

# EVERYMAN'S SCIENCE

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**EDITORIAL****VIOLENCE AGAINST WOMEN AND ITS IMPACT ON FERTILITY**

Domestic violence is a rather dark side of the institution of family in India. Surveys such as National Family Health Surveys (NFHS) conducted by International Institute for Population Sciences (IIPS) have shown that a very high percentage of women in Indian households have suffered from various forms of violence — physical, sexual and emotional. There is a need for government, civil society organizations and intellectuals to sensitize people to this threat to women's health and dignity. Studies show that domestic violence is caused by a variety of factors. Among them patriarchal social structure and dowry are the two main factors. Domestic violence is closely connected with exclusion and it is both a consequence and a cause of other social evils. In any case, it decelerates the march towards modernization. Researches have shown that violence against women leads to depression and several post-traumatic disorders. In the West, domestic violence has been found to be associated with injuries, homelessness, depression, psychosomatic disorders, sleep and eating disorders, hypertension, drug abuse, lower self esteem, and unemployment. Domestic violence is also the cause of lack of negotiation for safer sex and, therefore, women who suffer from domestic violence run a higher risk of unwanted pregnancy and HIV. I hypothesize that violence against women is a significant factor in high fertility in the demographically lagging States in India.

There is not much data on domestic violence in India except those collected as part of NFHSs. They were started by IIPS, Mumbai, with support from Ministry of Health and Family Welfare (MOHFW) and USAID. The first NFHS, conducted during 1992-93, however, had no question on domestic violence. For the first time NFHS-2,

conducted in 1998-99, collected data on attitudes towards and experience of domestic violence as part of background characteristics of women. The results showed that at the all-India level 56.3 percent of women respondents, age 15-49, agreed with at least one reason for justifying a husband beating his wife. The total number of women for which data were analyzed was 89,199. The reasons arranged according to frequency of response are : wife neglects house or children (40.0 percent); wife goes out without telling husband (36.6 percent); wife shows disrespect for in-laws (33.9 percent); husband suspects that wife is unfaithful (32.8 percent); wife does not cook food properly (24.6 percent); and natal family does not give money or other items (6.8 percent). The report said : 'In patriarchal societies such as India, women are not only socialized into being silent about their experience of violence but traditional norms teach them to accept, tolerate, and even rationalize domestic violence'. The analysis of data on experience of violence revealed that 21.0 percent of ever married women were beaten or physically mistreated by their husband, in-laws or other persons since age 15, 18.8 percent reported beating by husband, 1.8 percent by in-laws, and 3.1 percent by other persons. Of all the women, 11.0 percent had been beaten or physically mistreated in the past 12 months. The report also said : 'The percentage of women beaten in the 12 months preceding the survey varies from less than 5 percent in Himachal Pradesh and Kerala to more than 15 percent in Bihar, Arunachal Pradesh, Tamil Nadu and Nagaland.'

NFHS-3, conducted during 2005-06 produced extensive data on domestic violence in India by using more valid measures of violence. Analysis

showed that 33.5 percent women, aged 15-49, included in the survey had ever experienced physical violence since age 15. The total number of women included in this analysis was 83,703. Further, 15.8 percent of all ever married women had ever experienced emotional violence committed by their husband, 35.1 percent had experienced physical violence committed by their husband and 10.0 percent had experienced sexual violence committed by their husband. Overall, 39.7 percent ever married women had experienced violence in some form or the other - physical, emotional or sexual - mostly from their husband. Assuming that in the culture of violence many women would not report the experience of violence the actual incidence of violence may be much higher. The reverse violence, i.e., violence by women committed against their husbands is only a fraction of violence initiated by husbands. NFHS-3 data show that only 1 percent women report initiating violence against their husbands. This is sad to note that between NFHS-2 and NFHS-3 there was a rise in domestic violence (from 21.0 percent to 39.7 percent).

Both NFHS-2 and NFHS-3 revealed that illiteracy, rural residence, age, nuclear household, poverty, and working for cash seemed to aggravate violence. Regarding the State-wise variations the report said: 'The prevalence of physical or sexual violence ranges from 6 percent and 13 percent in Jammu and Kashmir and Meghalaya, to 46 percent in Madhya Pradesh and Rajasthan and 59 percent in Bihar.' Further, the data establish that the more violent States (where more women report experience of violence) are also the States which show a rather sluggish transition towards Zero Population Growth (ZPG). This is true for almost all States of both northern and southern India. Tamil Nadu is an exception where violence against women is high but fertility level is relatively low. High violence and low fertility in Tamil Nadu seem to be associated with increasing incidence of female infanticide (called *Penn shisu kolai* in Tamil) and female feticide.

In the recent past some literature has emerged on violence against women, i.e., women who have been the victim of domestic violence. This has not only raised questions about complexity of violent relationships and awareness of strategies that women may employ in violent relationships but this has also sensitized scholars to multiple responses to violence. For example, some women having negative emotions are likely to see victimhood as a reality; this emanates from a feeling of self-deficits distorting their cognitive attributes. This may result in denial and forgetting and such women are likely to be submissive, helpless and confused. Other women use survivorship as proactive strategy and carry a sense of competence. Thus domestic violence among women produced two contradictory responses - a narrative of victimhood and a narrative of survivorship. On the one hand, they felt deficiency and threat and a feeling that self is rooted in the past, and on the other, they felt motivated to struggle and gain strength to overcome the hardships experienced. Both these conditions weaken the motivation to limit family size.

Analysis of NFHS-3 data shows that there is a relationship between domestic violence and fertility. Comparison of State-wise data shows that violence against women has a significant positive relationship with Total Fertility Rate (TFR) and an insignificant but negative relationship with family planning methods. This implies that *caeteris paribus* under the condition of violence the process of demographic transition is stalled. My analysis of micro files further confirms that violence against women is significantly and positively related with Children Ever Born (CEB). In the multiple regression analysis adjustment was made for the age, age square, education, wealth index, place of residence, caste, religious groups, occupation, sex-composition of living children, women's autonomy and state of residence of respondent. The number of women included in the analysis was 58,839. This implies

that domestic violence may stall the process of demographic transition. However, contrary to the findings of the macro data, the multiple logistic regression analysis shows that violence against women is associated with increased family planning acceptance. I argue that in a patriarchal society gender inequality may lead to forced acceptance of family planning methods among women. It may be noted that an overwhelming majority of acceptors of family planning methods in India have accepted female sterilization as husbands wish to avoid male sterilization due to several misapprehensions. Overall, the analysis shows that in India: (a) there is very high incidence of violence against women; (b) in the recent past there has been a rise in the incidence of violence at home; (c) violence against women at home has a regional pattern; (d) low age of marriage seems to increase the threat of violence against women at home; (e) violent families produce more children; and (f) macro and micro evidences on violence and family planning relationship are contradictory. There is a need to understand what exactly the mechanism through which violence against women increases fertility level is.

I propose that violence weakens husband-wife communication, planning, shared decision making and rational orientation. On the other hand women empowerment and reduced violence lead to greater clarity and structuring of life objectives including demographic objectives. Thus it may be surmised that violence against women raises parity and adversely affects their nutrition status. There is a need for in-depth qualitative research on the subject and a need to improve upon the measures of violence. It is notable that social divide between high and low domestic violence States is as important a determinant of fertility as North-South divide. The state and NGOs have to show a greater sensitivity to gender issues than has been the case so far. The MOHFW has to focus more on effective spacing methods rather than on limiting methods. There is also a need to increase age of marriage, women's education and work participation rate. In addition, some thought has to be given for designing media policy and message regarding inter-spousal negotiation of contraceptives.

*A. K. Sharma*

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*Men love to wonder, and that is the seed of science.*

— *Ralph Waldo Emerson*

**PRESIDENTIAL ADDRESS**

**SURVEY, CONSERVATION AND UTILISATION OF RESOURCES**

Dr. H. N. Sethna

**INTRODUCTION**

The strength of nations — social, economic or political — is chiefly determined by the resources they command and their capacity to utilize and conserve these resources. When we speak of the evolution of civilizations, we normally think in terms of the advances made in their capacity to utilize resources and the induced social, economic, cultural and political changes. The Sumerian, the Mesopotamian, the Babylonian and the Gangetic river valley civilizations flourished because they could make use of the water resource available to them. Countries have been less developed because they could not adequately develop the capacity to exploit the resources placed at their disposal by Nature. The social and economic institutions which evolved in the framework of inadequate utilization of resources, in turn, became obstacles in the path of development of underdeveloped countries. Today, most of the countries are paying serious attention to the problem of resources — to their assessment, to their conservation and to their utilization. The reasons for this are different for developing countries from those of developed countries. For developing countries it is the problem of more efficient and higher utilization of resources and their distribution amongst the masses of their population. It is in this context that the Sixty-Fourth Session of the Science Congress would focus its attention on the survey, conservation and utilization of resources. Probably

\* General President, 64<sup>th</sup> Indian Science Congress held during January, 1977 at Bhubaneswar.

for the first time working scientists and technologists of this country are meeting on a common platform to attend to the most crucial problem faced by the nation. As we are, aware, the Science Congress decided in favour of a focal theme to make an inter-disciplinary examination of a topic of national importance in addition to discipline-centered investigations. To this end, I would like to state the dimensions of the focal theme, the questions which have to be answered, the possible solutions and the role Science Congress can play in evolving suitable strategies within the framework of a broad national policy.

**DIMENSIONS OF THE FOCAL THEME**

We need to understand the factors which affect the development and utilization of resources and which, in turn, are affected by the existing level of resource utilization in any society. History tells us that the older social economic and political institutions could not provide sufficient scope for the development of new modes of resource utilization. These had to give way to a new order of society which could provide nourishment for the growth and maturation of the new forces of production. In other words, a change in the old order of society is a prerequisite for a more efficient and higher utilization of resources at a pace which will provide adequate solutions to the fast multiplying problems. This implies that we cannot characterize the problem of resource conservation and utilisation as a technological problem even in

the broadest sense of expression. We have to recognize that the attitude of our people towards life and work, and the existing social, economic and political institutions determine, to a large extent, the ways and scope for resource utilization. Superstitious beliefs and irrational outlook, lack of alertness and adaptability, general resistance to change and experiment; submissiveness to exploitation by vested interests, low standards of health and productivity, low levels of work discipline and existence of a land tenure system detrimental to agricultural advance, underdeveloped institutions for enterprise and employment, weak infrastructure of voluntary organisations, and, at the root of all these deficiencies — a low degree of popular participation and a rigid, inegalitarian social stratification have, time and again, frustrated our attempts to successfully undertake the task of national development. Attitudes have generally supported the institutions and at the same time are supported by them. And again, these attitudes and institutions are effects of some more primary causes. The low level of national income, its uneven distribution, and the detrimental effect of such inequalities on the education and health of our increasing population are, I consider, the fundamental causes which have adversely affected the development of our country.

To find satisfactory solutions to the wide array of our unsolved problems, we need to adopt an integrated approach to the task of higher and efficient utilisation of resources. Finding solutions to merely technical problems will not suffice as we cannot assume that the existing social structure is conducive for the implementation of those solutions, nor can we assume that the social system will adjust itself to become receptive to the introduction of new doses of technology. The two have to go together; the answers must consist of an integrated solution to both technical and social problems. To

substantiate my contention, I have chosen some of the resources of utmost importance to the nation and will try to explore with you some avenues of thought and action and the steps to be taken to conserve and efficiently utilize our resources. I will first try to outline the Global and the Indian scene which would provide the backdrop for the discussion of the focal theme.

### **THE GLOBAL SCENE**

The developing countries produce a large fraction of the world's raw materials and control an insignificant fraction of international trade in finished goods. Their resources have been subjected to constant exploitation through the market mechanism of the developed countries. The Industrial Revolution was not allowed to "trickle down" among the developing countries by their colonial rulers and they were left far behind in the race for development. With the dawn of independence, most of the developing countries, at best, inherited a large and relatively uneducated population, scarce capital, nascent industry, a rudimentary infrastructure and a primitive agricultural system. The problems were gigantic, particularly, in the absence of any technological base which could have provided an impetus to the rate of resource utilisation. Though we did make significant progress after independence in developing our scientific and technical capabilities and in bringing about social reforms, we cannot say that it was adequate in its pace and magnitude to meet the revolution of rising expectations amongst the large masses of our population.

What is more striking is the fact that while over-utilisation of natural resources by the developed nations got reflected in the adverse shift of the ecological balance of the world, the less developed countries are still living in conditions of abject poverty because of under-utilisation of their

resources and are compelled to live in an environment polluted by the waste generating economies of the industrialised nations. This has been effectively brought out by the famous Club of Rome studies which raise pertinent questions about unbalanced exploitation of natural resources which may cause an irreversible damage to the quality of the life-supporting systems of ecology. If present trends of industrial and agricultural production, population growth and exploitation of non-renewable natural resources continue, there could be so much damage done to the ecology that the earth's carrying capacity of human beings may drastically decline. Also, the oil crisis which continues to be the most significant event of the seventies in the world economic scene, lends support to the grim realisation on the part of raw-material producing countries of the prospect of dwindling reserves of their natural resources largely due to over exploitation by the developed nations. Recent trends in the sphere of oil production and pricing have added a new dimension to the problem and the countries have learnt their first major lesson on the need for conservation and efficient utilisation of resources - specially the non-renewable natural resources. This should be a forerunner for all the developing nations to join hands in their attempt to protect their declining natural resources, which are being over-exploited to suit the needs of the developed nations and their transnational corporations. The international prices of raw materials have been artificially pegged at a lower level whereas those of finished goods have not only been inflated but their demand and usage have also been artificially created to spread the phenomena of "limitless consumerism". These prices, in most cases, do not reflect the true economic value of the products. Given that self-reliance is the paramount goal of developing countries, only a rational policy of international trade can help in removing the

obstacles on the path of development. Developing countries will have to take the responsibility of jointly safeguarding their natural resources and have to overcome the unequal terms of trade. This is the only way in which they can pull themselves out of the quagmire of poverty and its dire consequences.

### **THE INDIAN SCENE**

Availability of facilities like housing, medical care, schools, municipal water supply, transport facilities and per capita consumption of food, clothing, energy, minerals, and other natural resources are the principal indicators of levels of living of any country. The per capita consumption of natural resources and hence the levels of living in India are miserably low, as compared to the advanced countries. With more than 15 per cent of the world's population, India consumes only 1.5 per cent of the world's energy output. Even the modes of production in the field of agriculture are largely primitive and modern Science and technology could hardly make any inroads in the countryside. About two-thirds of our energy consumption is accounted by human and animal labour and non-commercial fuels like cowdung, firewood and vegetable wastes. There is an acute scarcity of drinking water and sanitation facilities in our country resulting in high risk of contracting diseases by the people who are already weak and vulnerable to incipient diseases on account of poor health stemming from lack of nutrition. Added to this are the problems of rising population and large-scale illiteracy.

In this context, our total efforts for exploration, development and conservation of natural resources have been meagre. An integrated approach to long-term resource planning has been practically absent. It was only in a crisis situation that we paid adequate attention to our resources and this



necessarily resulted in short-term resource planning which did not have any corresponding long-term plans in which it could fit in. Lack of education and adequate health care, and the presence of irrational attitude towards life and work, and traditional social institutions detrimental to advancement, have constantly threatened to thwart the forces of modernisation. Absence of fuller knowledge, development, utilization and conservation of our natural resources, in turn, is the cause of our inability to generate powerful forces of modernisation under whose thrust alone the existing blockades can be torn apart. It is not only that the effect is the cause of its cause, but it is “circular causation with cumulative effect”.

Yet we have to break the ice, and that too at its weakest spot if are allowed to try our hand once only. To mobilise sufficient strength of modernisation which emanates from the quantum and the state of development of resources, we have to answer the questions raised by the focal theme. We have to simultaneously attack the traditional institutions, which have determined the rhythm of our life for centuries and which can be changed only through the education of our people and through introduction of a series of reforms. Throughout the painful process of history there is a growing realisation that it is not possible to bring about technological reforms unless accompanied by institutional and attitudinal reforms, education useful in the immediate working environment and assured supply of critical inputs like water, power, fertilisers, pesticides, and modern agricultural implements. A series of integrated reforms need to be worked-out for each region and probably for each district at the micro level. Obviously there is no general panacea which would fit the needs of each region of the country. The predominant force responsible for a certain state of the society differ from region to region and the relative importance

which will have to be given to different aspects of modernisation will therefore be correspondingly different. This is particularly true in the context of uneven distribution of coal, oil and natural gas, forests, water, iron ore and other natural resources in the country which also has to put up with significantly different climates, rainfall, productivity of the soil, cultures and languages in its different regions. The paucity of capital makes imperative to rely on those resources which are abundantly available in the country such as labour, land and other natural resources. The central focus of this complex situation is that unless there is mass participation in the endeavours for advancement, there could be no prospect of rapid progress along a widefront.

#### **CONCEPT OF REGIONAL ECONOMICS**

A broad assessment of the problems and opportunities which stem from the focal theme underlines the immensity and complex nature of tasks which we need to tackle within a definite time frame. The most encouraging features of the landscape which inspire optimism in the face of these gigantic tasks are the assets we have in the form of the intellectual potential of our society embracing various types of scientific, technical and managerial skills, tools, techniques and temper provided by the recent advances in Science and technology and a wealth of resources endowed by nature. The most obvious need, as a first step, is to refashion our modes of thinking and action in evolving a multipronged strategy to mobilise our resources. Secondly, we have to select a line of attack which would pay immediate dividends without sacrificing long-term interests or more lasting social values. One of the alternatives on the horizon is the concept of regional economics. This concept aims at a fully integrated development of national resources in a region which would cut across State boundaries and would be chiefly

focussed on a comprehensive survey of new resources and maximum exploitation of the existing natural assets in the area with a balanced policy of conservation. Regional economics can grow to a point where several disciplines including technology, geology, economics and sociology are synthesised to obtain maximum benefits from the results of scientific and technological progress. The main objective is to create conditions under which the efficiency of capital investment is increased, the utilisation of raw materials and energy improved and benefits of interlinked and balanced development realised. The other aim of this strategy is to create supplementary opportunities for the growth of social and cultural values. Regional economics would cover the integrated development of the productive forces and of concrete social processes to ensure that every region operates under the most favourable conditions for growth. This idea can be given concrete shape by formation of "territorial complexes" which will require the combined efforts of many ministries and departments and non-governmental agencies. We have, no doubt, made significant advances in the planned management of our economy. But we are now confronted with the task of increasing the sophistication of our planning to match it to the new dimensions and complexities in the national scenario. We should formulate plans for geographical complexes which would be built around sources of power, water and raw materials while, in areas distant from coal and oil fields, nuclear power stations can serve as focal points in view of the flexibility in their siting. These energy centres can secure the most efficient clustering of productive forces and fulfil the need for developing new regions on techno-economic considerations, particularly regions with large resources of primary materials and fuels. The surplus of goods and services in one region would, on a scientific basis,

meet the needs of less developed regions which could be linked with the developed region in securing the needed inputs in terms of men, money or materials. Perhaps a chain reaction which would be generated by the success of a regional complex will transform our economy within the shortest possible time and will assist in "leap frogging" into the future by blending the achievements of our scientific and technological revolution with the ethos of a socialist order of society.

