge dissemination. To achieve these objectives, the following steps should be taken-up on priority basis :

- A strong national mechanism for research collaborations between Universities and National Research Institutes must be set up. This will improve research and teaching at Universities, and in turn will help generate quality manpower as input to National Institutes.
- Several new Inter University Consortia should be set up in carefully chosen areas of research and they should be funded adequately. They should be given sufficient autonomy to decide their programmes and collaborate with appropriate research centres in India and abroad.
- Considering the impact of Accelerator Physics and Technology in the contemporary research and societal applications, the subject of Accelerator Physics and Technology must be taught at the university level. In addition, teaching institutes like Indian Institutes of Technology must be funded to develop accelerator centres. This will generate the much needed quality manpower for the ambitious future. This initiative can be

worked out in collaboration with National Institute, IITs and Universities together.

- Photonics and Metamaterials is one area which has tremendous technological potentials in areas such as solar energy, lasers, low cost lighting and also strategic applications. The current level of research is not sufficient to lead in the international context, and countries like China and Korea together with US and European countries are making giant strides. In order that the country does not miss more opportunities in this particular area, a strong programme at various institutes and universities must be initiated. Such a programme should be configured with collaborations among Physicists, Chemists, Material Scientists and Electrical/ Electronic Engineers. This is important for development of frontline science and its translation into technology products. In view of the above, a National Centre for Photonics and Metamaterial Research may be formed in the country.

1.7.11 Plant Sciences

- Farmers should be educated about the use of bio-pesticides in their farms, their utility and soil protection.
- Bio-pesticides and Bio-fertilizers should be subsidized by the government as it is done for the chemical fertilizers.
- Registration of these pesticides should be done by the government and the government should follow the same policy as it is followed, through TIFAC of DST.
- Tissue culture techniques should be widely used for mass propagation of elite species.
- People should be educated about the use of GM plants to release much stress on the earth and soil. The results of the use of BT- cotton plants, similar commercial crops of GM crops can be used widely. Second green revolution could be attained by using biotechnological techniques.

KNOW THY INSTITUTIONS

NATIONAL RESEARCH CENTRE ON YAK, ARUNACHAL PRADESH

Yak, ship of plateau, is the most ecologically sustainable genetic resource of Indian Himalayas which provides livelihood support and nutritional security for highlanders. This animal species provide milk, meat and fibre and is also useful for transportation of household goods. Considering the importance of the animals in the life of the yak rearers (known as *Brokpa)* Indian Council of Agricultural Research (ICAR) established National Research Centre on Yak in the fag end of VII th five year plan in 1989. This species specific institute makes in-depth study on traditional yak rearing and also articulates future plans, strategies and programmes for overall development of sustainable ontogenesis of yak husbandry in India. Till 2009 the centre was functioning in temporary structure, but from 2009 centre got its own building (office-cum-laboratory building) which was inaugurated on 19th April, 2009 at Dirang, Arunachal Pradesh. Although full fledged laboratory is situated at Dirang, the experimental yak farm has been established at Nyukmadung which is situated at 2751 m above msl because yaks require extremely cold climate. Presently in the model farm 192 yaks are reared and for on farm trial, experimentation and scientific works, laboratory-cum-clinic with andrology laboratory is in function.

The vision of the institute is conservation and improvement of yak for higher productivity and profitability through innovative research. The mission of the institute is improvement of genetic potential, and enhancement of productivity and profitability. This institute also covers a broad mandate which supports full security to the yak population, encourages *brokpas* for scientific yak rearing for better profitability and food security to the highlanders.

MANDATE

- Survey for genetic resources, management practices, production level and problems associated with production.
- To establish a small herd of pure yaks to carry out observations on performances under range and semi-range systems of management.
- To conduct research on improvement of yak and its products through selection and breeding with exotic frozen semen.
- To conduct research on nutrition, physiology, production and managemental aspects under semi-range and confinement.
- To conduct research on fodder and development of pasture at mid and high altitude for yaks.
- To provide complete health coverage through proper therapeutic and prophylactic measures based on clinical and laboratory findings on the prevalent diseases of yak.

