

People's Participation Needed to Overcome Energy Problems

by Sharah-e-Hasan

CHILDREN picking up twigs, bullock carts heading for the local market loaded with fuelwood or housewives pasting dung cakes on mud walls of houses are a common sight in villages in this land of ours. In rural areas fuelwood is extracted by men. Women and children are involved in the gathering of fallen branches, twigs, leaves, agricultural residues, preparing and drying animal dung cakes.

Previously the rural agricultural system was almost self-sufficient in energy needs. To meet the growing fuel demand for an ever-increasing population, commercial energy in agriculture for irrigation and tillage has grown in importance. Electricity and diesel are used for running irrigation pumps depending on their availability at specific locations. Sudden failure in supply causes havoc in present-day rural production systems.

Biomass fuels obtained from trees, field crops and livestock play an important role in meeting the total energy demand and will continue to do so in the foreseeable future. Due to the scarcity of fuelwood, a high proportion — 70 to 80 per cent — of biomass fuels comes from agricultural residues and animal dung and thus agricultural land is deprived of organic nutrients.

In rural and urban households lower-income groups are forced to spend a good proportion of their meagre income on fuel and lighting which reduce their caloric intake. Unplanned use of biomass fuels is responsible for environmental degradation.

Prime Minister Begum Khaleda Zia in her Environment day address has called for planting at least 11 crore trees a year. "With our energy situation as critical as it is we Bangladeshis should plant and nurture at least three trees each a year. The biomass fuel must come

out of our soil," says Mr Haroun er Rashid, Senior Resident Advisor, the National Conservation Strategy (NCS). The NCS is helping the Government of Bangladesh draw up a conservation strategy for the country.

"The energy situation in rural areas has become specially acute over the last six to seven years. People are cultivating jute just for using the stalks (shola) as fuel. Planting of 'dhaticha' for fuel has also gone up," he said.

About the government's plans to set up more supply depots of liquefied petroleum gas specially in the northern region of the country Mr Rashid said, "The supply of LPG will definitely have an impact in areas without gas but as in the case of piped natural gas and rural electrification, only the rich will be benefited. They will still be out of reach of the rural poor."

Natural gas, hydropower, oil, coal, peat and solar power and other known energy sources. Among the non-renewable sources of energy only natural gas has been extracted commercially.

All the known gas reserves are located in the Eastern zone of the country. Consistent efforts have been made in the past 30 years to expand the use of natural gas, but due to technical and financial reasons rapid expansion of natural gas to different parts of the eastern zone has not yet been possible, not to talk of energy-poor western zone.

Hydrology and energy lost

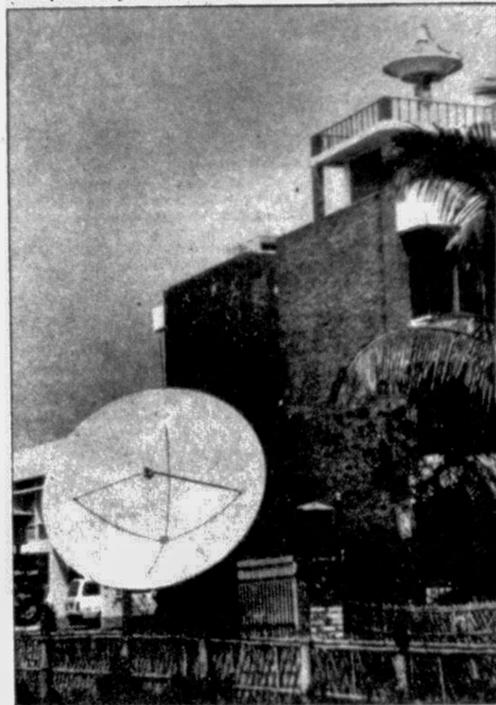
In this land of rivers total hydropower resources is limited to only around 1,500 Gwh (Giga Watt hour) a year of which about 1,000 Gwh potential has been utilised at Kaptai. With the sustainable supply of hydropower at Kaptai reaching the saturation level, there is a prospect of developing 3,000 Gwh at the Sangu and the

Matanihari rivers. But environmental impact of the Kaptai hydropower project on the local population should be kept in mind before undertaking new ones. It is also imperative to bring down the system loss in electricity generation and transmission. Over 42.3 per cent of total generated power remained unaccounted for in 1988 and the absolute amount of energy lost in the year was 2,769 Gwh. "The system loss of a well maintained and operated system of similar

size to that of Bangladesh should be around 18 per cent," says Prof M Nurul Islam of the Bangladesh University of Engineering and Technology.

