U.S. $50 per capita (1984 prices).

The per capita cost of water on Puerto Rico corresponds to a bilharzia prevalence rate of only 4 per cent. This rate does not correspond to the prevalence-consumption relationship found in the Sudan, because the Puerto Rican study included data from large urban areas – where there are no vector snails – and from some irrigation schemes where active bilharzia control was practised.

The costs of the four village water-supply systems and their impact on bilharzia transmission are presented in Table 9.8. In the two Sudanese irrigation schemes, where the water-supply systems serve villages of over 1000 people and the topography is very flat, the per capita costs are about U.S. $4. These costs cover multiple benefits (e.g. prevention of bilharzia, prevention of diarrhoeal diseases, and reduction of labour). On the mountainous islands of Puerto Rico and St Lucia, where the systems are small and serve houses on hillsides, the total annual per capita cost rises to U.S. $20 or more. Although the per capita cost on Puerto Rico is about 3 times that on St Lucia, the Puerto Rican systems deliver about 5 times more water per capita than the St Lucia systems.

Table 9.8 Comparison of per capita costs of water-supply systems and the incidence of intestinal bilharzia in the Sudan and the Caribbean Basin

Location	Year of observation	Total per capita cost (U.S.$)	Mean rate of of water consumption (l/cap/day)	Incidence of intestinal bilharzia (%)
Sudan				
Gezira	1982	$ 3.39	40	35%*
Gezira	1984	$ 4.54	70	(10-20%)
Rahad	1983	$ 3.71	73	10%*
Caribbean Basin				
St. Lucia	1974	$ 8.90	65	38%
Puerto Rico	1975	$27.00	330	4%

* Percentage in large areas that included non-endemic villages. This rate does not illustrate the precise consumption-prevalence relationship observed in villages in the Study Zone and on St Lucia, which were all in heavily endemic areas

9.4 Basic Sanitation

Excreta disposal and waste collection are common problems anywhere in the world. In developed countries, they have been solved by vast investments in technologically advanced solutions. Small-scale waste-disposal technology, appropriate for the rural parts of developing countries, has lagged behind (Pacey 1980).

In many parts of the developing world, human excreta are regarded as valuable commodities and are carefully collected and sold for use in fish farming and agriculture. In other countries, the majority of the rural population defecates in the immediate vicinity of houses and in fields. These time-honoured and culturally accepted practices are difficult to change. They form a major impediment to the improvement of environmental sanitation and, hence, to the control of diarrhoeal diseases, schistosomiasis, hookworm, and other infections. In 1985, only 18 per cent of the rural population in developing countries had adequate excreta-disposal facilities, and this figure was based on a very modest definition of 'adequate'!

Feachem et al. (1983) have identified six classes of excreta-related infections. They are presented in Table 9.9.

Rural sanitation is no longer primarily a technical problem. Appropriate and cheap designs for pit latrines and composting pits, suitable for application in rural situations, are now available (Feachem et al. 1977; Cairncross and Feachem 1983; World Bank Technical Notes 1-14).

Excreta-disposal systems should meet the criteria of Wagner and Lanoix (1958). In order of priority, these are:

- The system should be simple and inexpensive to construct, operate, and maintain;
- The handling of fresh excreta should be kept to a minimum;
- Excreta should not be accessible to flies or animals;
- The contamination of wells and springs should be avoided;
- Surface water should be safeguarded against pollution;
- The surface soil should not be contaminated;
- There should be freedom from odours and unsightly conditions.

Improving sanitation for the millions of villagers in developing countries is one of the greatest challenges for health planners. Cairncross and Feachem (1983) summarized the guiding principles of a rural sanitation program as follows:

- Excreta disposal is a sensitive matter about which people have strong cultural preferences. Therefore it is imperative to achieve the maximum involvement of the community in the design and implementation of any latrine programme. Solutions imposed from the outside are unlikely to succeed. Often, a modification of an existing practice or type of latrine may be much easier to implement than a completely new package of technology;
- People require a reason or a motivation for using a new kind of latrine. In general, health improvement will not provide such a motivation because the connection between latrine usage and health will not be perceived. Experience in South East Asia indicates that an economic motivation (e.g. the use of excreta in agriculture or fish farming) may sometimes provide the necessary incentive. Another motive might be the desire for privacy;
- Any type of latrine needs good maintenance and will become fouled and offensive without it. If this is allowed to happen, the latrine will either not be used or will become a major health hazard in itself. There is evidence that the use of a fouled latrine in rural areas provides a greater health hazard than the practice of casual defaecation in the surrounding bush.

9.4.1 Excreta-Disposal Systems

The many systems of excreta disposal are all variants of three basic systems: infiltration, destruction, and removal (Cairncross 1988; USAID 1982).

