RURAL INDUSTRIALIZATION- THE FUTURE OF TECHNOLOGY

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ABSTRACT

There is a need to think deeply on the kind of technology that can be sustained in future. The depletion of non-renewable resources (of energy, metals and minerals) which form the backbone of modern technology, serious environmental impacts (like global warming) and social impacts (like violence, crime and extremism) arising from increasing inequity reflected in islands of opulence amidst a sea of poverty, show that this technology is inherently unsustainable. We seem to have reached the peak of reaping the benefits of modern centralized technologies and the detrimental consequences are beginning to predominate. Even international development agencies like UNDP now recognize that mere growth of economy is not sufficient to eradicate poverty; the growth should be pro-poor and needs to be based on labour intensive technologies. Decentralized manufacturing, especially of products of daily consumption, done in small and cottage industries located in rural areas, where the raw materials for the same are produced, seems to be the need of the hour. The challenges thrown to engineers by this emerging need, and the work done by a team of IITD professors over last few years to respond to this need are brought out in this paper.

1.0 INTRODUCTION

While the positive consequences of globalization of our economy are being highlighted so often, the flip side of the picture remains confined to the sidelines. The boom in economy with the BSE Sensex crossing 10,000, GDP growth rate expected to touch 8 %, new mega malls being opened in cities, all make headlines in the media; but thousands of farmers committing suicide every year, and the progressive increase in the public debt of the governments seems to be of little concern. Consider just a few facts about the ‘development’ of our country: about 35% of our population earns less than $1 per day, about 80% earns less than $2 a day; the total public debt of government in 2003 was 76% of the GDP, the number of unemployed in 2001-2 was 4.3 crores. Surely, these demand that we re-look deeply at the model of development we have followed hitherto.

The fundamental tenet of the model of development that we, and all other nations, have followed, is to promote economic growth through industrialization based on centralized high cost, high energy consuming technologies – often termed as “high technologies” most of which have been developed in the Europe and the US. It is hoped that the wealth thus generated would get
naturally distributed, almost uniformly, among all sections of the society by “trickle down effect” (‘through an invisible hand of providence’ first postulated by Adam Smith). The empirical evidence of last six decades shows that while there has been spectacular economic growth, the “trickle down effect” has been ineffective with the result that the gap between the ‘rich’ and the ‘poor’ has increased phenomenally. Consider this data from HDR-2005: the ratio of the earnings of the richest 10% to the poorest 10% range from 7.3 in India, to 15.9 in US, 18.4 in China, 39.1 in Argentina, 68 in Brazil and 128.8 in Namibia. In global terms the inequity is even more alarming: e.g. the average per capita income of a Norwegian citizen in 2004 was $52,030 in contrast to about $100 for the citizens of many African countries. To quote HDR-2005: “The world’s richest 500 individuals have a combined income greater than that of the poorest 416 million. Beyond these extremes, the 2.5 billion people living on less than $2 a day – 40% of the world’s population – account for 5% of the global income. The richest 10%, almost all of whom are in the high-income countries, account for 54%.”. No wonder, these stark inequalities have led to social turmoil throughout the world which manifests in myriad forms: increase in crimes like corruption, bribery, kidnapping for ransom, emergence of mafia dons in most metro cities who demand “protection” money from the rich people, extremist groups like naxalites in India who profess to “fight” against these inequalities, and various forms of “spontaneous” mob violence, like the recent riots in France. As a result we find today that in spite of “development” – some say it is because of it-- peace and harmony eludes the human race. The rich and the prosperous nations/people live in a state of insecurity arising from the fear of crime and violence, while the poor, not sure of even meeting their basic needs like food, clothing, shelter and health care, live in a state of insecurity arising from deprivation. The whole saga of “development” can thus be crisply summarized as: “skewed economic growth and moral shrinkage”.

2.0 DEVELOPMENT AND EQUITY

All the international agencies for development like the UN, UNDP, World Bank, IMF etc. now agree that development without equity is both economically and socially unsustainable. This is reflected by the fact that latest annual reports of both the World Bank – the world development report 2006, and that of UNDP – the human development report 2005, have their focus on promoting equity. This was also the main theme of the historic UN Millennium Summit in September 2000, where 189 countries adopted eight Millennium Development Goals (MDGs), of halving poverty (i.e. the proportion of people with income less than $1 a day) between 1990 and 2015, reducing child (under five) mortality by two thirds and maternal mortality ratio by three quarters between 1990 and 2015, and halting and reversing the spread of AIDS by 2015. In the five years that have passed since that solemn declaration, some progress has been made on fight against poverty, but as HDR – 2005 notes, “the overall report card on progress makes for depressing reading. Human development is faltering in some key areas, and already deep inequalities are widening”. The increase in social turmoil and the enormous increase in terrorism in last five years is an indirect reflection of this failure.

