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Technology Choices for the Decade

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ROLE AND PLACE OF TECHNOLOGY

The success of a new facility for community water supply and sanitation is not the mere fact of its establishment; it depends on whether it is properly and effectively operated and accepted and used by its beneficiaries. This simple fact, which has only recently been generally acknowledged, has implied that we must take a new look at the criteria for the choice of technology. Despite the advocacy of Gandhi and the example of China's policy of "walking on two legs," the idea of looking for simple technology other than simply modern and sophisticated technology was often neglected. After its revival in the 1960s and 1970s, the inception and first experiences of the Water Decade have greatly influenced views on "the right technology" in the water and sanitation field.

Consequently the first rule for a successful choice of technology is that it should be in balance with the set of circumstances in which it is to function. The past decades have made clear that a technology on the one hand will and must have a certain modifying power over behavioral patterns. On the other hand, too large a gap in the relation of the technology to prevailing circumstances will condemn it to failure.

The second rule is that the appropriateness of the technology will be determined by those who will be most concerned with it in the long run,

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whether she (or, less importantly in some cases, he) will be responsible for operating it, maintaining it, or simply using it. These rules imply that those responsible for the choice of technology in real terms must know of technological options, but must be equally aware of the important role of local socioeconomic as well as geographical circumstances. These circumstances vary widely from region to region, from country to country, and from locality to locality. In each case technology choice should be based on the sum of conditions that prevail nationally or locally. A choice can never be determined by the argument of a technology being successful elsewhere.

One important element of water and sanitation technology is that it has to play its own role in the solution of the issues that generally hamper progress in water supply and sanitation development. Among the major ones are the lack of qualified and motivated labor, inadequate management, and limited financial resources. Trained personnel are not only deficient in many of the water agencies, but also in ministries, health agencies, community organizations, and labor categories of all kinds. Operation and maintenance, quality control, revenue collection, and involvement of the communities leave much to be desired. The scarce resources are barely or not at all sufficient to cope with the daily problems, let alone with investments for the future. These situations differ considerably from place to place. Several countries may have workers available but lack funds. Others may have ample funds, but have a shortage of trained people. Many have neither of them. Management problems occur almost everywhere. Communities—and especially the women in communities—almost universally have too limited a role in contribution to the solution of their own problems.

Technology by itself is certainly not the panacea that solves all these problems. Yet, these issues in their manifold implications demand their own answers in technology choice, and determine the context in which the chosen technology should fit. This concerns both hardware (e.g., hand pumps) and operational techniques (such as revenue collection methods). Adapting a set of "preconditions for successful program formulation" and project identification listed by WASH (1981) we can say that technology choice must be made in the context of

1. The water supply problems and related community needs that can realistically be met by the project;
2. The social and economic attributes of the people in the project communities;
3. The hierarchy of feasible choices of technology in the project localities, including lower and higher levels of service;
4. The anticipated benefits of the project, both immediate and long-term; and

5. The types of existing support conditions, complementary investments, and project-induced conditions that are necessary to support the selected intervention.

The main conclusion of WASH is that "there is no 'quick fix' to the identification of potentially successful projects. There is no simple set of indicators that can be used in all situations and under all circumstances. The consequence of this conclusion is that the planner who wishes to be best prepared to undertake project identification is one who thoroughly understands the concept of preconditions and the process by which they shape project success [p. 136]." This conclusion is similarly valid for technology choice.

In this context it is worth mentioning that the concept of support programs has been introduced recently by the World Health Organization (WHO, 1981). With support programs, governments would aim at reducing constraints, so that "coverage programs" directly seeking to extend coverage can be developed faster and last longer. Among the support programs mentioned are those "to provide information and technology." The document states that there is an interdependence of information and technology, and adds that "The scope for reducing costs and for making simple innovations in design and operation of installations for water supply and sanitation is limited, and in the gathering and dissemination of information, efforts may be directed more to the application of available but underutilized technology, to the transfer of suitable technology to countries which are unfamiliar with it, and to the adaptation of known techniques to local materials, needs and attitudes [p. 43]."