Table 9.9 Environmental classification of excreta-related infections

Category	Infection	Pathogenic agent	Dominant transmission mechanics	Major control measures (engineering measures in italics)
1) Faecal-oral	Poliomyelitis	V	Person-to-person contact	*Domestic water supply*
(non-bacterial)	Hepatitis A	V	Domestic contamination	*Improved housing*
Non-latent,	Rotavirus diarrhoea	V		*Provision of toilets*
low infec-	Amoebic dysentery	P		Health education
tious dose	Giardiasis	P		
	Balantidiasis	P		
	Enterobiasis	H		
	Hymenolepiasis	H		
2) Faecal-oral	Diarrhoeas and		Person-to-person contact	*Domestic water supply*
(bacterial)	dysenteries		Domestic contamination	*Improved housing*
Non-latent,	*Campylobacter* enteritis	B	Water contamination	*Provision of toilets*
medium or high	Cholera	B	Crop contamination	*Excreta treatment prior to re-use*
infectious dose,	*E. coli* diarrhoea	B		*and discharge*
moderately per-	Salmonellosis	B		Health education
sistent and	Shigellosis	B		
able to multi-	Yersiniosis	B		
ply	Enteric fevers			
	Typhoid	B		
	Paratyphoid	B		
3) Soil-transmitted	Ascariasis	H	Yard contamination	
helminths	Trichuriasis	H	Ground contamination in	*Excreta treatment prior to land*
Latent and	Hookworm	H	communal defaecation area	*application*
persistent with	Strongyloidiasis	H	Crop contamination	
no intermediate				

tapeworms			Field contamination	*Excreta treatment prior to land application*
Latent and persistent with cow or pig intermediate host			Fodder contamination	Cooking and meat inspection
5) Water-based helminths latent and persistent with aquatic intermediate host	Schistosomiasis Clonorchiasis Diphyllobothriasis Fasciolopsiasis Paragonimiasis	H H H H H	Water contamination	*Provision of toilets* *Excreta treatment prior to discharge* Cooking
6) Excreta-related insect vectors	Filariasis (transmitted by mosquitoes) *Culex pipiens*	H	Insects breed in various faecally-contaminated sites	*Identification and elimination of potential breeding sites* Use of mosquito netting
	Infections in Categories 1-6, especially 1 and 2, which may be be transmitted by flies and cockroaches	M		

B = Bacterium P = Protozoon V = Virus
H = Helminth M = Miscellaneous

Source: Cairncross and Feachem (1983)

Infiltration

Infiltration is the absorption and dispersion of excreted materials into the soil or groundwater. This type of system is commonly used in rural areas, where a sewerage system is often impracticable and the population density is low. It is a potential source of contamination of the water supply. Low-cost options for sanitation improvement include:

- Pit latrines, which are essentially nothing more than a hole in the ground. These latrines are commonly used as a temporary excreta disposal method or as a first step in the development of a village sanitary system. The cheapest improvement to a pit latrine is a prefabricated floor in the form of a squatting slab with a lid to cover the hole. In some countries, a seat is more acceptable than a squatting slab, although the cost is higher. Pit latrines often become breeding sites for flies and mosquitoes. Odour is a persistent problem;
- Ventilation-Improved Pit latrines (or VIP latrines), which alleviate the two principal disadvantages of conventional pit latrines. The vent pipe reduces odours, and its spiral-shaped superstructure, covered by a fly screen (mesh 1 mm), reduces the numbers of flies that can enter (Figure 9.4).

  In controlled experiments in Zimbabwe (Morgan 1977), 13,953 flies were caught during a 78-day period from an unvented pit latrine, but only 146 were caught from a vented (but otherwise identical) pit latrine. An additional device effective against flies and mosquitoes is a fly trap, which is placed over the drophole instead of a cover.

  Although the single-pit VIP latrine can be designed for long use, it is often more convenient (and possibly less expensive) to use a twin-pit VIP latrine. In this version, one pit is used until it is full; then the second pit is put into use. When that pit is full, the first is emptied and used again;

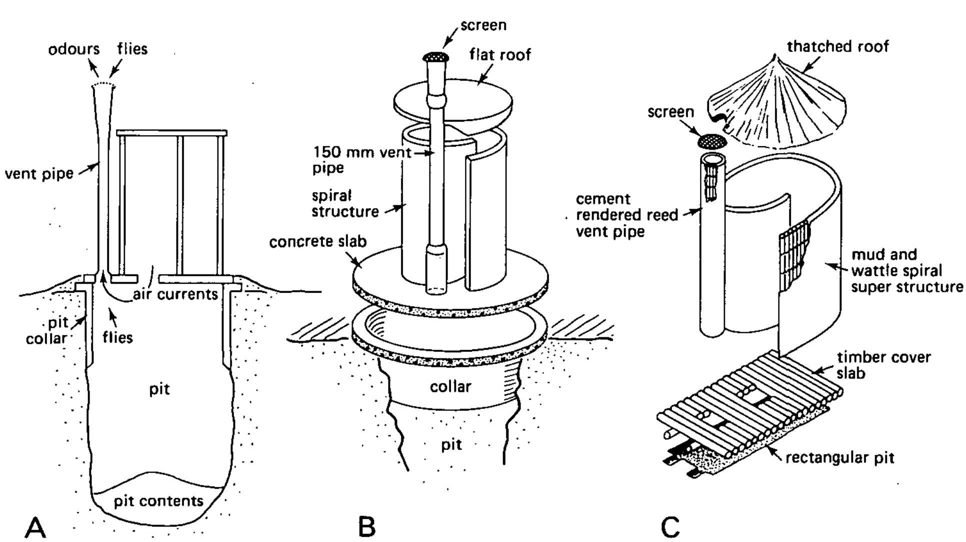

Figure 9.4 A Ventilation-Improved Pit Latrine (or VIP latrine)

- Pour-flush toilets, which offer the further improvement of a water seal below the seat or squatting pan. The water seal – a U-shaped pipe filled with water – completely prevents the passage of flies and odours. While the small quantity of water used in pour-flush toilets is not enough to operate them on a conventional sewerage system, it is nevertheless enough to carry excreta to a soakage pit up to 8 m away;
- Septic tanks, which are watertight settling tanks to which wastes are carried by water flushing down a short sewer. A septic tank does not dispose of wastes; it only helps to separate them and digest the solid matter. The liquid effluent flowing out of the tank remains to be disposed of, normally in a soakage pit or drain field, and the accumulating sludge must be periodically removed. Certain modifications will make the septic tank suitable for use in areas where the population density is 200 to 300 people/ha.