The problem of increasing inequity is, of course, a complex one; but the role played by the model of development and the technology choice is quite evident. We need to focus not just on over all
economic growth, but also its distribution, so that the poor have a greater share in future growth. Presently, the increase in income due to economic growth tends to be distributed in accordance with the existing income shares. Thus, for every Rs.100 generated by growth in India the poorest 20% would receive only Rs.8.9 while the share of the richest 20% would be Rs.43.3. If the development policies can achieve pro-poor growth, thus (say) doubling the share of the poorest section of the society, the poorest 20% would share Rs.17.8 out of Rs.100 generated by growth, thus reducing inequity. HDR-2003 gives some suggestions on how to achieve it: “growth is more likely to benefit poor people if it is broadly based rather than concentrated in a few sectors or regions, if it is labour intensive (as in agriculture or apparel) rather than capital intensive”. Clearly this demands a shift in the paradigm of development and the choice of technologies.

3.0 DECENTRALIZED MANUFACTURING – THE GANDHIAN ALTERNATIVE

The only way to achieve pro-poor growth is through decentralized manufacturing so that the wealth is generated in a distributed manner, by giving productive and satisfying employment to all, rather than generating it centrally and then hoping to distribute it through taxation, subsidies, unemployment allowance, and other measures of promoting social justice. This was the main thesis of Gandhiji’s concept of “gram swaraj”, i.e. village republics self sufficient in their basic needs like food, clothing and shelter by producing these locally. To achieve this Gandhiji advocated the revival of rural industries, and set up the All India Village Industries Association, AIVIA in 1934. It was clear to him that this could not be achieved without innovative inputs from science and technology, and therefore he repeatedly pleaded with the scientists and engineers to use their knowledge for developing new techniques for making decentralized manufacturing “sustainable” in its broadest sense, i.e. avoiding exploitation of both man and the Nature. His inaugural address to AIVIA in 1934 is very pertinent:

“------ there is such an infinite variety of industries to handle and organize that it will tax all of our business-talent, expert knowledge and scientific training. It cannot be achieved without hard toil, incessant endeavour and application of all our business and scientific abilities to this supreme purpose. Thus I sent a questionnaire to several of our well-known doctors and chemists asking them to enlighten me on the chemical analysis and different food values of polished and unpolished rice, jaggery and sugar etc. Many friends, I am thankful to say, have immediately responded, but only to confess that there has been no research in some of the directions I had inquired about. Is it not a tragedy that no scientist should be able to give me the chemical analysis of such a simple article as gur? The reason is that we have not thought of the villager....... I have just by one or two instances indicated my difficulty. What sort of organization should I have? What kind of laboratory research shall we have to go in for? We shall need a number of scientists and chemists prepared to lay not only their expert knowledge at our disposal, but to sit down in our laboratories and to devote hours of time free of charge to experiments in the directions I have indicated. We shall have not only to publish the results from time to time, but we shall have to inspect and certify various products. Also we shall have to find out whether the villager who produces an article of foodstuff rests content with exporting it and with using a
cheap substitute imported from outside. We shall have to see that the villagers become first of all self-contained and then cater for the needs of the city dwellers...........

Unfortunately, our S & T community failed to respond to this challenge, probably because the concept of “gram swaraj” appears to be more of a utopia visualized by a saintly person than a practical possibility suited for modern times when economies of scale achievable through centralization, and mass production through automation have become an inalienable part of our society. The manner in which science, technology and management principles have been established in the west, and are being taught throughout the world today, often creates a mindset which refuses to even examine the possibility of what Gandhiji called “production by masses” as an alternative to mass production. At IIT Delhi, a detailed feasibility analysis of this concept was initiated in late eighties and completed in 1991. The results of this study, presented in some details elsewhere, establish the technical and economic feasibility of setting up self-sufficient village republics by using the technologies available at present for the cottage and village industries.