### **PLANNING FOR DEVELOPMENT**

We need to state the objectives for which we plan to make use of our resources. These could be rationality, development and development planning, rise of productivity, rise of levels of living, social and economic equalization, improved institutions and attitudes, national self-reliance, social discipline and participation of the people in the task of nation-building. Though it may be difficult to attain all these goals for any nation what is needed is a change of direction towards the desired goals of development planning. It is in this direction that we have to re-orient our thinking and plans of action. And as we approach the desired goals, the changed social order will, in turn, accelerate the rate at which resources can be utilised or conserved.

The type of resources which need to and can be conserved depend on the availability of other resources, the final demand for them and the level of technology. For example, coal can be utilized for the production of power, fuel and has a potential for conversion into oil and other chemicals. Yet, to meet the demand for power, we have to use our coal reserves for quite some time to come. But on account of its exhaustible nature, and its other uses, alternatives have to be found for the production of power. These could be through nuclear energy, solar energy, or geothermal energy. And till a certain point of time, which we can call the threshold

point, we must make the maximum use of our coal resources and after this point we must conserve our coal resources. The period between the present point of time and the threshold point is the time available to us for the development of alternative methods of power production which are not dependent on non-renewable natural resources. Other modes of conservation and efficient utilisation of resources could be through appropriate technological reforms, recycling of waste, matching of the objectives of organisations engaged in resource exploitation with the national objectives, reform of the social institutions and education of our people in new techniques of resource development and utilization. In fact, survey, conservation and utilisation are three interlinked aspects of resources and cannot be considered in isolation without running the risk of drawing wrong conclusions. Geological and geophysical surveys enable us to identify the available resources, their concentration and their geographical distribution. This combined with the knowledge of the distribution of demand for these resources across the country can help us in working out the economics of their extraction, establishing the need for conservation and developing the technology for their optimum utilization. It may be prudent to develop a technology of extraction which simultaneously tackles the problems of utilisation and conservation of resources. This requires an integrated approach to resource planning. For, otherwise there is a risk of unintelligent overexploitation of resources as happened in the advanced countries, or under-utilisation of resources as in the developing countries. Economic and social advancement left to “natural forces” is highly unlikely to follow the desired direction. On the contrary, we may end up in a crisis situation — as happened during the oil crisis — from which it may be difficult and costly to retrieve lost ground and which certainly will impede our advancement.

I have chosen certain specific resources vital to our national development and would like to identify the issues stemming from the broad spectrum of the resources in the order of their importance.

### **HUMAN RESOURCES**

Human beings are at the centre of two different equations. First, it is for them that other resources are being utilised and second, they themselves are resources and if adequately developed are capable of unleashing an unprecedented scale of productive forces. Yet, this probably is the most under-utilised resource in our country. A sizable part of our labour force does not engage in any form of work and most of those who do work, work only for a fraction of a day, week, month and year, and that too not efficiently. Such a state of affairs has drained our agriculture — except in plantations and a few market-oriented subsectors — of much of its vitality. These attitudes towards work could survive over a long period of history only because of the traditional institutional framework of our society. The situation has become more and more serious as these attitudes and institutions are handed down to an ever-increasing population from their predecessors. Though more determined steps have been taken in the field of family planning in the last couple of years, the labour force will continue to increase somewhere between two and three per cent, probably till the end of this century. As in the past most of these newcomers to the labour force will have to earn their living in the village economy, particularly in agriculture. Large-or medium-scale industries may not be able to absorb even a small fraction of the under-utilised or un-utilised labour force of the country even if industrialisation proceeds at a more rapid rate. The reasons for this are, first, the relative smallness of the non-agricultural sector or, conversely, the vast size of the agricultural sector which sustains more than 70% of the country's population and second, the

absorptive capacity of the non-agricultural sector is severely limited. In fact, in the initial stages industrialisation may leave a back-wash effect on traditional industries, and thus reduce the total employment in the manufacturing industry as a whole. Small-scale industries have a good scope for growth and though capable of generating higher employment opportunities per unit of capital employed for which reason they must be encouraged, it is doubtful if the problems of under employment or unemployment can be adequately tackled through setting up of small-scale units alone. It is true that there is enormous scope for the creation and expansion of cottage industries in rural areas but they will have to face the competitive threat posed by the modern small-scale and large-scale industries which in the somewhat longer run will intensify in spite of protection and will thus compel the cottage industry to gradually go through the process of labour saving modernization. Thus we come to the conclusion that even if more employment is generated in the small-scale and cottage industries, they are unlikely to absorb a sizeable portion of our under-utilised or un-utilised labour force which must, therefore find work in the agricultural sector. Fortunately, there are certain important features of the agricultural sector which keep our hopes alive and permit us to state with certainty that a large part of our labour force can be productively absorbed in this sector. First, unlike traditional crafts agricultural sector is not vulnerable to the backwash effects of industrialisation and also unlike cottage industry agriculture does not face any market competition. Food will be required in larger and larger quantities in the future as the population increases.

While on the subject of human resources development, I would like to emphasize the concept of "Investment in Man" which is of recent origin and has not been given due recognition both in

theory and practice, particularly in the developing countries. There is hardly any doubt that the interdependent and self-supporting system of attitudes and social institutions plays a dominant role in the utilisation of human resources and in fact, all resources. Yet, our traditional social institutions and attitudes are in no way conducive for rapid development and utilisation of our resources. And this undesirable system which probably is the single most important obstacle on the path of our development can be removed only through formulation and implementation of more rational plans which give much deserved importance to health and education of our people. Our national planning models are still based on the traditional concepts — many of which were borrowed from western economics and are inadequate to explain or predict the reality in a developing country. Traditional economic and fiscal opinions continue to ignore the drift of current development and significance to public policy of the new insight which is emerging in the field of social sciences. So exclusively preoccupied are we with assumptions of physical investment that we continue to build models of economic growth on strictly materialist assumptions without any cognisance of the role of investment in human beings. We disregard the role of the development of human skills and creativity. Our major concern seems to be with elegant economic models which tend to ignore whatever is difficult to quantify even if these "unquantifiable" factors happen to be more important than those which are quantifiable. Investment in Man is one such area which is unable to find its due place in our economic models.

The developing countries have given too little importance to the development of their human skills and knowledge which could be of direct use in their immediate environment and have overemphasized on the physical investment, on the

installation of plants and equipments. This has led to an imbalance between human resources and physical resources and has consequently led to the failure of the countries to attain their optimum rate of economic growth. Yet it is remarkable that the theory of economies or in other words the theory of optimum resource allocation was built based solely on physical investment. One wonders how the models of economics could be developed without incorporating the social structure and attitudes supported by that structure which are responsible for the widespread existence of absentee land ownership and tenancy and the consequent low productivity of land and labour.

It is true that our plan documents have emphasized the importance of health and education or, in other words, of "Investment in Man" and they are certainly right in devoting more resources to these sectors; but that can only be regarded as an appreciation of the concept and are certainly vague and incomplete in the sense that they do not answer the questions of where should health and educational programmes be directed, how far should they be pushed, what means they should employ and what are other policy measures needed. The theory of "Investment in Man", though of great importance, is not sufficiently developed so as to enable the decision makers in the optimum utilisation of our resources.

Our political leadership had been aware of this problem from the pre-independence days and Mahatma Gandhi and Pandit Jawaharlal Nehru had emphasized the paramount importance of education and health of our masses which only has the capacity to transform our society into the new era. To quote Pandit Nehru, "It is clear that in the final analysis it is the quality of human beings that counts. It is man who builds up the wealth of a nation as well as its cultural progress. Hence education and health are of high importance so as

to produce that quality in human being... We have to remember always that it is right education and good health that will lay the foundation for economic as well as cultural and spiritual progress".

In the last decade, we have taken certain crucial and decisive steps towards the reformation of our social institutions under the inspired leadership of Prime Minister; Mrs. Indira Gandhi and we have been able to usher into a new era under the guidance of her 20-Point Programme. For a speedy implementation of the Programme, we have to find avenues for increasing the level of education and health care. One experiment which is being tried out and needs a large-scale expansion is the use of mass media provided by television, radio and films for education of our people.

We cannot wait for the availability of trained teachers in large numbers and will have to utilise the mass media to broadcast programmes on education tailored to the needs of each region or each district.

Many of us can point out notable exceptions to what I have stated about "Investment in Man"; but there is no doubt that at the aggregate level the problem is acute and has not been accorded due recognition in our policies and programmes. There is a need to define the problem more explicitly, to assess the needs for investment in human beings for each region and to develop appropriate theory based on empirical studies and to set up institutions which could implement our education and health plans. This, I consider, is the single most important area which, will have far-reaching consequences on the conservation, and utilisation of our resources. The delegates of the Science Congress may like to ponder over the aspects of human resource development during this session of the Science Congress.

## AGRICULTURAL SECTOR

It is in the field of agriculture that the battle for development will be won or lost. There is an urgent need to evolve strategies for exploration, development and conservation of our agricultural resources whose potential has hardly been tapped. Except probably for plantation and a few market-oriented sub-sectors, we have been unable to attain the maximum possible output feasible from optimum combination of land, labour, water and such other locally available natural resources which do not necessarily involve any fresh input of capital or even technology. Additional inputs of capital and technology will further raise the potential of this sector.

The low yields per acre are particularly remarkable when we consider about 70 per cent of the population of India is agricultural and has not been consistently able to produce the country's entire food needs. The labour input per worker is generally low in terms of man-hours and is of low efficiency. This means that not only the productivity of land but also of labour is low. And this, in turn, implies that agriculture in our country is not labour-intensive but, instead, labour-extensive. These work-patterns are supported by institutions of economic and social stratification and are related to land ownership and tenure which determine the use of land. These work patterns are also supported by low nutritional levels caused by poverty which in turn impairs the willingness and ability to work, thus keeping the yields down, which in turn is the cause of poverty. This process of circular causation leads us to believe that if we have to succeed in exploration, development, utilisation and conservation of our natural resources, we have to understand reality in its totality and determine solutions which are all-encompassing and are of necessity inter-disciplinary in nature. There could not be anything short of an integrated approach

which can solve our problems. When we observe that in only 15% of the gross cropped area is the output per hectare about Rs. 1500/- per annum and only 12% of our districts have achieved a growth rate of more than 5% in agricultural production, during the Fourth Plan period, we realise that urgent steps are required for improving agricultural productivity through irrigation, the adoption of improved technology and a speedy implementation of land reform legislations.

I emphasized on the social aspects of the problem, not because Science and technology are secondary in nature, but because the parameters which are commonly not understood, or are given relatively low importance are often social parameters. I have placed a major emphasis on these aspects because we cannot conceive of bringing about important technological changes in our country unless accompanied by no-less-important social changes. I want to stress that even without any increase in capital or technological inputs, substantial increase in the output can be achieved merely by increasing work in terms of number of man-hours per day and of higher efficiency. Increasing number of farm-management studies point out that there are significant differences in agricultural productivity not only from region to region, but also within a region, within a district, and a village and, in fact, adjacent farms. The yield per acre of the best farmers have been found to be several times higher than those produced by average farmers. The idle manpower can be used in such essential and labour-intensive works as the construction of roads, bridges, schools, irrigation canals, warehouses for storing crops and farm supplies, in digging wells to provide drinking water, for soil conservation, and labouring on afforestation and pasture improvement. Idle time can be used in keeping the villages clean, and in the manufacture of agro-industrial products. But the difficulties in

undertaking these works are enormous. The success of these ventures is dependent on cooperation, collective action, and hence organisation, that is often absent in a faction-ridden village. The one question which will be of paramount importance to each individual is: who is going to benefit from such ventures of cooperation? Our social institutions are such that a large fraction of the benefit of any developmental work accrues to a small but dominant minority and there is a sense of suspicion in the minds of the larger majority. This situation can be mended through legislative and administrative action directed towards transforming the existing order of society. We have taken a number of such steps since independence in this direction with varying degrees of success and we are fully aware that much more is required if we do not want to permanently lag behind on the road towards progress and prosperity.

Historically, few nations have managed to industrialise without first becoming self-sufficient with respect to agricultural products; hence the oft-cited generalisation that agricultural revolution is a prerequisite for a successful industrial revolution. This is particularly true in the case of densely populated agrarian economies with a low technological base. As a large part of the labour force is, and will continue to be, in the field of agriculture, it is very difficult to generate sufficient demand for industrial goods unless the agricultural productivity, level of employment, and utilisation of the labour force are considerably improved to raise the existing low levels of income. In conjunction with attitudinal and social changes, and increased work input, we have to bring about such technological changes, which are not capital-intensive but, instead, labour-intensive, which can make use of locally available resources, which can be mastered by the less educated, and which are capable of substituting primitive modes of

production. Technological reforms are not necessarily labour-saving if intelligently selected. Appropriately chosen techniques lead to more abundant crops requiring more work at the time of preparation of soil, sowing, weeding and harvesting. It is not possible to transplant western agricultural technology which is oriented to save labour inputs, into the Indian agricultural scene. In fact, while implementing our technological reforms, we have to restrict the availability of machines which just substitute labour.

To be successful in bringing about agricultural revolution we have to intensify our work on a comprehensive survey of climate, soil, crops, breeds of livestock etc. which are necessarily localised in nature and hold large dividends in store. In particular, soil surveys must be carried out in different parts of the country to enable us to identify the correct type and dosage of fertilizers that can be prescribed. Urgent steps are necessary to raise the quality of soil and for increasing its potential for production through irrigation, soil conservation, chemical and biological control of the soil, and use of fertilizers and manures. About 150 million hectares out of 300 million hectares are estimated to require soil conservation measures.

It is essential to keep a part of the land forested not only to supply timber, pulp wood, and fuel but also to provide soil protection and moisture control. Soil experts recommend that 30 to 33 per cent of the total area be forested with due consideration to their geographical distribution. In India the forests account for only 22 per cent of the total area. Despite all plans a steady destruction of forests seems to have continued for a long time. Yet the fact that more forests are needed does not in itself demonstrate that potential for cultivated area will be reduced. Much land suitable for reforestation is either remote from existing villages and put to no worthwhile use, or is used only intermittently in

shifting cultivation or grazing. Reclamation of large parts from the 33 per cent of the total land area which is put to no use at present, is possible through better drainage and soil conservation systems.

One of the most promising ways of increasing the acreage available for cultivation and labour utilisation is through a reduction of claims on space now made by animals. The same number of animals could be much better nourished on tilled fodder crops requiring only a fraction of the acreage now under pasture. It is not right to say that all the land now used for grazing is waste land and could not be tilled in any case. A good fraction of this "waste land" can be used for food production by the application of modern agricultural methods. On the other hand, India commands a large number of domestic animals many of which are stray, and useless and those which are in use are of poor quality and we have not been successful in their full utilisation. There is an urgent need for a large-scale control of the unchecked increase in the animal population and to raise good quality cattle through cross-breeding and proper nourishment. If appropriate steps are taken to improve the quality of cattle, it is not only possible to reduce the cattle population but also to effect a substantial increase in their total output.

When we prepare our perspective plans for agriculture for the next 25 years to ensure supply of food for the increasing population, we have to adopt modern methods of cultivation. This would imply increased supply of irrigation water, fertilizers, improved seeds and other technological inputs. Through appropriate technological improvements, we have to increase the quality of organic manures abundantly available in the countryside that can be utilised along with the inorganic fertilizers supplied by the industrial sector. I will discuss the prospects of irrigation a little later in the context of our water resources.

## WATER RESOURCES

Our water requirement for irrigation, drinking, industrial use and power generation is mainly met by rainfall and groundwater natural reserves. The criticality of water resources underscores the fact that if immediate action at the national level for conservation and efficient utilisation of water resource is paralysed due to whatever reason, a delay of decades may be caused in the economic development of the nation. We need to intensify explorations to identify potential groundwater sources and take urgent steps for the conservation of water which is lost through seepage, evaporation and evapo-transpiration. The average annual rainfall all over India amounts to more than 3000 million acre-feet of water. Out of this, 1000 million acre-feet are immediately lost due to evaporation and roughly 650 million acre-feet seep into the soil, leaving 1350 million acre-feet to flow into the river systems. One-third of the river flow, i.e. about 450 million acre-feet is considered utilisable for irrigation. Use of chemical monolayer films need to be tested and extensively employed to conserve water in reservoirs. It is estimated that normal evaporation can be reduced by 33% through efficient use of such films.

Out of the total arable area of 175 million hectares in the country, it was estimated that 142 million hectares would be under cultivation at the end of the Fourth Plan. On present estimates, 107 million hectares of land can be ultimately irrigated both from surface and groundwater sources and it was estimated that a potential of 44.9 million hectares and utilisation of 43.1 million hectares would be achieved by the end of the Fourth Plan. The total irrigation potential likely to be created during the Fifth Plan period is placed at 13.1 million hectares, thus increasing the total land under irrigation to 58 million hectares by the end of the Fifth Plan.



More accurate meteorological forecasts are necessary to enable the agricultural sector to plan its harvest. Training in modern techniques of utilisation of irrigation water in combination with fertilizers, pesticides, high yielding seeds, etc. appropriate to the local soil and climatic conditions is a prerequisite for efficient utilisation of irrigation water. Many of the results to date, particularly of major irrigation works, have not been encouraging due to the inability of the farmers in making a quick and full use of the facilities offered. In the absence of adequate funds and the capital-intensive nature of irrigation projects, it is essential that a reasonable contribution from the local manpower is sought in the setting up of irrigation projects. Planning Commission observes that "participation of local manpower in construction considerably enhances the prospects that the irrigation water, once available, will be intelligently and efficiently used".

