

## **Nation Building, ITians and Happiness**

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Good afternoon ladies and gentlemen,

I must thank Dr. Ashok Mishra the Director of IIT Bombay and his colleagues Dr. Uday Desai and Dr. Aruna Dixit for inviting me to give this lecture. I used to come regularly in 90's to IIT for giving lectures on Energy Systems in Mechanical Engineering department and hence it feels good to be back at this premier technological institute.

My lecture today will be on how young and bright students from IIT can help in building a vibrant and prosperous India and in doing so bring happiness to themselves and to a large number of Indians.

I run a small rural NGO in Phaltan, which is about 300 kms southeast of Mumbai. We try to use excellent tools of science in producing and developing technologies for rural applications. I will touch on this subject later in my talk.

### **What is nation building and why is it important?**

All life forms want a comfortable and happy life. In case of human beings it is a sum of two things, personal happiness and better environment.

Personal happiness can be obtained in a variety of ways. Basically one becomes happy when one is contented or at peace with oneself. We will talk about how to become happy and contented later on.

Environmental improvement is what I call nation building. It is the enabling environment which makes you feel happy to live in, work in and just be a part of it. This environmental happiness also gives us a sense of belonging, makes us feel proud of our surroundings and gives us a sense of ownership. If we create a happy environment for our work and living then we will make this country a great place to live. Each one of us should therefore work towards improving our immediate environment so that it becomes nice and cheerful. Then we will be genuinely proud to be a part of it.

For environmental happiness and nation building we need excellent young people like you.

### **How can youth participate in nation building ?**

First accept that whatever we are today is because of the country and society. Hence we should give something back to the society. Gratitude is the essence of being human. I believe that

the whole purpose of our existence is to increase personal and societal infrastructure. Personal infrastructure includes health, happiness and general well being. By improving our personal “infrastructure” we become better human beings and it helps in our emotional growth and evolution. By giving back to the society so that its “infrastructure” increases we help in mankind’s evolution. Both these activities when carried out simultaneously can give us a great joy and satisfaction.

One should keep aside half an hour per day (only 2% of the time) for society work. It is almost 200 hours/year. This is substantial time for society and the work can add up year after year.

For nation building you can work on anything in which you interact with the surroundings and can help make it better. Thus work for helping needy students, cleaning the surroundings, energy saving etc. can all be part of your work for society.

Just trying to conserve energy in whatever way you can will be a great way of helping the society. Keep a daily log of the energy consumed and how you can save it. Even thinking on improving your surroundings, writing about it and telling others is societal work. Follow the mantra “act locally, think nationally” and you will help in societal improvement.

However in all these things be very active and this activity will give you a positive frame of mind. Develop a “can do” approach. Everything is possible with a strong will and a good aptitude. At young age the mind is very active and hence you should be bubbling with ideas. Best ideas are the maximum ideas. The more ideas you have the higher is the chance of producing a great idea.

Be positive in your approach. Rise above the negative things and make them irrelevant. This is how nature works. It evolves by branching out and only that branch, which interacts properly with the environment, survives and evolves. The other branch, which does not, withers away. Thus nature never suppresses the other branch – it becomes automatically irrelevant. This is a higher mode of development where the whole system is upgraded and lifted up. Learn to follow nature in everything you do specially in design. It has evolved through million of years and hence has great design templates to copy and emulate.

Don’t worry about the outcome. Positive things will happen if you are honest and conscientious in your work. You are doing the societal work for your benefit namely discipline and discovery. Besides you will also feel tremendous satisfaction in helping others. Every work you do will help you learn new things and will help in increasing your “infrastructure”. If you have this attitude then any work you do becomes enjoyable. Never say “what is in it for me”. That is a negative attitude.

### **What are the issues in nation building and how you can help?**

Around 60% of our rural population lives in very primitive conditions. They have no electricity and their lives are in darkness. They use inefficient kerosene lanterns for light and primitive and ancient biomass cook stoves for cooking. Modern technology somehow has not touched their lives. Besides the poor quality of end product, the devices used by them create tremendous household pollution. Thus there are estimates that around 1.5 million deaths per year in rural areas are attributable to inhaling smoke from the inefficient and primitive biomass stoves.

Without these people getting into the mainstream, environment cannot be improved. Around 54% of India's population is below 25 years of age and most of them live in rural areas and are unemployed. Creation of rural based enterprises is the best way to create wealth, improve their quality of life and bring these people into mainstream of development. Our leaders are talking about making India the third biggest economy by 2012. Unless the lives of rural population are improved this will not be possible.

