Talukas can provide critical mass for India's sustainable development

Anil K. Rajvanshi

It is suggested that talukas in India can provide critical mass for sustainable development. A study done for Phaltan taluka in western Maharashtra has shown that all its energy needs like electricity, liquid fuel, etc. can be met by judicious use of agricultural residues and other biomass resources grown in the taluka. The study also suggests that biomass energy-based supply options have the capacity to create substantial wealth and employment in any taluka. An energy and food self-sufficient taluka can be a new paradigm of rural development. Various technological and policy issues needed to move this concept forward are outlined.

THE energy situation in most developing countries is quite alarming. Energy is the basis of all activities. From it flow activities in agricultural, economic and social areas. Without adequate energy, the development of these countries is jeopardized resulting in economic stagnation and hence in tremendous internal upheavals. Consider the following facts:

1. In 1995–96, India imported about Rs 40,000 crore worth of petroleum products. The petroleum import bill was 25% of the total export earnings. The demand for petroleum products is increasing at the rate of 7–8% per annum and with increased economic growth the rate will increase further[1]. It is estimated that in 2001–02 India will be importing petroleum products worth Rs 70,000 crore[2].
2. In 1996, the electricity shortfall in India was estimated to be 15,000 MW and the Government of India does not have money to install this additional capacity. Even if this capacity is somehow added, there are estimates that half of the population in rural areas will not have access to electricity. India requires about 140,000 MW of additional capacity by the year 2010, with an estimated outlay of about Rs 5,50,000 crore. Because of tremendous shortage of electricity, industrial growth and general life in the country is seriously affected[3]. Moreover with any problems in the national grid, rural areas are affected the most, since the state electricity boards provide urban areas with electricity on priority basis.
3. In the ghettos of Delhi and Surat (the twelfth largest and the fastest growing city in India with a population of about 2 million) about 500 people died of dengue fever in 1996 and of plague in 1994, respectively. This was a direct consequence of extremely unhygienic, filthy and overcrowded conditions prevalent in the two cities. The ghettos are composed of migrant labourers from rural areas. The plague epidemic had a very negative effect on foreign investment in India[4].
4. In Mumbai, in 1992, about 400 people died and property worth crores of rupees was looted and destroyed as an aftermath of destruction of the Babri mosque located 2000 km away in a remote town of Uttar Pradesh. The carnage had little to do with the destruction of an ancient religious structure, but was due to a release of pent-up emotions of a population which is mostly made up of migrants from rural areas and who live in overcrowded and increasingly difficult conditions. The events in Mumbai (the commercial capital of India) had a very negative effect on international and local investment[5]. The effects are felt even today.
5. Between 1950 and 1995, the Government of India spent Rs 50,000 crore on surface irrigation projects, including storage facilities. Till today only 50% of these irrigation facilities, built at such an enormous cost, are being properly utilized. Hence most of the country as usual goes through the cycle of floods and droughts. Besides, the increased use of inorganic fertilizers and pesticides to sustain Green Revolution is reducing the fertility of land, thereby compounding the land–water management problem[6].
6. Developing countries are spending between 2 and 8% of their GNP on medical costs related to declining environment. Thus in India, the number of premature deaths in cities due to environmental pollution is ~ 52,000/year and the number of hospitalizations (due to asthma and other lung-related diseases) was ~ 25 million last year. These casualties cost India about Rs 4600 crore/year, which is equivalent to the cost of adding 1150 MW electricity to the grid every year[7].

Anil K. Rajvanshi is in the Nimbkar Agricultural Research Institute, P.O. Box 44, Phaltan 415 523, India
e-mail: anilrajvanshi@vsnl.com

We feel that these events are a direct consequence of a lopsided development model that developing countries like India have been following and which is leading to an undercurrent of economic discontent. The model is based on a 50–100-year-old model of the Western countries, which includes centralized energy production, development of megacities at the expense of rural areas and the unsustainable husbanding of land. This development model has led to high levels of unemployment and poor quality of life in rural India and large-scale exodus of the population to big cities. This exodus is the result of lack of sustainable agriculture in rural areas.