Because of the regional imbalances in water availability due to uneven precipitation and routes taken by our perennial and seasonal rivers, we have not been able to tap the full potential of water in our agricultural sector. In fact, a portion of our water resources becomes detrimental to our agricultural system in the form of floods and accumulation due to inefficient drainage system. The sediment and detritus transported by the rivers whether in suspension or along their beds have an important bearing on storage, flood control, soil conservation, etc. There is an urgent need for a critical study of the behaviour of flowing water under different conditions and design of structures for the control and conservation of water. Construction of dams should not take place for flood control alone but should be planned in such a way that the water can be fully used for the purpose of irrigating downstream land also. Work on the construction of distributories, water courses,

and field channels should proceed in step with the construction of dam and the reservoir. Many of our projects in the past had to face long delays sometimes through inadequate planning, sometimes because of budgetary constraints.

Though, rivers are now considered as national assets, studies need to be conducted for an optimum apportionment of water depending upon irrigation needs and intra-basin and inter-basin needs. Immediate steps are required for the protection of water from pollution and for monitoring environmental characteristics of inland water.

Only about 37% of the surface water was utilised in 1973 and much less of the groundwater potential. The efficiency of utilisation is of course, highly questionable. According to some experts, the actual cultivator of the soil, has frequently viewed irrigation more as an insurance against monsoon failure than as a device to raise his yield and possibly engage in multiple cropping. This could be due to the inherited institutional systems as well as inefficient administration of the distribution of water. In the past, irrigation has not been thought of as the focal point around which coordinated programmes with respect to simultaneous introduction of technological inputs, supplies, credits, marketing, better communication, land reforms could have been introduced. In this sense, combined action on the part of number of government agencies as well as action at the community level become crucial to the speedy utilisation of new irrigation facilities.

### **ENERGY**

One of our foremost concerns today is the energy crisis. This crisis is being faced by most of the countries of the world and it highlights the central role of energy in our civilization. The magnitude, type and the nature of use of energy inputs throughout the ages have determined the life styles, economic prosperity, military power and the

social modes of various countries at different points of time. Energy can no longer be considered as an isolated economic and social problem. The generation of electricity from very large stations has resulted in many inter-dependencies among areas and regions. Any disruption in the supply of fuel or energy in an advanced society today, will result in a serious dislocation of economic activities and life styles of people. The impact of recent oil crisis is a telling example of our dependence on energy.

An energy deficient society is weak and is not adaptable fast changing environmental conditions in comparison to a high energy society. Such a hardened society cannot take advantage of the expanding opportunities for economic development generated by advances in Science and technology.

Ours is not a high energy society. However, political compulsion and the social aspirations of our people demand that we produce and consume more energy in the future to improve the quality of life of the large masses of our population. There is fragmentation and inefficiency in the production, distribution and consumption of energy in our country. Urban areas consume energy in a large measure. The distribution of energy consumption like the distribution of income and wealth is largely skewed in favour of the urban areas. To promote development and social equality in the future, energy policy appears to be a potent instrument. The policy options open to us are, *inter alia*, in the choice of technologies, interfuel substitution, pricing, energy allocation, and environmental quality. While choice of social goals is a political process in our country, we find this choice takes place at various points of time by the force of events in an unarticulated manner and not by conscious planning. Even if the goals are defined, the alternative strategies that are open, are not often

explicit. I will try to suggest a few broad strategies about our future energy planning.

1. Since the design and construction of a power station take 7-12 years, energy planning would necessarily require, a long-term integrated approach. Energy planning in India, in the past, has been largely a choice of series of projects with different technologies. As no clear understanding of the nature and components of demand for electric power exists, capacity addition and pricing of power are usually done in ad hoc manner. The current methods of cost-benefit analysis are somewhat inadequate to evaluate power system alternatives. These methods take into account only monetary costs and benefits and not social costs and benefits. However, questions like who pays and who benefits are not satisfactorily answered by cost-benefit analysis. Current pricing policy of electricity undertakings, largely based on accounting data, does not reflect social priorities for the use of energy.

2. If we make a modest assumption that by the end of this century our per capita electricity consumption should be about half of the present per capita consumption in Western Europe, we will need a total installed capacity of about 180,000 MWe (at 60% load factor). Assuming that our hydro electricity potential of about 40,000 MWe is fully tapped, there will still remain a gap of 140,000 MWe which has to be filled by coal or some other source of energy. In the event of coal having to fill the gap of 140,000 MWe, the total coal production including coal required by industries would have to be over 1,000 million tonnes. The production and distribution of such an amount of coal which is about ten times the present level of production and distribution would pose formidable financial and technical problems. Other sources of energy like geothermal, wind, tidal or solar power are either very limited or localised and seasonal, or may involve considerable amount of R&D over a long

period of time. Thus it is inevitable that in the long run, nuclear power will have to substantially contribute towards electricity generation in India. The intrinsic compactness of nuclear fuel as well as of the effluent of a nuclear power plant make them eminently portable, and will reduce not only transport costs and hence the price of electrical energy, but also the strain on our already over-worked transportation network. The current installed capacity of nuclear power is 600 MWe. During the 5th plan, this would be increased to about 1000 MWe. With the currently available uranium resources and reactor technology, the total potential for nuclear power is about 5,000 MWe. An active atomic mineral exploration programme is under way and it is expected that more uranium resources would become commercially exploitable. Simultaneously, the development of breeder technology is being undertaken in an accelerated manner so that more power can be generated from the existing uranium and thorium resources. In addition to fission energy, attempts are also being made to obtain fusion energy which will ensure an almost inexhaustible source of energy.

3. Most of the state electricity grids have been formed by interconnection of power systems so that integration and optimisation of power generation and distribution can be achieved at the state level. A few zonal grids are also operating with some exchange of power between the states. Attempts are being made to form a national grid by the end of this decade so that an overall optimisation can be achieved. The distribution and utilisation of various types of fuels can be done in the best possible manner with necessary interfuel substitution by the interconnected grids. Significant improvements in energy generation and distribution systems can be brought about by using operations research and computers, better training of personnel and maintenance of equipments, a rigorous estimation

of sectoral demand of energy so that allocation and price could be in accordance with the priority of activities, reduction of construction time, and cost of power stations to name a few. A large portion of these tasks can be carried out by a national energy authority which could plan, finance, coordinate and regulate energy generation, distribution and utilisation. Or, in other words this agency can coordinate and regulate the activities of various organisations like Coal Mines Authority, National Coal Development Corporation, Bharat Coking Coal Ltd., Geological Survey of India, Mineral Exploration Corporation of India, the ONGC, the Railways, the State Electricity Boards and some municipal corporations which are engaged with energy systems in some form or other.

4. Since losses due to the use of low quality coal and poor transmission of power are very high, R&D programmes have to be initiated to solve this problem as soon as possible. Research also needs to be done in improving conversion efficiency and thermal exchange of different types of generating plants. Many of our electric appliances are very inefficient in the use of power. These have to be redesigned so that they use power more efficiently. Fuel efficiency in many of our industrial enterprises can also be improved significantly by redesigning industrial equipments like boilers.

5. In the rural areas we need to make use of locally available sources of energy, There is a great potential in non-commercial fuels like vegetable wastes, firewood, and animal wastes. According to certain estimates "every year some 460 million tonnes of cowdung are burnt in India providing 70 per cent of household fuel requirements. This dung contains 1.38 million tonnes of nitrogen and 0.69 million tonnes of phosphates. If this were applied to fields instead of going up in smoke, it could produce an extra 14 million tonnes of food grains. The investment needed to mine and distribute the

46 million tonnes of coal to replace dung completely would be prohibitive.”

Towards utilising this important resource we had talked a good deal about bio-gas plants and more generally about appropriate technology. The idea was to ferment the dung anaerobically in a pit, the gas being collected in a tub and transferred by pipe to cookers and gaslights, and to use the residue as a manure. In a specific case, plants were developed for commercial scale operation and installed. On follow up it was found that only one in five of the plants was in use. The moisture in the gas had clogged the pipes and spoiled the gaslight mantles. The flame was uneven and took a long time to cook food. Farmers were still compelled to burn dung because the volume of gas generated was not enough to meet the family cooking needs. Leaving apart socio-economic reasons like the cost of the plant and need for a minimum of five cows which only the richer farmers, could afford, the principal failing was one of research. “The conversion efficiency of the plant turned out to be only half of what was expected, because the average temperature of the plant in operation was 10°C lower than that claimed for the pilot plant”.

If we had given more attention to the problem, we would have developed not only less costly plants but also directed our efforts towards breeding a new strain of bacteria capable of multiplying much faster and at lower temperatures to achieve the needed gas output with the available dung input. I suppose we will direct our attention to this problem, now.

While energy crisis is truly a global phenomenon, its solution will continue to be national in a very large measure for a long time to come. Also, in India we are, to some extent dependent on other countries for supply of fuels like oil and enriched uranium. We, therefore, have to look, towards

increasing our coal production, tapping hydroelectric potential and intensifying oil exploration. Commendable efforts have been made by the ONGC in this direction. In the Department of Atomic Energy, we are concentrating on the use of natural uranium based nuclear power to eliminate our dependence on imports. We recognise the important role of atomic energy in meeting the future power requirement and towards this end, we have been concentrating our efforts on the development of fast breeder technology which would generate more fuel than what is consumed in the reactor.

### **SCIENCE & TECHNOLOGY**

To achieve the goal of self-reliance, urgent steps are needed to streamline the efforts of various public and private institutions towards establishing the most efficient and effective methods of mobilising indigenous resources in tune with our needs of industrial and agricultural development. Most of the developing countries today, are seized with the chronic problem of sub-optimal utilisation of available manpower, machinery and natural resources. A good deal of this is due to indiscriminate adoption of foreign technology and inadequate orientation of indigenous efforts. We are aware of the social problems which arose from direct transplanted of imported technology. We are also aware that many times we ended up with imported plant and machinery which could not efficiently process local raw materials. We had the painful experience of capital-intensive technologies which did not create sufficient employment opportunities. Nor did they achieve the results in terms of desired products and scale of operation in relation to the limited size of the domestic market. We did not give due recognition to the fact that optimum size of an enterprise is determined not only by technological factors, but is also governed by several other considerations like economics in marketing and finance. Even India which is

relatively more fortunate in the field of Science and technology among developing countries is faced with wide and substantial gaps on the frontiers of its research and development. More than 50 per cent of the country's land surface had not been mapped ecologically on 1 to 1 scale by 1973. A total of only 500 odd geophysical investigations were carried out for minerals between 1956 and 1973. Till 1973, only 20% of the land surface had been surveyed by reconnaissance geology and hardly 100 geophysical studies conducted for ground water since independence. Our success ratio for exploring ground water tube-wells was at a low figure of about 35% whereas in some countries it is between 82% to 85%. On the one hand we are heavily dependent on the import of metals, minerals, petroleum etc. and on the other hand we allow a time lag of 5 to 7 years between surveys and production of maps thus affecting the timely execution of natural resource development programmes.

It is particularly important for a country like India to know the nature and extent of its physical resources through effective surveying. It is a global phenomenon that many of the earlier geological surveys in many countries did not disclose the mineral wealth which has been discovered in more recent decades making use of more sophisticated technologies. Likewise our country may be much richer than we thought a few years ago. The most arid or unprofitable deserts are now found in many cases to be natural geological basins containing oil, minerals and vast quantities of underground water which are capable of being exploited and could more than adequately pay for the capital and effort involved. There seem to be boundless possibilities in an integrated survey of physical resources, study of rocks, minerals, and soil, rainfall and river flows, subsoil water, fisheries, forests, and what is most important, ocean bed resources. The agencies which

make these studies often suffer from lack of trained personnel, shortage of suitable equipment and want of a multi-disciplinary effort which alone can match the magnitude of the task and its varying complexities.

Next in importance is a survey of our capabilities in the field of Biological Sciences for adapting new technologies for better breeding of plants and animals, control of pests and diseases, evolution of new food materials and plant nutrients. Most of these problems can fortunately be solved by the application of existing knowledge and skills to concrete conditions in a particular region. The main thrust of our effort has to be in the direction of stimulating development quickly through inexpensive methods and simple technologies so that existing manpower would become more efficient and the surplus utilised in more productive vocations.

All these facts focus our attention on the need for accelerated indigenous research and development. Successful development and implementation of Science and technology plans which must be accompanied with social reforms, necessarily depend upon local parameters like terrain, quality of soil, climate, distribution of water resource, irrigation, network, available infrastructure of transport, power and other utilities, and geographical distribution of natural resources. We cannot depend upon the developed countries to help us out in the field of Science and technology because their social setting and physical system provided by Nature is very different from ours and hence their modes of exploration, development and conservation are unlikely to be applicable in our setting. This, of course, is not to imply that we should not go in for foreign collaboration in very high technology fields where we may not have adequate know-how and the output of which is of utmost importance to the economy. In fact, there is

a strong case for utilising the most modern technology among developing countries in certain selected areas. Use of satellite for surveys, use of remote sensing technology for assessing mineral resources as well as standing crops, use of radioisotopes for establishing the characteristics of the flowing water, use of atomic energy for the generation of power, use of the most modern equipments for more reliable meteorological forecasts, use of mass media for education and also for rapid information flow, are just a few of the illustrations. Modern technology *per se* does not presuppose existence of a sound industrial base and is not necessarily costlier than the traditional technology. In fact, the scope for using modern technology provides a very effective way for leap frogging into the modern era and thus avoiding the long and tortuous path of development followed by today's developed countries.

For a smooth and rapid progress in the field of indigenous Science and technology what is most important is to forge links amongst research and educational institutions, national laboratories, government agencies in the fields of Science and technology, industry and agriculture. Considerable efforts have already gone in this direction, yet we cannot say that we are anywhere near the optimum point of inter-organisation cooperation and collective action. We have to speed up the communication between organisations, set up inter-organisation terms for research projects, decentralise authority, and take concrete steps towards motivating scientists and technicians. These are probably the only ways of creating a favourable atmosphere for a rapid advancement of Science and technology in the country.

#### **NON-RENEWABLE NATURAL RESOURCES AND ECOLOGY**

While talking about the energy sector we had discussed a good deal about the exhaustible nature

of the fossil fuels and its adverse impact on the environment. The discussion needs to be extended to minerals, metals and such other non-renewable natural resources which we cannot indiscriminately exploit, nor can we keep importing, them nor create ecological complications.

Of the 3.28 million sq. km of the country, 32% is accounted by sedimentary areas favourable for petroleum, natural gas and ground water resources, 16% is covered with the Deccan Lava flows, and the remaining 52% needs to be explored for minerals. This would involve much intensified geological and geophysical surveys for effective action to quickly meet the requirements of non-renewable natural resources, the import bill for which is likely to be in the range of Rs. 1200 crores by the year 1980-81. The optimum exploration, utilisation and conservation of non-renewable natural resources can be effected only through organised machinery whose actions can be subjected to coordination and which is capable of developing an integrated approach to non-renewable natural resource management. We have to implement our ideas on the export of higher value-added products instead of just ores. To counter the machinery of international trade which is heavily biased against the raw material producing developing countries, we have to reduce our emphasis on export of raw materials. The third world countries are realising in an increasing manner the importance of conservation of non-renewable natural resources. Recent trends in the developing countries indicate that steps will be taken to cut down the exploitation of their natural resources not only to conserve them for future generations but also to obtain a better price per tonne of export. As we are aware the cost of mining will sharply increase as we go deeper and deeper, and this fact needs to be kept in mind while exploiting, selling and pricing such minerals. According to the Fifth Plan document the objective

is “to supply the growing needs of non-renewable natural resources at minimum social cost and to utilise nation’s non-renewable natural resources at optimal depletion rate”. The government rightly intervened to nationalise coal mines and thus save them from the ruthless exploitation by vested interests whose profit motivation predominated national objectives.

We have to undertake social cost benefit analysis before embarking on the exploitation of non-renewable natural resources. The parameters which will go into this will be much more than simple financial and economic analysis. Analysis must take into account who is going to pay for the investment and who is going to benefit from it, what are the ecological consequences, and questions raised by resource balancing. Many of these decisions are political in nature and can be brought into effect after creating a deeper awareness and understanding of the underlying factors on a technological and social plane.

Nature in the process of its evolution, has possibly experimented with almost all permutations and combinations of simple and complex molecules. Whatever was found to be functional for life was retained and whatever was dysfunctional was rejected by it. There is nothing like waste in the delicately balanced kingdom of Nature. The waste of one species is food for another. The balance is maintained through the control of population operating in the cycles of nature. Human beings by their ability to control some of the natural forces, of course without much understanding the complex cybernetic system of Nature, disturbed the balance by creating linear chains of resource exploitation which are characterised by rapid generation of waste for which there was no readily available mechanism at the disposal of Nature for adequate reprocessing. Nor was the disposal of waste taken care of by the people who created it. We are aware

of public hue and cry about how the rivers and consequently harvest and fish were affected by pollution generated by chemical plants. Unlike many of the advanced countries, pollution in India is fortunately confined to certain pockets only. Yet, if we want to make use of the experience of the advanced countries, along with industrialisation we should undertake simultaneous preventive measures to control pollution. This will not only avert crisis at a later point of time but is also socially and economically more prudent. Waste can be treated chemically and can be used as a raw material. Ash generated in thermal power stations can be used for making bricks and urban sewage can be treated and used as fertilizer. In the Department of Atomic Energy, we have been successful in setting up plants for the manufacture of heavy water based on ammonia produced as a byproduct in fertilizer plants. A good deal of R&D is required to identify ways of using waste as raw material not only for economic reasons but also for ecological protection.

#### **THE INDUSTRIALIZATION ISSUE**

In the developing countries characterised by high man/land ratio, a low technological and industrial base and a large under-utilised labour force, the agricultural sector has to play a prime role for some time to come in the upliftment of the levels of living of the weaker sections of our society. Yet, in view of the rapid and accelerating increase in the labour force, there is no prospect that incomes and levels of living can be substantially and permanently improved in the longer run, unless a much larger proportion of the labour force can be effectively utilised outside agriculture and especially in modern industry. Though in the early phases of industrialisation the absolute size of the labour force engaged in all types of manufacturing may happen to fall because of this risk of the backwash on traditional manufacturing, industrialisation will have an important employment-creating influence

once it has reached a higher level. And that precisely is the reason that industrialisation should forge ahead at a much faster rate. As a matter of fact, our government has vigorously promoted industries oriented towards export or import substitution not only to achieve the goal of self-reliance but also to minimise the adverse effects on traditional industries. Through the instrument of industrial licensing we have also taken important steps towards protecting the interests of small-scale industries and village craftsmen. Steps are being taken to modernise the small-scale industries and village crafts through introduction of technological changes which do not decrease the demand on labour and which attempt to utilise the local resources to the maximum possible extent.