INFRASTRUCTURE

Although this institute is situated in a very remote place but through condescension from ICAR, this institute is having highly equipped central instrumentation laboratory and individual subject specific laboratories. These infrastructure provides support to conduct research on reproductive biotechnology, molecular signature of biomolecules, pathway of nutritional intervention and management and detection of yak pathogen through antibody fingerprinting. Library is not only rich by virtue of books on various subjects it provides support for scientific database collection. Presently the institute is also enriched with *commercial* software which provides support to the scientists for *in siilco* analysis of sequence information. The centre is also having establishment of yak product technology unit which provides organic yak products which is having immense potential in future for earning foreign exchange.

SALIENT RESEARCH ACHIEVEMENTS

During the last couple of decades this centre has been conducting comprehensive research on yak, implementing various action programmes pertaining to genetics & breeding, nutrition, physiology, reproduction, health, management, product technologies and extension considering yak as national resource of India. There have been significant achievements right from the year of its inception in 1989 on different spheres of yak husbandry.

- Introduction of exotic grasses *(Phleum pratense, Dactylis glemerata, Lolium perenne, Trifolium pretense* and *T. repense),* area specific mineral mixture and low cost complete feed block (CFB) was helpful for optimum production and growth of yak during winter seasons.
- Categories of yak (common, bisonian, white, bare-back) was characterized genotypically and found indistinguishable from each other.
- Frozen semen technology was standardized for yak and Artificial Insemination (A.I.) is practiced regularly at institute's farm since 2006.
- Mutation scan screening could find polymorphism in immunoregulatory genes of which speaks for different pathway of immunoregulation

First yak calf born through ETT : one female calf named MISMO took birth from a recipient yak cow on 27th June 2005. This success indicated the prospect of implementing ETT for *ex-situ* conservation of yaks.

- The Ovsynch protocol could synchronise the heat and was helpful to conduct fixed time AI which helped to initiate successful breeding programme
- Ovum pick up (OPU) was helpful to collect oocytes from superior yaks and development of embryos through *IVF* required for genetic improvement.
- Cryptic stage of protozoa was detected by molecular approach which overcame the disadvantage of conventional technique.
- First global report of cutaneous papillomatosis in yak has been confirmed through sequence information of pro viral partial gene for capsid protein.

- Alkaloid containing poisonous plant like *Senecio crysanthomoides* was identified by the Scientists which had fatal effect on yak. This plant poisoning was a major problem in this region. Further pathway *of Senecio* poisoning was explored through pro-inflammatory, oxidative and pro-apoptotic signaling.

EXTENSION ACTIVITIES

The scientists of this institute also assess the developed technologies through extension programmes, trainings, awareness camps and participate in Agri. fairs and Melas.

TECHNOLOGY READY FOR COMMERCIALIZATION

Scientists of NRC on Yak have developed users' friendly technology which are not only useful for *Brokpa* but also useful for the consumers of yak products in India.

- **Functional Paneer from Yak Milk :** Yak milk paneer is usually prepared with full fat milk having as high as 8.5% fat resulting in 25-30% fat in paneer. For health conscious consumers development of low fat paneer is warranted. Interestingly, low fat paneer prepared from yak milk having 1% fat has very hard texture. To mitigate the issue inulin was incorporated for improvement of product quality.
- **Area Specific Mineral Mixture and Complete Feed Block :** Area specific mineral mixture formulation for yak and yak-hybrid comprises of zinc (Zn), copper (Cu), Cobalt (Co) and manganese (Mn). This is useful since soil web system, feed and fodder of yak rearing regions are found deficient in certain trace minerals. Thus, feeding mineral deficient feed resources to livestock lead to poor animal health and productivity. This mineral mixture can be further supplemented in complete feed blocks prepared from locally available feed resources. Complete feed block is made using maize stover, concentrate mixture and molasses in proportionate ratio. This has an additional advantage of an ease in transport and storage in difficult hilly terrains due to compact size of voluminous feed.