I am sure you will all go and become leaders and important people in your own enterprises, in corporate, Government and other sectors. In whichever sector you go use your considerable clout to help the rural population increase their quality of life. Even if you go abroad think how you can create conditions to improve the lives of these people. This is your contribution to the society.

In order that you understand what rural population needs and how they can be helped it is necessary that you spend sometime in becoming familiar with their plight. The best way to do so is to spend a year or so with rural based NGOs. Thus on a selfish note I would love to have 4-5 of you to spend 1-2 years with my NGO. By spending time with such NGOs you will achieve two things. Firstly you will understand the problems of rural India and secondly you will know how these NGOs work. Later on this knowledge may help you in starting your own NGO if you wish to do so.

You all are in the age group of 20-25 years. Spending one or two years in rural areas will hardly be noticed by you later on but the experience will be extremely rewarding and it will attach you firmly to the roots of the society. This time spent in rural areas is also your contribution to the society because I am sure that young and bright students like you will think very hard on the problems that you will encounter during your stay. And I do hope that these experiences will stay with you the rest of your life so that when you have the resources and a chance you will do something about them.

Thus for some of you who will go in corporate area think how you can help in creating rural enterprises by creating venture funds. For some of you who will go into R&D think about how you can develop technologies to create better devices for rural areas and for some of you who might go in government service a whole range of activities will be open to you for helping the rural population.

### **Technology Intervention**

However in order to help the rural population improve their lives technological intervention is required. This is a technological age. Whatever we do is governed by technology and thus technology plays an extremely important role in our lives. For rural areas sophisticated technology is needed. Most of the technological efforts in the past for providing basic facilities to rural areas have been based on a "tinkering" approach, meaning a small adjustment here and there, and using "low" or appropriate technology. This approach, which has been used by various agencies, normally resulted in incremental changes like development of improved chulhas (cookstoves) or better bullock carts. Tinkering, however, has barely made a dent in the quality of life of poor people. And often, the introductions of these technologies brought other problems such as increased workloads for women.

Rural population has the same aspirations as you and I have. With increased exposure to mass media their desire to improve their lot has also increased. Thus technology intervention is required in using rural resources to provide products and services to these people. Filtering down

approach of urban goods to rural areas in the long run will not work because of lack of infrastructure, resources and different rural situations.

I also believe that sophisticated – or “high” – technology is needed to convert efficiently the locally available resources and materials into useful products. This is the hallmark of evolution where natural systems evolve into very efficient materials and energy converters. In this process, size reduction and increased complexity of system takes place. Some of our designs and technologies are following the size reduction route, for example, computer chips, cellphones, power plants, etc. Technology developers should follow this strategy in developing rural technologies. In fact, much more sophisticated thought and “high” [technology is required for solving rural problems](#) since the materials and energy resources available are limited and often only available in “dilute forms”. The strategy of high technology allows maximum energy and materials to be extracted for useful end products.

I think as students of premier technological institute you should work in technology area rather than in management. It is the technology and its appropriate applications, which provide solutions to mankind’s problem. Only after the technology is available that you can manage it. For rural areas the technology will not come from U.S. or Europe. We will have to develop it ourselves and some of our brightest minds should do it. I will now give few examples where high technology intervention can provide a quantum jump in the quality of life of rural population. These examples are for lighting and cooking energy where 75% of total energy is used in rural households.

### **Strategy for lighting**

The history of civilization is the history of lighting. Lighting allowed mankind to extend daylight hours and hence increase productivity and commerce. It is a sad state of affairs in our country that nearly 60 years after independence there are 60% of rural population without electricity. They use simple but very inefficient hurricane kerosene lantern for lighting.

NARI worked on developing a very efficient lantern called [Noorie](#) the details of which are given at [this site](#). This lantern produces about 1250 lumens (lm) of light (equivalent to light from a 100 W electric bulb). However in developing the lantern we became aware that the stumbling block in improving its efficiency was the thermoluminescent (T/L) mantle. Presently these T/L mantles have efficacy of 2-3 lm/W. In comparison a 100 W light bulb has efficacy of 10-13 lm/W and a compact fluorescent lamp (CFL) ~ 50-70 lm/W. If by adequate R&D we can match the T/L mantle efficiency with that of light bulb then the liquid fuel lighting can become better than the electricity based lighting. How can this happen?

If we take the power plant-to-light efficiency (PPL) point of view then PPL of CFL is only 12-14 lm/W since 70% of energy is lost in heat from the thermal power plant and again there are energy losses in T&D. Thus the R&D in producing better T/L mantles can provide tremendous advantages to decentralized rural lighting.