Generally speaking the extent to which industrialisation can be brought about through assimilation of stimuli for change and improvement is a function of levels of mass education and ability to change attitudes and social institutions. Improvements in the education and health and change of attitudes and institutions are necessary not only to compensate for the relative absence of automatic spread affects but also to support the industrialisation drive itself. To promote the growth of modern small-scale industry and craft industry in villages which are responsible not only for utilisation of local resources but also for generating employment, there is an urgent need for guaranteeing market protection to them and efforts to increase their productivity. Development and application of appropriate technology not only in the small-scale sector but also among the large-scale industries will have the most telling effect on the success of our industrialisation efforts.

Increased efforts are required for maximum utilisation of already established capacity in the industrial sector. This can be achieved through increased research and development, better

maintenance of our plants, efficient management, change of product mix, and possibly change of designs.

Urgent steps are needed for developing indigenous industrial designs which have a profound effect not only on the utilisation of the country's resources, but also on the quality and scale of whatever is produced. Good designs should make it possible to produce the articles actually needed by the people, thus ensuring a stable domestic market for the local industry. This would require cooperation and collective action on the part of the various public and private research and educational institutions engaged in the task of developing indigenous know-how and scaling it up to the commercial level. What is presumed, of course, is the existence of an integrated plan and the administrative machinery through which such efforts can give fruitful results.

## CONCLUSION

I have tried to outline the important factors which affect the survey conservation and utilisation of our resources. I have made certain suggestions in relation to improving the level of mass education and health as well as changing the existing system of attitudes and social institutions which are mutually supporting and have become a major obstacle on the path of our development. This, of course, is not to imply that modern Science and technology have a secondary role to play in our developmental efforts. On the contrary we must give urgent attention to the development and application of appropriate Science and technology to achieve the goal of self-reliance, but such efforts must give due cognisance to the sociological factors right from the conception of an idea to its implementation. This would require an integrated approach to resource planning on the part of the state agencies, administrators and scientists. In view



of the utmost importance of our agriculture sector, steps need to be undertaken to tap the potential provided by nature and technology. This can be achieved only through a series of reforms effectively administered.

Though increasing number of studies are being made available to obtain a better grasp of the reality in its totality, there is an urgent need for intensifying efforts towards obtaining further insight through empirical studies. This would involve not only the analysis of presently available data with various institutions, but also conducting further surveys at the regional district or even block level and putting them together for arriving at important generalisations.

I would like to suggest that from among the delegates of the Science Congress and may be

some more experts within the country, interdisciplinary teams consisting of specialists from social sciences, economics, agriculture, geology, statistics, etc. are formed to undertake further studies on survey conservation and utilisation of resources. Such studies should be formalized under the existing educational and research institutions and budget grants made for the purpose. The teams could be formed around each important resource with an organisation to ensure inter-team discussions as the resources themselves are closely interlinked.

The results of these studies will be useful not only in obtaining a deeper insight into the existing pattern of utilisation and conservation of resources, but can also be used in arriving at an integrated approach to exploration, conservation and utilisation of our resources.

## THE INDIAN SCIENCE CONGRESS ASSOCIATION

14, DR. BIRESH GUHA STREET, KOLKATA – 700 017

### ANNOUNCEMENT FOR AWARDS : 2013-2014

**1. Prof. Hira Lal Chakravarty Award :** Nominations applications in prescribed forms are invited from Indian Scientists, below 40 years of age as on December 31, 2012 with Ph. D. degree from any University or Institution in India, having significant contributions in any branch of **Plant Sciences**. The award is given on original independent published work carried out in India within three years prior to the award. The award carries a cash amount of ₹ 4,000/- and a Certificate. Awardee will be required to deliver a lecture on the topic of his/her specialization during annual session of the Indian Science Congress in the Section of Plant Sciences. Last date of submitting application is **July 31, 2013**.

**2. Pran Vohra Award :** Nominations applications in prescribed forms are invited from Indian Scientists, below 35 years of age as on December 31, 2012 with Ph. D. degree from any University or Institution in India, having significant contributions in any branch of **Agriculture and Forestry Sciences**. The award is given on original independent published work carried out in India within three years prior to the award. The award carries a cash amount of ₹ 10,000/- and a Certificate. Awardee will be required to deliver a lecture on the topic of his/her specialization in the Section of Agriculture and Forestry Sciences during the Indian Science Congress Session. Last date of submitting application is **July 31, 2013**.

For proforma of application forms and necessary information, please write to the **General Secretary (Membership Affairs), The Indian Science Congress Association, 14, Dr. Biresch Guha Street, Kolkata – 700 017, E-mail : iscal@vsnl.net/es.sciencecongress@nic.in Fax No. 91-33-2287 2551.** The form can also be downloaded from <http://sciencecongress.nic.in>

## FACTS ABOUT CANCER

A. S. Zarena and Shubha Gopal\*

**The uncontrolled growth of abnormal cells anywhere in a body is cancer. Cancer is of different types and some are exclusive to women and others affect only men. Cancer is not contagious, it is usually caused by genetic damage that happens inside an individual cell. Symptoms and treatment protocols vary according to the type and stage of the cancer an individual has development. Most treatments include surgery, chemotherapy, and radiation therapy. Some cancers can be prevented by taking simple precautions in our day to day life.**

### INTRODUCTION

The word CANCER spells fears in all of us. World cancer day is marked on February 4<sup>th</sup> to raise awareness of cancer and to encourage its prevention and treatment. The American Cancer Society estimates that in 2012 about 173,200 cancer deaths will be caused due to increased usage of tobacco and about one-third of the 577,190 cancer deaths are expected to be related to obesity, physical inactivity and poor nutrition.<sup>1</sup> Like in United States, in India cancer is the second biggest cause of death. According to a report published in The Lancet, cancer has killed 556,400 people across the country in 2010. The 30-69 age groups accounted for 71 percent of the deaths. The three most common fatal cancers were oral (22.9%), stomach (12.6%), and lung (including trachea and larynx 11.4%) in men and cervical (17.1), stomach (14.1%), and breast (10.2%) in women. The overall majority of cancer mortality was due to tobacco chewing and smoking<sup>2</sup> followed by obesity. The prevalence of obesity in India is 2-15 % in urban and 0-6% in rural population.<sup>3</sup>

### WHAT IS CANCER ?

In simple terms cancer is defined as a disease in which cells start to grow out of control. The medical term for cancer is neoplasm meaning 'new growth'. The cancer cells keep on growing and make new cells and no longer respond to the signals of the normal cells. When abnormal growth is confined to a particular location it is called benign tumor (non cancerous) and when the tumors cells invade nearby tissues and spread to other parts of the body it is called malignant tumor (cancerous). The spread of cancer from one part of the body to another is called metastasis. Malignant tumor make new blood vessels to feed itself in a process called angiogenesis. There are two important genes contributing to cancer : *Oncogenes* that are responsible for normal cell division when over-expressed leads to tumor, on the other hand *suppressor genes* prevent cell from dividing or causes cell death (apoptosis). If this gene is missing or not working properly, the oncogenes will not be suppressed, turning the cells to cancerous form.

Cancer is not inherited but a genetical disorder caused by mutation in the gene. Carcinogens (cancer causing agents) such as mutagenic N nitroso (NOS) compounds formed endogenously from nitrogenous residues in red meat are associated with cancer.

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Acrylamide a chemical formed in some plant based food (potatoes, train products, coffee) during high temperature frying, roasting and baking is carcinogen. Food carcinogen such as aflatoxin which is produced by the fungus *Aspergillus flavus* on stored grains, peanuts and butter are known to cause cancer in animal studies. Artificial sweeteners like aspartame, spicy and smoked food have been reported to cause cancer in humans. Tumor virus such as hepatitis B (liver cancer), human papilloma viruses (genital cancer), human T-cell leukemia-lymphoma virus (leukemia and lymphoma) and Epstein-Barr virus (cancer of the nose or pharynx) result in cancer formation.

Commonly exposed carcinogens are

- Environmentally occurring natural exposures (ultraviolet light, radioactivity substance and radon gas)
- Medical treatments (chemotherapy, radiation such as X-ray)
- Chemical exposures at work place and pollutions (pesticides such as atrazine, and endosulfan, asbestos, heavy metals, lead, mercury, cadmium, benzene, nickel, arsenic, nitrosamines and polychlorinated biphenyls (PCBs)).
- Food and life style (tobacco, smoking and alcohol).

### SYMPTOMS OF CANCER

Some of the cancer can be easily visualized if the tumor is close to the surface of the body or a swelling can be felt through a lump on the breast or testicle. Skin cancer is often noted by a change in a wart or mole on the skin or a wound that does not heal. Oral cancers present white patches inside the mouth or white spots on the tongue. If the tumor is deep within the body it can go unnoticed unless the tumor grows and pushes against organs and blood vessels. Colon cancers lead to symptoms such as constipation, diarrhoea, and changes in

stool size. Bladder or prostate cancers cause changes in bladder function such as more frequent or infrequent urination. If cancer spreads to the brain, patients may experience vertigo, headaches or confusion. Blockage of airway in the lung can cause coughing and shortness of breath. Pancreas cancers are usually too small to cause symptoms until they cause pain by pushing against nearby nerves or interfere with liver function causing jaundice. Similarly blockage of the intestine by the tumor causes constipation and vomiting. Tumor may cause fluid to accumulate in the abdominal cavity called ascites and in chest cavity called pleural effusion which inturn cause swelling and pain in belly and chest. Leukaemia or blood cancer results in anaemic, fatigue and joint pains. The other symptoms of cancer can be weight loss, fever, swollen glands, sweat and fatigue and changes in body's metabolic activity<sup>4</sup>.

### CANCER DIAGNOSIS

Physicians who specialize in the study, diagnosis and treatment of cancer are called oncologists. Cancer is diagnosed by X-rays, CT (Computed Tomography) scans, MRI scans (Magnetic Resonance Imaging), PET (Positron Emission Tomography) scans, radionuclide scanning and ultrasound scans. These diagnostic equipments are regularly used to detect where a tumor is located and which organs may be affected. Oncologist may also perform FNAC (Fine Needle Aspiration Cytology) biopsy wherein a piece of tissue is removed from a tumor and examined under a microscopy to determine the extent of cancer. Doctors may also conduct an endoscopy, which is a procedure that uses a thin tube with a camera and light at one end, to look for abnormalities inside the body.

### CANCER TREATMENTS<sup>5, 6</sup>

**Surgery :** It is the most common treatments for cancer. Surgery is used to remove the cancer when

it is confined to the organ where it started and is the best way of treatment.

**Radiation therapy :** It uses high-energy waves, such as X-rays, electron beam or radio isotope to damage and destroy cancer cells without exceeding the safe level of normal cell. It can cause tumors to shrink and even destroy completely by killing the DNA of the cancer cell. Radiation is good at destroying cancer cells but they also destroy healthy cells. The side effect of this therapy is loss of appetite, tiredness, nausea and hair loss. But not everyone who is undergoing this therapy suffers from side effects.

**Chemotherapy :** It is the use of anti-cancer drugs before or during radiation therapy. Chemotherapy is very successful in treating cancer effectively with successful results. These medicines are sometimes taken as a pill, but usually are given through intravenous route. The advantage of chemotherapy is that it is not a localized treatment but it treats the whole body allowing the tumor to shrink making it easy for surgery. Few side effects are that along with cancer cell the healthy cells especially in the mouth lining, gastro intestinal tract, bone marrow are also affected causing vomiting, nausea, hair loss, diarrhea, low blood count and sore mouth. But soon the healthy cells can repair themselves.

**Biologic therapy/biotherapy/Immunotherapy :** It is used to strengthen the ability of the immune system to destroy cancer cells. Injection of monoclonal antibodies into an affected area, for example, results in inflammation that causes a tumor to shrink.

**Hormone therapy :** It is designed to alter hormone production in the body so that cancer cells are blocked or are killed completely. By removing the organs (eg. testicals, adrenal, pituitary) that produce hormones, the production of hormone which contributes to the cancer can be reduced or controlled. For example the male hormone testosterone stimulates prostate cancer, some

medication prevent the hormone production from testical thus providing treatment for prostate cancer but these may also have some side effects. The female hormones estrogen and progesterone can promote the growth of some breast cancer cells and often these cancers are treated by reducing estrogen levels by medicating one of the commonly used drug tamoxifen or fareston.

**Gene therapy :** It is applied to replace damaged genes with ones that work to address a root cause of cancer. For example, researchers are trying to replace the damaged gene that signals cells to stop dividing (the p53 gene) with a copy of a working gene.<sup>7</sup>

#### SIMPLE WAYS TO KEEP CANCER AWAY

Cancer may be an occasionally life threatening issue and there is no assured strategy to avoid cancer but with some simple adjustments in way of life and nutritional changes, one will be able to substantially decrease the chances of getting cancer. The possibility that fruit and vegetables may help to reduce the risk of cancer has been studied for over years, but no clear protective effects have been firmly confirmed. Nutritional studies indicate that healthy diets should include moderate amounts of fruit and vegetables. Persons with low fruit and vegetable intake experience about twice the risk of cancer compared with those with high intake.

Dr. Willett<sup>8</sup> in his review has provided some simple strategy in preventing cancer.

1. The National Cancer Institute's 5-Day program was developed in 1991 to promote increasing average consumption of fruits and vegetables to five or more servings per day.
2. Be moderately to vigorously active for at least 30 minutes on most days.
3. Replace red meat with chicken, fish, nuts, and legumes, and consume dairy products at moderate.

4. Limit alcohol consumption and avoid tobacco chewing.
5. To take multiple vitamin containing folic acid, particularly if alcohol is consumed daily.
6. Consume cereal products in a minimally refined, whole grain.
7. Cervical cytology (Pap smear) screening programs, mammographic screening for breast cancer and regular breast self examination need to be promoted for early detection of breast cancer.
8. Avoidance of overweight and weight gain during adulthood.

In 2002, the International Agency for Research on Cancer (IARC) reviewed sufficient evidence for an association between body weight and cancer. The IARC concluded that evidence existed for avoiding weight gain to protect against cancer to colon, breast (postmenopausal), endometrial, kidney (renal cell) and oesophageal cancers.<sup>9</sup>

Among cancer of the breast survivors, a current examination established that exercising soon after diagnosis is lessened possibility of breast cancer deaths and its recurrence. Concerning colon cancer survivors, systematic research suggest physical exercise cuts fatalities from colon cancer and also reduces the potential risk of cancer reoccurrence.<sup>10</sup>

Along with maintaining a healthy life style an individual must be educated to know the benefits and risks of cancer treatment and a proper counseling should be provided. The fear of cancer should be overcome by the will to live. New approaches to take care of cancers are constantly being discovered and implemented. Role of preventing cancer should be realistic and attainable.

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## LAKSHADWEEP ISLANDS, THE ATOLL ECSTASY OF INDIA : CHALLENGES AND OPPORTUNITIES FOR SUSTAINABILITY

Swagat Ghosh, K. V. Dhaneesh, T. T. Ajith Kumar\* and T. Balasubramanian

**Lakshadweep is vulnerable to various threats such as climate change, ecological damage, over exploitation and human obstruction which may lead to devastate the islands in future. Some policies, issues and awareness programmes are there but, still it is the need of the hour for restoration and conservation of the marine resources.**

### INTRODUCTION

The enchanting coral island in the Arabian Sea, constituting a smallest Union Territory in India, is called as Laccadive, Minicoy and Amindivi Islands in ancient times, though they were popularly known as Lakshadweep since 1<sup>st</sup> November 1973. The islands are irregularly scattered in the Arabian Sea between 8° - 12°3' N latitude and 71° - 74°E longitude and about 225 - 450 km from the Kerala coast (Murty, 2002). The islands are made of coral formations developed on the Laccadive-Chagos submarine ridge intensifying sharply from sea bed of about 1,500-4,000 m. They encompass 12 atolls, 3 reefs and 5 submerged banks with a total land area of 32 km<sup>2</sup> and useable land area of 26 km<sup>2</sup>. It has 4,200 km<sup>2</sup> lagoon area, 20,000 km<sup>2</sup> of territorial waters and about 4, 00,000 km exclusive economic zones. Among 36 islands, 11 are inhabited viz. Agatti, Androth, Amini, Bangaram, Bitra, Chetlat, Kadmat, Kavaratti, Kalpeni, Kiltan and Minicoy. The uninhabited islands are Viringili, Cheriya, Kodithala, Tilakkam I, Tilakkam II, Tilakkam III, Pitti I, Pitti II, Tinnakara, Parali I, Parali II, Parali III (submerged

island), Kalpitti, Suheli Valiyakara, Suheli Cheriya, Pitti (Bird Island) and Perumal Par. An old dialect of Malayalam is spoken in all the islands except Minicoy, where the inhabitants speak 'Mahal' and use the 'Divehi' script of the Maldives. All islands are flat and scarcely rise more than two meters from the normal sea level. Kavaratti is the administrative headquarters and Agatti is the only island connected with air services.

### UNDERWATER GEOMORPHOLOGY

The reefs of all atolls are widest on the south-west side. Echo sounding on the reefs of these atolls shows that the first break in the profile of reefs at depth about 4-8 m which extends to about 12 m. After this, the depth falls off steeply almost vertically to about 50 m. In several islands (Bangaram and Kadmat) before this depth is reached, well marked submerged terraces are observed at 7-12, 15, 21-36 and 43-47 m depth. The deeper central area is bordered by shallow sand banks along the reef margin. The development of sand banks on the reef margin is dependent on the continuity of the reef.

### BIODIVERSITY

The coral fauna of Lakshadweep is known to harbour a total of 105 species divided among 37

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genera 29 new species has been recorded and it has been reported that the corals of Agatti reef flats are dominated by *Acropora* spp, *Pocillopora* spp.<sup>8</sup> *Parities* spp and *Psammocora* spp. There is a profusion of blue coral (*Helipora coerulea* and *Millepora* spp.) which forms the dominant element in the lagoon. Eighty six species of macrophytes, ten species of Anomuran crabs, eighty one species of Brachyuran crabs, 155 species of Gastropods, 24 species of Bivalves, 13 species of sea stars, six species of brittle stars, 23 species of sea cucumbers, 15 species of sea urchins and 120 species of fishes are reported<sup>8</sup>. Cowries are one of the valuable resources in Lakshadweep and Tiger cowry (*Cypraea tigris*), Carnilian cowry (*Cypraea carneold*), Money cowry (*Cypraea monita*) and Gold ringer (*Cypraea annulus*) are commonly distributed in this region.