A small deposit of oil has been discovered in Haripur, Sylhet with an estimated reserve of 1.6 million tonnes. The test well is producing at the rate of about 15,000 tonnes of crude oil a year against the total consumption of 1.7 million tonnes a year.

Coal deposits have been discovered at three locations



Bright future for Solar energy

till now — Jamalganj in Bogra, Barapukuria and Dinajpur and Khalispur in Rangpur. Extraction of Jamalganj coal has not yet been found to be economically viable. A feasibility study for the development of Barapukuria coal is continuing and there is a possibility of undertaking a coal mine development project, during the Fourth Five Year Plan period, along with coal-fired power plant. Feasibility study for the development of Khalispur coal is yet to be undertaken. Bangladesh being a late starter in this field has the good fortune to learn from the mistakes of others about environmental consequences of development and use of coal which would help solve the commercial energy problem in the western zone of the country.

The total peat deposit in Bangladesh has been reported at 600 million tonnes of which 25 million tonnes are located in Faridpur and Khulna districts. In some rural areas, locally extracted peat is used for domestic cooking. There is a possibility to undertake a peat development project during Fourth Five Year Plan period in the private sector.

Solar energy

About solar and wind energy, experts emphasize the need for up-to-date research with foreign collaboration to assess their real potential.

The average daily solar radiation in Bangladesh varies from 5.05 kw (kilowatt hour) per square metre in winter to 8.36 kw per square metre in summer. Solar energy at present is widely used as a convenient and low-cost means of drying crops and fish, and for producing salt by solar evaporation. Limited experiments with solar dryers have been made to dry produce but has not proved economically viable. High taxes on imported photovoltaic cells, which are widely used abroad, necessitates their local development.

It is neither possible nor

desirable to meet the total energy requirement of the country by developing commercial energy sources only. Sustainable development of energy resources should consider the planning and development of both commercial energy sources and biomass fuel in an integrated manner after studying their impact on the environment.

Active participation of the community, local administration, government agencies, non-governmental organisations and private enterprises should be given due consideration for a quantum leap in social forestry which would go a long way to meet the demand for fuelwood.

Shortage of land will not permit the meeting of total demand of biomass fuels by fuelwood only. For sustainable development, the supply of fuelwood, agricultural residues and animal dung in meeting the demand for biomass fuels should be considered upto their respective regenerative limits. When regeneration of those biomass fuels are less than the demand, the shortage should be met with suitable commercial fuels.

Traditional forestry management practices are found to be insufficient in bringing large areas of denuded forest land under tree cover. Active participation of local people should be given due consideration for rapid development and management of denuded areas. This action will reduce both costs and time in raising plantations," says Prof Islam. "Poor people's endeavour to meet their basic needs sometimes cause overexploitation of resources. Active participation of poor and landless groups in development programmes like tree plantation should be given priority," says Prof Islam adding, "Only then shall we be able to improve the condition of the productive environment." The need for appropriate technology is all the more felt.

Mix-Gardens protect Samoa's watersheds

by Mary Lynn Hanley

LAMA and Fturri Masofa carefully arrange strips of plastic around the neat rows of beans and sweet corn in the small, contoured plot overlooking the lush, wooded hillsides.

The plastic will keep down weeds while the plants mature and eliminate the need for harmful chemical herbicides. In just eight weeks the vegetables will be ready to eat.

"I will sell them in the market," says Mrs Masofa. "We like to put money in the bank."

Mr and Mrs Masofa are tending a demonstration garden open for inspection by their neighbours. It has been set up to show cultivation techniques which farmers

Samoa has lost between 800 and 1,000 hectares of forest to agriculture every year since 1778. Only a little over half the country's total land area remain forested

need to apply to protect soils and forests in the Vaisigano watershed.

Covering 3,300 hectares, this watershed is in the north central region of Samoa's Upolu island, only a few kilometres from Apia, the capital city. Drained by three branches of the Vaisigano River, it provides both drinking water and hydroelectric power to Apia and the surrounding villages, home to about a quarter of Samoa's 166,000 people.