AWARDS AND RECOGNITION

Scientists of the Institute have been able to bring laurels to the institute through several prestigious awards like CSIR award, Fakhruddin Ali Ahmed, Jawaharlal Nehru award received in different occasions, besides being honoured with conferment of membership of the National Academy of Veterinary Sciences, Associate Fellow of National Academy of Agricultural Sciences and best paper presentation awards in various conferences time to time.

VISIONARY JOURNEY

NRCY has been consistently working to develop the yak and the yak farmers through systematic research. Although modern developments - biotechnological, social, economic, industrial, informational- are changing rapidly, this has little impact in changing scenario of this region. Most such developments are controlled by complex interactions by many variables. Few are susceptible to simple solutions and also demand intervention through skills and experiences of scientists and researchers of NRCY. By using expertise NRCY has the motto to conserve yak germplasm, improvement of nutritional status of yak for more productivity, establishment of disease free zone and finally these actions will lead to socio-economic upliftment of poor yak farmers. Therefore, with continuous intervention and effort, NRCY in future will be describing and analysing the problems of yak husbandry and will identify better outcomes for individuals and society by illuminating strategies of intervention.

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Conferences / Meetings / Symposia / Seminars

Wetland 2012, 21st – 23rd November, 2012, Silchar, Assam, India.

Themes :

- Diversity, biota, energetic management and conservation of Wetlands.
- Taxonomy, Biodiversity, ecology, biology, pathology, parasitology and molecular studies of wetland fishes.
- Trends of Aquaculture and fishery economics.

Contact : Professor Devashish Kar, Convener, Wetland 2012, Department of Life Science & Bioinformatics, Assam University, Silchar–788 011, Assam, Phone : 9435070519. E-mail : devashishkar@yahoo.com, web : www.aus.ac.in

VIth World Aqua Congress 2012, 28th – 30th November 2012, New Delhi, India.

Themes :

- Sustainable Water Management-Challenges, Technologies, Solutions
- Water resources and Global Change
- Enhancing Water Use Efficiency-Rural, Agriculture, Urban & Industrial
- Emerging New Technologies
- Adaptive & Integrated water management
- Water, Climate, Food & Energy
- Governance and water law
- Effective involvement of Children for Water
- Learning from Traditional Water Management Practices

Contact : Praggya Sharmaa, Organizing Secretary, Cell : + 91-9818568825
E-mail : wac@worldaquacongress.org, /info@aquafoundation.in

National Conference on Parallel Computing Technologies (Parcomptech 2013) on 21st & 22nd Feb 2013, Bangalore, India.

Themes :

- Parallel and Distributed Architectures
- Multi-core Computing
- Giant scale computing
- Interconnection networks

- Parallel I/O and Storages Systems, Databases
- GPU / Accelerators / Heterogeneous computing
- Parallel software - Algorithms, Compilers, OS, Programming languages and libraries
- Grid and Cloud computing
- Middleware for Cloud and Grid
- Power optimization and Green computing
- Self aware and Self healing systems
- Fault-Tolerant, Scheduling and Load balancing Algorithms
- Performance Analysis, Benchmarking
- Peta and Exascale Computing
- Scientific/Engineering/Commercial Applications and Workflows

Contact : Organizing Secretary, Parcomptech 2013, C-DAC, Knowledge Park No. 1, Old Madras Road, Bangalore - 560 038, Tel : +91-80-25244059, Fax : +91-80-25246356, Email ID : parcomptech@cdac.in http://www.cdac.in