The green turtle and the hawksbill turtle are common in all the islands. They graze on sea grass beds and frequently visit the shore. Many species of fish, molluscs and crustaceans, which are favoured by islanders, are vulnerable to over fishing. The zooxanthellae live symbiotically with the coral polyps, take up their nutritional requirements from the coral excreta and translocate nitrogen back to the corals through a quick re-cycling process. Borrowing filamentous and calcareous algae are also associated with the corals and the latter are secondary frame builders in the reef. Benthic macroalgae like sea grass are the most prolific primary producers. The ocean contains substantial living and non-living marine resources which include sharks, rays as well as a large number of food fishes such as tuna, seer and halfbeaks.

About 78 species of echinoderms are recorded from these islands<sup>2</sup>, 91 species of sponges has been reported<sup>9</sup> and observed 114 species of seaweeds<sup>4</sup> and 6 species of sea grasses with 601 species of fishes belonging to 126 families from this area of which 400 species occurs in the lagoons. Of these,

over 300 species belonging to about 35 families are known for their attractive colours and shapes<sup>5</sup> termed as ornamental fishes. The fishes belong to the family Labridae and is the most abundant in terms of species and population<sup>6</sup>.

The lagoon plays an important role in islander's life as it provides fish for consumption during the heavy monsoon period (June-September) when, they have very limited transportation outside the islands.

### PROBLEMS OF REEF ECOSYSTEM BOULDER, SHINGLE AND SAND COLLECTION

Coral boulders are normally collected by the islanders for their own use, particularly for construction purposes. There is no class distinction for collecting coral boulders and people in all groups use to collect corals. Shingle collection is a regulated activity and the people who wishes to collect it must get the permission from the Lakshadweep Administration and the person has to pay Rs. 5 per bag. But the available records had shown that no one had followed this regulation since 1998. Further, sand collection also goes on the shore all around the island during fair season. The indiscriminate collection of coral boulder, shingle and sand from islands give maximum stress along the eastern shore and reef along the western side during low tides.



Figure 1. Coral and shingle collection in Kalpitti Island during low tide

### CORAL MINING AND DREDGING

The health of coral reefs is threatened by various activities such as mining of corals and boulders for construction of buildings and roads. Stepping on and hitting the corals, while octopus hunting and cowry collection is a routine practice. The habitat destruction of coral reef organisms happens during dredging activities to ensure shipping routes and it also increases turbidity. These long term activities have changed the terrestrial face of the Lakshadweep atolls.

### CLIMATE CHANGE

The southwest monsoon period is the chief rainy period which lasts from late May to early October. The temperature starts rising in February and reaches its peak in April-May. The average temperature of Lakshadweep ranges between 24.31 and 31.2° C. The air is humid throughout the year and the relative humidity is approximately 70-75%. According to Intergovernmental Panel on Climate Change (IPCC), fourth assessment report (2007)<sup>1</sup>, the Indian Ocean is undergoing a temperature rise as 1-4°C and climate change will have a severe impact on low lying small islands including a projected 0.4-60 cm sea level rise in upcoming 100 years. A mass bleaching of corals and its associated organisms at the Agatti Island of Lakshadweep was 0.6 served during May 2010<sup>10</sup>. They observed several species of corals that belong to the genus *Acropora*, giant clams and sea anemones were bleached and they pointed that it may due to the high water temperature (34 °C) of the particular area during the reporting period. So it is predictable to result in more frequent coral bleaching because these are vulnerable to thermal stress and have low adaptive capacity. The increased sea temperature may also affect oceanic currents and the route of migratory species such as tuna. Change in tuna migration may directly affect the islanders because this is the one major income source for them.

### SOIL AND BIO EROSION

The soil compatibility of islands is decreasing as a result many shore line coconut trees are falling down. In under water, many borers and foulers attack both living and dead corals. The major groups that cause erosion to coral skeleton encompass are algae, sponges, polychaetes, sipunculids, bivalves and echinoderms.



Figure 2. Effect of soil erosion in Thinkara Island

### REEF POLLUTION

Comparing main land including Andaman, the present status of pollution at Lakshadweep is negligible but now a day's inhabited islands are also affected by pollution and the major pollutants are incorporated with untreated sewage, solid waste

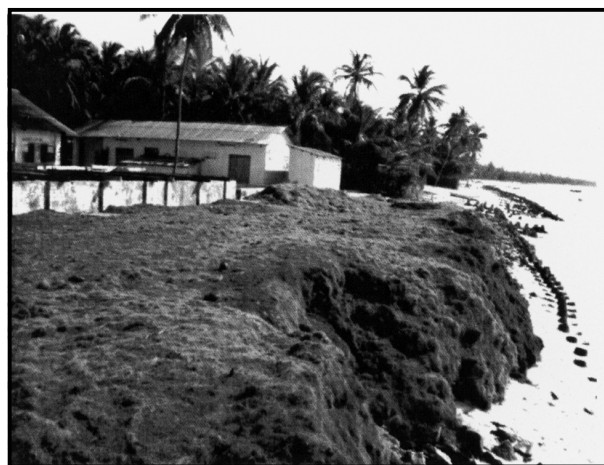


Figure 3. Coir factory at Agatti Island



and buried fish waste during tuna processing. The coir factories situated in some islands (Amini, Agatti, Androth, Kadamath, Kalpeni and Kavaratti) have been creating a part of pollution in the sense of dumping coconut husk in the coastal area. The coconut husks kept for retting along the beach tied with stones are a source of pollution.

Large scale oil pollution was caused by the American tanker "Transhuron" which was stranded in Kiltan atoll in September, 1974. Approximately 3,325 tons oil was thought to be spilled from the tanker<sup>7</sup>. As a result, many organisms were affected and the worst one was holothurians, *Holothuria pardalis* and *H. impetians* in the lagoon and many of which were found dead and washed ashore<sup>2</sup>.

#### NOTIFICATIONS AND BANS

- **Turtle ban :** In general the islanders are correlating the decline of reef fish and increase in turtle population. The green and hawksbill turtle numbers have been steadily growing. They also link the reduction of lagoon fish population with turtles and growth of sea grass. They believed that the turtles used to eat the sea grass, which is the habitat for some lagoon fishes. The turtles inadvertently eat or scatter the fish eggs when they graze on the sea grass, thereby reducing the chances of population.
- **Collection of coral shingle and boulders :** People perceive coral shingle collection as their right and they are unable to understand how this can destroy the island. Several laws and notifications which are regulating and banning the use of coral reef resources have been published, unfortunately no one follow this. They are already aware that they owe their existence to reef building corals. Through integrated conservation and management approaches, the livelihood security of resident populations can be greatly enhanced.

#### ROLE OF RESEARCH IN BIO-DIVERSITY CONSERVATION

Few organizations have been working in Lakshadweep islands for the purpose of research and development and conservation aspects. During the past ten decades, the Central Marine Fisheries Research Institute (CMFRI), the National Institute of Oceanography (NIO) and the Zoological Survey of India (ZSI) have undertaken several studies in this region. The ZSI has carried out extensive surveys in 1982-87 and 1991 and, published a volume on the fauna of Lakshadweep. Similarly, the CMFRI carried out a survey from January to March 1987 to document the fishery potential which culminated in the publication of a special issue on Lakshadweep (CMFRI bulletin 43, 1989). The Bombay Natural History Society (BNHS) has launched a research scheme on "Project Giant Clam" in the Lakshadweep islands since 2005 and still it is under progress.

On 2008, the Centre of Advanced Study in Marine Biology, Annamalai University has established a field centre in connection with the project on "Development of technology for hatchery production of marine ornamental fishes - Technology transfer to islanders" at Agatti Island with the financial support of the Centre for Marine Living Resources and Ecology, Ministry of Earth Sciences. The project helps in conserving the wild habitat from over exploitation, particularly on ornamentals fishes. The field centre is functioning in the name of CMLRE - Field Station and the main objective is to provide alternate livelihood to the islanders, which exactly helps to develop their life style.

#### CONCLUSION

Even though, the above discussed opportunities and problems are available in Lakshadweep, the Lakshadweep Islands have still demand for eco-tourisms throughout the world. The major change is in the attitude towards promoting tourism based on coral reefs and associated organisms. The main

threat due to anthropogenic forces is the increase in human population. All households have multiple sources of income and have some dependency on reef resources. This population has put great pressure on the limited land, fresh water, and lagoon-reef resources which has caused the marine pollution. This is the crucial time to give a priority on the research of reef pollution and restoration management.

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## OXIDATIVE STRESS, DIETARY TRANSITIONS AND THE RISING PREVALANCE OF NON-COMMUNICABLE DISEASES

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**Higher incomes, urbanization and changing preferences have given rise to oxidative stress which is basically the imbalance between oxidants and antioxidants in favor of the oxidants, potentially leading to damage in the structural and functional integrities of a cell that leads to the proliferation of cells rather than their death. This is leading to a number of disease states in humans like disorders of neurological system, cancer and inflammatory disease around the world. With changing trends in nutrition, it becomes imperative to enhance our fruit and vegetable intake thereby increasing our antioxidant power within the body.**

### INTRODUCTION

**O**xidative stress, defined as “the imbalance between oxidants and antioxidants in favor of the oxidants, potentially leading to damage.”<sup>1</sup>

Oxidative damage causes changes in the structural and functional integrities of a cell that leads to the proliferation of cells rather than their death and leads to a number of disease states in humans like disorders of neurological system, cancer and inflammatory disease.

### DIETARY TRANSITIONS

Higher incomes, urbanization and changing preferences are raising domestic consumer demand for high value health products in developing countries. The demand for ready-to-cook and ready-to-eat food it also rising particularly in urban areas<sup>2</sup>. Recent estimates reveal that the major source of energy has shifted from carbohydrate to fat.

Though about 10% energy from fat is recommended, the intake in reality is 40%.<sup>3</sup>

Similar transition in diet has been observed throughout the world. Traditional foods have not been abandoned instead they have been loaded with fast foods like hamburgers, potato chips and fries, colas. There has been a rapid rise in the spread of fast food chains from urban cities to smaller towns with the decline in fruit consumption. In the national diet and nutrition survey (NDNS), it was revealed that two thirds of the UK population does not consume the recommendation for fruit and vegetables<sup>4</sup>. Approximately 16 million (1.0%) DALYs and 1.7 million (2.8%) of deaths worldwide are attributable to low fruit and vegetable consumption, which are concentrated sources of antioxidants<sup>4</sup> and do not consume the recommended 5 servings of fruits and vegetables per day<sup>5</sup>.

### FREE RADICAL-ANTIOXIDANT THEORY

Free radicals are electrically charged molecules, i.e., they have an unpaired electron, which causes them to capture electrons from other substances in order to neutralize themselves. Free radicals are capable of attacking the healthy cells of the body,

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causing them to lose their structure and function<sup>6</sup>. There are many forms of free radicals like hydroxyl radical, superoxide radical, nitric oxide radical etc.

Free radicals are generated endogenously and exogenously. Urbanization and industrialization have resulted in increased exposure of free-radical. Pollution, cigarette smoke, drugs, illness, stress, and even exercise leads to increased free radical exposure. Free radicals are also produced during the formation of ATP, when our immune system fights infection.

Increased free radicals favour “Oxidative Stress” which gives rise to Non communicable diseases (NCDs) such as cardiovascular diseases, diabetes, cataract, cancer etc. However, such imbalances can be curbed by enhanced generous intake of antioxidants including vitamins C, vitamin E, β-carotene and plant polyphenols, as they confer protection against these conditions.

**INCREASING PREVALENCE OF NCD's and ROLE OF NUTRITION**

The burden of NCDs is growing exponentially. As per WHO report 2010, a total of 57 million deaths occurred in the world during 2008; 36 million (63%) were due to NCDs, principally cardiovascular diseases, diabetes, cancer and chronic respiratory diseases. Nearly 80% of these NCD deaths (29 million) occurred in low- and middle-income countries<sup>7</sup>. NCDs will be responsible for a significant increase in total number of deaths in the next decade<sup>8</sup>. NCD deaths are projected to increase by 15% globally between 2010 and 2020 (to 44 million deaths). As populations age, annual NCD deaths are projected to rise substantially, to 52 million in 2030.

Due to population pressure and increasing urbanization, highly productive agricultural land is increasingly being used for urban development. Over-dependence on a few plant species in the

metropolitan market exacerbates many acute difficulties faced by communities in the areas of food security, nutrition, health, ecosystem sustainability and cultural identity<sup>9</sup>. Global food security and economic growth now depend on a declining number of plant species. This has placed the future supply of food and rural incomes at risk.

It has been well established that a plant-based diet with high intake of fruits, vegetables, and other nutrient-rich plant foods may reduce the risk of oxidative stress-related diseases<sup>10</sup>.

Nutrition plays an important role in maintaining the body's enzymatic defense against free radicals. Several essential minerals including selenium, copper, manganese and zinc are involved in the structure or catalytic activity of these enzymes and their inadequacy may impair enzymatic defenses<sup>11,12,13</sup>. Table 1 reveals how antioxidant levels deteriorate in diseased conditions. Table 2 reveals the average antioxidant capacity of commonly consumed food in each food group<sup>33,34</sup>.

**Table-1  
Diseases in which specific Plasma Antioxidants measured have been shown to significantly lower in patients as compared to controls<sup>33</sup>**

Disease	Significantly Depleted Antioxidants
Cystic fibrosis	β-carotene
Wilson's diseases	Ascorbic acid, uric acid, α-tocopherol
Lung cancer	β-carotene, β- cryptoxanthin, lutein/zeaxanthin
Prostate cancer	Lycopene
Cataract	Ascorbic acid
Age related macular degeneration	α-tocopherol,
Coronary heart disease	α-carotene, γ-tocopherol

**Table-2**  
**Antioxidant for each Food Category<sup>34</sup>**

S. No	FOOD CATEGORY	ANTIOXIDANT VALUE (mmol/100g)
1.	Plant based foods	11.57
2.	Animal based food	0.18
3.	Mixed Food	0.91
4.	Berries and berry products	9.86
5.	Beverages	8.30
6.	Breakfast cereals	1.09
7.	Chocolates and sweets	4.93
8.	Dairy products	0.14
9.	Egg	0.04
10.	Fats and oils	0.51
11.	Fish and seafood	0.11
12.	Fruit and fruit juices	1.25
13.	Grains and grain products	0.34
14.	Legumes	0.48
15.	Meat and meat products	0.31
16.	Condiments	0.77
17.	Nuts and seeds	4.57
18.	Vegetables and vegetable products	0.8
19.	Spices and herbs	29.02
20.	Poultry and poultry products	0.23

### CARDIOVASCULAR DISEASES (CVD)

Lipid peroxidation has a pivotal role in atherogenesis. Atherogenesis occurs at sites of endothelial damage whereby plaques are formed by the attachment of activated monocytes and T-lymphocytes to the endothelial cell layer at the site of damage. The transformation of these monocytes into active macrophages produces ROS, leading to the oxidation of low density lipoprotein (LDL) and stimulation of foam cell production (macrophages which have engulfed the oxidised LDL)<sup>14</sup>.

The link between CVD and antioxidants was established because of the rate-limiting role of antioxidants in lipid peroxidation<sup>15</sup>.

In various European populations an inverse relationship was found to exist between cardiovascular risk and diets rich in vitamin C, in particular, but also  $\beta$ -carotene and vitamin E, selected in terms of blood plasma levels<sup>16</sup>. Dietary nitrate supplementation through beetroot juice, improves endothelial function<sup>17</sup>.

### CANCER

Cancer or malignant neoplasm is characterised by uncontrolled DNA replication and cellular division of abnormal cells leading to the development and/or metastasis of cancerous tumours which invade and destroy adjacent tissues, blood or the lymphatic system. Cancer caused 13% of deaths worldwide in 2007. Cancerous cellular proliferation can be initiated by ROS-mediated cell damage, immune dysfunction, and the regulation of gene expression. Fundamentally, there must be an alteration in one of the two types of gene which regulate cell growth and differentiation (oncogenes and tumour suppressor genes) in order for a cell to become cancerous<sup>18</sup>.

Cancer cells rely on an increased level of oxidative stress, primarily the generation of  $H_2O_2$ , to signal the transcription of genes involved in their survival and to regulate the balance between proliferation and apoptosis. Furthermore, tumour formation is affected by ROS-mediated DNA breakage, DNA cross-linking and the undesirable modification of transcription and replication pathways<sup>19</sup>.

Thus, antioxidants can play a major role by regulating oxidative stress which will suppress the proliferation of genes involved in cancerous cells.

In the Hiroshima/Nagasaki prospective life span study (38,540 men and women), daily fruit consumption was associated with a 12% reduction in total cancer mortality compared to consumption once a week or less (RR = 0.88 (95% CI = 0.80-0.96)). Patients with untreated breast cancers in

comparison to matched controls have lower plasma levels of vitamin C,  $\beta$ -carotene and vitamin E<sup>20</sup>.

Data from specifically linked consumption of green and yellow vegetables with a 0.75 relative risk (95% CI = 0.60-0.95) of liver cancer and fruit intake with a 0.80 relative risk (95% CI = 0.65-0.98) of stomach and lung cancer. Green and yellow vegetables are good sources of the carotenoid  $\beta$ -cryptoxanthin which has been proposed to have protective effects, particularly against lung cancer<sup>21</sup>.

Additionally, lycopene has been shown to decrease the relative risk of prostate and digestive tract cancers in large prospective studies<sup>22</sup>.

## DIABETES MELLITUS

Antioxidants may play a role in either increasing insulin sensitivity or modulating the rise in blood glucose following carbohydrate consumption through their interaction with digestive enzymes<sup>23</sup>.

Meta-analysis of epidemiological studies concluded that there was sufficient evidence to recommend an increased consumption of green leafy vegetables in order to prevent the development of type 2 diabetes mellitus. The authors reported a hazard ratio of 0.86 (95% CI = 0.77-0.97,  $P = 0.01$ ) for consumption of 1.35 portions per day (highest) compared with 0.2 portions per day (lowest)<sup>24</sup>. Black and green tea supplementation resulted in reduction in glycated haemoglobin<sup>25,26</sup>. *Gymnema* (a woody plant) has antidiabetic activity; it increases the activity of enzymes responsible for glucose uptake and utilization, and inhibits peripheral utilization of glucose by somatotrophin and corticotrophin<sup>27</sup>.