These T/L mantles have not changed since early 1860s when Welshbach in Germany made them out of radioactive Thoria/Ceria mixture. Many people have tried to improve them but have not succeeded. We still do not understand how the light is produced from this mixture. The 2000°C flame

produces light as if it is coming from a 3600<sup>0</sup>C black body. I feel the emerging field of nano science can help in developing materials, which can glow efficiently at 1000-1500<sup>0</sup>C. Besides R&D is necessary in making these mantles out of sturdier materials like carbon composites, ceramic-based thermoluminescent materials etc.

Ultimately for decentralized light based on chemical fuels we should try to copy the bioluminescence mechanism of firefly where visible light is produced very efficiently and at room temperatures. With grid electricity still a distant dream for major portion or rural areas, efficient liquid fuel lighting needs to be encouraged.

Simultaneously we have to explore decentralized electricity based lighting since 100 years of R&D has gone in perfecting this type of lighting.

We at NARI pioneered the development of strategy of biomass based power [plants for taluka level](#). It became a national policy and was run by MNES from 1996 till 2002. About 40 biomass-based plants of 6 MW capacity each were set up and the whole program had a mixed successes. This was because the Electricity Act of 2003 had not come. With the advent of this act there are indications that there will be an explosive growth of such power plants all over the country.

In the range of 10-500 kW(e), R&D is needed in biomass gasifier based plants, steam engines, sterling engines, biogas-based gas turbines and even nuclear power. There is a whole array of technology to be developed so that the power is produced from renewable fuels, which are biomass based, environmentally friendly and can be produced in our country. NARI has [recently made a recommendation](#) to Maharashtra Electricity Regulatory Commission (MERC) regarding the mechanism of setting up small utilities in rural Maharashtra.

On micro scale there are exciting possibilities for lighting. For example there are tantalizing indications that new class of materials are being researched into which can produce 3 electrons/photon thereby providing a quantum jump in the efficiency of solar cells. This type of solar cells together with ultra capacitor batteries (instead of regular lead-acid batteries) can revolutionize rural lighting.

Similarly there have been a quantum jump in the efficiency of thermoelectric elements. These elements can be incorporated in any cook stoves and about 40-50 W of power can be produced. This power is enough to power a small fan so that the combustion efficiency of cook stove is improved and part of the power can be stored in ultra capacitors for lighting.

Work is also going on in producing 10-20 W micro engines via MEMS process. These engines can run on ethanol and methanol and hence can eliminate the need of storage batteries. The storage of energy is in the fuel. Thus an extremely efficient decentralized lighting system can be thought of which consists of micro engine powering a CFL lamp.

### **Cooking Energy Strategy**

Only liquid and gaseous fuels produced renewably can provide clean cooking energy. Two fuels fall into this category. Liquid fuels like ethanol or biodiesel and gaseous fuel like biogas.

Ethanol is an excellent fuel for cooking. At NARI we have [developed a stove](#) which runs on 50% ethanol water mixture. This mixture is very safe and the stove which has a maximum thermal

capacity of 2.5-3 kW has flame control so that it works just like an LPG stove. Large scale testing in the field has been very positive and almost all the rural women compare it very favorably with a LPG stove. However in order that ethanol can be used as a rural household fuel the presently tough excise laws have to be modified. Thus a policy change is needed by Govt. of India in this regard.

Biodiesel is another fuel which can be grown locally. Government of India has recently embarked on a major program of using biodiesel for automobile purposes. However R&D is required in improving its yield/ha and also its use in cooking stoves.

A clean gaseous fuel that can be produced from the existing biomass sources is biogas. Biogas has been used extensively in rural areas of India. However it is produced very inefficiently in fixed and floating dome systems and requires considerable amount of cowdung and other nitrogenous material. It is not suitable for a household with less than 3-4 cattle. Besides there are problems of gas production during winter and improper mixing of mixed inputs like biomass, night soil, cowdung, etc. The biogas which is a mixture of methane and carbon dioxide cannot be liquefied and requires very high pressure (> 100 atmospheres) to compress it so that it can be used over extended periods.

Thus R&D is necessary in two areas. One is in the development of extremely efficient biogas reactors so that the production/unit of biomass inputs could be maximized. The second area is to develop appropriate storage materials which could store biogas at medium pressures.

R&D is being done world over in methane storage and recently experiments have been conducted in storing it at medium pressures (< 40 atmospheres) in hydrates, porous carbon and porous organic structures. There is thus a need to develop low cost storage materials so that biogas could be stored in them for usage in households. New materials developed through nanoscience and nanotechnology can be developed for this purpose. Thus a scenario can be thought of whereby a micro-utility company can be set up in rural areas which will buy locally available raw materials like cowdung, biomass, etc. and will use them in a very high tech biogas reactor to efficiently generate biogas. This gas can then be stored in small cylinders lined with gas absorbent structures and can be transported to households like the present LPG cylinders. This will revolutionize the cooking system in rural India.