Agriculture is mostly dependent on energy. Lack of energy is therefore the single-most important reason for decline of agriculture-based activity and hence the economic activity in rural areas. A sustainable food and energy strategy for rural areas will therefore create new economic activity and can stem the desperate exodus to cities. With an ever-increasing unmet demand for goods and services, because of economic reasons, a great chasm is developing between haves and have-nots, which is resulting in conflict and a general unrest in the country. The present slowdown in the Indian economy is also creating large-scale unemployment and could further create frightening scenarios of social instability, if timely correction is not made.

It can also be argued that the above situation and events have come about because of mismanagement by and corruption in the Indian Government. But it is our belief that the centralized big-government model in developing countries inherently leads to corruption and mismanagement.

The increase in demand for goods has also led to a sharp increase in energy usage, both in urban and rural areas. With increased penetration of electronic media, the citizens of developing countries aspire for quality of life available in developed countries. Sometimes one wonders whether the wasteful Western quality of life is better and desirable. For example, the US alone is contributing 30% of global greenhouse gas pollution[8]. However, if all the people in developing countries like India and China (40% of mankind) have energy consumption similar to that in the US or Europe, then it will have a disastrous effect on the world economy and environment. Thus there are estimates that oil energy consumption in developing countries could surpass that in developed countries within 20 years[9]. This will create great conflict among nations and it is quite possible that in future the wars will be fought over energy resources. There is, therefore, a need for an alternative development model based upon renewable energies, which is decentralized and takes into account the aspirations of the rural population.

Historically, it has been shown that the quality of life is proportional to the per capita energy consumption. Energy consumption of a country can be broken into two parts – the cumulative energy consumption $E_I = \int E_c \, dt$, where E_c is energy consumption of the country at any point in time and E_{II} is the energy consumption per capita per year. E_I goes in building infrastructure like roads, bridges, power plants, communication networks, etc. During the early and middle parts of this century, developing countries because of historical reasons (most of them were colonized), had very little of E_I. Thus it is difficult for them to reach the US or European quality of life, even if E_{II} somehow becomes available. Since the lifestyle in Western countries is unattainable, we should try to develop an alternative lifestyle in India. I think a lifestyle based on the maxim of 'simple living and high thinking' is a possible choice. Thus our ancient philosophical thought should be used to temper our greed for resources and energy. Gandhiji showed that with minimum needs and energy he was capable of producing the highest quality of thought. This has also been the tradition of our great saints[10]. The Gandhian model may be difficult to follow, but it shows the way towards low energy development strategy.

In India about 75% of the population lives in rural and semi-urban areas. It is estimated that for the next 50 years or so, the major part of the population in India and other developing countries will still be village-based. Hence rather than pumping in huge resources in urban areas where the quality of life is becoming worse by continuing on the present path, it is much better to improve the quality of life in rural areas through an alternative model based upon sustainable growth and renewable energy.

In the past, most development efforts for rural poor have focused on villages. But because of inadequate infrastructure, income-generating capability and economic power, they have become sinks for development funds. There are a large number of examples the world over where well-meaning development efforts in small villages have not yielded the desired results. Villages are small but they are unsustainable. Cities in developing countries on the other hand may have rapid growth and development, but they have an ugly growth pattern. Therefore a middle path of a taluka-based development model is being proposed for sustainable rural society.

What is a taluka?

A taluka is an administrative block generally comprising about 90–100 contiguous villages, with a small town as its headquarters. On an average 8 to 10 talukas make up a district. For example, in Maharashtra there are 30 districts and 236 talukas. The average area of a taluka is ~ 1000–1500 km^2 and its total population is between 200,000 and 250,000. The town population is about 50,000. Data on commercial energy usage show that on an average a taluka consumes about 10–15 MW of electricity and about 10–15 million litres/year of petroleum products[11]. There are about 3342 talukas in India. The major economic activity in a taluka is primarily agriculture-based.