## ANTIOXIDANTS IN MYRIAD DIETS

### MEDITERRANEAN DIET

The diet is characterized by abundant plant foods (fruit, vegetables, breads, other forms of cereals, potatoes, beans, nuts, and seeds), fresh fruits, olive oil as the principal source of fat, dairy

products (principally cheese and yogurt), and fish and poultry consumed in low to moderate amounts, zero to four eggs consumed weekly, red meat consumed in low amounts, and wine consumed in low to moderate amounts, normally with meals. This diet is low in saturated fat ( $< \text{or} = 7\text{-}8\%$  of energy), with total fat ranging from  $< 25\%$  to  $> 35\%$  of energy throughout the region. The pyramid describes a dietary pattern that is attractive for its famous palatability as well as for its health benefits<sup>28</sup>. Olive oil contains an abundance of phenolic antioxidants including simple phenols (hydroxytyrosol, tyrosol), aldehydic secoiridoids, flavonoids and lignans (acetoxypinoresinol, pinoresinol). All of these phenolic substances are potent inhibitors of reactive oxygen species attack on, e.g. salicylic acid, 2-deoxyguanosine<sup>29</sup>.

In Lyon Diet Heart study, Mediterranean diet was tested whether it will reduce the rate of recurrence after a first myocardial infarction. It was observed that protective effect of the Mediterranean dietary pattern was maintained up to 4 years after the first Infarction<sup>30</sup>.

Adherence to Mediterranean diet resulted in 11% increase in total antioxidant capacity levels and 19% decrease in oxidized LDL-c. This may explain beneficial effect of this diet on cardiovascular system<sup>30</sup>.

### EUROPEAN DIET

Diet in North and South Europe are different. South European diet includes olives, chick peas and fish stew, Spices (in particular, saffron), oranges, lemons, rice, sugar cane, and several types of sweetmeats and addition of nuts to dessert and sauces. Alternative name is Spanish Mediterranean diet. Reports indicate that the TAG of the Spanish Mediterranean diet was 6014 and 3549  $\mu\text{mol}$  trolox equivalents by FRAP (ferric reducing antioxidant power) and ABTS (free radical-scavenging capacity)

procedures, respectively. About 68% of TAG came from beverages and 20% from fruits and vegetables, with a very low contribution from cereals. The capacity to inhibit *in vitro* LDL oxidation of plant foods and beverages was consistent with their antioxidant capacity. The recommended daily intakes of antioxidant vitamins, C and E, represent about 10% of TDAC. Total phenolics intake was estimated as 1171 mg gallic acid/person/day by the Folin-Ciocalteu method.

### JAPANESE DIET

Japanese diet concentrates the magnificent energy of food into a compact and pleasurable size. Major components of Japanese diet are - eat more fish, vegetables, and fruit; serve smaller portions; eat mindfully and slowly; and add some healthy options like tofu and rice.

Commonly consumed vegetables are Red bell peppers, green beans, zucchini, eggplant, onions, burdock, tomatoes, green peppers, lettuce, carrots, spinach, bamboo shoots, beets, lotus root, turnips, daikon (or giant white radish), shiitake mushrooms, sweet potatoes, and seaweed (or sea vegetables), such as kombu, nori, and wakame. Most commonly consumed dishes are sashimi and sushi. A typical Japanese dessert includes seasonal fruits, sliced and peeled. Rice is the staple food of Japan.

Total mean intakes of flavonoids (sum of flavonols and flavones) and isoflavones of Japanese women were 16.7 and 47.2 mg/d, respectively. The major source of flavonoids was onions (45.9%) and that of isoflavones was tofu (37.0%). Total intake of isoflavones exceeded that of other dietary antioxidants, such as carotenoids (3.5 mg/d) and vitamin E (8.2 mg/d), and was approximately one half of the vitamin C intake (109 mg/d). The total intake of flavonoids was inversely correlated with the plasma total cholesterol concentration (TC) and plasma LDL cholesterol concentration<sup>31</sup>.

### INDIAN DIET

Indian traditional diets, are based predominantly on plant foods like cereals, pulses, oils and spices, are all good sources of these classes of phytochemicals, particularly dietary fibre, vitamin E, carotenoids and phenolic compounds<sup>32</sup>.

RDA for dietary fiber intake is 40g/day. Dietary fiber intake in India by different socioeconomic groups varies from 60 to 70 g/day, depending upon the type of cereal consumed. This is because traditional Indian diet is cereal based. Dietary fiber intakes in wheat - or millet-based diets are generally higher than in a rice-based diet<sup>25</sup>.

Spices and condiments are extensively used in Indian diet. Clove, pepper mint, garlic, cinnamon, bay leaf etc are concentrated sources of antioxidants and are the real flavour of Indian dishes.

Indian traditional diets have always been vegetarian. It is cereal based diet, with focus on vegetables and fruits. However, it lacks good source of proteins. Eating fruits after meals and for brunch have been a traditional practice. However, due to the transition in dietary habits only 12.7% people consume fruits, daily<sup>23</sup>.

Thus, in this fast tract world, wherein everyone is running the race in the name globdlization, it is imperative that we consume enough antioxidant rich foods in order to reduce our oxidative stress and overcome the rising prevalence of NCDs.

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## MICROBIAL ENHANCED OIL RECOVERY : A COMPREHENSIVE APPROACH

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**The present article attempts to undergo a review work on Microbial Enhanced Oil Recovery (MEOR). It tries to study the two MEOR processes, the effect on the action of bacteria and the injection of microbial products on enhanced oil recovery. The merits and demerits of both the processes are discussed in relation to the environment of the oil reservoir.**

### INTRODUCTION

Petroleum, often called as crude oil or simply oil, is also known as fossil fuel because it was formed from the remains of plants and animals that died millions of years ago. As plants and animals died, they sank to the ocean floor. Sand and sediments covered them and turned into sedimentary rock. As millions of years passed, the weight of the rock and heat from the earth turned them into petroleum.

Various methods and techniques are employed to maximize the production of crude oil. In general, there are three stages of oil recovery; primary recovery, secondary recovery & tertiary recovery. Primary recovery involves use of natural drive energy to produce crude oil. Due to lack of sufficient natural drive in most reservoirs has led operators to introduce some form of artificial drive, the most basic method being the injection of natural gas or water, commonly known as waterflooding. Tertiary recovery, also known as Enhanced Oil Recovery (EOR) involves injection of more exotic and correspondingly more expensive fluids other than water & non-miscible gases. This method mobilizes and recovers the oil that has been left behind or cannot produce economically by conventional

means. Using EOR, 30–60% or more, of the reservoirs original oil can be extracted compared with 20–40 % using primary and secondary recovery. There are different types of EOR methods like thermal methods including conventional steam, steam assisted gravity drainage, cyclic injection and *insitu* combustion, chemical including surfactant, surfactant with polymer, surfactant with foam, gas injection including CO<sub>2</sub>, N<sub>2</sub>, NGL, flue and microbial injection. Microbial injection is also known as microbial enhanced oil recovery.

Microbial Enhanced Oil Recovery (MEOR) is a potentially inexpensive method in which micro-organisms are used to recover the oil remaining in the reservoir. MEOR is a multidisciplinary field incorporating geology, chemistry, microbiology, fluid mechanics, petroleum engineering, environmental engineering and chemical engineering.

### MEOR

In 1926, the first utilization of micro-organisms as agents for recovering the remnant oil entrapped in porous media was proposed by Beckman<sup>4, 6, 11</sup>. Since that time numerous investigation have been developed, and are extensively reviewed<sup>4, 6</sup>. The research on the MEOR began with the investigation of ZoBell in 1940. He observed that SRB (Sulphate reducing bacteria) utilize some petroleum

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hydrocarbons as a nutrient and are able to release oil from solid sediment. In 1995, a survey of MEOR projects in the USA showed that 81% of the projects successfully increased oil production, and there was not a single case of reduced oil production<sup>6</sup>. Today, MEOR is gaining attention owing to the high prices of oil and the imminent ending of this resource<sup>6, 11</sup>. Lazer did an extensive study on methods of adopting bacterial cultures to reservoirs and concluded that under ideal laboratory conditions, a mixed culture of species of the genera: *Pseudomonas*, *Escherichio*, *Arthrobacter*, *Mycobacterium*, *Pepto coccus*, *Micrococcus*, *Clostridium* and *Bacillus*, all at a concentration of  $10^7$ – $10^9$  cells/ml, possess the ability to enhance the recovery of 19.5 to 48.5 % of the residual oil<sup>7</sup>.

#### MEOR MECHANISM

The applicability of the MEOR depends upon the petroleum reservoir, viscosity of the crude, the characteristics of the reservoir rock and the technology and the economics of production microbial systems. Petroleum reservoirs, having average permeability more than 100 md, are best suited for MEOR. Deep reservoirs, where temperature of the desired with a high permeability (1000-5000 md), and 40% oil saturation of pore volume, bacterial release of the oil to a residual level of 32% of the pore volume may be obtained. Microbial activity also depends upon various physical, chemical & biological factors like pH; oxidation potential, which is the thermodynamic driving force of anaerobic respiration, which takes place in oxygen depleted environments; pore size or pore diameters which are interconnected should be at least 0.2  $\mu\text{m}$ ; etc.

There are various mechanisms by which bacteria might enhance the recovery of oil from petroleum reservoirs<sup>13</sup>.

1. Bacteria may break large hydrocarbon molecules into smaller ones, thus reducing the viscosity of oil and increasing the flow rate of oil.

2. Bacteria often grow preferentially firmly attached to solid surfaces. This process might crowd oil off the surfaces.
3. Bacteria growing in aqueous culture media often produce surface active agents, detergents or wetting agents which reduce surface tension and interfacial tension between oil and water, liberating oil from sand particles.
4. Bacteria may produce gases, including carbon-dioxide, hydrogen and methane which can increase reservoir pressure and expel oil from microtraps.
5. Bacteria may produce water soluble polymers which increase the viscosity of the water phase in an aqueous solution drive and thus decrease the water breakthrough.

#### METHODS

There are two basic methods of MEOR processes, one direct injection of bacteria into the reservoir and other injection of their metabolic products.

##### By Injecting Bacteria

(a) By Sulfate Reducing Bacteria (SRB) : Various experiments were carried out by injecting sulfate reducing bacteria. La Rivere 1955 studied the effect of bacterial activity and concluded that injection of bacteria produces surface active agents that lower the surface tension and enhances the release of oil<sup>5</sup>. But Updegraff and his associates, after a long series of experiments concluded that SRB do not produce the quantities of gases, acids or surface active agents probably required for efficient oil release from subsurface formations<sup>12</sup>. In 1957, Dostalek *et al.* studied the effect of pH, oxidation-reduction potential and size of inoculum on oil release by SRB. He found that bacterial oil release was most efficient between a pH of 6.5 – 7.5 and an initial oxidation-reduction potential of 0.060 V. Optimal size of inoculum was in the order of 1.5-2%<sup>3</sup>.

(b) By Sugar Fermenting Bacteria : Several species of anaerobic bacteria belonging to the genus *Clostridium acetobutylicum* grows on blackstrap or beet molasses as a fermentation substrate. Experiments were conducted with mixed cultures growing in a medium containing molasses, potassium nitrate, sodium phosphate & sucrose along with bacterial suspension as a fermentation product, to be injected in different wells. This process leads to increase in oil recovery of about 3.5 times more than the normal predicted value. Some experiments proved to be failure also because of low permeability rock, lack of strata continuity from injection well to the production well, movement of unconsolidated sand in the reservoir, undesirable high temperature (52-56°C) and high salt concentration in the connate water (170-190 gm. NaCl/l).

#### By Injecting Microbial Products<sup>2</sup>

Injection of bacteria directly into a reservoir may cause potential hazards, so an alternative method may be employed, i.e. injection of microbial products. Different Microbial products responsible for EOR include :

- (a) Biosurfactants
- (b) Bio-emulsifiers
- (c) Bio-polymers

Surfactants produced by microorganisms are usually lipids, and often they are glycolipids. These biosurfactants reduce the IFT between oil & water interface and helps in increasing oil recovery. Some microorganisms growing on hydrocarbons produce surfactants which then begin to emulsify the oil. This in turn made more nutrients available for surfactant production. These are known as bioemulsifier.

Bio-polymers, like bacterially produced polysaccharides are used as floodwater thickening agent, to increase the viscosity of injected water and to enhance the oil recovery.

#### MEOR ADVANTAGES

- (a) Microbes do not consume large amounts of energy to produce MEOR agents and the use

of microbes is not dependent on the price of crude, as compared with other EOR processes.

- (b) Easy application and less expensive set up.
- (c) Economically attractive for mature oil fields before abandonment.
- (d) Injected microbes and nutrients are cheap and easy to handle in the field.
- (e) Beneficial microbes are indigenous and only need nutrients to stimulate growth. Microbial growth occurs at exponential rates and produce large amounts of useful products rapidly from inexpensive and/or renewable resources.
- (f) Cellular products are biodegradable and can be considered as environmental friendly.

Microbes are able to produce effective surfactants at low price, which make it possible to recover substantial amounts of residual oil, and hence increase oil production<sup>1, 6, 9, 11</sup>

#### MEOR DISADVANTAGES

- (a) A large quantity of feedstock material would be required to sustain microorganism on the scale needed to generate oil mobilizing metabolites.
- (b) Rapid multiplication and activity of sulfate-reducers are required for oil release and this leads to the production of hydrogen sulfide. The crude oil along with hydrogen sulfide produced will have corrosive effects on oil field hardware and may have possible reservoir plugging.
- (c) The oxygen deployed in aerobic MEOR can also acts as corrosive agent on non-resistant topside equipment and downhole piping.

Exogenous microbes require facilities for their cultivation and Indigenous microbes need a standardized framework for evaluating microbial activity, e.g. specialized coring and sampling techniques<sup>1, 3</sup>.

## ENVIRONMENTAL ASPECTS

The environment of an oil reservoir is a very important aspect of MEOR. Microbial growth for enhancing oil recovery depends upon various environmental constraints.

Increase in Temperature leads to increase in random molecular motion, generally exerts negative effects on enzyme function, since the active-site configurations required for catalysis are disrupted. In general, microbes can be classified according to their optimum temperature range at which they can grow, as psychrophiles (< 25°C), mesophiles (25-45°C), and thermophiles (45-60°C). The mean geothermal gradient beneath the continent should be of the order of 25°C per km, and assumes more conservative upper limit of 110°C for bacterial activity<sup>8</sup>.

The effects of Pressure on microorganisms are closely associated with those of temperature since elevated pressures in natural environments are always associated with temperature variations. The effects of pressure on microbial growth under deep ocean conditions were investigated by ZoBell and Johnson in 1949. They concluded that growth rates of normal bacteria decrease to zero as hydrostatic pressure approaches about 40 MPa.

## CONCLUSION

The review work on MEOR suggests that microbes are able to produce effective surfactants at low price inside the porous media of the reservoir rock. This makes it possible to recover the trapped oil after waterflooding from the underground oil reservoir. This process is aimed to apply in the oil reservoirs of Upper Assam basin for the substantial recovery of crude oil.

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## SCIENCE, CULTURE AND DEVELOPMENT — A CONNECTED PHENOMENA

P. K. Ray

**For Scientific creativity is needed proper social/cultural environment for spinning an idea to bring it to fruition. Science in India flourished for such creative thinking and its execution during the past two centuries when a nationalistic urge to bring respect and honour to India was pervading throughout the entire nation. That made the foundation of modern India and its development was possible for such creative activities, stimulated also by the leaders of our nation.**

### SCIENTIFIC STRENGTH OF ANCIENT INDIA : HISTORICAL PERSPECTIVES

India is an ancient country with thousands of years of rich tradition, culture and history. The entire world was enriched by its wisdom and philosophy. In fact, Indian civilization is one of the oldest in the world. The entire world used to look forward to Indian philosophy, scientific knowledge, its rich resources and their utilization for the growth and development of its society. Ancient Indian scientists could realize that without the application of scientific knowledge, societal development was not possible. There are many examples of that scattered all around the country. Ancient Indian forts, buildings, “stupas”, cave paintings and sculptures bear some of the examples of its vast knowledge of chemistry, mathematics, geometry, and also other areas of science and engineering.

The Ancient Indian Scientists who had made strong foundations of Indian Science and Technology are named below; their fundamental contributions in mathematics, geometry, physics,

chemistry, biology, medicine and agriculture were phenomenal. In the area of medical sciences and in the process of treatment of various ailments, including surgical treatments Charaka and Sushruta made fundamental contributions.

In the area of Civil and Mechanical Engineering and also in Architecture, Indian contributions were very significant. In the area of ship building and navigation Indian Scientists and Engineers contributed a great deal which facilitated business and trade in earlier times.

Side by side, in the field of literature, arts, music, painting and sculpture, including sports and games, the nation made remarkable contributions. We owe a great deal to all of them and many others for the present successes in the field of our literature, arts, music etc. and also in the field of Science and Technology development in the country.

The eminent ancient scientists were- Aryabhata, Baudhayana, Bhaskara, Brahmagupta, Charaka, Halayudha, Jayadeva, Nagarjuna, Sushruta, and Varahamihira to name the most of the important ones.

Ancient India's contribution to science and technology include :

- Mathematics – Vedic literature is replete with concepts of zero, the techniques of algebra and algorithm, square root and cube root.

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- Astronomy – Rig Veda (2000 BC) refers to astronomy.
- Physics – Concepts of atom and theory of relativity were explicitly stated by an Indian Philosopher around 600 BC.
- Chemistry – Principles of chemistry did not remained abstract but also found expression in distillation of perfumes, aromatic liquids, manufacturing of dyes and pigments and extraction of sugar.
- Medical science & surgery – Around 800 BC, first compendium on medicine and surgery was compiled in ancient India
- Fine Arts – Vedas were recited and recitation has to be correct, which gave rise to a finer study of sound and phonetics. The natural corollary was emergence of music and other forms of performing arts.
- Mechanical & production technology – Greek historians have testified to smelting of certain metals in India in the 4th century BC.
- Civil engineering & architecture – The discovery of urban settlements of Mohenjodaro and Harappa indicate existence of civil engineering & architecture, which blossomed to a highly precise science of civil engineering and architecture and found expression in innumerable monuments of ancient India.
- Shipbuilding & navigation – Sanskrit and Pali texts have several references to maritime activity by ancient Indians.
- Sports & games – Ancient India is the birth place of chess, ludo, snakes and ladders and playing cards.