Communal latrines are usually cheaper to build than individual household latrines. They have many disadvantages, however, and the decision to introduce them should not be taken lightly.

Destruction

Destruction is the conversion of excreta and other wastes into useful and harmless substances. This system is based on:

- Composting toilets, which use dry composting techniques to destroy wastes and provide an inoffensive, stable soil conditioner. The twin-vault VIP is, in fact, a kind of composting latrine with a prolonged decomposition time. Designs for composting toilets in which the composting process is accelerated, thereby permitting a smaller chamber and more frequent emptying, have been used successfully in Vietnam and Guatemala. In the Vietnamese double-vault composting latrine, urine is collected separately and ash is added after use. When full, a chamber is sealed for two months, after which the compost is removed and applied to the land. Latrines of this type cannot be introduced into an area without an enormous supporting effort to ensure that they are used properly.

Removal

Removal is the collection and transportation – either manually or through a sewerage system – to a discharge site or central facility for further processing. Waste-disposal systems relying on excreta removal are used mostly in urban areas. They are:

- Bucket latrines, which consist of a squatting slab or seat placed immediately above a bucket. The bucket is positioned in such a way that it can be removed from the back of the cubicle. It is filled within a few days by the excreta of an average family. A collector calls regularly (once or twice a week) to empty the bucket. The wastes are carted off or carried away by truck. This is one of the oldest, and generally least hygienic, of the sanitation systems. The handling and spillage of the wastes typically results in heavy contamination of the site and of the depot where the contents are emptied for treatment, composting, or use in agriculture. A bucket system can only work well under situations of tight institutional control, where all opera-

tions are carefully supervised. It should be considered a temporary measure, to be used only while more permanent solutions are being sought;
- Aquaprivies, which are essentially septic tanks located directly underneath a squatting plate. VIP latrines and pour-flush toilets are less expensive than aquaprivies and less prone to malfunctioning;
- Cesspools, which are covered chambers that receive all waste water from a dwelling or dwellings.

9.4.2 Selection of an Excreta-Disposal System

An excreta-disposal system should never be imposed on a community from outside. Technical criteria for the selection of an excreta-disposal system are the size of the area to be served, the density of population and housing, the cultural patterns, the level of development, and the soil-drainage conditions. The most critical consideration is the effect an excreta-disposal system will have on the per capita rate of water consumption. Pour-flush toilets and aquaprivies use moderate amounts of water. Conventional water-flushed toilets with indoor cisterns use large quantities of water. If the volume of waste water generated exceeds 50 litres per person daily, some sort of sewerage system will be required.

Another important consideration in selecting an excreta-disposal system is the cost to each household. In developing countries, barely 3 per cent of household expenditure is for sanitation. The comparative costs of various systems are given in Table 9.10.

Table 9.10 Comparative monthly costs of various excreta-disposal systems per household (in U.S.$)

Excreta-disposal system	Approximate monthly cost*
Pit latrines	5
Pour-flush toilets	5
Composting toilets	5
Cartage	5
Aquaprivies	15
Septic tanks	45
Conventional sewerage	45

* Includes payments on investment loans at a hypothetical interest rate of 8% over 5 years (for low-cost systems), over 10 years (for medium-cost systems), and over 20 years (for high-cost systems). Source: World Bank (1978)

At some point after an excreta-disposal system has been installed, the people using it may wish to make improvements. In developing countries, it is best to do this in stages. Cairncross and Feachem (1983) advocate starting with a modest improvement, and then progressively upgrading in a 'sanitation sequence'.

9.5 Use of Biomass Fuels

Biomass (or traditional) fuels are the principal source of energy for cooking and heating for about half of the world's population. These fuels (i.e. wood, charcoal, crop residues/agricultural wastes, and manure) are composed of complex organic matter, vegetable proteins, and carbohydrates incorporating carbon, nitrogen, oxygen, hydrogen, and certain other elements in trace amounts. Their combustion often produces harmful substances (e.g. a range of polycyclic hydrocarbons not found in the fuels themselves). Although biomass fuels supply only approximately 10 per cent of global energy requirements in terms of total energy output, half of the world's households cook with them daily. In developing countries, 30 per cent of urban households and 90 per cent of rural households rely on biomass fuels. The severity and extent of health problems associated with pollution from the combustion of biomass fuels are discussed by de Koning et al. (1985) and Smith (1987).

Cooking and heating serve basic functions in human well-being, but the population growth is causing biomass fuels to become scarce. If the appliances used for biomass-fuel combustion (i.e. cooking stoves and fires) do not satisfy minimal criteria of availability, efficient combustion, and environmental hygiene, public health and well-being will suffer. The social costs of domestic energy requirements – like those of domestic water supply – can be expressed in terms of disease and the time and energy expended by housewives.

Various studies have focused on how much time family members (usually women and children) spend on collecting or harvesting biomass fuels. Results from Latin America, Africa, Asia, and the Pacific indicate that, per household, some 0.7 hours a day (from a range of 0.02 to 1.67 hours) is spent on collecting fuel and that some 2.9 hours a day (from a range of 0.25 to 6.4 hours) is spent on cooking (WHO 1984).