The vegetable plot is part of the Vaisigano Pilot Watershed Management Project, supported by the United Nations Development Programme (UNDP) and the UN Food and Agriculture Organisation (FAO). Although the watershed is still largely covered with trees and other tropical vegetation, there is already evidence of decline. Stark brown patches of barren soil on some slopes attest to the erosion that is taking place.

"People say that taro grows very well in the forest," says PM Baisyet, Chief Technical Adviser for the watershed management project, who is from Nepal. "Farmers don't consider the damage to the slopes."

Clearing land to plant taro, a root crop which is Samoa's staple food, is one of the main reasons for erosion. The farmers practise shifting cultivation, clearing trees from a two-acre plot of land, working it until the soils are depleted, and then letting it lie fallow while they move on to strip a new area.

It is estimated that Samoa has lost between 800 and 1,000 hectares of forest to agriculture every year since 1978. Only some 150,700 hectares — a little over half the country's total land area — remain forested.

The steep hills and river banks in the Vaisigano watershed are farmed without any buffer zones between the cultivated areas and the river. The felling of trees has led to rapid flooding of streams when the heavy rains come. Silt washed down the mountains has discoloured water supplies and disrupted power production

before being swept out to sea. There it poses a threat to marine life.

Samoa's soils and forests can only be saved by motivating the local people to adopt appropriate land use practices.

The village chiefs are the main target group for UNDP and FAO-supported activities, since they decide on how 80 per cent of Samoa's total land area of 284,000 hectares will be used. Farmers to whom the chiefs entrust the land are also being reached by the projects as women's committees, youth groups and students.

Mr Baisyet realises that communities would be unlikely to change their ways unless they were offered some incentives. "While the whole concept of forestry conservation is long-term," he says, "We brought a short-term benefit."

Various types of plants are incorporated within the mixed farming system recommended for long-term protection of the watershed. Trees are planted at the top-most borders of a plot. The types chosen have the ability to fix nitrogen in the soil and can also be used for fuelwood.

Just below these forest species, fruit trees are planted, including mango, banana and papaya. The remainder of the plot is devoted to crops such as maize, sweet corn, beans, soybeans, cabbage and tomatoes.

Some of these will be ready for harvest after just eight weeks. Mr Baisyet has calculated that a farmer can easily earn an extra US\$870 a year by applying the mixed farming system.

Mixed farming has nutritional as well as environmental advantages. Samoans traditionally don't eat enough vegetables, relying instead on taro, bananas, fish, chicken and high-fat cuts of meat such as lamb and pork. Consequently, many are overweight and there is a high incidence of hypertension and diabetes.

Terracing is also being introduced on the hillsides. A variety of techniques are employed to get environmental message to the people. A colourful poster graphically contrasts a view of a thriving, productive area of managed watershed with the bleak and barren vision of what would become of the same area if no management were applied. A comic book on conservation has been produced for use in schools.

Samoa's agricultural extension service is also promoting mixed farming. "Rather than explaining the concept myself I ask the farmers to explain," says Mr Baisyet. Those interested in trying out the system receive technical assistance but must agree to help clear the land, pay half the cost of seedlings obtained from the project nursery, and be responsible for all maintenance.

But the demonstration plots — and the farmers who maintain them — are the most persuasive motivators. Take one recent convert, Ata Tataloa. "In the beginning Mr Baisyet came looking for a piece of land," she says. "He did terracing and planted vegetables and fruit trees. He put money in my pocket." — *Depthnews Asia*



reinforced with short Saffil fibres to improve toughness and thermal shock resistance, and filament wound freeze gelled tubes used for hydraulic oil filtration, the unfiltered micro porosity acting as the filter.

The programme involves a £ 300,000 grant from the ACME directorate of the Science and Engineering Research Council to the School of Materials Science, University of Bath with a further contribution of £ 1,47,000 from the collaborating industrial partner, Ceramic Developments Midland Ltd, Corby.

Filament winding, injection moulding and simple casting procedures have been demonstrated as suitable methods of producing CMC components to near net size and shape. Two key areas have been highlighted for further investigation and development. These are infiltration/pressureless densification and control of the fibre/matrix interface.

—(Spectrum)

Fabrication of fibre rein processing shapes sol-gel forced ceramic

by Richard Russell-Floyd, School of Materials Science, University of Bath.