S & T ACROSS THE WORLD

HOW MICROBES CAN BUILD ELECTRIC GRIDS

New research demonstrates that bacteria exploit conducting minerals in their environment to shuttle electrons between species, allowing greater growth. How does a microbe know how to share electrons with an inanimate object ? A wide variety of microbes can send electrons into, or accept electrons from, conducting materials. Witness the fuel cells that rely on different types of bacteria to exchange electrons with graphite electrodes. But investigators have wondered how that ability arose. Most organisms internally generate energy by coupling the addition of electrons to one molecule with their removal from another. But some microbes find themselves in circumstances where they must cooperate to generate the energy for life, swapping molecules or electrons with other species. Do these microbes enhance their energy management, and thus their ability to grow, by shuttling electrons back and forth to one another through conductive materials in their environment ? Research published in *Proceedings of the National Academy of Sciences* suggests the answer is yes; some bacteria do indeed build electricity-conducting grids in the wild." Microbes use conductive minerals as electric wires for transferring electrons between each other," says microbiologist Kazuya Watanabe of the Tokyo University of Pharmacy and Life Sciences, part of the team that performed the research. This marks the first time anyone has provided "solid evidence" that different species transfer electrons to each other in that way, he adds. The researchers tested a variety of solutions containing the soil bacteria *Geobacter sulfurreducens* and *Thiobacillus denitrificans,* which thrive by eating acetate (an organic compound that makes vinegar sour) and nitrate (a negatively-charged molecule of biologically available nitrogen and oxygen), respectively, when they can find a spare electron or two. When the scientists placed either of these microbes alone into a solution containing the two compounds, nothing happened. Nor did the situation improve when both types of microbes were put together into this solution of their favorite foods, suggesting the organisms lacke.d the ability to directly transfer electrons between them. But when the scientists added magnetite, an electricity-conducting iron-based mineral famous as the lodestone that provided ancient magnets, the bacteria busily got to work eating, cooperating merrily by 'shuttling electrons back and forth via the magnetite grains. And, although the same effect could be had by adding the rusted red iron mineral hematite, which is a poor conductor, the resulting microbial growth was much smaller and slower (and nonexistent when nonconductive aluminum minerals were tried). In fact, the only thing slowing the microbes down in the presence of magnetite was their own ability to grow. "We think [such electron swapping] must be quite common in soil, sediments and ores," Watanabe says. When the scientists examined the cells in the growing communities closely, they found nanoparticles of magnetite on the surface of cells and, in some cases, grains of the iron mineral connecting microbial pairs. They observed, in other words, a basic, biological electric grid and one that, because of its size, offers very little resistance to the flow of electrons. Prior to this research, microbial ecologist Lars Peter Nielsen of Aarhus University in Denmark and his colleagues had shown that microbes working in the oxygen-free muck at the bottom of Denmark's Aarhus Bay exchanged electrons over relatively large distances of centimeters, although how the bacteria managed the trick remained unknown. One hypothesis was that they built nanoscale wires for the task, or released molecules from cell to cell. But using electrical conductors already in the environment

would require much less of an energy and material investment than building a biological structure like a nanowire or molecule, and that is what microbes may do based on the new findings.