There is growing evidence that emissions from the combustion of biomass fuels are a major factor in the high rates of mortality and morbidity in developing countries. Intoxication or acute and chronic irritation by air pollutants affect the respiratory tract and can give rise to:

- Acute respiratory infection (ARI), which is responsible for about a third of all childhood deaths in developing countries (Pio et al. 1985). Although vaccination and case management are partially effective, long-term solutions will depend on controlling risk factors. Besides indoor air pollution, these factors include malnutrition, crowded living conditions, and low birth weights. Pandey et al. (1987) estimated that, in Nepal, the control of indoor smoke would eliminate as much as 25 per cent of all moderate and severe ARI's in children under 2 years;
- Chronic respiratory disease, which is the result of long-term exposure to indoor air pollution and repeated respiratory infections. It causes permanent damage to the lungs and, eventually, to the heart. Women, especially, fall victim to this disabling and life-shortening condition. There is growing evidence that in certain areas (often at high altitudes) chronic respiratory disease is a serious public health problem;
- Cancer of the respiratory tract, which is linked to the carcinogenic and mutagenic substances contained in the emissions from biomass fuel. These are some of the same substances found in tobacco smoke. The levels of exposure to them are such that, theoretically, a significant incidence of lung cancer can be expected. Reliable statistics to confirm this hypothesis, however, are still lacking;
- Carbon monoxide intoxication, which, in its acute form, can be lethal. In its chronic form, CO intoxication reduces the oxygen-carrying capacity of the blood. In pregnant women, this can retard foetal growth and result in a low birth weight.

The availability of adequate cooking facilities influences the frequency of cooking and the quality of the dishes prepared. By this link, biomass-fuel combustion has an impact on nutrition and the occurrence of food poisoning and diarrhoeal diseases. Generally, there is a close interaction between food hygiene, water supply, excreta disposal, and cooking facilities (WHO 1984a).

In rural areas, cooking stoves are often inefficient in that only 10 to 15 per cent of the fuel's energy potential is used. Stoves can be classified according to their type of combustion chamber. These may be:

- Open chamber (e.g. the three-stone fire found world-wide);
- Enclosed chamber without flue. These stoves are made of clay or metal. Examples are the 'Thai bucket', the clay stoves of Pondicherry (India), and the deep pit stoves of Bangla Desh;
- Enclosed chamber with flue. A chimney on the flue creates a natural draft. Examples are the Magan and Hyderabad stoves of India, the Singer stoves of Indonesia, and the Lorena stoves of Guatemala.

The rate at which fuel is burned greatly determines the composition of the emissions. High burning rates lead to more complete combustion and a reduced release of harmful products into the air. Nevertheless, high burning rates lower the efficiency of cooking stoves, especially with dishes that require slow cooking. Numerous improved designs have decreased the combustion efficiency of stoves by enclosing the combustion chamber and reducing the air flow. While this makes better use of the fuel, it can lead to higher emissions of pollutants (Bussman 1988). Ideally, then, designers should strike a balance between stove efficiency and pollutant emission (Smith 1989).

Indoors, the ambient air quality is a function of the quantity of emissions from combustion and the rate of ventilation. Ventilation depends on housing design and climate. To ascertain the ambient air quality and the extent of indoor air pollution, one commonly measures the levels of carbon monoxide and Suspended Particulate Matter (SPM). Data on the ambient air quality in houses in developing countries are now available from numerous studies. Generally, the results indicate that indoor air pollution is a matter of grave concern. In 15 recent studies, the concentration of SPM in the air ranged from 2000 to 5000 micrograms/m^3 (Boleij et al. 1988). In contrast, in industrialized countries, indoor air pollution from tobacco smoke at levels of 100 micrograms/m^3 is regarded as a risk factor for acute respiratory infections in children.

High concentrations of air pollutants do not necessarily mean high exposure unless people spend time in places where and when these concentrations are found. In rural areas in the tropics, where agriculture is the main occupation, people spend much time outdoors. Cooking and sleeping take up most of the time spent indoors. Cooking implies high levels of emissions from the fire. Accordingly, the exposure of the cook/housewife is high. Small children, who usually stay near their mothers, are also at risk. Women and small children, therefore, generally suffer more from respiratory ailments than men do. As a rule, these findings apply to situations where people cook, live, and sleep in a single room, or where different rooms are not properly closed off. When the kitchen is separate from the living quarters, exposure risks are less.

Engineering solutions to the problems of biomass-fuel combustion are complex and involve the design of low-cost wood stoves and the removal of emissions by flues, chimneys, and proper ventilation. Programs to introduce improved cooking stoves have had encouraging results (Foundation for Woodstove Dissemination 1987). Some programs choose factory-produced metal stoves requiring a high degree of quality control; others choose locally-made stoves of mud and clay. Whatever the choice, to be successful, these programs have to respect local cultural preferences and ensure the active participation of the community. They also need the support of a strong educational effort to motivate and instruct prospective users.

The body of technical and socio-economic knowledge and expertise on improved cooking stoves is growing. Advice, or information on organizations active in this field in various countries, is available on request from:

Foundation for Woodstove Dissemination
Executive Secretariat
Korte Janstraat 7
3512 GM Utrecht
The Netherlands.

