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Sustainable Rural Development *A Gandhian Perspective*

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Structure of Talk

- Present problems in rural India
- Decentralized high technology solutions
 - Energy production
 - Energy devices for lighting and cooking
- Relevance of Gandhiji's philosophy for holistic India
- Strategy for rural development

Introduction

- 60% of rural population (~ 400 million) in India live in primitive conditions. No electricity and primitive cookstoves. Around 300,000 deaths/yr take place because of pollution from these stoves. Modern technology has not touched their lives even after 60 years of independence.
- 54% of India's population is below 25 years of age and most of them live in rural areas with very little employment opportunities. Around 260 million people (1/4th of our population) live on less than Rs 50/day.
- Because of rural poverty large scale migration to cities takes place leading to serious urban problems.
- Increased aspirations because of mass media are leading to social unrest. Riots in Delhi, Mumbai, Gujarat and recently in UP. Release of bottled-up emotions. Spark could be from any source.

Introduction (cont..)

- Poverty in rural areas has resulted in suicides of a large number of farmers. In last 10 years about 150,000 farmers have committed suicide. Poor support price, increased input costs and aspirations. Also no long term agriculture policy.
- Serious energy crisis in India. In rural areas 250 kWh/yr per capita electricity consumption. This is 2% of that in US and lowest in the world.
- In Maharashtra alone ~ 6000 MW shortage resulting in 12-15 hours daily blackouts in rural areas.
- Last year India imported Rs. 120,000 crores worth of petroleum products. Serious balance of payment problems. 8-9% p.a. growth in petroleum consumption.
- Above events are direct result of lopsided development. Based on 100 year-old centralized model of developed countries. Preference to cities over rural areas.

Introduction (cont..)

- Centralized production and control inherently leads to corruption. Decentralization leads to accountability.
- Governance is the first casualty of corruption. All the above problems are result of non-governance.
- With proper governance, one of the best technological solutions for the above problems is energy production via agriculture.
- Energy is the basis of life. Lack of it produces economic stagnation and social upheavals.
- Energy from agriculture will provide rural wealth and create employment. Can bring 60% marginalized people into mainstream India, without which India cannot become an economic superpower.

Energy Production

- India produces ~ 600 million tons/yr of residues. Mostly burned in fields. Creates environmental pollution and loss of energy.
- Fuels from these residues can take care of major requirements of energy for India. With increased agriculture these residues will further increase.
- From crops and residues we can produce three types of fuel
 - Liquid fuels like ethanol, biodiesel or pyrolysis oil.
 - Gaseous fuel like methane (biogas).
 - Electricity via biomass-based power plants.
- In any agriculture 25-40% of produce is food and rest are residues. No remunerations from residues, hence farming is uneconomical. No industry can survive on such norms.
- Residues for energy can give an extra income of Rs. 2000-4000/acre/season to the farmers. Insurance against distress sale.

Energy Production (cont..)

- Residues can produce 156 b l/yr of ethanol which is 42% of India's oil demand in 2012; or 80% of oil demand via pyrolysis oil or 80,000 MW of electric power.
- With increased industrial demand for fuel and electricity, large tracts of farmlands may come under fuel crops only.
- Need to do R&D on multipurpose crops. NARI's work on Sweet sorghum.
- Farms and farmers are the backbone of any nation since they can produce food, fuel and hence wealth from the land. Country suffers when farmers are neglected.



Water Issues

- Increased farming for energy production will require adequate water supply.
- Already water shortage though adequate rainfall.
- Rainwater harvesting provides the best solution. Need for setting up private rural water utilities.
- Issues of ownership of water bodies need to be resolved. Water Act similar to Electricity Act needed.
- Use of flue gases from power generation can provide potable water. Combined electricity and water plants will improve efficiency.

Energy Industry from Agriculture

- ◆ Energy production from agriculture alone can be of the order of Rs. 30-40,000 crore/yr industry. Similar numbers may exist for water utilities in rural areas.
- ◆ Will also create about 30 million jobs in rural areas. Could increase large number of industries in these areas.
- ◆ Will supply liquid, gaseous fuels and electricity from biomass.
- ◆ Wealth of a country comes from its land and we should encourage farmers and provide funds and technologies for farming sector.
- ◆ Need for enlightened agriculture policy which has energy production as its cornerstone.