From what has been mentioned above, it is quite clear that India was quite ahead of several others in the area of Science and Technological advances for quite some time.

### **FALL OF SCIENTIFIC AND TECHNOLOGICAL ADVANCES**

It was surprising that India could not continue to keep its advances in scientific development for a longtime in between. Among various reasons, we find that the whole country was split into small states of Zamindars, Rajas and Maharajas. There was almost no unity among the states. So Foreigners invaded India many times. More than three hundred years, our country was under the Muslim domination. Even at that time, the country was split into several small parts. They were fighting amongst themselves. India's growth and development was not their concern at all. They were busy with their small interests only. Collection of revenues was their main objectives. People were kept under severe domination. Freedom and justice were rarely seen anywhere. From the hands of the Muslim rulers of India, the political power came in the hands of the British. Gradually, the British occupied the entire India and brought it under one rule. Initially, they did some developmental work for their own interests and benefit. The most important one was introduction of English education for the simple reason that they could communicate with the English speaking people in order to rule over the Country for a long time. They were ruling for a pretty long time in India, about 200 years. Thus, for more than 500 years of foreign rulers' domination, they did not involve themselves in any significant developmental work, such as Science promotion, infrastructural development and indigenous developments of Science and technology in the country. Their only purpose was to rob India of its natural resources. That is why the actual progress and development of India was hampered to a large extent and for a long time.

### **INDEPENDENCE MOVEMENT AND NATIONALISM PROVIDED THE RIGHT CULTURAL MILIEU TO THE INDIANS TO PROVE THEMSELVES**

We have observed that from the latter part of the 19<sup>th</sup> century, a galaxy of very prominent personalities

appeared in the horizon of science and technology and also in the field of arts and culture in our country. Most of them were nationalists. Their scientific commitments and discoveries provided a moral push to the nation. Their dedication in developing a scientific temper and a cultural environment in the country had much to do in these efforts. The fact that Indian Scientists have had the wisdom, capabilities and perseverance which are needed to produce first grade scientific discoveries and inventions, became imminent one after the other.

From the middle of the 19<sup>th</sup> Century when Freedom movement began in India, the country was swayed through an unprecedented emotion and love for independence. Many Indians came forward to bring India to the fore-front of Science and Technology. Some others were striving to promote Indian culture and education that could give birth to independent and free thinking. Many of them concentrated on promoting education, arts and culture side by side. Several of them made a mark in the world. Soon India received two Nobel Awards—one in Literature and the other in Science. Poet Rabindra Nath Tagore received Nobel Prize in Literature in 1913 and Sir C. V. Raman received Nobel Prize in Physics in 1930. These events combined with several other major contributions from notable Indians paved the way for ultimately getting our independence in 1947. A new Independent India was born.

#### **INDIAN SCIENTISTS WHO BROUGHT NAME AND FAME TO OUR COUNTRY DURING THE PRE AND POST INDEPENDENCE ERA**

Chandrasekhara Venkata Raman (Sir C. V. Raman), the physicist who discovered the Raman Effect during the pre-independence era, which raised the eyebrow of the world scientists and brought much pride and enthusiasm among the Indian scientists. Raman got Nobel Prize for his discovery of RAMAN SPECTRA in 1930.

In 1896, Acharya Prafulla Chandra Ray published a paper on preparation of a new stable chemical

compound: Mercurous nitrite. This work made way for a large number of investigative works on nitrites and hyponitrites of different metals, and on nitrites of ammonia and organic amines. He was a nationalist and always thought of his country, which was lagging behind in Industrial development. So he started a new Indian School of Chemistry in 1924 and also established Bengal Chemical and Pharmaceutical Company to help manufacture of chemicals and pharmaceuticals indigenously.

Sir Jagadish Chandra Bose pioneered in the discovery of radio and microwave optics and is the inventor of the Crescograph. Sir J. C. Bose's invention was the basis of many discoveries and inventions of gadgets and technologies now in use of mass telecommunications and in IT sector. Sir J. C. Bose did his pioneering work on Millimeter Wave and in Plant Electrophysiology to measure the response of plants to external stimuli. He demonstrated for the first time that like animals, plants do respond against external stimuli. Both of these studies were original and also pioneering in the whole world. He established Bose Institute at Calcutta.

Prof. Meghnad Saha is known for his discovery of Thermal ionization, known as Saha ionization equation. He was the founder of National Academy of Science at Allahabad and was also a close associate of Acharya Prafulla Chandra Ray. Together they founded the Indian Science News Association at Calcutta of which Prof Ray was the founder President and Prof Saha was its first Secretary. They started publication of the Journal SCIENCE and CULTURE to facilitate the publication of scientific articles of Indian Scientists, which was otherwise difficult to find space in foreign journals at that time.

Prof. Satyendra Nath Bose is known for his discovery of Bose-Einstein condensate, Bose-Einstein statistics, and Bose gas (Boson, God's particle). Prof. S. N. Bose's work on Bose-Einstein equation and fundamental concept on the existence of "Boson particles" created a stir in the World. Recent discovery about the existence of so called "BOSON particles or GOD'S particle" by the CERN



experiments, once again supported the predictions of Prof. S. N. Bose. Prof. Bose was the pioneering scientist who promoted the concept of teaching science through one's own mother tongue and created Bangiya Vigyan Parisad to promote that cause.

Many believe that these two scientists (Sir J. C. Bose and Prof. S. N. Bose), should have been awarded Nobel Prize for their fundamental contributions. Although they were deprived of their due recognitions, scientific truth cannot be hidden under the cover, they are as strong as the sunlight. The world did recognize them much later.

Prof. B. C. Guha was the doyen of the Indian Biochemists. He was a student of Acharya Prafulla Chandra Ray and was famous for his outstanding personality and dynamism. He was instrumental for opening postgraduate teaching and research in Biochemistry in Calcutta University and many other Universities and Institutions all over India. Accordingly, Prof. Guha is considered to be the Father of modern biochemistry in India. Prof. Guha visualized that fundamental researches would be pursued in India with great care, but hoped that applied research would also continue side by side.

Dr. Bidhan Chandra Ray (former Chief Minister of West Bengal) was instrumental to help in the establishment of Bengal Immunity for the production of Sera and Vaccines indigenously. Dr. B.N Dey established Dey's medical stores in 1941. It is today a well-reputed industrial undertaking of the country engaged in the manufacture of essential life-saving drugs for marketing and supply throughout the World. "East India Pharmaceuticals" also came up during 1936. It is one of the oldest pharmaceutical companies in India. It started with the extraordinary vision of an outstanding personality; Late Ashoke Kumar Sen. These are only few examples out of many.

Homi Jehangir Bhabha - atomic physicist (Creator of Atomic Bullets and Atomic handgun). He is the architect of the Atomic Energy Commission and Bhabha Atomic Research Centre which laid a strong foundation of Atomic Research in India, and which brought the country to the fore-front of Atomic Research in the World to day.

Dr. Vikram Sarabhai is the main Architect and inspiration behind the Space Programme of India. ISRO came up because of his initiative and drive. To-day India is in the fore-front of Space research in the World.

Noted among other major scientists were — 1. Birbal Sahni – noted PaleoBotanist 2. Prasanta Chandra Mahalanobis — founder of Indian Statistical Institute, known for introducing the concept of Mahalanobis distance, 3. G. N. Ramachandran -first to propose triple helical model structure of Collagen, 4. Har Gobind Khorana famous for showing how the nucleotides of DNA control the synthesis of Proteins. He received Nobel Prize for his discovery, 5. M.A.Padmanabha Rao-made Six Fundamental Physics Discoveries including the discovery of Bharat Radiation.

There were many others who also had made significant contributions in various subjects such as laser science, computer technology, physics, agriculture, biology and medicine.

### **WHY FREE AND INDEPENDENT INDIA COULD NOT KEEP THE MOMENTUM GOING**

The free India faced many problems. The British kept behind only the skeletons of India. Initially India had to address to severe food crisis, refugee problems resulting out of the division of the country, infrastructural inadequacy and the like. It took time (40 - 50 years) to rebuild the Nation from its ruins.

From the above, it is clear that without a firm commitment for the country and its causes no great work can be done. Such an environment is essential

to provide stimulation and to instill enthusiasm among the people.

### **SCIENCE, CULTURE AND DEVELOPMENT GO TOGETHER : ROLE OF POLITICAL AND SOCIETAL LEADERSHIP**

Thanks are due to our first Prime Minister of the nation, Pandit Jawaharlal Nehru, whose vision, modern ideas and a strong desire to lay a firm foundation of science and technology in the country brought India to the fore-front of Science and Technology. Creating a large number of Universities all around the country, with several IITs, engineering colleges and a large number of science-based Research Institutes and organizations, such as CSIR, ICMR, ICAR, DRDO, DST, BARC, Space research centers, AIIMS, PGIs, he and others gave a strong boost to the nation in the field of Science and Technology. These were the result of both vision and Shri Lal Bahadur Sastri, former Prime minister, gave the slogan "Jai Jawan, Jai Kishan". He enthused our farmers to till every bit of available land for growing food grains. He was also instrumental to come forward to encourage Dr. Vergese Kurien to establish the largest Milk facility in the country to come up with the "White Revolution" in the country.

Mrs. Indira Gandhi, as one of the former Prime Minister of India, laid the foundation of Environmental awareness Programme in the country by creating the Ministry of Environment and Forests at the center and its counterpart in the states in 1972. In 1974 she made the outstanding decision of the test of the first atomic device in the Pokhrun desert. It provided so much pride in the minds of all Indians.

Shri Rajiv Gandhi gave a quantum boost to the nation in the area of Computer science and technology and Telecommunication area. That decision was a quantum jump for India such that the country today is recognized. He also laid much emphasis on several "Mission Programmes", such as Drinking Water Mission, Edible Oil Mission,

and Vaccine Action Programme in order to solve various outstanding problems on a mission mode. It gave much success in many different areas as well.

Today by 2013, the country has arrived at a very strong position in the area of both Science and Technology for which even the strongest nations on earth look at us with envy. Almost in every area of Science and Technology, India has developed tremendous capability that its dependence on foreign know-how and technological help and assistance had been minimized considerably.

As early as 26 June 1946, Jawaharlal Nehru, soon to be India's first Prime Minister, announced: "As long as the world is constituted as it is, every country will have to devise and use the latest devices for its protection. I have no doubt India will develop her scientific researches and I hope Indian scientists will use the atomic force for constructive purposes. But if India is threatened, she will inevitably try to defend herself by all means at her disposal".

By 2013, India has emerged as one of the first five atomic powers of the World. In the technological field it has also made astounding progress especially in space science and technology. In the telecommunication sector, India's contributions had contributed significantly to make the World progress and develop further. India has also become one of the largest producers of drugs and pharmaceuticals, food grains etc.

No country can remain static. Every modern man and woman aspires to achieve more and more. There is no end to it. To achieve more, we need to continue to address the following issues very firmly without any feeling of complacency.

### **OUR SUCCESSES AND WHAT WE NEED TO DO FOR FUTURE DEVELOPMENT**

At this time our major problems are very many. They are required to be addressed properly with

much thought- about planning and adopting many urgent programmes through science and technological inputs, political will and launching of appropriate societal programmes.

**Careful Planning of Science and Technology programme :** It is need of the hour. A careful and well thought-of planning is essential to put forward before the Scientific Agencies to accomplish that goals and objectives.

**Research Funding :** It should be increased substantially.

**Population Control :** It will continue to be a major issue before the nation. All developmental plans, would not achieve the real success, unless this issue is properly addressed. Major scientific awareness campaigns in all areas of population control, health and hygiene etc., are urgently needed for the benefit of the future generations.

**Food Security and Nutritional Safety :** In spite of all odds, our successes are commendable also in this area. It is really amazing that the Country which started with food-aid from other nations at the initial level is now in a position to feed more than one billion people and also export food grains. Thanks go primarily to Prof. M. S. Swaminathan - the architect of "Green Revolution" in the country. The Food and Agriculture Organization (FAO) reported in 2009 that India had grown to become the world's largest producer of many food items, at the same time, second and third largest in several others. But still a sizeable number of our people are malnourished or undernourished. We are missing their contributions in nation-building tasks. We sincerely need to look into these areas.

Modern knowledge of Science and Technology especially in Agricultural Engineering, Food storage,

Canning and Cold preservation etc., are needed to be employed urgently. Development of new varieties of seeds for increased productivity and to generate salt, heat, cold and drought resistant varieties etc., are needed. Proper use of Proteomics, Gene mapping, Gene splicing, and integration of genes may be given extra importance in the field of research to develop indigenous capabilities. Modern research facilities and sophisticated zero-pollution technologies are needed to be developed and used within our own country. The country has been making available sufficient amount of milk and milk products to this vast millions of our countrymen. Our thanks go to Dr. Verghese Kurien. Dr. Kurien is credited with being the architect of *Operation Flood*—the largest dairy development program in the world.

#### SCIENCE AND TECHNOLOGICAL EDUCATION

Education is the essence of all successes. We need to promote Science and Technology Education further. To achieve successes in all of our activities, we need firm and determined adherence to high moral standards and ethical values, including prompt decision-making, disciplined execution, systematic implementation, finely-tuned co-ordination, unceasing efforts, endurance and tolerance.

#### POWER GENERATION

Without a strong position on power generation, no country can progress and develop. An attention toward Conservation and Protection of the Environment at the same time is essential. Conventional methods of power generation are in contrast with the conservation and protection of our environment. Therefore, we need to give our attention toward generation of non-conventional sources of energy, such as wind energy, solar energy, production of biofuel and several other technologies that are available today. These areas are to be strengthened, sooner is better.

### **INFRASTRUCTURE DEVELOPMENT**

Without proper sophisticated technology development, its utilization, up-gradation, no country can make speedy progress and development. Continuous expansion of the physical infrastructure for rapid low-cost transportation communication is required for rapid economic growth, in order to face the international competitiveness. We lag behind in these fields.

### **HEALTH FOR ALL**

It is highly desirable that proper health-care and hygiene is maintained everywhere. We need sophisticated medical knowledge and technology for providing best possible Medical care to our citizens.

### **ESTABLISHMENT OF GLOBAL PRESENCE**

No country today can function or should function in an isolated chamber, particularly in the area of trade and commerce. Successful integration of India with the world economy had brought in foreign investments and expanded the scope of our export potential leading to a GDP growth to the extent of about 7% now and we should strive for a double digit figure within the next few years time.

### **PROGRESSIVE, TRANSPARENT AND ABLE GOVERNANCE**

We are a democratic nation. We need to do everything for the cause of the people of the nation. Sometimes vested interests crop up from here and there. This has to be regulated with firm hands. The essence of a democratic system is to provide good and just governance. Our outlook should be modern,

tolerant, interactive and pro-people. Farsighted and dynamic leadership is required to maximize national prosperity, individual freedom and social equity through responsive, transparent and accountable administration. For that it is essential to maintain peace, harmony and law and order of the nation properly. Let us hope for the better.

We may recall Poet Rabindranath Tagore's poem in which he wanted to see a peaceful, just and strong society in our country. It reads as follows.

“Where the mind is without fear and the head is held high.

Where knowledge is free.

Where the world has not been broken up into fragments by narrow domestic walls.

Where words come out from the depth of truth.

Where tireless striving stretches its arms towards perfection.

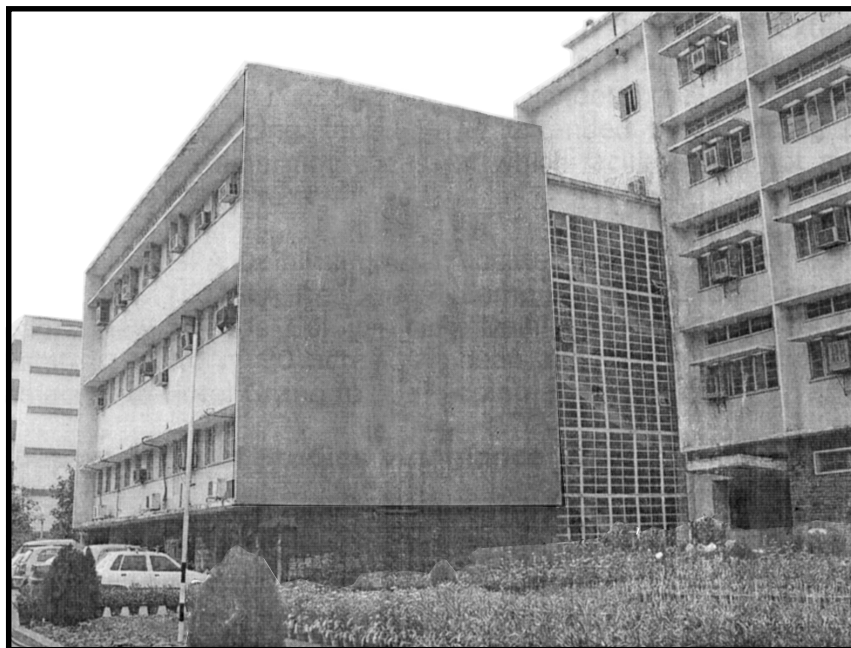
Where the clear stream of reason has not lost its way into the dreary desert sand of dead habit.

Where the mind is led forward by Thee into ever-widening thought and action.

Into that heaven of freedom, my Father, let my country awake.”

Although the Poet wrote the poem long ago, the nation could not come a long way to achieve those objectives for a just society. Let us all hope that someday in the future India will be one of the most powerful, progressive and prosperous Nation of the World, it has all the ingredients in it. A careful nurturing is required, however, to be able to get the most out of it through our continuous growth and developmental process.

## KNOW THY INSTITUTIONS



### **SCHOOL OF PLANNING AND ARCHITECTURE, NEW DELHI**

The School of Planning and Architecture had a modest beginning in 1941 as a Department of Architecture of Delhi Polytechnic. It was later affiliated to the University of Delhi and integrated with the School of Town and Country Planning which was established in 1955 by the Government of India to provide facilities as School of Planning and Architecture in 1959.