Of course, if we focus only on the product quality, productivity and the cost per unit of production the centralized industries seem to be much superior. However, if we also include factors like employment generated per unit capital investment, energy consumed per unit of production, environmental impact etc. the picture begins to change. If we couple this with the problems created by centralized industrialization discussed above, it become imperative to relook into the possibility of achieving growth with equity through rural industrialization. It is evident that by providing comprehensive inputs of science, technology and management in the village industries – just as has been provided to the centralized industries systematically throughout the world -- it should be possible to improve the product quality, productivity and marketability of the produce of village industries. There have been sporadic efforts in various S&T institutions of our country, and abroad, in this direction. Indian Institute of Science, Bangalore was probably the first such national institute where an interdisciplinary centre called ASTRA – application of science and technology to rural areas – was formed in 1974. Many IITs followed suit and work on rural technologies was initiated by a small number of faculty members in these institutes out of their intrinsic motivation. This has resulted in many new technologies for renewable energy systems, low cost housing, food storage, agro-processing etc. many of which have been transferred to the field. IIT Delhi launched the first comprehensive programme of strengthening rural industrialization in the country in 2001 with the financial support of KVIC, some details of which are presented below.

4.0 IITD-KVIC PROJECT

KVIC (Khadi and Village Industries Commission) is the main governmental agency, set up by an act of parliament in 1956, for promoting Khadi and village industries in the country. It has an in-house R&D centre in Wardha named JBCRI (Jamnalal Bajaj Central Research Institute). JBCRI has had a hoary past, and stalwarts like J.C. Kumarappa and Devender Bhai were associated with it and it is located in the same premises where Gandhiji started the AIVIA in 1934. It made good contribution to development of rural technologies till 1976, but thereafter, due to a variety of
reasons, no R&D work could be undertaken. A number of committees went into the causes for the same and suggested measures to revive this institute. It is in this background that KVIC approached IIT Delhi in 2001 to revamp this institute so that it could again “play a dominant role in the development of suitable technological innovations in the village industries compatible with the demands of the day”. It was a turnkey project that involved developing a comprehensive vision for this institute, the necessary infrastructure including well-equipped laboratories, linkage with prominent S&T institutions and NGOs, and most importantly a field demonstration of the viability of S&T interventions in strengthening rural industrialization. This project has just been concluded. A comprehensive Detailed Project Report giving the complete vision, its organization structure, the staff and budget requirements has been prepared. The necessary infrastructure, including well-equipped laboratories has been set up, and a network of NGOs and S&T institutions agreeable to work with this new institution, which has been named Mahatma Gandhi Institute for Rural Industrialization, has been formed. The approvals necessary to declare it an autonomous institute of the Ministry of ARI, Government of India, with its own dedicated staff, are likely to be obtained soon. I would like to focus here on some of the technology development work done during this project to bring out the challenges of strengthening rural industrialization and the possibilities of innovative work for engineers.

4.1 Khadi sector

From a purely scientific perspective, khadi garments – because of their porosity arising from loose fiber-fiber bonding, good moisture absorption characteristics and eco friendly nature of the fiber- are best suited for tropical climates like ours. Yet, these are not so popular because of their inconsistent quality, coarse finish, lack of good designs, and also because of some additional technologies introduced in the mill sector like “wrinkle free”, which make their garments much more user-friendly. As a part of this project the technologies used in the mill sector- mercerization, soft and stiff finish, wrinkle free finish - were scaled down to the cottage level in such a manner that these could be employed in the Khadi sector with minimal capital investment. Two of these finishing technologies – the soft and stiff finish-- have been adopted at a number of Khadi units, and garments treated with these finishing techniques are being sold at higher price. KVIC has set up a model garment-finishing unit using these simple technologies at Barabanki and old stocks of khadi garments worth over Rs30 lacs have been treated and sold over last few years. Another major effort has been in development of a Quality Control manual for Khadi so that consistent quality of the products could be maintained. Some other technological interventions include development of simple machines for mercerization of the Khadi yarn in order to prevent any harm to the workers from sodium hydroxide used in the process, blending wool with acrylic for shawls and special protective clothing for beekeepers.

4.2 Rural Chemical “industries”

There are a number of products being made traditionally in cottage industries wherein inputs from chemical engineers can go a long way to improve the product quality, its economics and the
productivity. Three important products were identified after interaction with field agencies for intervention during the project, viz. soap, leather and pottery clay.

The main challenge in improving the quality of the soap being made in the VI sector is that of getting good and consistent quality soap, at competitive costs from poor quality raw materials. The technologies being used in the organized sector for fat splitting and glycerin recovery need to be properly scaled down without impairing the cost-benefit ratio. Work on both these technologies has been initiated during the project. Innovative, low cost quality control measures need to be introduced to test the quality of raw materials as also the final product. As a first step in this direction a quality control manual for non-edible oils used in soap industry has been prepared and a portable kit has been developed to test the quality of raw materials and the soap produced.