9.6 Housing Design and Construction Materials

People spend a great deal of time inside their houses. They may, however, share this habitat with certain insect vectors. Moreover, the micro-climate in the house may favour the man-to-man transmission of bacterial and viral diseases. Hygienic standards for housing should take into account the local health hazards, and should be concerned with housing density and spatial layout; with floor space and the number of rooms; construction materials for the floor, walls, and roof; and ventilation, insulation, and lighting. Some of the pertinent features to be considered will be discussed below.

Screening and the Use of Bed Nets

Mosquitoes enter and leave houses through eaves, windows, and doors. Hence, screening these openings can help to control malaria. In practice, the effectiveness of screening depends on the bionomics of the local vector and the pattern of transmission. To be effective, screening requires household discipline in its use and maintenance. Because of its cost and the behavioural requirements, screening is not used much in low-cost housing.

Bed nets have been used in the tropics for many years. When used correctly, they are an effective protection against mosquitoes. A simple method of treating bed nets and curtains with pyrethroids was recently described (Rozendaal 1989; Lines et al. 1987; Major et al. 1987; WHO 1987). This method can be implemented by anyone with only a little supervision. Treated bed nets remain effective for 6 to 12 months. The cost of treatment per net is as low as U.S. $0.50. An extra advantage of this method is that protection against mosquitoes continues even if the bed nets are damaged or not let down over the bed; their mere presence in the sleeping area seems to reduce man-vector contact.

Building Materials

In Latin America, the vectors of Chagas' disease are peridomestic triatomine bugs. These bugs find a suitable habitat in the thatched roofs and cracked mud walls of rural houses (Mott et al. 1978; WHO 1987). Vector densities – and consequently disease transmission – can be reduced by the use of more permanent materials for roofs and alternative materials for walls, or, if mud is used, by smoothing wall surfaces properly. Field trials have shown that insecticide added to paints also provides effective long-term protection. The additional costs of more permanent construction are offset by the costs of periodic insecticide spraying.

In southern Sudan and other parts of the Sahel, cracks in mud walls provide suitable breeding spots for sandfly vectors of kala-azar. Measures similar to those taken against Chagas' disease can also help to prevent kala-azar.

Space and Ventilation

The combination of overcrowding and poor ventilation not only increases the risk of direct disease transmission, but also creates a micro-climate particularly favourable to the spread of airborne infections by droplets and dust particles.

Although meningococcal meningitis, which is an airborne infection, is not usually a public health problem in temperate climates, it can break out in devastating epidemics under certain tropical conditions (Greenwood et al. 1984; Cvjetanovic 1976). In the so-called Cerebro-Spinal Meningitis Belt (CSM Belt) of Africa, which lies between the equator and the south of the Sahara and extends to the Indian Ocean, epidemics flare up from time to time. Recently, there have been CSM epidemics in Mongolia, where climatic conditions are cold, but equally dry. In Africa, the disease is associated with certain types of the traditional *banco* houses, which are badly lit and poorly ventilated. In Mongolia, it is associated with a similar type of traditional house: the *yurt*. Studies in Mali and Burkina Faso have shown that better ventilation and lighting in houses can reduce epidemics.

Martin (1977) summarized reports published between 1842 and 1966 on housing, health, and social conditions in England. He found that the high rate of urban morbidity and mortality was associated with overcrowding of houses and land, but that it was twice as likely to be associated with overcrowding inside houses. Estimates were that, between 1928 and 1938, one-third of all infant mortality was attributable to overcrowding.

An American study (Britten 1942) showed that prolonged and intimate household contacts have a striking influence on the transmission of acute, mainly respiratory, infections (e.g. measles, whooping cough, diphtheria, mumps, scarlet fever) and chronic respiratory infections (e.g. pneumonia, tuberculosis, rheumatic fever).

A typical observation from temperate and cold climates is that, when windows are opened again in spring, droplet infections tend to disappear. These lessons from past studies of living conditions in England and America apply equally well to the present situation in developing countries.

9.7 Improvement of Nutrition and the Role of Women

Good nutrition is a vital component of human welfare and the main determinant of good health. Accordingly, the improvement of nutrition should be a major concern in the planning of all agricultural and economic development (Pacey and Payne 1985; FAO 1984; Anten et al. 1986).

Various diseases are brought on by an insufficient or unbalanced intake of nutrients. Too few calories or too little protein, which are usually supplied by staple foods, are the main causes of poor nutrition. In children, malnutrition stunts growth and retards development; in adults, it lowers labour capacity, thereby influencing economic development.

Malnutrition lowers resistance to diseases and increases their severity once they have set in. In a malnourished patient, a relatively harmless illness is more prolonged and the outcome is more often fatal. Estimates are that malnutrition is indirectly responsible for more than half of all childhood deaths in developing countries.

Just as malnutrition can lower resistance to disease, so, too, can disease contribute to malnutrition. In many parasitic infections, the parasites take nutrients away from the already precariously little food consumed by their host. *Ascaris* infections, for instance, can result in the loss of 3 to 25 per cent of ingested calories, depending on the worm load (Latham et al. 1977). In other parasitic infections, protein and other nutrients are lost through blood in faeces (hookworm) and urine (schistosomiasis). In malaria and other febrile infections, growth in children is retarded and anaemia is common. Similarly, growth retardation has been demonstrated in *S. haematobium* infections, especially if the worm loads are high. Iron-deficiency anaemia is caused by hookworm and schistosomiasis infections.

Although the results of research largely pertain to children, their implications are equally valid for adults. A study in Indonesia, for example, revealed that the productivity of non-anaemic labourers was approximately 20 per cent higher than that of anaemic labourers (Karyadi and Basta 1973).