Optimization of biogas production from a reactor requires sophisticated electronic based controls and bio-chemical engineering technology. A small utility can afford to do it whereas for a household it might be too costly. Tinkering around with existing biogas reactors will not solve the problem. A very sophisticated science and technology input has to be brought to bear on the problem for optimizing the biogas production in rural areas.

The use of high technology in lighting and cooking energy can result in considerable economic development in rural areas. Our estimates show that this energy industry can be of the order of [Rs. 30-40,000 crores/year](#). Since it will be rural based hence it can bring in substantial wealth to these areas both in terms of biomass production and also in processing it to produce the fuel. To my mind the wealth of the country comes from the land and with the development of fuel in rural areas it can help improve the lives of people living in these areas.

However as the course of agriculture gets dictated by increased industrial demands for fuel and electricity production there is a need to debate the food vs. fuel scenario. In that context the

pioneering work of [NARI in developing sweet sorghum](#) becomes very relevant. From a sweet sorghum crop one can produce food (grain), fuel (sweet juice from its stem can be fermented to produce ethanol) and fodder (the bagasse is excellent fodder for animals). Thus from the same piece of land one can get all these things simultaneously. No other crop can do this.

There is a need however to develop a whole plant approach where every part of crop should be utilized for human consumption. Thus the production of ethanol from agricultural residues requires extensive R&D and has a potential of converting farms into food and fuel factories. NARI had recommended to the Planning Commission setting up of a National [Technology Mission on cooking and lighting](#), so that all the above issues are debated and suitable funds allocated.

## Water Issues

For the increase in agriculture and prosperity in rural areas adequate water supply is extremely essential. With green revolution has also come extensive use of water resulting in shortage in some parts of the country. However if we look at the total rainfall received by India it is  $\sim 4 \times 10^{12}$  m<sup>3</sup>/yr whereas the total water consumption is  $\sim 65 \times 10^{10}$  m<sup>3</sup>/yr which is 16% of total rainfall. Theoretically we have adequate water. However the rainfall is not evenly distributed over India and it comes in short spells. Thus there is a tremendous need for rainwater harvesting and storage programs. Already such programs are in place in some parts of the country.

However the issue of rainwater harvesting in rural areas raises a question of who will own the water bodies. I feel we need to develop policies so that just like electricity act we have water act so that rural water utilities can be set up which can harvest the rain, store it and then supply this water to village throughout the year. These water utilities may also be able to buy water from the government through the existing canal system.

Two most important issues for rural development are water and electricity. NARI has [developed a strategy](#) whereby it is shown that a microutility producing 500-kW<sub>e</sub> power for rural areas can easily use the heat of the flue gases of the engine to boil or distil water to make it potable. Thus the combined cycle of electricity and water will increase the efficiency of the power plant. Besides tremendous R&D is also needed in improving the distillation process so that minimum energy is used in effecting it.

I hope by these examples you have gotten a feeling of the need for very sophisticated technology required for solving the rural problems. The development of technologies can be done through a combined and concentrated effort of academia, corporate sector, S&T NGOs and government labs. With the introduction of these technologies the wealth can be created in rural areas and the environment can be improved.

## How to create personal happiness?

However for an individual to work for the society it is necessary that he/she should be secure and happy. And now I will discuss about how to be secure and happy.

Happiness is a state of mind. You start feeling happy when you become internally secure. [Deep thought or Sanyam](#) helps in creating internal calmness and security. When you become honest

with yourself and try to understand yourself deeply you start becoming internally secure. Deep thought, Sanyam or Yoga helps you focus on a particular subject for a long time. This concentration helps the mind get calm and makes it extremely powerful. A powerful mind can move mountains and becomes very sensitive to the surroundings. This propels us to start changing our environment to make it better.

This internal security also helps us become less greedy for materials and resources. This is the genesis of [spirituality and sustainability](#). Presently we are following the example of U.S. where an average citizen consumes 350 GJ/person-yr. This is because of their greed. An average Indian consumes ~ 10 GJ/person-yr. I feel through spirituality we can cap our greed and we can have a very decent lifestyle in 40-50 GJ/person-yr. This can happen if we follow the maxim of "simple living and high thinking".

With the reduction or removal of greed the individual becomes happy. A happy individual can then give back to society both knowledge and resources. This is the essence of nation building. Thus if we all work together for creating happiness in our personal lives and for nation building then India can teach the world a new way towards sustainable living.

Thank you very much.

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