The traditional leather workers in rural areas have been victims of social barriers due to a variety of reasons, and this cottage “industry” is now facing extinction. The offensive nature of the process of handling carcass and the by-products deters young people from taking up this profession. Leather industry, including that in the organized sector, has also been associated with environmental problems arising from poisonous effluents. During the project attempts have been made to address some of these issues. Thus a new technology for composting of the carcass has been introduced at a KVIC unit in Kalyani (WB) with excellent results – elimination of all offensive odours and production of high quality compost, which they have been able to sell at a premium. Improved techniques for vegetable tanning of leather and a simple process for recovery of chrome from tannery waste are also under development.

Pottery is one of the most ancient crafts practiced by mankind. In the area around Wardha, the potters are facing a unique problem. The black cotton soil was earlier being used in pottery by mixing it with horse dung. As the horses have almost disappeared from the region, the potters are unable to use this local soil and need to procure clay from far off areas thus adversely affecting their economy. The challenge is to develop new, but locally available, binders that can make the black cotton soil suitable for potters. Extensive studies have been done in this direction and some binders identified which have increased the ratio of black cotton soil that can be safely mixed with other clays, but still much remains to be done.

4.3 **Bio-processing based “industries”**

There is a whole range of technical issues pertaining to ‘emerging’ agricultural practices and the processing of agro products in rural industries that merit consideration of chemical, thermal, food and agricultural engineers. With increasing emphasis on production of high value organic ‘health’ foods, there is a new avenue of developing rural entrepreneurs providing quality bio-manures and pesticides needed for organic farming. As a part of the project standards have been developed, for the first time, for quality assurance of bio manures. A portable diagnostic kit to help ‘measure’ the quality has also been developed to ensure that farmers can know the efficacy of the compost they are using. Studies have also been carried out to assess the shelf life of these composts under various storage conditions so that the users can know the extent of deterioration in the efficacy of these manures with passage of time. To create a culture of decentralized solid waste disposal, portable household vermi-composting units have been developed for conversion of kitchen waste...
into useful product. Vermi-wash is another emerging product for enrichment of the composts and detailed field trials have been carried out to establish the efficacy of these enriched composts in increasing crop output.

In view of the worldwide recognition of the beneficial effects of herbal products, there is a great potential for setting up of rural “industries” for a variety of herbal healthcare and food products. The nutritive and therapeutic effectiveness of these products is, in general, the highest when the processing is done slowly without raising the temperature too much. Thus these are ideally suited for rural industries. Unfortunately, the traditional manufacturers of such products, including those manufacturing ayurvedic products, often do not take enough care to follow good manufacturing practices (GMP) resulting in inconsistent quality and bad publicity for the whole sector. During our project we have focused on these quality issues and developed, as an example, standards for some common herbal and panchgavya products using modern spectroscopic techniques, and a manual of GMP for herbal products. A number of new herbal products like vatnashak oil, herbal hair tonic, herbal mehndi etc; and some value added products based on forest produce like tamarind and amla have also been developed, and preliminary field tests have shown their good acceptance by users.

4.4 Rural Crafts and engineering

Craftsmen and artisans have been an integral part of our culture for millennia, our traditional engineers and architects, but the onslaught of mechanization has brought untold misery to them. Very little attention has been given by S&T community to ameliorate their condition and help them retrieve their rightful position in the society. Finding innovative ways and means of empowering artisans was a key part of our project. A series of path-breaking workshops were organized in which traditional artisans, industrial design professors from IITs and some other reputed fine arts colleges, and a professionally trained sculptor interacted for three weeks, working together under a common roof to develop innovative designs and related techniques for different crafts like pottery, metal and stone works, bamboo crafts, twig and branch furniture etc. Numerous novel product designs were developed during these workshops and displayed in exhibitions.

As a part of empowering artisans trained in the traditional way, the process of their certification through IGNOU using its concept of distance education has been conceived. To start with, the programme of certification of potters has been initiated. Comprehensive curriculum development, preparation of suitable study material, and identification of suitable study centres has been done by IGNOU and about 300 potters from various parts of the country are presently undergoing this programme. It is proposed to develop similar programmes for other trades followed by distance learning packages for the award of Diploma and Bachelors degree to various craftsmen so that they can get integrated into the mainstream technical education.