FASTER PROGRESS NEEDED

There is ample reason to continue the critical review of past approaches and introduction of new concepts in water supply and sanitation development. The progress achieved by developing countries with assistance from international organizations and donor agencies in the provision of community water supply and sanitation facilities during the 7 years since the Water Conference in 1977 indicates that it will be very difficult to meet the Decade targets as defined in the Mar del Plata Action Plan and that at the present rate of progress, despite all efforts, the means and methods that are being employed appear to be incapable of meeting present, let alone projected, needs. In many areas of the world we are still falling behind population growth and community expansion.

It would indeed appear that in order to be able to approach the Decade targets, a further change in policies and a major increase in resources devoted to water and sanitation development are needed. Equally important, this has to be complemented by a significant shift in approach to and emphasis on the technology that is applied.

In terms of effort it implies that all resources should be mobilized, especially those potentially available within the countries. In terms of cost it implies that more people would have to be served with the resources available. No doubt much can be gained in this respect by applying less costly equipment and by an increased use of locally available resources. In terms of timing it implies that more facilities should be built per year. The availability and use of local labor plays an important role, but again, the choice of the right technology is another. In terms of technology application it implies that the introduction of the technologies must permit, or even stimulate, chain effects, in order to assist governments to make progress despite continuing population growth.

It may seem that the agreed targets of the Decade will most probably not be met. The Decade may nevertheless be brought to a very positive outcome, if it leads in each country to adequate structural and institutional conditions, on the basis of which in later years the goal of continuous water and sanitation provision for all can be reached. This may be an even more meaningful result than the mere availability of facilities, which in many cases, due to lack of necessary preconditions, are doomed to fall into disrepair in the following few years.

The success of the Decade will depend on the degree of self-reliance achieved in water and sanitation development. That is not measured by the number of taps and pumps, but by the ability of people to construct, maintain, and properly use them. In the long run such a result is of more significance than the attainment of a certain "coverage." The right choice of technology and the important impacts that can be derived from it are potential important contributors to such a favorable development, provided the right criteria are applied.

BETTER CONTINUITY

Numerous cases of breakdowns and failure of water supplies in almost every developing country indicate the use of inappropriate equipment or processes that have been designed with insufficient consideration of local resources and capabilities. Some reasons are

1. Use of sophisticated techniques which are based on conditions in industrialized countries and for which the skill for adequate operation and maintenance is not available locally;

2. The use of costly imported equipment for which the spare parts are hard to find;
3. The introduction of systems that are not socially acceptable.

Therefore, techniques should be used that

1. Can be designed and constructed by local consultants, contractors, and self-help organizations;
2. Under the local conditions provide water supplies and sanitation facilities that can be well operated and maintained by local people and give long lasting service;
3. Provide solutions at costs that are within the resources of the community and/or country, including in particular the costs of operation and adequate maintenance.

The third point cannot be overstressed. Fast construction of facilities alone can never ultimately lead to the provision of water and sanitation for all within a reasonable period; it is more important that the equipment introduced and the services established be able to perform their functions for a long time to come. If the development strategy attempts to achieve real improvement, modern high-technology methods must be weighed carefully against more locally based techniques (e.g., improved traditional methods), which can last a long time after their introduction.

The conventional way of looking at these problems is to assume that we need new designs and new techniques which will perform better than the ones that fail on such a spectacular scale. Several organizations have therefore put a lot of effort into the redesign of conventional engineering plants and equipment, and into the reappraisal of existing water supply techniques. The aim of most of this work has been to generate designs and techniques that will perform satisfactorily with minimum maintenance in the harsh conditions of rural and urban fringe areas of developing countries, where heat, limited technical capabilities, and the availability of only poor materials inevitably add to the problem. There have been benefits from this work, but one must doubt whether the key problems have yet been faced or tackled. One of the great illusions of this work, which largely concentrates on the engineering side of problems, is that lasting progress can be made purely by giving attention to hardware.