Since the geographical boundaries of a taluka are fixed, it can be thought of as a closed biomass and rainwater basin. It is the thesis of the author that a taluka can produce a majority of its demand of food, fuel, fodder and fertilizer from the natural resources and agro-based material available in it and hence the development can be truly sustainable. For some talukas that do not have sufficient biomass, other sources like solar and wind can be used to produce energy.

Why a taluka-based model?

Societies are living and dynamic structures. In an evolutionary process, they can be thought to follow the laws of a natural living system. The hallmark of evolution of a dynamic system is its size reduction, increase in energy usage efficiency, increase in complexity, possession of critical mass, and its 'punctuated equilibrium' with its surroundings. In the 'punctuated equilibrium' phase, the system stabilizes for a certain time[12]. One of the crucial conditions for the evolution of a dynamic system is the availability of critical mass. The critical mass enables the system to process materials and energy through it and hence allows it to grow. If the critical mass is not available, the system does not grow and dies-off.

Societies can also be thought to be like Prigogine's dissipative structures[13]. For example, a convection cell in a body of water heated from below is a dissipative structure and is energy-dependent. The resulting shape of these structures therefore depends on the quality and quantity of energy passing through them[13]. The systems possessing a critical mass grow with energy input and go through a 'punctuated equilibrium' phase after which they become unstable and collapse into smaller systems. These small systems then coalesce through time and again form a critical mass and the cycle continues.

However for the societal systems to grow in a sustainable manner, certain conditions have to be fulfilled. Thus sustainable systems can be compared to a chair[14]. The four legs of this chair can be thought to be made of four activities: Energy, Economic, Environmental and Equity (social/cultural issues). All of them have to be of equal size for comfortable sitting and interconnected to provide stability. The base (seat) has to be of the right size. Too big a base will make the chair sag and too small a base will make it unstable. Correct base size can therefore be thought of as the critical mass.

It is our thesis that because of its population size and its fairly developed infrastructure, a taluka has the ability to form a critical mass for a sustainable society for developing countries. With proper use of its agricultural and natural resources, it can produce food, feed and fertilizer in a self-reliant, environmentally sound and economically attractive manner. Hence it can provide the four legs of the chair for sustainable development. As the energy and other resources available are decentralized in nature, a taluka can form an appropriate 'dissipative structure' and can remain in 'punctuated equilibrium' phase.

From the above evolutionary model it can also be conjectured that in future, with the increasing use of renewable energy, all societies will evolve to be decentralized, high technology-dependent and village-based. Similarly, the mega-cities will break into smaller sustainable units. India is already a village-based decentralized society. Hence, instead of following the mega-city-based model, it is better to arrest this trend by introducing high-technology systems in the taluka. These high-technology systems may include internet connectivity, desktop-manufacturing units, and micropower production systems like microturbines and fuel cells.

Taluka model

India produces in its talukas ~ 400 million tons/year of agricultural residues which theoretically can produce ~ 53,000 MW of power through biomass-based power plants[11]. This power is 70% of the total amount available in the country at present from all other sources[3]. Not only can these residues produce adequate power to supplement existing power production, but husbanding this resource properly can also produce adequate animal feed and fertilizer. With increasing food production, the quantity of agricultural residue will also increase. Its judicious use will improve the rural economy and the quality of land. However, this agricultural residue is spread all over the country and is dispersed. This points towards decentralized power production systems.

Besides producing power, the challenge is also to maintain high quality and productivity of land so that food, animal feed, fertilizer and fuel could be produced in a sustainable manner from it. For this, water and soil conservation has to be implemented. It is possible to achieve this by rainwater harvesting and by planting trees and grasses and general management of biomass resources in talukas. As the economic returns will be directly dependent on the increased biomass production, the landowners in a taluka will take up such measures readily. The strategy will also help increase the income of the farmers (since they will get money from residues which are presently wasted), will provide jobs for labourers in each taluka to collect residues and will create employment in other biomass-based industries. It is estimated that each taluka can create about 30,000 new jobs from such activities[15].