As a part of rural engineering activity, a series of workshops were held for the welders working in rural areas of Punjab to improve their productivity, product quality and create awareness about safety issues related to this field. These workshops evoked tremendous response showing the zeal of the traditionally trained people to learn more and improve their skills.
4.5 Energy and Infrastructure

Lack of availability of commercial energy has been one of the key factors hindering rural industrialization. Development of reliable, efficient and user-friendly decentralized energy systems using resources abundantly available in rural areas, like biomass, animals and water streams (especially in hilly areas), is thus a great challenge for engineers. The work done in the project in these areas includes: a comprehensive technology package for biogas enrichment and compression into high pressure cylinders; pollution free biomass burners and gasifiers and engine systems using this gas; improved low cost and high efficiency micro-hydel turbines and animal driven prime movers.

Efficient use of energy is another challenge in many rural industries like honey processing, gur and soap making and crafts like pottery, metal works etc. The key requirement is to improve energy efficiency without increasing the cost. As an illustration we can cite the work done in improving an updraft pottery kiln used by traditional potters whereby the efficiency is increased by 30% without any increase (there is in fact a marginal reduction) in its cost. Surely there exists a potential to do even greater savings in many other village industries.

4.6 Management and Systems

The management (including quality assurance) techniques being taught to the budding engineers and managers today are entirely oriented towards the centralized manufacturing practices prevalent in the organized sector and most of these can not be directly employed to decentralized manufacturing practised in village industries. Development of such systems is thus a major challenge before the science, technology and management experts. As a part of the project, a generic template for Q/A system for decentralized manufacturing sector was developed. Use of modern techniques like MIS is also imperative to improve the functioning and productivity of VI units and this was demonstrated by developing such a system for a major KVIC certified outlet.

There is also a need for improving the marketability of the products of KVI sector by improving their packaging, and developing innovative ways of sales promotion through, for example, the use of Internet. As a first step in this direction, the work on developing a comprehensive web-based GIS for KVI sector has been initiated during this project.

4.7 Technical Interface Units of MGIRI

An important part of the project was to develop linkage with other S&T institutions and NGOs working in this direction. Most of the technology development work and subsequent dissemination has been done in collaboration with prominent NGOs in various parts of the country. To involve other S&T institutions in this endeavour, twelve technical interface units (TIU) of MGIRI have been set up during this project in five other IITs, some prominent NITs and other engineering colleges of the country. These TIUs act like arms of MGIRI spread across the length and the breadth of the country and have the same objective of strengthening rural industrialization by working on technologies relevant to that region. Some of the novel areas of work initiated by these interfaces include optimization of heat treatment of agricultural tools,
using agricultural wastes and non edible biomass for producing laminates, activated charcoal and other value added products; small scale cotton ginning machine; optimal design of reactors for bio-diesel production in cottage industries; low cost/locally available housing materials; value addition in locally available food materials through innovative processing; pedal driven machinery like electric generators etc.

5.0 CONCLUDING REMARKS

It should be evident from the above presentation that strengthening rural industrialization offers a wonderful opportunity, and a challenge, to our engineers to use their creativity and ingenuity and develop “appropriate technologies” which will enable “production by masses” to compete with “mass production”. Our experience shows that there are certain niche areas like herbal and organic health foods, bakery products, soaps and other toiletry products, handmade paper based products, and biomass based energy systems, micro-hydel systems etc. where decentralized production in rural areas has a natural edge over centralized production in urban and semi-urban locales. If sufficient attention is given by engineers to improve the existing primitive technologies used in this sector it should be possible to produce high quality products in rural industries at very competitive prices.

The focus of attention of consulting engineers — whether in the S&T institutes or in the field— has hitherto been in the mainstream areas of the so-called “organized sector”. Here is an opportunity to diversify to new territories. This is certainly challenging, but it promises to be enormously satisfying especially when we appreciate the importance of strengthening rural industrialization from the social perspective of reducing ever-growing strife in the society caused by increasing inequity. It is very crucial to appreciate that mere economic growth in the organized sector is not enough to eliminate poverty; it should be pro-poor growth where the wealth is produced in a distributed manner, since only that will lead to development with equity.

This is also necessitated by other facts staring humanity in the face: dwindling fossil fuels, metals and minerals (expected to last 50 years, by the most optimistic estimates), increasing environmental pollution and resultant global warming. Clearly, from a long-term perspective (of more than fifty years), modern fossil fuel based technology is inherently unsustainable. Rural industries based on renewable resources for energy and matter (mostly harvesting of solar energy through biomass directly, and through animals indirectly) seems to be the only hope for the long-term future. It would therefore not be an exaggeration to term rural industrialization as the technology of the future. The challenge before engineers is to start working towards appropriate technologies well in time to ensure a smooth and peaceful transition from a society based primarily on centralized fossil fuel based technologies to one using primarily renewable energy based decentralized technologies.

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7.0 REFERENCES