Development of Energy Devices

- High technology devices needed for rural areas.
- Resources and energy in dilute forms.
- Very efficient devices allow maximum energy and materials to be extracted for useful purposes.
- Hallmark of evolution is size reduction, increase in complexity and efficiency. All our modern devices follow this route. Sustainable size for high efficiency.
- Future societies may be taluka-type powered by high technologies in communication, power, etc.
- Examples of high technology for lighting and cooking, since 75% of total household energy is used for this purpose.

Strategy for Lighting

Liquid fuel for lighting

- ◆ Simple hurricane lanterns used presently. Very poor light output.
- ◆ Noorie lantern a major improvement.
- ◆ Presently mantle efficacy $\sim 2-3$ lm/W; light bulb $\sim 10-15$ lm/W and CFL $\sim 50-70$ lm/W. Need to match mantle efficacy with that of light bulb.
- ◆ Power plant-to-light efficiency (PPL) point of view **liquid fuel lighting can be superior to electric lighting**. PPL of CFL is $\sim 12-14$ lm/W. With increased T&D losses PPL will further reduce.



Noorie lantern

- Lightweight 2 kg
- Light output ~ 1350 lm
- Runs on kerosene, diesel or low conc. ethanol
- Lighting and cooking
- Low cost Rs.400-450/-

Liquid Fuel Lighting (cont..)

- ◆ Present T/L mantles have rare earth oxides and are 1880's vintage. Use 99% thorium oxide and 1% cerium oxide.
- ◆ Nanotechnology can help in developing new mixtures of rare earth or other oxides which can glow at lower temperatures (1000-1500 °C) with higher luminous efficacy.
- ◆ R&D also required in developing sturdier mantles. Could be ceramic cloth-based, carbon-carbon composites, etc.
- ◆ Need to copy bioluminescence technology of firefly.
- ◆ With grid electricity still a distant dream for major portion of rural areas, efficient liquid fuel lighting based on home grown fuel needs to be encouraged.

Electricity-based Lighting

- ◆ Taluka level plants (10-20 MW capacity)
 - ◆ Biomass or clean coal-based technology.
- ◆ Small scale plants (10-500 kW_e range):
 - ◆ **R&D needed in:**
 - ◆ Gasifiers, space-age steam engines.
 - ◆ Stirling engines, biomass gas turbines, low cost PV, etc.
 - ◆ Nuclear power for micro utilities.
- ◆ Micro scale power units:
 - ◆ Thermoelectric elements for cookstoves. Can produce 40-50 W power for small fans and LED. R&D needed in efficient batteries, ultra capacitors, etc. Paper thin batteries developed.
 - ◆ 10-30 W micro engines? No batteries needed.
 - ◆ Human-powered small PMDC generators. Real play radios. Gandhiji's energy charkha.



Cooking Energy Strategy

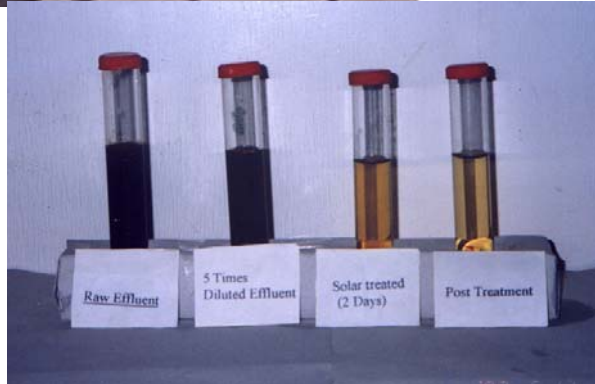
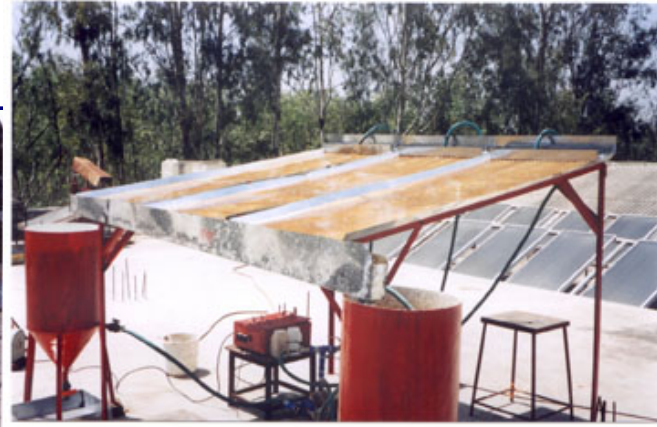
- ◆ Liquid and gaseous fuels best. Ethanol is an excellent fuel for cooking. 50% ethanol-water is easy to distill and a very safe mixture.
- ◆ Excise laws need to be modified for use of ethanol for cooking and lighting.
- ◆ R&D required for biodiesel and pyrolysis oil in stoves.
- ◆ R&D required in high-tech biogas reactors and storage of biogas in hydrates, porous carbon, etc. Nano materials for such structures.
- ◆ Scenario of a small utility in rural areas which processes waste into biogas and supplies it in small gas cylinders lined with storage materials. Will revolutionize rural cooking.