Following this approach an energy self-sufficient taluka model was developed[15]. This model was developed for Phaltan taluka. However we feel that this methodology can be easily used for other talukas in the country. The strategy for taking care of energy needs was based on biomass resources. Based upon the historical data of energy needs for Phaltan taluka[15] it was found (as of 1995) that in the year 2000, it would require about 13×10^8 MJ of electricity and about 26 million litres of petroleum products (diesel, petrol and kerosene)[15]. It was established that all this energy can be easily met by biomass-based power plants, production of ethanol from sweet sorghum and from existing distilleries, and pyrolysis oil production from agricultural residues and energy plantations. Electricity from biomass-based power plants would replace the MSEB-supplied electricity, while ethanol and pyrolysis oil would replace the liquid petroleum products. The technology for producing all these products already exists[16,17]. The details of the strategy are given in Rajavanshi[15]. This study also showed that with a capital input of Rs 300 crore, Phaltan taluka can produce wealth of Rs 220 crore/year and provide employment to about 30,000 people year-round.

This study became the basis of a national policy on energy self-sufficient talukas and was adopted by the Government of India in 1996 (ref. 11). As a part of this policy, presently all the states in India are collecting data on availability of biomass residues in their talukas. This study therefore showed that it is possible to provide all the energy needs of a taluka from its own resources, thereby pointing towards sustainability.

One of the tragedies of rural areas in India and other developing countries has been the lack of production of value-added goods. This has resulted in very little remuneration to the farmers and hence the depletion of rural wealth. We feel that a taluka provides a critical mass for production of agro-based and value-added products. With availability of power and raw materials (agriculture-based), fertilizers, chemicals, processed food products, etc. can be produced. With smart 'bench-top' production facilities available in future, it may be possible to produce substantial amounts of locally consumed items. This will further help in increasing the wealth of a taluka and in creating extra employment. Recently, micropower projects like gas-based microturbines and fuel cells are becoming available[16,18]. They will further usher in an era of efficient small-scale manufacturing facilities. Identification and evaluation of such cutting-edge technologies for both agro-based industries and consumer products will help talukas leapfrog into the modern age.

Technological issues

There are some other issues that need to be tackled before the taluka model can become truly sustainable and self-sufficient in energy and food production. They are transportation, water supply, environmental pollution, and fertilizer production.

Transportation

The Phaltan taluka study showed that ethanol and pyrolysis oil production can take care of the historical demand of transportation for Phaltan taluka. However, this will fuel the already explosive growth of two-wheelers and three-wheelers. An alternative to the existing vehicles is electric cycle-rickshaws[19]. These are 40% more efficient than existing petrol and diesel three-wheelers and are also environmentally sound transportation systems. The electric rickshaw can easily take 2–3 passengers at 30–35 km/h and can go up to 60 km with one battery charge[19]. It is our belief that these vehicles can easily provide the public transport system for talukas (20–25 km radius travel). For inter-taluka travel, ethanol and pyrolysis oil fuel can be used to run the existing fast-moving vehicles like two- and four-wheelers and also help in reducing environmental pollution. Historically, it has been shown that the structure of towns and cities is mostly guided by the transport system. It is our belief that with electric cycle-rickshaws, the size of existing taluka towns can be maintained.

