

to date appears to indicate that this can be achieved under our conditions in Singapore.

Other project activities include the production of biogas from waste solids removed in the primary clarification of raw wastewater before loading into the ponds. This biogas will be used to provide energy for the postharvest processing of algæ, thus enhancing the energy economy of the process. Current feeding experiments with steam-cooked, centrifuge-harvested algæ have indicated that algal protein could replace a large proportion of soybean protein in the pig diet. In the first experiment conducted, algal protein replaced all soybean protein without significantly decreasing growth and carcass quality of pigs over a 3-month period.

During phase two, scheduled to begin in September, the emphasis will be on the development of innovative and economical algæ harvesting systems. It is hoped that the results will provide the breakthrough necessary for making the recovery of protein from pig waste or other organic wastes more than just a concept. It is an important step that could lead to practical application of this method of resource recovery.

The project is still in its developmental stages: it is therefore too early to categorize its total impact in absolute terms. The results now available, however, indicate that large-scale culture of microalgæ on diluted pig wastewater is technically feasible, and promise to advance the state-of-the-art to the point where it can be readily applied.

For Singapore, the most apparent benefit from such an application would be an effective and economical pig wastewater treatment system. This would provide a key for controlling the pollution by piggery waste.

The application of the algæ wastewater treatment system would also enable the reclamation of a large volume of water suitable for recycling as washwater to farms. This would reduce farmers' need for costly potable water. In the drier season of the year, the availability of recycled water would permit farmers to continue the good management practice of keeping pigs clean, thus minimizing the possibility of serious disease outbreaks.

Harvesting the algæ cultured in high-rate ponds leads to the recovery of biologically valuable protein suitable for use as animal feed. Producing algal protein will therefore contribute to the livestock economy in Singapore, which annually imports S\$24 million of soybean products for animal feed.

The recovery of protein in this process could also have significant effects on the world food situation. Current livestock production practice in Singapore and elsewhere is to use soybean products as the main source of protein for livestock feed. The mass production of microalgæ and their substitution in

animal feed would therefore release large quantities of soybean for direct human consumption.

The application of algæ technology is definitely not limited to Singapore. Given the climatic conditions of warm ambient temperature and ample sunshine, many tropical and subtropical countries are suitable for algæ mass culture. Provided that organic wastes are readily available, high-rate ponds can be used. The Singapore project will yield the required scientifically documented and evaluated results that will provide a sound basis for application and technology transfer to other countries.

In terms of technology transfer and expertise development, this project is staffed by Singapore scientists and engineers recruited from the ASEAN region. Only one part-time American consultant, with previous experience in algæ technology, is employed on the project.

All the project facilities have been designed and constructed in Singapore, using locally available manufactured items, equipment fabrication, and construction skills. Only a minimum number of components such as pumps, centrifuge, specialized speed-reducing units, drum-dryer, and instruments have been imported, in many cases from other Asian countries. This attempt to develop local technology has resulted in project costs far below that of comparable facilities in developed countries. It therefore puts the Singapore model within the economic means of many developing countries. Thus, in addition to providing the technology for waste treatment and resource recovery, the mass culture of microalgæ as developed in Singapore will also provide benefits to manufacturers and construction industries in countries that plan to adopt similar technology.

The Singapore project is an example of adaptive technology transfer. Mass culture of microalgæ, though long recognized for its potential in sewage treatment, has not been studied as intensively for livestock waste treatment. There are also technological obstacles, such as harvesting methods, that need to be overcome before the process can be fully utilized. Singapore, with its intensive pig industry, has the unique potential to make an in-depth effort to apply known research findings to develop a new aspect of the concept. The project is therefore playing a role in developing an appropriate technology for application in other countries. □

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This article is adapted from one chapter of Give us the tools: science and technology for development, recently released by the IDRC (see page 27).



Low-cost housing in Singapore. As general living conditions improve, population growth declines.

Population message from the village

Michelle Hibler

Tarzie Vittachi, Chief of Information of the United Nations Fund for Population Activities (UNFPA), recounts a conversation he recently had with a taxi driver in Mexico City where he was attending a population conference:

"Very important problem for Mexico. Any solutions, sir?"

"No", replied Vittachi.

"Just as I thought."

And yet, the young driver, after two children, had undergone a vasectomy to assure his family of a better life in the growing city.