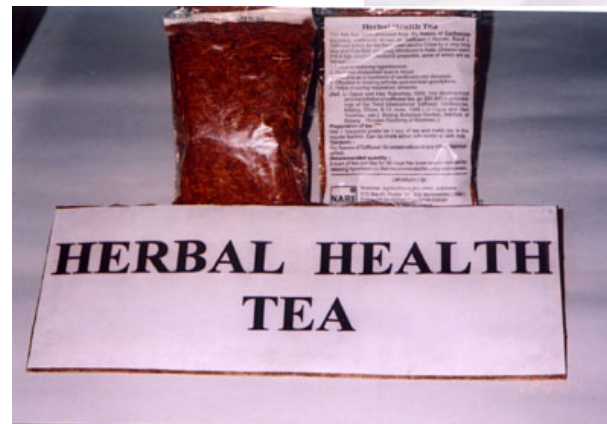
NARI alcohol stove

- 50% (w/w) ethanol
- 0.7 - 2.5 kW_{th} capacity
- Controllable flame
- Silent and easy to light
- Cost ~ Rs. 1500/-

NARI technologies



NARI technologies



Gandhiji's Philosophy

- Gandhiji was a spiritual being first. Other things were by-products of his spirituality.
- His spirituality guided all his work in politics, rural development and non-violence.
- He realized from an early age the importance of a great body and mind. His experiments on food, brahmacharya and fasting came from this belief. He followed age old yogic tradition.
- A spiritual person becomes less interested in hoarding things. This was the basis of Gandhi's sustainability. He believed in simple living and high thinking.
- With little energy and very few needs he produced a very high quality of thought.

Gandhiji's Rural Development

- Gandhi focussed on rural development for last 30 years of his life.
- He felt intuitively that future of India is in decentralized rural development. His concept of dream village was based on local rural production and consumption. Taluka strategy as a step towards fulfilling his dream.
- Evolution of decentralized systems can be helped by biomimicry-based solutions. Gandhiji's philosophy.
- Gandhi was not anti- technology or science. He was a *pujari* of human body. He was a prisoner of his time.
- Modern high technology (examples given earlier) provides tools to bring his dream village to reality. Desktop manufacturing units may further help in this process.

Strategy for Rural Development

- Modern systems in rural areas require management and technology. Need for partnership between corporations, NGOs and villagers. NARI/NFCL.
- Makes lot of business sense for corporate world. Need to curb the excessive greed of profit making.
- Also there is a need to reduce our consumptive lifestyle. If we follow American lifestyle then we will need resources of 4 earths.
- A decent lifestyle is possible with energy consumption of 50-70 GJ/person/yr. US consumption is 350 GJ and India's is 10 GJ.
- This can happen when we become spiritual and hence internally secure. This is what Gandhiji showed through his life.
- Becoming sustainable in our personal lives and giving something back to the society will help make India a holistic and sustainable society according to the dream of Mahatma Gandhi.

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Thank you

Useful sites

- www.nariphaltan.org
- <http://education.vsnl.com/nimbkar/spiritual.html>
(my writings on spirituality and sustainability)