CONSUMERS' ACCEPTANCE

The progress achieved in the area of engineering works and unit process design for water supply facilities should, of course, not be disregarded. However, in the provision of water supply to rural and urban fringe areas, there are many more dimensions than the technical one alone. Consumers' acceptance is one of them. Especially in the target sector of rural and peripheral areas in which the users are directly involved and work with the devices introduced, such as hand pumps and standposts, good maintenance is related to and very much dependent upon consumer acceptance. Because programs very much affect people in daily life, active participation is indispensable. The role of women, in particular, deserves ample attention. Despite good intentions and expressions in the world's meeting rooms of benefits to be gained, in practice there is much left to be desired. The problems should be given due consideration in drafting programs for the implementation of water and sanitation schemes.

ISSUES IN THE CHOICE OF TECHNOLOGY

The Maintenance Issue

Choosing technology for optimum maintenance is not a simple matter. One of the reasons why maintenance is so often neglected is that it is generally difficult to find the funds for it. This is particularly true in the poorer Third World countries, including many in Africa, where foreign aid provides a high proportion of the government's capital expenditure. The foreign donor is usually not inclined to pay for recurrent costs like those of maintenance, because it may tend to establish a long-term dependent relationship which neither of the parties may desire. The national government is reluctant to pay for maintenance on the scale required by the increasing number of improved water supplies being installed through capital aid programs, because its recurrent budget is small, often declining in real terms. This reluctance may often be compounded because of the lack of glamor in maintenance: Politicians and even water engineers may think there is more prestige to be gained from bringing a new water supply to a community than from ensuring that an old one continues to work. (Though this may or not be true: Perhaps a lot of prestige is lost when supplies fail.) Regional and local governments have even less capacity in their recurrent budgets which, moreover, in cases of centralization of political power often depend on national subsidies.

For these reasons many people in the water sector now voice the opinion that the local community is the only group really interested in maintaining the water supply, and therefore it should be responsible for maintenance. In many cases, however, there is reluctance in the local community to pay for water which it feels should be delivered free by the national state. In other cases the rural population may simply feel that they do not have the money to pay for maintenance. The local community may not be inclined to think of a system installed by outsiders as something for which they should take responsibility. If the supply only improves water purity but is not more accessible than the unimproved supply, then it is likely to be accorded little or no importance unless the unimproved source is clearly recognized as the source of water-related diseases such as schistosomiasis.

Perhaps the main reason why it is difficult to get local communities to pay for maintenance, however, is that only rarely are local communities organized enough. That is, only rarely is there a village government recognized by the national government as able to raise and handle its own funds, legitimate in the eyes of the local people who consider the officers trustworthy, and not driven by local factionalism.

What can be done about these problems of maintenance, and in particular what implications do they have for technology choice? One possible answer is to attempt to overcome the need for maintenance altogether by designs that are so sturdy and durable that they do not need any maintenance. In well technology, for instance, where hand pumps are used and are the Achilles heel of the system in that they tend to break down long before the wells cave in, there is a school of thought that hand pumps can be made virtually indestructible (and without any need for servicing). Indeed it has been suggested that such hand pumps have already been developed (e.g., in the Federal Republic of Germany) to serve as the last resort in case of destruction of other public supplies in a war. Others say that a maintenance-free pump is a chimera, and those who have been attempting to develop one for rural use in the Third World have continually had to revise downward the estimates made for the maintenance-free period for each successive design they have developed.

What does appear feasible is to install hand pumps that will last for a few years on average (e.g., 3–4 years) and can then be exchanged for new pumps as another capital aid project, that is, one that the aid donor does not mind funding. Obviously, this is not an ideal solution. It has probably never been adopted intentionally in advance, but only as a result of a disappointing performance of the installed pumps and maintenance system.

At the opposite technological extreme, some advocates of appropriate technology say that every element in the technical system (in this case, every part of the hand pump) must be within the capacity of local people to maintain and repair without any help from outsiders. Parts must be available to them locally without their relying on any new system of distribution. In parts of the Third World (much of Asia and Latin America) where local technical capacities are high and commercial availability of spare parts is ensured, the principle allows for fairly complex technical solutions. In much of Africa, however, they would be limited to the simplest of devices, for example, protected springs or rope-washer pumps for shallow wells; whereas probably no improvement on the open well is feasible in many areas where neither the skills nor the parts are available. Of course, the argument could then be that effort should be concentrated on spreading skills and establishing systems for making parts available, for example through national networks of appropriate technology demonstration centers and small enterprise support organizations. This is an argument of those who think of development as being most importantly a matter of "development of people," which, in fact, should be the main thrust of the Decade.