A few years earlier, in Singapore, Mr Vittachi was visited by a Sri Lankan couple who had sought him out, a very distant relative, for advice on family planning. The previous week they and their four children had been relocated from a squatter settlement on the outskirts of the city to a modern, high-rise, low-cost apartment building. A problem had arisen: by 8 am the father had to be at work, and three of the children at school. But as early as 6 am, the queue for the communal washroom stretched down the hall, making it nearly impossible to be on time. In their former home there had been no problem ... there had been no washroom. They reasoned that more children would make this situation worse.

Amusing anecdotes perhaps, or, for the family planning workers, proof that population programs are having some effect. But these two stories also provide a glimpse of what lies at the heart of the population question — individuals, personally motivated. With a change in these people's living conditions had come a change in their values.

Mr Vittachi was addressing a meeting of population experts and journalists gathered together in London, Ontario, at a conference on *Population: from now to 2000*, sponsored by the School of Journalism of the University of Western Ontario and the Canadian International Development Agency (CIDA). What emerged from the three days of sessions was an overview of the population question and of how

perspectives have changed in recent years, following the apparent failure of many birth control programs, the Bucharest Population Conference, and now, the optimistic note that global fertility levels are declining.

The recent drop in the rate of population growth, following hard on the heels of the doomsday reports that the population bomb was about to detonate, has been widely reported. The UNFPA's best estimates indicate that since the 1960s, birth rates have fallen by some 15 percent in 45 to 50 developing countries representing 40 to 65 percent of the developing world. Will they continue to fall, however, and at what rate? Will fertility rise once again? At this point the debate is raging between demographers who cannot agree either on the future trends or the causes of the present decline.

No matter how encouraging the trends, the UNFPA cautions that they should not obscure the fact that even if fertility was to fall by 30 percent by the year 2000, it would still bring the world population to at least 5.8 billion people. Some two billion more people will need to be fed, educated, cared for, and employed.

If agronomists and economists are right, we cannot expect another significant rise in world food production. According to Lester Brown of the Worldwatch Institute, most countries have known only a slight increase since 1971, when the effects of the Green Revolution and other developments petered out. In the USA, one of the world's major food producers, there is also now a technology gap: all known agricultural technology for increasing yields is being applied. Faced with a shortage of new land, energy, and water, the most one can expect, he said, is an increase of one percent a year, not enough to match the population increase.

Some, like Mr Brown, argue that food scarcity may well become a contraceptive factor. Food is only one element of the complex equation of development, however, although it has a direct bearing on health and

mortality. The slowdown of population growth has been attributed in part to a decrease in infant mortality and a longer life expectancy in developing countries. If a shortage of food overturned these improvements, it could have the effect of stimulating fertility, resurrecting the spectre of the "population bomb".

The link between food and population is a long-standing one, enshrined in western (industrialized) economic thought and theory. As explained by Prof. Charles K. Wilber, Chairman of the Department of Economics of the University of Notre Dame in Indiana (USA), the seeds were laid when Thomas Malthus published his essay on population in 1798. The poverty of the poor, explained Malthus, is a function of the poor's proliferation of their own numbers. The earth cannot match this fecundity and provide enough for everyone's subsistence. Because of the free market law of distribution, the rich are powerless to help the poor. If only the poor would accept this truth, he said, they would feel less discontent and irritation at the rich.

Of course, Malthus' theory fell in line with Adam Smith's self-interest economic theory, whereby a competitive system would make the most efficient use of resources and result in the common good. If poverty still existed, it was because some countries restricted the free operation of markets, or it was the result of the miserliness of physical nature and the improvidence of human nature in the form of population growth.

Over the years, population growth thus became the easy explanation for underdevelopment. As the complexities of the underdeveloped countries became better known after World War II, economists came to recognize that economic development influenced population growth as well as the other way around. Thus was born the "demographic transition" theory wherein population growth would decrease as development proceeded, but only with a time lag. The crucial problem of development became one of controlling population growth until the transi-

tion was completed. Population control became the *sine qua non* for any successful development program.

If it sounds familiar, it is because this theory is still much in vogue. It is a comfortable theory for the industrialized countries because it lays the blame neatly outside the scope of political and economic systems, right at the feet of individuals and the perversity of human nature. The western cultural dominance also pervaded the search for solutions, and from the fascination with technique and technological solutions — far easier than political ones — came the obvious technological response to the problem of poverty: education, training programs, and birth control.

The dismal performance of the birth control programs that proliferated might have shaken the foundations of the theory somewhat. The fatal blow came in 1974, in Bucharest, at the World Population Conference when the developing countries rejected the agenda — and the premises — established by the industrialized countries.