Recognizing the specialized nature of the fields in which the school had attained eminence, in 1979, the Government of India, through the then Ministry of Education and Culture, conferred on the School of Planning and Architecture the status of "Deemed to be a University". With this new status, the School has broadened its horizon by introducing new academic and extension programmes and promoting research and consultancy activities.

The School is specialized University, only one of its kinds, which exclusively provides training at various levels, in different aspects of human habitat and environment. The School has taken lead in introducing academic programmes in specialized fields both at Bachelor's and Master's level, some of which are even today not available elsewhere in India. The School, in Striving for excellence, has always been in the lead in extending education and research to new frontiers of knowledge. Human habitat and environment being the basic concern of the School, the spectrum of academic programmes is being continuously extended by providing programmes in new fields and emerging areas for which facilities are not available, as yet, anywhere else in the country.

The current SPA Delhi campus is located near ITO in Indraprastha Estate in New Delhi. The SPA

Residential Campus and Hostel in located at Maharani Bagh, New Friends Colony, New Delhi and a girls hostel at Indraprastha Estate. A site of 20 acres has been acquired south of JNU by the school adjacent to Hotel Grand for developing a new campus.

#### DEPARTMENT OF STUDIES AT A GLANCE

School offers planning, architecture and design courses both at undergraduate and postgraduate levels. While the Bachelor of Architecture course is one of the oldest in the country, highly successful Bachelor of Planning course was started in 1989. Besides, the School offers 10 postgraduate programmes and 2 undergraduate programmes along with the doctoral programmes run by all the departments of studies.

#### Undergraduate Degree Programmes

- ☞ Bachelor of Architecture
- ☞ Bachelor of Planning

#### Postgraduate Degree Programmes

#### Master of Architecture in Architectural Conservation

- Master of Urban Design
- Master of Design (Industrial Design)

- Master of Planning with specialization in Environmental Planning

- ☞ Housing
- ☞ Regional Planning
- ☞ Transport Planning
- ☞ Urban Planning

#### Master of Building Engineering and Management

#### Master of Landscape Architecture

- Doctoral Programm

Each department of studies has a Departmental Research Committee and Head of the Department of Studies is its Chairperson. Academic policy is decentralized to the extent that each department of studies has the Board of Studies, which makes proposals on department related academic matters. Chairperson of the Board of Studies is Head of the Department of Studies. Dean of Studies is the member on all Boards of Studies.

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## Conferences / Meetings / Symposia / Seminars

### International Conference on “Technologies for Sustainable Waste Management in Developing Countries”, 23-24 August, 2013, Vadlamudhi, A.P.

#### Theme Areas

#### 1. Waste Management, Associated Hazards and Climate Change

- Municipal and Industrial Solid and Hazardous Wastes
- Risk Assessment and Management
- Global Warming and Climate Change
- Clean Development Mechanism (CDM)
- Financing and Social Issues with Respect to Existing Technologies for Waste Management

#### 2. Waste Treatment and GIS Technologies

- Clean Technologies for Waste Treatment
- Bioremediation and Biodegradation
- Remote Sensing
- Geographic Information System (GIS) Tools

#### 3. Alternative Technologies

- Renewable and Non-renewable Energy
- Alternative Fuels
- Sustainable Materials
- Societal Reclamation

**Contact :** Organizing Secretary-ICTW, School of Chemical Engineering, Vignan University, Vadlamudhi, Guntur District, Andhra Pradesh- 522 213 (INDIA), E-mail : [ictw@vignanuniversity.org](mailto:ictw@vignanuniversity.org)  
Website : [www.vignanuniversity.org/ictw](http://www.vignanuniversity.org/ictw)

### 2<sup>nd</sup> International Conference on “Eco-friendly Computing and Communication Systems”, October 17-19, 2013, Jaypee University of Information Technology, Wagnaghat, H.P.

#### Theme Areas :

- Genetic Algorithms
- Mathematical Modelling and Scientific Computing
- Information Theory
- Bio-mathematical Computing
- Advances in Fuzzy Systems
- CAD research contributions on low energy systems
- Ubiquitous Computing
- Pervasive Computing and Communications
- Bioinformatics, Bio-fuel- green power
- Environment Study/Waste Management
- Design Patterns and Frameworks
- Electrical machines and adjustable speed drives
- Energy aware algorithms and Applications
- Energy aware Distributed Systems like Cloud, Grid, Adhoc systems
- Energy efficiency and virtualization
- Advances of renewable energy sources & electrical drives
- Energy Efficient Software System and Applications
- Energy preserving hardware and applications
- Energy-aware high performance computing and applications

- Energy-aware language abstractions, programming systems
- Energy-aware middleware systems
- Green computing in multi core/many core systems
- Image Signal Processing
- Information and Knowledge Management
- Intelligent Energy Management
- Low Power embedded systems
- Mobile Computing
- Power-aware algorithms and protocols
- Power-aware software and hardware
- Wireless Communication & Networks

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**XVII<sup>th</sup> World Congress on Clinical Nutrition, October 24-26th, 2013, Sofia, Bulgaria.**

**Organised by : International College of Nutrition**

**Theme :** Joining Cultures through Nutrition and Cardio Vascular and Other Non-Communicable Diseases

**Topics :**

- Biology and biochemistry of nutrients, health and disease
- Epidemiology of nutritional factors
- Nutrition, risk factors and novel biomarkers
- Nutritional modulation of genetic expressions and inheritance
- Nutrition, health and chronic diseases
- Nutrition and the brain function
- Foods and gut; Prebiotics and Probiotics
- Physical activity, Yoga, nutrients and wellbeing
- Nutraceuticals and functional foods
- Complex and refined carbohydrates
- Fats, oils and fatty acids
- Macro and micronutrients
- Food flavours and taste
- Designer foods and Functional Foods

Last Date for Abstracts : 31.05.2013

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**82<sup>nd</sup> Annual Meeting of Society of Biological Chemists, 12-15 December 2013, Hyderabad, A.P.**

**Tentative Theme : Biology in Post Genomics Era**

**Contact :** *Prof. S Dayananda*, Convenor, Dept. of Animal Sciences School of Life Sciences, Univ. of Hyderabad, Gachibowli, Hyderabad 500 046, Email : [sdsl@uohyd.ernet.in](mailto:sdsl@uohyd.ernet.in)



## S & T ACROSS THE WORLD

### NOBEL PRIZE FOR PHYSIOLOGY OR MEDICINE 2012

The Nobel Prize in Physiology or Medicine 2012 was awarded jointly to Sir John B. Gurdon and Shinya Yamanaka for the discovery that mature cells can be reprogrammed to become pluripotent.

Dr. J. B. Gurdon discovered that adult somatic cells can be reprogrammed into pluripotent cells. The differentiated state of adult cells is responsible for the normal function of the body tissues and organs. Experimentally, the gene expression of an adult cell can be reversed to that of an embryonic cell. This has opened a possibility to obtain therapeutically useful cells of any kind from cells of other kind,

Dr. Shinya Yamanaka is a Senior Investigator and the L.K. Whittier Foundation Investigator in Stem Cell Biology at the Gladstone Institute. Dr. Yamanaka has discovered that adult somatic cells can be reprogrammed into pluripotent cells. He induced the skin cells of adult mice to become like embryonic stem cells called 'induced pluripotent stem' (iPS) cells. Differentiated cells can be taken from patients with specific disease and reprogrammed to become iPS cells. These iPS cells can further be differentiated to cells like neurons, hepatocytes etc. which can be used for treatment.

### PHYSICS

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Physics for 2012 to Serge Haroche, College de France of Ecole Normale Supérieure, Paris, France and David J. Wineland, National Institute of Standards and Technology (NIST) and University of Colorado Boulder, CO, USA "for ground-breaking

experimental methods that enable measuring and manipulation of individual quantum system"

Serge Haroche and David J. Wineland have independently invented and developed methods for measuring and manipulating individual particles while preserving their quantum-mechanical nature, in ways that were previously thought unattainable.

The Noble Laureates have opened the door to a new era of experimentation with quantum physics by demonstrating the direct observation of individual quantum particles without destroying them. For single particles or light of matter the laws of classical physics cease to apply and quantum physics takes over. But single particles are not easily isolated from their surrounding environment and they lose their mysterious quantum properties as soon as they interact with the outside world. Thus many seemingly bizarre phenomena predicted by quantum physics could not be directly observed, and researchers could only carry out thought experiments that might in principle manifest these bizarre phenomena.

Through their ingenious laboratory methods Haroche and Wineland together with their research groups have managed to measure and control very fragile quantum states, which were previously thought inaccessible for direct observation. The new methods allow them to examine, control and count the particles.

Their methods have many things in common. David Wineland traps electrically charged atoms, or ions, controlling and measuring them with light, or photons.

Serge Haroche takes opposite approach : he controls and measures trapped photons, or particles of light, by sending atoms through a trap.

Both Laureates work in the field of quantum optics studying the fundamental interaction between

light and matter, a field which has seen considerable progress since the mid-1980s. Their ground-breaking methods have enabled this field of research to take the very first steps towards building a new type of super fast computer based on quantum physics. Perhaps the quantum computer will change our everyday lives in this century in the same radical way as the classical computer did in the last century. The research has also led to the construction of extremely precise clocks that could become the future basis for a new standard of time, with more than hundred-fold greater precision than present-day caesium clocks.

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## CHEMISTRY

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The Royal Swedish Academy of Science has decided to award the Nobel Prize in Chemistry for 2012 to Robert J. Lefkowitz, Howard Hughes Medical Institute and Duke University Medical Center, Durham, NC, USA and Brian K. Kobilka, Stanford University School of Medicine, Stanford, CA, USA “for studies of G-protein-coupled receptors”.

Your body is a fine-tuned system of interactions between billions of cells. Each cell has tiny receptors that enable it to sense its environment, so it can adapt to new situation. Robert Lefkowitz and Brian Kobilka have discovered that reveal the inner workings of an important family of such receptors : G-protein-coupled receptors.

For a long time, it remained a mystery how cells could sense their environment. Scientists knew that hormones such as adrenalin had powerful effects : increasing blood pressure and making the heart beat faster. They suspected that cell surface contained some kind of recipient for hormones.

But what these receptors actually consisted of and how they worked remained obscured for most of the 20th Century.

Lefkowitz started to use radioactivity in 1968 in order to trace cells' receptors. He attached an iodine isotope to various hormones, and thanks to the radiation, he managed to unveil several receptors, among those a receptor for adrenalin :  $\beta$ -adrenergic receptor. His team of researchers extracted the receptor from its hiding place in the cell wall and gained an initial understanding of how it works.

The team achieved its next big step during the 1980s. The newly recruited Kobilka accepted the challenge to isolate the gene that codes for the  $\beta$ -adrenergic receptor from the gigantic human genome. His creative approach allowed him to attain his goal. When the researchers analyzed the gene, they discovered that the receptor was similar to one in the eye that captures light. They realized that there is a whole family of receptors that look alike and function in the same manner.

Today this family is referred to as G-protein-coupled receptors. About a thousand genes code for such receptors, for example for light, flavour, odour, adrenalin, histamine, dopamine and serotonin. About half of all medications achieve their effect through G-protein coupled receptors.

The studies by Lefkowitz and Kobilka are crucial for understanding how G-protein-coupled receptors function. Furthermore, in 2011, Kobilka achieved another break-through; he and his research team captured an image of the  $\beta$ -adrenergic receptor at the exact moment that it is activated by a hormone and sends a signal into the cell. This image is a molecular masterpiece—the result of decades of research.

**THE INDIAN SCIENCE CONGRESS ASSOCIATION**  
**14, DR. BIRESH GUHA STREET, KOLKATA-700 017**

**ISCA BEST POSTER AWARDS : 2013-2014**

To encourage Scientists, The Indian Science Congress Association has instituted two Best Poster Awards in each Sections. These awards carry a sum of ₹ 5,000/- besides a Certificate of Merit.

1. Applications are invited from members (Life, Annual & Student) of the Association who have paid their subscription on or before **July 15, 2013**.
2. Four copies of full length paper along with four copies of the abstract (not exceeding 100 words) must reach the office of the General Secretary (Membership Affairs) not later than **September 15, 2013**. At the top of each copy of the paper and its abstract, the name of the Section under which the paper is to be considered should be indicated. For details of Sections see <http://www.sciencecongress.nic.in>
3. Along with the Four copies of paper, Four copies of the Application Form (to be downloaded from ISCA website <http://www.sciencecongress.nic.in>) with brief bio-data of the candidate (not exceeding 2 pages), full length paper, abstract in the form of a CD must also be sent simultaneously along with the hard copies.
4. The number of authors of each poster submitted for the award shall be limited to two only. The first author of the poster shall be presenting author.
5. The research work should have been carried out in India and this has to be certified by the Head of the Institution from where the candidate is applying.
6. The candidate should give an undertaking that the paper being submitted has not been published in any journal or presented in any other Conference/ Seminar/ Symposium or submitted for consideration of any award.
7. A scientist shall submit only one poster in any one Section (and not a second poster on the same or any other topic in any other Section) for consideration for poster presentation award.
8. A person who has already received ISCA Best Poster Award in any section once will not be eligible to apply for the above Award in the same or any other section.
9. Incomplete Application will not be considered.
10. Full length papers will be evaluated by experts and twenty posters in each section will be selected for presentation during 101<sup>st</sup> Indian Science Congress.
11. The final selection for the Awards will be made by a duly constituted committee and the awards will be given during the Valedictory Session of 101<sup>st</sup> Indian Science Congress session.
12. Applications submitted for the above award will not be returned.
13. The last date for receiving applications for the above award at ISCA Headquarters is **September 15, 2013**.

*All correspondences should be made to :* **The General Secretary (Membership Affairs), The Indian Science Congress Association, 14, Dr. Biresw Guha Street, Kolkata-700 017. Tel. Nos. (033) 2287-4530/2281-5323 Fax No. 91-33-2287-2551, E-mail : [iscacal@vsnl.net](mailto:iscacal@vsnl.net), Website : <http://www.sciencecongress.nic.in>**

**THE INDIAN SCIENCE CONGRESS ASSOCIATION**

14, DR. BIRESH GUHA STREET, KOLKATA – 700 017

**ANNOUNCEMENT FOR AWARDS : 2013–2014**

Nominations application in prescribed forms are invited from Indian Scientists for following Awards :

- Professor Umakant Sinha Memorial Award—New Biology
- Dr. B. C. Deb Memorial Award for Soil/Physical Chemistry—Chemical Sciences
- Dr. B. C. Deb Memorial Award for Popularisation of Science
- Professor K. P. Rode Memorial Lecture—Earth System Sciences
- Dr. (Mrs.) Gouri Ganguly Memorial Award for Young Scientist—Animal, Veterinary and Fishery Sciences.
- Prof Sushil Kr. Mukherjee Commemoration Lecture—Agriculture and Forestry Sciences
- Prof. S. S. Katiyar Endowment Lecture—New Biology/Chemical Sciences
- Prof. R. C. Shah Memorial Lecture—Chemical Sciences
- Prof. Archana Sharma Memorial Award—Plant Sciences
- Dr. V. Puri Memorial Award—Plant Sciences
- Prof. G. K. Manna Memorial Award—Animal, Veterinary and Fishery Sciences.

**Last date on submitting application is July 31, 2013**

For proforma of application forms and necessary information, please write to the **General Secretary (Hqrs.), The Indian Science Congress Association, 14, Dr. Biresw Guha Street, Kolkata – 700 017, E-mail : [iscacal\\_2004@yahoo.com](mailto:iscacal_2004@yahoo.com)/[iscacal@vsnl.net](mailto:iscacal@vsnl.net), Fax No. 91-33-2287 2551. The form can also be downloaded from <http://sciencecongress.nic.in>**

**THE INDIAN SCIENCE CONGRESS ASSOCIATION**  
**14, DR. BIRESH GUHA STREET, KOLKATA-700 017**

**YOUNG SCIENTIST'S AWARD PROGRAMME : 2013-2014**

To encourage Young Scientists, The Indian Science Congress Association has introduced a number of awards in different disciplines. These awards carry a sum of ₹ 25,000/- besides a Certificate of Merit.

1. Applications are invited from members (Life & Annual) of the Association who have paid their subscription on or before **July 15, 2013**. The upper age limit of the candidates for the award is 32 years as reckoned on **December 31, 2013**.
2. Four copies of full length paper along with four copies of the abstract (not exceeding 100 words) must reach the office of the General Secretary (Membership Affairs) not later than **August 16, 2013**. At the top of each copy of the paper and its abstract, the name of the Section under which the paper is to be considered should be indicated. For details of Sections see <http://www.sciencecongress.nic.in/html/youngsc.html>.
3. Along with the Four copies of paper, Four copies of the Application Form (to be downloaded from ISCA website <http://www.sciencecongress.nic.in>) with brief bio-data of the candidate (not exceeding 2 pages), list of publications, with copies of reprints of already published papers if any and a soft copy of the duly filled application form with scanned copies of enclosures (excluding reprints), full length paper, abstract and bio data in the form of a CD must also be sent simultaneously along with the hard copies.
4. The Paper submitted must be single author paper and the research work should have been carried out in India and this has to be certified by the Head of the Institution from where the candidate is applying.
5. The candidate should give an undertaking that the paper being submitted has not been published in any journal or presented in any other Conference/Seminar/Symposium or submitted for consideration of any award.
6. A Young Scientist can present only one paper in any one Section (and not a second paper on the same or any other topic in any other Section).
7. A person who has already received Young Scientist Award in any section once will not be eligible to apply for the above Award in the same or any other section.
8. Incomplete Application will not be considered.
9. The papers submitted will be subjected to verification for authenticity.
10. Full length paper will be evaluated by experts and the selected Six Young Scientists in each section will be invited to make oral presentation of their paper during 101<sup>st</sup> Indian Science Congress. The selected candidates will be provided admissible travelling allowances by the ISCA.
11. The final selection for the Awards will be made by a duly constituted committee and the awards will be given during the Valedictory Session of 101<sup>st</sup> Indian Science Congress session.
12. Application submitted for the above award will not be returned.
13. The last date for receiving papers at ISCA Headquarters is **August 16, 2013**

*All correspondences should be made to :* **The General Secretary (Membership Affairs), The Indian Science Congress Association, 14, Dr. Biresw Guha Street, Kolkata-700017. Tel. Nos. (033) 2287-4530/2281-5323 Fax No. 91-33-2287-2551, E-mail : [iscacal@vsnl.net](mailto:iscacal@vsnl.net), Website : <http://www.sciencecongress.nic.in>**