The argument is generally rejected by those who think in terms of achieving the fastest coverage with adequate water systems. For them, some kind of compromise between these two extremes is necessary. This would involve combining a maintenance system with a choice of technology in such a way that the water supply institution would have an effective maintenance organization at low cost, implying that as many as possible of the more routine maintenance functions be carried out at as local level as possible, including the maximum use of community members. Where population densities are lower and distances between water systems are correspondingly greater, and where foreign exchange for the importation of vehicles and fuel is more of a constraint, it would be all the more important to delegate functions to lower levels including that of the community: One of the main causes of failure of maintenance systems is their transport constraints.

Frequently, a three-tier maintenance system will be appropriate, in which (*a*) a local community member handles the simpler tasks, especially preventive maintenance (including daily operation where this is required); (*b*) tasks of intermediate complexity are given to a skilled artisan typically based in a small town and using bicycle or motorcycle to get to the villages; and (*c*) major repairs that require four-wheeled transport are in the hands of the district organization of the water authority. The latter will probably be state employees, whereas the artisans will have a contract for their work and the local operator will ideally be paid in proportion to the work required, at local rates for labor rather than national wage levels, by the local community. It may then also be provided that where a repair job requires unskilled labor (redigging a trench, for instance, or replacing the sand in a filter), the community members can be called upon to perform this work voluntarily. A three-tier system (somewhat different in detail from the one just outlined) has been well established for hand pump maintenance in Tamil Nadu, India, whereas using unskilled labor for repairs works well on a voluntary basis in, for example, the Malawi gravity piped supply program.

The three-tier system outlined is, it must be recognized, an ideal picture. Too often, community payment of an operator will not work because there is lack of trust—the operator has no sanctions against the community if it fails to pay, or the community can take no action against an operator who fails to do the jobs required. Community payment for an operator is likely to work only if either or both of the following hold.

1. The community is already organized to make regular payments for other kinds of work, such as sweeping the streets or looking after the children in day-care centers, and this has been done satisfactorily in the past.
2. There is, as is usual in Latin America, a system with house connections, so that those community members who fail to pay can be effectively denied access to the water: A community water board can in this case be established to charge water rates sufficient to cover maintenance costs.

Otherwise it may be necessary for the water agency to pay the operator either directly or through the community. But this can still be a relatively cheap solution, since it can be at local rates not at the salaries of agency staff; and only for the hours of work actually required. The system would then be similar to that used for the payment of village health workers in many primary health care programs, as is done in India.

Under such a three-tier system of maintenance, the choice of technology should aim to minimize the use of the higher tiers, especially the agency's own team. Hand pumps should be removed from the well without need for equipment requiring four-wheeled transport to bring it to the site. Similar principles apply to other techniques, for example, slow sand filters have been observed that require a pump to be brought in in order to clean them, an obvious design fault. The technology should be adapted to the existing skills of the artisan and local operator, or the new skills which he or she can easily absorb in a short course which must be arranged. A system for enabling the artisan to acquire necessary spares and tools and the community operator to acquire such items as washers and taps must be established whenever the items are not readily available locally. Ideally, the design will allow a maximum use of items that are readily available anyway, as well as simplicity in the number and types of spares and tools.

There is a fundamental difference with regard to the maintenance of sanitation facilities in rural areas as compared with that of water supply facilities: Sanitation facilities will generally be owned and maintained by the individual household. Collective sanitation provision (public latrines) is not generally advisable in rural areas of developing countries because, universally, low status is accorded to those who perform tasks relating to the disposal of other people's wastes. It will generally be very difficult to ensure that operation and maintenance are satisfactory, and that the workers' health is protected, when there is social prejudice of this kind against them.