Thus, the relation between nutritional state and infection is reciprocal: malnutrition results in lower food production, and lower food production results in malnutrition. Malnutrition can precipitate an infection and, in its wake, the infection takes a more serious course. Consequently, planning efforts to improve nutrition in the community clearly require a double-pronged, multi-sectoral approach (Figure 9.5). On the one

IMPROVING NUTRITION IN THE COMMUNITY
satisfy minimum nutritional requirements

IMPROVE GENERAL STATE OF PUBLIC HEALTH THROUGH:	INCREASE FOOD PRODUCTION AND AVAILABILITY THROUGH:
• vector-borne disease control	• good staple crops
• good housing	• adequate agricultural inputs
• safe water supply	• proper food storage/preservation
• sanitation	• cash crops and income
• health care and immunization	• access to transportation
• education in nutrition	• marketing facilities

Figure 9.5 Outline of a double-pronged, multi-sectoral strategy to improve nutrition in the community

hand, the incidence of endemic illnesses needs to be reduced to improve the people's general physical condition and enhance their ability to derive the full nutritional benefit from the foodstuffs they consume. On the other hand, the production of food needs to be increased and a sufficient portion of it made available to the population.

The role that women play in nutrition is a special one. Women as a group are considered to be particularly vulnerable to adverse nutritional conditions and to need extra attention in plans for health and nutrition. Women are also social actors who influence other people's nutritional condition, especially that of their children.

Naturally, these views are reflected in nutrition programs, but the role of women should also be viewed in a much wider context. In Africa, women have always been responsible for a major portion of small-scale crop production, both for home consumption and the market (FAO 1979). In 1974, it was estimated that women formed 60 to 80 per cent of the agricultural labour force. In general, women spend more hours on agricultural activities than men do. Women make certain decisions on planting and cultivation, adapt to innovations, and decide on the disposal of foodstuffs not needed for family consumption. In animal husbandry, women are usually responsible for poultry, but they are also responsible for the minor livestock (goats and sheep). As a result of male out-migration and cash-cropping, women are now spending more time tending large livestock, but they are not deriving the benefits.

The socio-economic development policies that have induced the male out-migration have left – to the care of women – the food crops that sustain the family, the cash crops, and animal husbandry. An example of how women have fared in development schemes is presented below.

The Mwea Irrigation Settlement Scheme, Kenya

The Mwea Irrigation Settlement Scheme lies near the foothills of Mount Kenya at an altitude of 1100 m. The Scheme is on a semi-arid plain, which had a low population density before irrigation was begun. The colonial government started the Scheme in 1951 to settle landless families. It has been used almost exclusively for semi-mechanized rice cropping. *Schistosomiasis mansoni* caused serious problems between 1960 and 1970, but was successfully controlled with molluscicides. Malaria is seasonal in the area.

In their final assessment of the Scheme, Hanger and Morris (1973) stated: '... the unsatisfactory recognition of a woman's rights and needs within the Scheme remains one of the greatest weaknesses of the Mwea system'.

From 1966 onwards, various nutritional, health, and general socio-economic surveys were conducted among the Scheme's population (Korte 1969). For comparison, information was also collected from nearby off-Scheme areas (including a coffee-growing area). The survey findings indicated a discrepancy between the socio-economic progress in the Scheme and the improvement of the general health and nutrition of the people, particularly when compared with that of off-Scheme people. The investigators concluded that a higher income does not automatically lead to better health.

In the off-Scheme coffee-growing area, on the average, about half of a woman's agricultural work was done for her husband's cash crops (coffee and maize). Quite distinct was the time a woman spent on her own food-crop garden, which was intended primarily to feed her family. Viewed against the background of the off-Scheme community, the position of the Mwea women was decidedly less favourable. The most significant difference was the lack of land where women could cultivate their own crops and thus provide for their families. Instead, women in Mwea had to rely on cash contributions from their husbands. The loss of independence was also evident in the supply of fuel. The off-Scheme women usually gathered their own firewood, but firewood in Mwea was scarce and all households had to buy it.

Houses in Mwea were planned without much consideration for the women. There was no separate kitchen. Water was easily available within the Scheme, but was polluted. Prices of commodities were higher than in the off-Scheme areas, presumably because the tenants were so dependent on the market. The Scheme also required the women to help cultivate the rice. During the peak of the agricultural season, the demands on the women increased so much that they created a direct clash of work priorities. At this time, moreover, the larger numbers of people in the household and other difficulties made preparing food very burdensome.

A comparison between the Mwea women and their off-Scheme counterparts showed a distinct deterioration in the general household affairs and farming of the Mwea women. Hangar and Morris (1973) concluded that the welfare of the tenant families could have been greatly influenced by more systematic planning and greater attention to housing, a domestic water supply, a clear recognition of a woman's claim to at least half of the rice income, a system of firewood provision on the Scheme, and a minimum allowance in land use for a subsistence crop other than rice.

9.8 Health Services

The health services are one of the partners in the intersectoral collaboration for Primary Health Care (PHC). The nature and magnitude of health problems that PHC has to tackle differs, of course, from country to country and even from region to region in the same country. These differences are reflected in the priorities that ministries of health give, for instance, to malaria or schistosomiasis control, and in the tasks of health workers.

In the control of vector-borne diseases, the tasks of health workers are generally (WHO 1983; 1984b-c; 1987) the following:

- To conduct mass vaccination and treatment campaigns;
- To diagnose, treat, and follow-up cases by passive or active case-finding;
- To collect epidemiological data for the monitoring and surveillance of the local situation;
- To control disease vectors and household and personal pests (e.g. mites, lice, fleas);
- To provide education in hygiene and to encourage community participation.