Water supply

A large number of talukas in various parts of Gujarat, Rajasthan, Maharashtra, Andhra Pradesh, etc. have woefully inadequate water supply. This greatly reduces the agricultural activities besides creating conditions for water-borne diseases to spread. The government naturally has gone for mega irrigation projects, which have not helped the cause[6]. The time has come to think of private, decentralized water utilities. This will include rainwater harvesting and treating and recycling used water. Just like the power utilities, one can think of water utilities in a taluka. Anecdotal data suggest that rural people are ready to pay the necessary price for assured and good supply of water. There will still be pockets of resistance for paying for water (which in most places is free and hence wasted), but that resistance can be overcome by the quality of water supply. Water on demand is a luxury in most areas of India and hence its availability can ensure proper payment. Rainwater harvesting can create good supply of water for both agriculture and household uses. Our data showed that rainwater harvesting in Phaltan taluka can yield 4 to 5 times more water per year than the existing canal supply[15]. This water can be collected in 3000 check dams of about 1 ha size and can supply water, both for irrigation and household purposes in Phaltan taluka[20]. The cost of water from such a supply will come to 1 paisa/litre. The Nira Right Bank Canal is the main source of water for both irrigation and water supply for Phaltan taluka. A private utility in a taluka can manage this easily compared to the corrupt public system. There are a good number of examples of cooperative society-managed water utilities which are coming up in

India and their examples can be followed for talukas[21,22]. With increased water supply, there will be a tremendous increase in agricultural production and consequently in availability of agricultural residues, thereby helping both power and fertilizer production in talukas.

Environmental pollution

Environmental pollution in taluka areas is normally from three sources: (i) Agroprocessing industries like food processing, distilleries, etc.; (ii) vehicular pollution, and (iii) sewage. Vehicular pollution can be taken care of by use of ethanol and pyrolysis oil in existing vehicles and with the use of battery-powered vehicles for shorter distances. Agro industries produce tremendous pollution in rural areas and destroy the water and land resources by their effluents. In Phaltan taluka there is one distillery of 30,000 l/day capacity, which produces about 450,000 l of effluent[15]. With an average COD (chemical oxygen demand) loading of 100,000 mg/l in the effluent, its treatment can put tremendous pressures on water supply. Various technologies like solar detoxification of effluents are becoming available and can be used[23]. Here again the role of water utilities becomes important. The effluents can be treated and made available to farmers as irrigation water. Similarly, sewage treatment can also come under the umbrella of water utilities.

Fertilizer production

Availability of organic fertilizer is extremely important to maintain fertility of the soil and hence sustainability of land. With almost all the agricultural residues taken for energy generation, the fertilizer issue can become critical. However, there exists enough potential for making fertilizer from night-soil and composting of weeds and vegetable waste so that the possibility of fertilizer issue to be solved exists. Our study showed that enough night-soil and dung (from draught animals, poultry and sheep/goat) exists and it can be used with unutilized biomass (weeds, grasses, etc.) to produce excellent fertilizer[15]. Also, the increased agricultural activity (because of availability of water) will create more residues, which can go for fertilizer production. Technologies also exist whereby these materials can be composted in fast reactors[24,25]. With the availability of power in a taluka, it is felt that the production of organic fertilizer can become a major industry. Farmers presently sell raw dung in rural Maharashtra at a good profit. With the processing of this dung, remuneration to the farmers can increase further. There will nevertheless be a competition for agricultural residues between the power plant and the fertilizer factory. However, we feel that the market forces will ultimately decide their allocation.

Policy issues

The following policy issues will have to be addressed before the above scenario can become a reality:

(a) A policy decision will have to be made by the Government of India to set up a Taluka Development Corporation and invite private-sector participation in setting up power and water utilities in talukas. A partnership among the corporate sector, local NGOs and the government can be a new paradigm for rural development.

(b) A policy will also have to be formulated so that the corporate sector will not only produce power/water, but will also be allowed to carry out its distribution. Most of the independent power projects have been bogged down by the disputes regarding distribution. Only possession of distribution rights will allow the utilities to make money and give good service.

(c) Since both power and water production is from renewable sources (biomass and rain), existing norms, tax benefits and soft loans applicable and available to renewable energy sources should be made available to the corporate sector involved in the taluka programme.