In some regions, where other jobs are becoming available, it will be difficult to attract workers for rural sanitation systems at all.

Distaste extends also to maintenance of one's own household sanitary facility, and to removal even of composted material. In areas where there is no existing tradition of doing these jobs, it will often be advisable to avoid the problem by introducing technologies that require no such tasks, or only a minimum of them, in particular those systems in which the excreta drop vertically with no fouling and no need for removal (the trench latrine and the pit latrine, including the ventilated improved pit latrine). Then, the requirements may be reduced to covering the excreta and to digging a new trench or pit—a clean job—and transferring the superstructure or building a new one. There may still be a problem of people neglecting to do this as soon as they should, but by minimizing the tasks there will be fewer and less serious problems than there are with more complex systems. Unfortunately, where water is used for anal cleansing, the pit latrine may be unable to cope with the extra liquid, and a pour-flush system is then indicated although it requires more careful maintenance.

However, local people should be the best judges of what systems they will be able to operate and maintain in good order, and the alternatives should be discussed with them. The only reservation is that they may sometimes overestimate the work they will be prepared to do, particularly if they are enthusiastic about the advantages of a more complex system. Also, both villagers and agency personnel may be overenthusiastic about capital-intensive solutions such as the vacuum truck, which promises to eliminate the need for digging new pits, but which is very likely to break down in typical rural conditions. Such solutions should not be offered except where the beneficiaries are able and willing to pay the full costs.

The Level of Service Issue

In many countries where a high proportion of the population uses a grossly inadequate or inaccessible and/or a grossly polluted supply, the most cost-effective means to improve health is to make small improvements on a large scale rather than large improvements for only a small number of people. Obviously this has implications for technology choice. Unfortunately, suggesting a "lowering of standards" goes against the traditions of water engineers, just as teaching community members preventive and curative skills, which have been the exclusive province of nursing and medical staff, goes against the traditions of doctors.

A national agency often resists looking at the needs of those not living in the communities that can be supplied in the next few years with water systems of the types installed by the agency. One result is the proliferation of agencies responsible for water, as other authorities set up departments to cope with the water problems of smaller communities. In some countries the various agencies have been brought under a single water authority in a reorganization. But this may well have the effect of subordinating the unit responsible for the smallest rural supplies to the authority responsible in its own eyes "primarily" for larger supplies, and may only serve to reinforce the tendency for funds to go to these larger supplies. Of course the argument should not be reduced to the simplistic "small rural improvements are good; larger scale supplies are bad," in allocating priorities and funds. But there could be more consideration of the possibility of providing special funds for small improvements in those smaller communities where the existing water source is particularly unacceptable, but that do not qualify for immediate inclusion in regular programs for new supplies.

In countries where a substantial proportion of capital expenditure for water is from aid sources, there is a difficulty parallel with that for maintenance: A program of small improvements will generally require recurrent expenditures as it is primarily a matter of providing salaries for the skilled staff. Also, it will not be reasonable to list every community in a program in advance before requesting funds, despite the preference of donors for this; they will need to adjust their requirements. Within national water agencies, the major change required is to respond not to pressure or requests from larger communities wanting higher levels of service, but to seek out the communities most poorly served by their existing supply. A more ambitious alternative would be to establish a minimum level that the source of supply in every small community in an area should have, within a very short time—say 2 or 3 years—before further plans are laid for any greater upgrading. The minimum should be expressed both in terms of access and quality, but the criteria could be, at the first stage, very much lower than those currently used, and they could be related flexibly to feasibility of improvement and size of the settlement involved (i.e., to *per capita* cost).

Currently very little attention is paid to the adequacy of existing sources when new water supplies are planned. Indeed, sometimes it seems as though the better off people are with their existing supply, the more likely they are to get an upgraded one. This is perhaps not surprising, because they will already be in contact with the water agencies if they have an existing "official" supply; larger villages, otherwise preferred by water agencies as sites for their new systems, are likely to be larger precisely because they are located in well-watered areas permitting dense settlement and cultivation. Drier areas will have smaller villages. It is here that the villagers will have to go the farthest for any water, and that will be, as a general rule, of the worst quality.