THE class of materials termed ceramics ranges from the traditional clays used for domestic house bricks, through the fine porcelains and China in crockery and wash basins to the SiAlons, and boron nitrides, used for rocket nozzles. In design terms, ceramics and glass materials have traditionally been used only in low stress, non-critical applications and where stress is predominantly compressive. The reason is their inherent brittleness which makes them prone to sudden and unpredictable failure.

But in much the same way as a family of tough, strong fibre reinforced plastics was devised several years ago by combining brittle fibres with relatively weak and brittle polymers, a comparable tough and extremely corrosion resistant group of materials is being developed by combining brittle fibres with a brittle ceramic matrix, yielding ceramic matrix composites which can withstand at high temperature.

Ceramics have many attractive characteristics: including hardness, wear resistance, and retention of properties at high temperatures. New research is focusing on making these available to engineers in the form of unconventional or technical ceramics with superior mechanical, thermal or electrical characteristics over the established metals and plastics.

Their potential applications are enormous. They include ceramic based automobile and marine diesel and petrol engines, nozzles for high temperature exhausts, cutting tools, corrosion proof chemical plant, bearings and even gas turbine blades.

Strength, reliability and cheap fabrication

The development of new high performance ceramic materials depends on overcoming two major defects: brittleness and high processing costs. Traditional unreinforced ceramics typically fail catastrophically from the sudden propagation of a crack from a single tiny defect. The critical flaw size may be a few microns compared with several millimetres for metals and alloys.

Initial research into stronger and more reliable ceramics centers on new processing techniques to reduce

the size and quantity of voids and flaws. Ceramics were produced by blending different proportions of minerals of various particle size such as alumina, titania, quartz, or feldspar which were either cold pressed with an appropriate binder or mixed with large amounts of a solvent, typically water, to produce a slurry which was then poured into a porous mould (slip casting) and allowed to dry. Components were then sintered to bond the compacted ceramic powder. Forming and sintering can be done simultaneously by hot pressing, where the powders are compacted between two pistons and heated. Although widely used these techniques are not particularly suitable for producing complex shapes and the plain ceramics produced still lacked

ventional fibre reinforced plastics processing technology to the combination of reinforcing fibres with sol-gel matrices and fabrication of components; and development of ways to improve the density of materials by filling the pores that are inherent in sol-gel derived matrices.

Benefits of sol-gel

Sol-gel processing offers several advantages for ceramics fabrication including increased homogeneity but most importantly a liquid phase precursor. A sol consists of a stable or semi-stable dispersion of very small particles (from 1 to 500 nanometers) or macromolecules in a liquid. It is not dissimilar to an aerosol in which fine droplets of a liquid are dispersed in a gas. Under certain conditions,

before becoming semi-solid. The gel must have sufficient 'green' or pre-sintered strength to allow removal from a mould or mandrel. In addition, the sol viscosity must be below 2000-3000 centipoises. Any filler particles with the sol must be small enough to infiltrate the gaps between the reinforcing fibres.

Work at Bath University/CDML has been directed to tailoring sol-gel systems to fulfil these requirements. Various routes have been investigated to the formulation of alumina, silica and nullity matrices, both via aqueous colloidal and alkoxy sols. Key areas of interest include gelation behavior, controlled atmosphere drying and additions of various filler powders and sintering aids to reduce shrinkage and cracking during

penetration of the remaining restricted porosity.

Carbon fibres, traditionally considered expensive by the fibre reinforced plastics industry at £50-£100 per kilogram, therefore become attractive for lower temperature CMC applications.

Freeze gelation

After preparation of the sol and addition of fillers using a high shear disperser to break up agglomerates, the sol and fibres are combine/shaped. The article is then cooled rapidly to prevent growth of columnar crystals of ice using liquid nitrogen. Slow thawing to ambient temperatures followed by drying yields the CMC shape. Repeated infiltration in a colloidal silica sold before sintering can produce a green body with adequate green strength to undergo machining. Post-sintering infiltration is still required however to achieve maximum density.

Sintering temperatures around 1100° C are typical at present, though sols have been developed which sinter at less than 700° C. This has led to the possibility of using very cheap R-glass fibres for low service temperature applications.