BIOFUEL FOR JUMBO JETS

World's second commercial jet flight on biofuel relies on African weed. Air New Zealand became the second airline to fly partially on biofuel—and the first to use jet biofuel refined from a non-food crop. Fuel from the weed jatropha powered an Air New Zealand jet on a two-hour flight today—the world's second flight of a commercial jet on biofuel. One out of the four Rolls Royce engines on an Air New Zealand Boeing 747–400 burned a 50–50 blend of regular jet fuel and a bio-version made from jatropha. The flight more than doubled the air time of the first biofuel flight—a 40 minute jaunt between London and Amsterdam in February. The plane climbed to an altitude of 35,000 feet and the engine performed normally, according to chief pilot Capt. David Morgan. Jatropha—a weedy bush from Africa that produces seeds rich in oil—was selected because it is not a food crop and can be grown on land unsuitable for food production. The roughly three tons of liquid jatropha biofuel came from plants grown in India, Malawi, Mozambique and Tanzania, the airline says. UOP, a division of Honeywell, refined the jatropha oil into a synthetic jet fuel using a process similar to that for refining typical petroleum fuels. As a result, the fuel is functionally the same as petroleum-based fuel, including not turning freezing until – 70.6 degrees Fahrenheit (– 57 degrees Celsius)—above the Jet Al specification of – 52.6 degrees F (– 47 degrees C), according to chemist Jennifer Holmgren, UOP's general manager of the renewable energy and chemicals business. "We can use any kind of vegetable oil—palm, jatropha—they all have the same [chemical] backbone," she says. "We just adapted what we tend to do in a [oil] refinery for this application. This is not rocket science, we feel very comfortable scaling this up." She adds, however, that this fuel is not a "drop-in replacement" for Jet Al. That's because jet fuel from petroleum contains so-called aromatics—hydrocarbon rings—that interact with the seals in current engines, helping swell them shut. "We don't make aromatics through the vegetable oil route," she says. "If we wanted to fly on 100 percent [biofuels], there are issues around O-rings and things like that." The appeal of such biofuels is that the growing of the plants ostensibly absorbs as much carbon dioxide (CO_2)—the most common greenhouse gas warming the planet—as is emitted when the fuel is burned. Although airplane travel contributes only 3 percent of global greenhouse gas emissions, according to the U.N. Intergovernmental Panel on Climate Change (IPCC), the emissions are of particular concern because they occur high in the atmosphere. The flight, originally planned for Dec. 3, had been delayed due to an unrelated Air New Zealand-owned plane crash in November. On Jan. 7, Continental Airlines plans to fly a similar two-hour flight out of Houston with an engine burning a 50-50 blend of petroleum-based jet fuel and biofuel from algae and jatropha. Japan Airlines plans to fly on a biofuel made primarily from camelina—an oilseed plant—on January 30. Though environmentally sound, however, economics may delay a switch to the alternative fuel. Plant-derived fuel is now significantly more expensive to produce than the fossil fuel variety thanks to a drop in oil prices, making it a less attractive alternative than when Virgin Atlantic conducted the first commercial biofuel test flight in February. It remains to be seen whether that will affect Air New Zealand's goal that biofuels make up 10 percent of its nine million barrel-a-year fuel use by 2013—or the broader industry group the Air Transport Association's goal of 10 percent of all aviation fuel by 2017. "Eighty-five percent of the cost [of the biofuel] is the feedstock," Holmgren says. "It's pretty hard when the jet fuel made from oil sells at a lower price than soy."

CAN SOIL SENSORS SAVE FROM DROUGHT ?

An innovative effort would embed sensors in agricultural fields in a bid to cut down on irrigation-saving farmers money and preserving water for endangered species. By June 15 gasoline-powered augers will have drilled 100 holes in the corn, cotton and peanut fields of the Lower Flint River Basin in southwest Georgia. Into the holes, scientists from the University of Georgia (U.G.A.) will slip half-meter-long PVC pipes filled with sensors for soil moisture and temperature topped with a flexible antenna that can be run over by a tractor and spring, back into place. Over the course of the next two years, these sensors will continuously relay soil conditions from 20, 40 and 60 centimeters deep to a computer. Combined with more accurate weather forecasts, the data will help farmers decide where and when to use their irrigation systems. "The biggest problem we've got with irrigation is we just don't know—we use old wives' tales to decide when to irrigate," says farmer Marty Tabb, who will host the probes in a field at his 1,050-hectare Bushwater Farm near Colquitt, Ga., to help him irrigate corn, cotton and peanut crops. In addition to saving water (agriculture is responsible for 70 percent of human water use globally), the technology can also help produce more crop per drop. "Using the simplest soil monitor and a computer program, my peanut yields jumped 20 percent," Tabb reports. "I know, just from that, that if we learn how to water corn, cotton, wheat, we can save water because we tend to overwater." Overwatering is a major problem in the Lower Flint River Basin, which liejs in a region that has been gripped by drought so severe in recent years that it prompted the former governor of Georgia to pray for rain. The region pro.duces the most peanuts and pecans in the nation, as well as vast quantities of cotton and sweet corn. And the Lower Flint River Basin is the major recharge zone for the Floridan Aquifer that supplies water to Florida, Mississippi, Alabama, Florida, South Carolina and Georgia, as well as the home of several endangered freshwater species, such as the flatwoods salamander and the oval pigtoe mussel. Fanners in the Flint River Basin have a direct impact on this groundwater resource, because waters on the surface and belowground are directly linked: a hurricane's downpour in the area can replenish the aquifer, whereas too much pumping of underground water to irrigate fields can literally suck the water out of surface rivers and streams. "Because of the drought and because of us irrigating, we have pulled water down, and the springs along Spring Creek don't pump anymore," Tabb says of the^Flint River tributary in his backyard. "You couldn't have told me that creek would ever dry, but I drove my motorcycle two miles down Spring Creek because it was so dry."