Because of their professional knowledge and skills, health workers fulfil a key role in PHC. Equally important, however, are their familiarity with the local health situation and the trust they enjoy from the community they serve.

9.8.1 Vaccination

The global eradication of smallpox in 1979, after an enormous international effort lasting more than ten years, is a shining example of how effective vaccination can be. As vectors and parasites build up resistance to chemotherapeutics and insecticides, vaccines are becoming an ever more vital line of defence against disease. Vaccination is especially important in combatting infections that affect large populations in the tropics and have the potential of flaring up into seasonal epidemics or of spreading into the temperate zones. At present, the most important vaccine available is that for yellow fever, but gradual progress is being made in developing vaccines for malaria and dengue fever.

The 17D yellow fever vaccine is highly effective and safe. Re-vaccination is recommended every ten years, but protection will persist for 40 years in at least 62 per cent of those vaccinated. Experience during epidemics indicates an even higher percentage of persistence.

Effective vaccines are also available for tick-borne encephalitis, Japanese encephalitis, Rift Valley fever, and Venezuelan equine encephalomyelitis, but they are used on a very limited scale only. Usually, the spread of these arboviral epidemics can be controlled by vaccinating the host animals (e.g. horses, pigs, sheep, and cattle).

Vaccination is a major activity of PHC. It has significantly reduced infant and child morbidity and mortality throughout the world. Through national immunization programs, children are being protected against poliomyelitis, measles, whooping cough, tetanus, diphtheria, and tuberculosis.

9.8.2 Chemotherapy in the Control of Vector-Borne Diseases

Bilharzia

Praziquantel is the drug most commonly used nowadays to treat bilharzia; it is effective against all types of the disease. Another drug, metrifonate, is effective only against urinary bilharzia and is quite cheap, about U.S. $0.50 per average dose. The administration of metrifonate, however, is complicated, requiring three separate doses at 15-day intervals, which makes it difficult to get people to complete the full course of treatment. Thus, in most cases, cost estimates for a program of control can be made based on praziquantel, which would not differ markedly from the costs of a program that uses metrifonate.

Praziquantel is used in the Study Zone of the Blue Nile Health Project. The program of administration proceeds in two phases, the 'attack phase' and the 'passive phase'. The attack phase has two parts:

- An intensive mass chemotherapy campaign in the 'core' and 'fringe' strata villages;
- A slower program in the 'road' stratum villages.

(For explanations of 'core', 'fringe', and 'road' strata, see Volume 2, Annex 4.)

The passive phase is one of detection and treatment, and is a permanent feature of the health services system. It continues as long as transmission takes place and, if preventive measures are able to maintain transmission at low levels, should be able to hold community prevalence below 10 per cent.

The attack phase should not need to be repeated, given the integrated nature of the trial strategy, which seeks to lower transmission permanently. Thus the cost is regarded as a single expenditure, covering only a short period. Included in the cost are the mapping of detailed census results, the training of personnel, and preparatory village meetings. For each of the separate strata, the cost is expressed per capita and per village.

The attack phase in the 24 villages of the core and fringe strata cost about U.S. $50,000 in 1982 prices, which is about U.S. $2000 per village, or U.S. $1.53 per capita. In the road stratum, the cost was about U.S. $4900, or U.S. $700 per village and U.S. $0.20 per capita. The attack phase in all 31 villages cost about U.S. $55,000, or U.S. $0.96 per capita in 1982 prices. After adjustments for inflation, this price would be about US $1.00 per capita in 1984 prices.

The passive phase of the praziquantel chemotherapy was conducted by 6 rapid-diagnosis laboratories, which were established as part of the improvements to the basic health services. Each of these laboratories cost U.S. $103 a month to operate, plus additional monthly costs of about U.S. $5 for equipment, U.S. $20 for praziquantel, and U.S. $5 for other drugs.

The annual cost of the 6 laboratories was apportioned to the basic health services (50 per cent), to schistosomiasis control (25 per cent), and to malaria control (25 per cent). The annual praziquantel cost was added to the cost of schistosomiasis control, giving a total annual cost of U.S. $3384 for passive chemotherapy for schistosomiasis control. This amounts to U.S. $0.06 per capita in 1984 prices (Table 9.11).

Malaria

Malaria chemotherapy usually takes the form of preventive mass chemotherapy, in which the drug is the main expense – about U.S. $0.25 per person treated. In a long-term program, however, a passive case-detection system is used to reduce drug wastage. In this type of system, treatment is given only if infection is detected by microscopic examination of a blood slide. The costs of malaria chemotherapy in rapid-diagnosis laboratories are similar to those for bilharzia, except for the lower cost of the drugs. In the Study Zone, the annual per capita cost of passive malaria diagnosis and chemotherapy in all 31 villages was U.S. $0.04 in 1984 prices, for a population of 57,286. Drugs accounted for 20 per cent of all foreign purchases (Table 9.11).

9.9 Education in Hygiene

The provision of even the very best of facilities to control disease in the domestic environment will prove futile unless the people understand why these facilities have been provided and how they should be used. If the farmers and their families are not motivated to use the facilities properly, disease transmission will continue unabated.