Frequently it is found that people in a community provided with a new supply are not interested in it: There is said to be a problem of acceptance. It may be that in many of these cases the previous supply was actually fairly adequate—polluted to some extent, but with pathogens to which the community had acquired a considerable degree of immunity. Above all, it was probably sufficiently near to their houses (or as near as the new supply).

Before carrying out a "minimum level upgrading" then, it is suggested that water agencies should undertake through their district offices (and should be helped by donors) to do simple surveys of existing water provision for each settlement in the district, with some indications of adequacy in terms of access and degree of contamination. This would preferably include a good measurement of bacteriological contamination: The ideal would be an indication of human fecal contamination at the season of greatest risk; in many cases practical constraints will no doubt require the use of more rough-and-ready indicators. The people should be asked their opinion on the healthiness of the sources, although it should be kept in mind that the replies may not be reliable as objective reports, except in the case of schistosomiasis and Guinea worm disease. They will, however, indicate community satisfaction or dissatisfaction with this aspect of their supplies and hence the likelihood of their cooperating to improving it.

The smaller the community, the more cooperation will be required, otherwise, per capita costs to the agency would be prohibitive. In some of the worst cases, perhaps, no improvements will be feasible at reasonable per capita cost. But in many other cases a feasible technical option will exist. Even if people continue to have to go some distance for water at the latter part of the dry season (rain catchment if nothing else will normally be possible in the wet season), an improvement from the worst levels of contamination should be possible everywhere through some form of source protection. Measures of the level of bacteriological pollution are also appropriate for existing improved supplies, especially simple gravity piped supplies. It is a curious fact that although some gravity supplies in the Third World are chlorinated and others are not, this often depends neither on the degree of bacteriological pollution of that supply, which is rarely measured, nor on the wishes of that community but on the attitude of the engineer(s) in charge toward chlorination in general.

There are other questions involved in the choice of levels of service for those communities that can be provided with more than help toward a simple improvement. There are, of course, first of all the technical constraints which we shall not go into in any detail here. Huisman (1982) writes:

> Taking into account water quality and quantity and the difficulties of keeping pumping and treatment plants for rural supplies in developing countries in good operating conditions, the preferences for a dispersed population using individual

watering points are protected spring, a sanitary well and private rainwater catchments in this order. For village supplies needing larger amounts of water and having some sort of distribution system, the preferences are: spring-water recovered some distance above the supply area and requiring neither treatment nor pumping; groundwater requiring pumping but no or only a very simple treatment; artificial or induced recharge converting surface-water into an artificial ground-water with the same advantages as mentioned above and only as a last resort water from rivers and lakes, asking for both treatment and pumping."

When, however, does a village "need" larger amounts of water and a distribution system? What the water agency must take into account are (*a*) the per capita cost of providing the reticulated supply; and (*b*) the adequacy of the simpler alternative, in terms of access. Where a nearby, abundant, perennial spring is available for a gravity supply, it would be illogical not to take advantage of it. Where there is no possibility of all-year-round wells in the immediate neighborhood of the village, so that people have to go a long way for water, there is a better case for constructing a more expensive (per capita) supply than when adequate year-round wells exist. But to be fair to the many others elsewhere in the country whose water supplies will still be inadequate, (apart from exceptional cases) supplies should not be installed at a per capita cost more than, say, two or three times that which is average for the country as a whole (unless the local population is willing to pay for it themselves so there is no subsidy).

Since many of the aims of improving water supply are achieved by bringing it closer to the consumer (even health aims, because it is most important for health that larger quantities of water be used, as they are when it is more accessible), the two main criteria of per capita cost and degree of improvement in access could be combined in a single measure of priorities, namely cost per meter of daily journey to the water source from each house in the community to be saved through the new system (cost divided by average distance times number of households). This is explained in greater detail in White (1981, Appendix 3, pp. 157–160).