The consensus at Bucharest was that population should be viewed from its historical evolution and as inseparable from political and economic problems. Development, it was said, is the best contraceptive. This "developmentalist" view, emerging strongly in the Third World and gaining ground in many aid agencies, stresses that population growth *per se* is not an important variable in economic development. The emphasis of development policies should be rapid economic change, which will mean change in socioeconomic institutions, which will in turn lead to a decrease in fertility. Emphasizing a direct attack on population growth is seen as a diversion from the main problems, and besides, it will probably be unsuccessful.

The new issues of population are seen not to lie in whether you must first stop population growth and then develop, or the other way around, or both simultaneously, but in whether there are more direct correlates of fertility decline like women's education, reducing infant mortality, raising levels of health, which — if tackled directly — would make it possible to slow down population growth earlier, and with fewer resources. "This does not imply that there is no need for family planning programs", says Mr Wilber, "only that they must support general development strategies, not be the main thrust of development policy itself."

It's another theory, but one that has some examples to support it. Prof. T.N. Krishnan, formerly of the Centre for Economic Studies in Trivandrum, India, and now at UNFPA, outlined the experience of his home state, Kerala, where birth rates are rapidly declining and had begun to do so before India intensified her family planning program.

Located at the southwest corner of India, Kerala state is geographically cut off from the rest of the country. As a result of its isolation, and a flourishing spice trade that brought visitors to the region, it developed differently than the rest of the country.

The two southern districts — Travancore and Cochin — were "native" administrations under the British, ruled by Maharajahs, a status that permitted them a degree of autonomy. Matriarchal societies, they were strongly influenced both by Christian missionaries and Arab traders.

From the mid-1800s, health services and schools were established. As education spread — to women as well as men — government posts became available to the population, who clamoured for more schools as a means to enter the "modern" sector. The spread of education also led to a greater recognition of the importance of health care (the Ayurvedic tradition had been long established), and clinics and hospitals multiplied. Because the population of these districts was dispersed rather than concentrated in villages, the health posts were located in easily accessible areas.

As education and health care increased, infant mortality rates declined and life expectancy increased. The age at marriage rose, and birth rates began to decline. By 1956, the birth rate was 35.6 per thousand. In Malabar, a district to the north annexed that same year to form Kerala state but which did not share Travancore's and Cochin's history, the birth rate was 45.6, a rate comparable to the rest of India. By 1971, Travancore and Cochin had a birth rate of 24.7; Malabar, 31.1. By 1975, the birth rate in parts of Kerala was as low as 21 per thousand.



Maternal and child health clinics, like this one in Thailand, contribute to reducing infant mortality and raising levels of health, two important factors of fertility decline.

These changes were effected in Kerala without overall economic growth — which lays to rest the theory that falls in fertility take place only when there is economic progress — and before India's family planning program gained momentum. It is also significant that the incomes in Kerala are not higher than in the rest of the country, nor are the expenditures on health and education. The useage of facilities is, however, considerably greater. And if the incomes of individuals have not increased, their living conditions have improved considerably as a result of better education (the female literacy rate was 52.5 percent in 1971), better health, and land reforms that gave the landless ownership of their means of subsistence.

The case of Kerala may be unique in many ways, but it supports the developmentalist view of population growth and decline.

But why is it, asked Kumaresh Chakravarty, Assistant Director of the Press Foundation of India, that despite their declared stand, and the evidence that declines in infant mortality and greater education — particularly of women — have been found to have some favourable impact on the birth rate, most developing countries still accord highest priority to family planning education, sterilization incentives, and strong media campaigns in support of smaller families? In India, for example, public expenditures on family planning grew from 1.45 million rupees in the first development plan in the mid 1950s, to 2844.33 million for 1969-74, to 4973.6 million in the fifth plan (1974-79). Public expenditure on education and health, he said, have meanwhile shown decelerating growth rates; women's participation in the labour force is decreasing; and, despite bumper crops, actual food consumption in India has stagnated or even decreased among the poor.

Whether the next 20 years will see a significant change depends on a wide range of issues, from unemployment in the industrialized countries, to international migration and racism, to restructuring the economies of developing countries to distribute benefits more widely. There is no one solution because there is no one problem.

In many ways the world and the population experts have received what Tarzie Vittachi calls "a message from the village". And part of that message is that things don't have to get worse before they get better — they have to get better before they get better □

The proceedings of this symposium and of an earlier one held in England will be published in August. Contact the School of Journalism, University of Western Ontario, London, Canada N6A 5B7.