It has long been recognized, therefore, that irrigation projects need a component to educate the people in hygiene. This education should aim at changing attitudes and behaviour to break the chain of disease transmission associated with poor hygiene

Table 9.11 Comparative costs of the passive maintenance phase of the bilharzia and malaria chemotherapy programs in the Study Zone (in 1984 U.S.$)

Item	Total amount	Allocation for bilharzia chemotherapy	Allocation for malaria chemotherapy
Monthly local costs (for 1 laboratory)			
– Buildings	$ 8.00	2.00	2.00
– Cleaning & maintenance	2.00	.50	.50
– Salaries	80.00	20.00	20.00
– Supplies	5.00	1.25	1.25
– Training (0.1 man-month)	8.00	2.00	2.00
	103.00	25.75	25.75
Monthly foreign costs (for 1 laboratory)			
– Equipment	5.00	1.25	1.25
– Praziquantal	20.00	20.00	0
– Other drugs	5.00	0	5.00
	30.00	21.25	6.25
Totals	$ 133.00	47.00	32.00
Annual costs			
– For all 6 laboratories	$ 9,572.00	3,384.00	2,304.00
– Per capita	.17	.06	.04

and sanitation. Nevertheless, education in hygiene must be based on the fact that human behaviour is deeply rooted in social and cultural factors. It is no longer viewed as something to be modified to suit technology. Decision-makers must understand the cultural roots of behaviour before they can hope to change it. The success of new ideas, facts, or behavioural patterns introduced from 'outside' will be determined by their compatibility with the indigenous cultural system. Any attempts at rapid socio-cultural change can shake the people's cultural foundations and lay them open to a radical displacement of values and behavioural patterns.

Dunn (1976) visualized a cultural system as a broad-based pyramid. Its foundation is formed by large immovable blocks that he calls 'value orientations'. These have to do with man's relation to nature and the supernatural world. Upon the large blocks rest many smaller blocks that represent values, attitudes, and beliefs. These are linked to the underlying values and value orientations. Because of their size, the smaller blocks can be more easily torn out of the cultural structure and replaced in the process of adapting to a changing environment. Resting lightly upon the structure of beliefs and attitudes are many small blocks at the top of the pyramid. These represent individual and group behaviour in all its variety.

Education in hygiene is part of a wider concept of health education (Burgers et al. 1988; Boot 1985). In spite of this, only a few projects pay explicit attention to the relationship between development, human behaviour, and disease. Since its start in 1919, the Gezira Irrigation Scheme was beset with health problems. Malaria, bilharzia, diarrhoeal diseases, and cholera were rife, as were smallpox, meningitis, and relapsing fever (Bayoumi 1979). In 1973-74, a severe malaria epidemic once again struck Gezira. When it was shown that this epidemic was responsible for an average loss of 33 working days per tenant, the authorities decided that a different health policy was required. As a result, the Blue Nile Health Project was conceived and has been implemented since 1981.

The neglect of hygiene in development projects reflects the longstanding separation between the various sectors involved in development. Most of the professionals concerned have been trained in a scientific tradition that allows them little time to explore outside their own field, even though successful project implementation requires active cooperation among engineers, epidemiologists, and behavioural scientists. It would be a good thing if the curricula of engineers, social scientists, economists, and health professionals included courses in epidemiology and the use of environmental engineering to control diseases.

9.9.1 Modifying Health-Related Behaviour

In Individuals

Ideally, at an early stage in project planning, the social and cultural dimensions of the project should be highlighted with a careful study of disease-related behaviour. The study should include the relationships between specific types of behaviour and specific diseases. This information can be gathered from interviews or from literature. As part of field research, other information (e.g. on epidemiology) will have to be collected during surveys, so, because this is expensive and trained personnel is scarce, surveys should have a multi-purpose function, incorporating demographics, epidemiology, and behavioural science. During the surveys, many related topics can also be studied to support appropriate project design. We have already discussed many of these topics in this chapter (i.e. water contact, water use, excreta disposal, use of biomass fuel, housing design, and nutrition).

Dunn (1976; 1979) advocates classifying health-related behaviour as one of four types:

- Deliberate health enhancing;
- Non-deliberate health enhancing;
- Deliberate health lowering;
- Non-deliberate health lowering.

Behavioural data classified in this way provides a sound basis for programs of education in hygiene. The key decisions in planning these programs are:

- Which behavioural categories need changing? (These will be the subjects of the program);
- Which groups urgently need to change their behaviour? (These will be the target groups of the program);

- What should the new behavioural categories be? (These will be the objectives of the program);
- Who can best do the educating, or who are the best intermediaries?
- When and where can the program best take place?
- How can the program best be done?

In Organizations

Traditionally, hygiene has been considered the responsibility of the project beneficiaries. The outbreak of epidemics in irrigation projects, however, has taught us that it should be a prominent consideration in policy decisions. In a sense, then, policymakers, planners, and the executive officers of projects are also a target group for education in hygiene, in that they must be made aware of the need for it.

Essential for this purpose are well-designed research projects to assess the effectiveness and efficiency of controlling diseases by environmental modification and management, and by changes in behaviour. If it can be demonstrated that such measures are effective at an acceptable cost, this will help greatly in persuading financing bodies, planners, engineers, and even individual farmers to allocate resources for their application (PEEM 1986a).

Education in hygiene is also important for project staff – both professional and non-professional. This can be provided by in-service training or by short courses (IRC 1987). If such training is given by the more senior staff, it can reinforce the idea that hygienic behaviour is a matter for the entire project organization. A consistent code of conduct within the project organization will help the educational programs for the community at large. Nevertheless, getting the message across to the people will require considerable care, dedication, and persistence.

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