(d) Policy decisions will also have to be made by municipal corporations/bodies of taluka towns to allow only environmentally sound vehicles to ply within the town. Since the area of a taluka and the number of vehicles running in each taluka are small, it may be possible to manage this issue.

It is our thesis that in a democratic society like India, sustainable taluka development will decentralize economic and hence political power. Decentralization of economic and political power is the best bet against economic deprivation, corruption and unaccountable ruling elite and can be the engine for internal peace, stability and development of a compassionate society. It is my belief that development and democracy work best in a decentralized power structure, a message that was constantly preached by Gandhiji. I also feel that the taluka plan has the potential of producing a sustainable society for one-fifth of mankind (India's population) and in the process can show the world a new way.

One of the great strengths of India is that the majority of its people can be satisfied with a few material comforts. This strength can become useful in the paradigm outlined in this paper. In a democratic set-up, one cannot force the population into a certain lifestyle. But the existing traditions, norms, strengths, etc. can be used to guide the society into sustainable living. We hope this paper will help start a debate on this issue.

1. Sarma, E. A. S., pers. commun., Ministry of Power, Govt. of India, October 1997.
2. Anupama Airy, *Indian Express*, 1 September 2000.
3. *Power Map of India 1995*, Central Board of Irrigation and Power, Government of India, New Delhi, 1995.

4. Shah, G., *Economic and Political Weekly*, 1994, vol. XXIX, pp. 2671–2676.
5. Engineer, A. A., *Economic and Political Weekly*, 1993, vol. XXVIII, pp. 81–85.
6. Vohra, B. B., RGICS Paper No. 35, Rajiv Gandhi Foundation, New Delhi, 1996, p. 46.
7. Kumar, Priti, *Down to Earth*, 1997, **6**, 29–43.
8. World Resource Institute, USA, http://www.wri.org/climate/contributions_map.html.
9. Hatfield, C. B., *Nature*, 1997, **387**, 121.
10. Rajvanshi, A. K., Acceptance Speech for Jamnalal Bajaj Award 2001, delivered at Mumbai on 6 November 2001.
11. Task Force Report, Ministry of Non-conventional Energy Sources, Government of India, New Delhi, March 1995.
12. Per Bak, *et al*., *New Sci.*, 1994, **141**, 36–39.
13. Prigogine, Ilya, *From Being to Becoming*, W. H. Freeman and Company, San Francisco, 1980.
14. di Casti, Francisco, *Nat. Resour.*, 1995, **31**, 207.
15. Rajvanshi, A. K., *Economic and Political Weekly*, 1995, vol. XXX, pp. 3315–3319.
16. Dunn, Seth, *Renewable Energy World*, 2000, **3**, 80–89.
17. Weinberg, Carl, J., *Cogeneration and On-Site Power Production*, 2001, **2**, 49–64.
18. Fairley, Peter, *MIT Technol. Rev.*, 2001, **104**.
19. Rajvanshi, A. K., *Human Power*, Winter 1999–2000, No. 49, pp. 15–18.
20. Agrawal, Anil and Narain Sunita (eds), *Dying Wisdom*, Centre for Science and Environment, New Delhi, 1997, p. 321.
21. Fernandez, Aloysius, P., *ILEIA Newsl.*, 1998, **14**, 12–13.
22. Kakade, B. K., *Leisa India*, 2000, **2**, 18; 40.
23. Rajvanshi, A. K., Final Project Report submitted to MNES, New Delhi, June 1999, p. 63.
24. Cuevas, Virginia, C., *ILEIA Newsl.*, 1993, **9**, 11–12.
25. Moorthy, V. K., *LEISA India (Suppl.)*, 1999, **1**, 12–14.

ACKNOWLEDGEMENT. I thank Prof. S. P. Sukhatme and Dr C. R. Bhatia for their helpful comments and suggestions.

Received 3 January 2002; accepted 17 January 2002