Properties enhanced

Furthermore, these properties are being enhanced continually by improvements in the pressureless methods of infiltration of the pores in the matrix and by improved control of the fibre/matrix interface. The latter is critical. The sol-gel matrix must be prevented from over-reacting with the reinforcing fibres, thereby degrading their properties and causing the composite to behave more as a monolith. One solution under investigation for tighter control is through deposition of a pyrolytic carbon or SiC on the fibre prior to use.

Very promising results have been obtained over the first year of the research project at Bath/CDML. Matrix systems have been developed which undergo very low levels of shrinkage, allowing crack free composites to be formed.

Commercial application of the technology developed by the research project is already under way. This includes freeze gelled CMC gas burners

The need of the manufacturing, automotive and light engineering industries for corrosion resistant, but tough and cheap new lightweight materials presents a demanding area of research and development. Engineering design has traditionally been orientated around the tough metals and alloys, the properties of which have progressively been improved over many decades. New materials are now challenging the dominance of metals, particularly in hot corrosive environments and where weight is important, for example, motor vehicles, aircraft and chemical plant.

toughness and reliability.

The introduction of reinforcing fibres made of silicon carbide into the ceramic, has been shown to solve the problem of toughness. The fibres act as crack stoppers, with fibre debonding and pullout absorbing fracture energy during failure so increasing fracture toughness.

Several problems exist however for these ceramic matrix composites (CMCs). They are made and processed in hot presses and chemical vapour deposition, both of which are very time consuming and expensive, with severe limitations on the size, shape and accuracy of the fabricated components.

A newer concept on which the University of Bath is working in collaboration with an industrial partner, Ceramic Developments Midlands Ltd (CDML), combines two techniques: sol-gel processing and the fabrication of CMCs by conventional and established fibre reinforced plastics technology. The research at Bath University/CDML has focused on three main areas: development of low shrink sol-gel matrix systems; application of con-

destabilisation of the sol will lead to formation of a gel which occupies the same volume as the original sol. This occurs when the solid particles form a three dimensional solid network with the solvent entrapped within the pores.

Subsequent removal of the solvent will leave a homogeneous highly porous solid which, because of the very small size of the primary particles and high surface area, is highly reactive and can be sintered at much lower temperatures than in conventional powder ceramic fabrication.

An important goal is the development of liquid sols which undergo little bulk volume change during gelation, drying and sintering. This characteristic opens the way for the use of established fibre reinforced plastic processing technology to be used for CMCs; the sol directly substituting for the liquid polymeric resin. Apart from the final sintering, most sol-gel processing would be conducted at or near ambient temperature.

Avoiding shrinkage

The sol must have a minimum gel time of 15 minutes to allow combination with fibres

drying and sintering.

One of the most promising sol-gel matrix systems is based on fine colloidal dispersions of 15-30 nanometer (nm) silica particles which are gelled by rapid freezing.

Production processes tested

Various continuous and chopped fibres are being combined with different matrices by a variety of processing/fabrication routes; resin transfer moulding, filament winding, hot pressing, casting and injection moulding. The use of conventional fibre reinforced plastics processing technology, allows the combination of the matrix with reinforcing fibres and the shaping of components in a single operation.

The most important method to date is filament winding, using continuous Nestle, FP-alumina and carbon fibres to produce hollow tubes. A microprocessor controlled filament winder has been developed around a conventional lathe which can wind 1 meter length tubes at least 30 mm in wall thickness, with fibre angles from 0-45 degrees. The main problem encoun-

50 kilowatt (kw) induction heater used to heat graphite die containing fibre/matrix pre-preg will shortly be installed at Bath. The aim is to produce very low porosity materials by a combination of high temperature and pressure.

Infiltration and Densification

In order to retain sufficient sol fluidity during processing a minimum of 20-30 per cent by weight of solvents has to be found essential. But this can result in too great a porosity in the matrix after drying and sintering, which must be reduced in order to improve mechanical properties. Consequently, research has focused on achieving the ideal density without resorting to high pressures, but by liquid and vapour phase infiltration of the porosity in the matrix.

Liquid phase infiltration has been capable of reducing porosity down to 15-20 per cent by volume, though only in relatively thin sections. At this stage vapour phase infiltration will take over. In this case a suitable vapour is passed across the article with a carrier gas such as nitrogen, the vapour being capable of greater