A final question on levels of service concerns the choice between standposts and house connections. The latter have a number of virtues, including the fact that much more water will be used and the health benefits will be correspondingly greater. Another virtue, mentioned already, is that it is much easier to charge water tariffs since people are willing to pay and since their supply can be cut off if they do not. The experience of many Latin American water agencies is that it is also possible in this case to organize community water boards that handle the daily administration of supplies, collect the water tariffs and pay for local operation and maintenance, and provide some training and supervision by a staff of promotors from the agency. However, financial constraints may make this solution inappropriate, especially where, for instance, springs or clean mountain streams provide sufficient water for gravity supplies and standposts, but household supplies would require pumping and/or treatment, and therefore an altogether higher order of per capita cost. A calculation can be made of the additional cost per capita of household as opposed to standpost supplies, the capital element being added to the recurrent element by a simple rule of thumb (say by dividing it by 10); this can then be compared with per capita income. A norm can be established that it should be no more than a certain percentage of the local per capita income (e.g., 5%, which is in accordance with the 3–5% often mentioned as being the maximum percentage of the household income people can be expected to pay for water) or of the national per capita income (in which case a lower percentage would be appropriate). Otherwise the local people will be unable to pay a reasonable share, and there will necessarily be a subsidy at a level too high to be replicated everywhere.

With regard to sanitation, and bearing the upgrading of systems in mind, the World Bank (1980) distinguishes between on-site technologies and off-site technologies with dry and "wet" alternatives in both categories. The recent Bank series, Appropriate Technology for Water Supply and Sanitation, for example, Kalbermatten *et al.* (1980), discusses sanitation options in great detail.

The Issue of Standardization in Relation to Policies for Appropriate Technology, Local Production, and Employment Generation

Far too often the equipment for water supplies, even simple water supplies, is imported rather than being locally produced. This is because those in charge are responsible for effective, and it is hoped, *cost*-effective provision of water supplies but not for other government objectives such as employment generation or income redistribution. In countries where foreign aid finances a large part of the capital expenditure of the water sector, another great bias is generally introduced as the donor's equipment becomes easy to obtain and therefore "cheaper" in a real sense, certainly in effort, from the point of view of the water authority's senior staff. This is the way that real development (in which people's standards of living rise) is replaced by a mere appearance of development—the completion of attractive looking projects. Some donor aid agencies are fully aware of this, but changes in donor practice (to encourage local procurement) have been slow, aid budgets themselves often being a compromise between a humanitarian and global political impulse on the one hand and a commerical exporting interest on the other.

The question of local production is closely tied up with questions relating to appropriate technology and standard designs. Local production should imply the using of materials and skills that are locally available in adequate quantity, not the automatic construction on local soil of a factory to turn out exactly the same product that had hitherto been imported. If this is done, few if any gains will be made: It might even turn out that when the costs of importing the machinery for the factory and its raw materials—often in fact semifinished parts—are added up, they total to more foreign exchange than importing the finished product would have cost (to say nothing of local expenditures or the reduction in quality which will inevitably be felt). Rather, a policy for local production should be part of a broader approach to technology.

It is important to realize that almost any developing country (apart from some island ministates) has water problems of sufficient scale to justify the creation of a set of standardized techniques to solve the problems. The techniques should be such that associated equipment be produced locally according to designs that exploit local skill and ingenuity and local materials, as far as possible, and that maximize the use of local workers while minimizing the cost of imported machinery and equipment.

The standardized techniques and equipment should use an appropriate technology. That is to say that, for one thing, production should be by techniques that are appropriate to the country's endowment of capital and of labor. Most Third World countries have little capital but an abundance of labor. An appropriate technology there is one that, although performing the task in a satisfactory way, uses as little capital as possible. More exactly, one may define an appropriate technology in relation to the total capital stock of the country divided by the total labor force to give an average amount of capital available per economically active person in the country's economy. Most industrial technologies imported from more advanced countries require a capital-labor ratio much higher than this average, and their use implies that others in the economy will have to continue to work with very little capital indeed. An appropriate technology uses capital and labor in a ratio that is about average for the country, and certainly not much more capital intensive. It may be more labor intensive than the average, but only in so far as the income of the workers involved can be sufficient, without subsidy, to attract a labor force (i.e., to draw them away for even more labor intensive and low-paying occupations). Thus, generally, an appropriate technology is *intermediate* in terms of the capital-labor ratio, between technologies imported from advanced countries and technologies traditional in the Third World countries concerned.