In a bid to cut down on that water use—while maintaining the more than $2 billion worth of corn, cotton, peanut and other crop production in the region—the Nature Conservancy and the U.S. Department of Agriculture, along with U.G.A. and the University of Florida, teamed with more than 1,000 local farmers starting in 2000. The partnership started by switching some irrigation systems from high pressure mists to a low pressure system that more directly mimicked rain, saving water and energy. When applying at high pressure "you lose water to wind drift and also evaporation," explains David Reckford, director of this Flint River Basin Partnership for the Conservancy. The switch to a low pressure system alone can reduce water use by more than 22 percent.

HOW BIODIVERSITY KEEPS EARTH ALIVE

Species loss lessens the total amount of biomass on a given parcel, suggesting that the degree of diversity directly impacts the amount of life the planet can support. In 1994 biologists seeded patches of grassland in Cedar Creek, Minn. Some plots got as many as 16 species of grasses and

other plants—and some as few as one. In the first few years plots with eight or more species fared about as well as those with fewer species, suggesting that a complex mix of species—what is known as biodiversity—didn't affect the amount of a plot's leaf, blade, stem and root (or biomass, as scientists call it). But when measured over a longer span—more than a decade—those plots with the most species produced the greatest abundance of plant life. "Different species differ in how, when and where they acquire water, nutrients and carbon, and maintain them in the ecosystem. Thus, when many species grow together, they have a wider set of traits that allow them to gain the resources needed," explains ecologist Peter Reich of the University of Minnesota, who led this research to be published in *Science* on May 4, 2012. This result suggests "no level of diversity loss can occur, without adverse effects on ecosystem functioning." That is the reverse of what numerous studies had previously found, largely because those studies only looked at short-term outcomes. The planet as a whole is on the cusp of what some researchers have termed the sixth mass extinction event in the planet's history: the wiping out of plants, animals and all other forms of life due to human activity. The global impact of such biodiversity loss is detailed in a meta-analysis led by biologist David Hooper of Western Washington University. His team examined 192 studies that looked at species richness and its effect on ecosystems. "The primary drivers of biodiversity loss are, in rough order of impact to date: habitat loss, overharvesting, invasive species, pollution and climate change," Hooper explains. Perhaps unsurprisingly, "biodiversity loss in the 21st century could rank among the major drivers of ecosystem change," Hooper and his colleagues wrote in *Nature* on May 3. Losing just 21 percent of the species in a given ecosystem can reduce the total amount of biomass in that ecosystem by as much as 10 percent—and that's likely to be a conservative estimate. And when more than 40 percent of an ecosystem's species disappear—whether plant, animal, insect, fungi or microbe— the effects can be as significant as those caused by a major drought. Nor does this analysis take into account how species extinction can both be driven by and act in concert with other changes—whether warmer average temperatures or nitrogen pollution. In the real world environmental and biological changes "are likely to be happening at the same time," Hooper admits. "This is a critical need for future research." The major driver of human impacts on the rest of life on this planet—whether through clearing forests or dumping excess fertilizer on fields—is our need for food. Maintaining high biomass from farming ecosystems, which often emphasize monocultures (single species) while also preserving biodiversity—some species now appear only on farmland—has become a "key issue for sustainability," Hooper notes, "if we're going to grow food for nine billion people on the planet in the next 40 to 50 years."