It is also necessary to compare the technology chosen with others whose product it might displace in the market. A technology that displaces imports or more capital intensive production is more appropriate than a technology that displaces the activities of those who are employed in labor intensive workshops. Unfortunately, "appropriate technology" is sometimes thought of in terms of the kinds of projects its adherents are able to set up: often small-scale innovations in villages, using techniques the villagers can adopt with little outside help, which implies that the very techniques are simple. This is sometimes dismissed as having little to do with standard designs for use on a large scale by a national water agency. Yet the standard designs should also be appropriate in the sense just defined: using an appropriate capital-labor ratio (generally one that is *intermediate* between capital intensive and labor intensive, hence an "intermediate technology").

The pursuit of standardization, then, should involve preparation of standard designs for each of the components of each of the types of supply system to be adopted in any significant number in the country, including variations for different local conditions. For example, several designs of hand pump may be needed for wells of different depths and perhaps also according to other factors such as patterns of use or indeed potential misuse by the local population and different conditions for maintenance. The designs should be drawn up with a view to the production of the equipment including its component parts being as far as possible within the national economy, and using an appropriate technology as just defined. Contracts for the standard items of equipment as well as for carrying out standard construction jobs can be made with a variety of local contractors, taking advantage of economies of scale but also encouraging small enterprises wherever feasible.

In some countries it will be appropriate to carry such standardization to the point of the approach being fully "modular," in which every possible facet of organization and design is covered by the standard plans. This will be the case when very large numbers of supplies are to be constructed by one authority. Elsewhere, and particularly where a high level of skill exists among the agency's staff, more elements of design can be left to those who have the time and the competence to carry them out at local level.

Standard designs and specifications for equipment require periodic updating to take advantage of improvements. In areas such as hand-pump design these need to be frequent because previously inadequate designs are undergoing rapid development. This does, however, somewhat detract from the virtues of standardization since, for instance, there will have to be stocks of different spare parts for the different models used at different times.

So, standardization should be regarded as a valuable means to achieve desirable ends such as taking maximum advantage of scarce skills, making economies of scale in production, or providing for easier logistics of maintenance. But the ends should always be borne in mind: standardization should not simply be treated as an end in itself, since it may have disadvantages also. In certain circumstances these can even outweigh the advantages.

Sociocultural Issues

Non-social-scientists often place too much weight on "exotic" cultural values when they consider the problem of acceptance of a water or sanitation technology by the population (Curtis, 1978). By *exotic values* is meant those that are not readily understandable to the outsider, rather than attributes the outsider might adopt if in the situation of the people concerned. Much more often, reasons for nonacceptance lie in the much more mundane area of attitudes with which we can all identify if we are willing to sympathize with the position of the nonacceptor.

By far the most important type of "nonacceptance" is that people are rarely willing to walk much further to collect water from a protected source or a standpost when they have closer sources that appear reasonably clean or that they have always used in the past. They may nevertheless say they know the protected or piped supply is more likely to be free of germs (not always actually the case, but that is another matter). This can be readily understood if we put ourselves in their position of comparing risk with effort. On each day's journey, the fairly remote chance that that day's water collected from the closer source will make the family ill can be put against the certainty of having to make the additional effort of going further. Similar decisions are made every day on the roads of advanced countries, and some people are more cautious than others. Can we be confident that the decisions made by the water carriers of the Third World are any more injudicious than those of the road users in the First, given the uncertainties involved?

This comparison also puts into focus the limits of health education. It is sometimes assumed that if people do not accept a protected source (or if they do not conform to expectations in other ways) then the answer is education: we know better, and sooner or later they learn, though it may take a long time because traditions are deep rooted. But education in such areas is not always particularly effective, just as it has not eliminated dangerous driving. It is certainly not enough to say we must add a health education component to make a water supply well accepted and used. Depending on the methods used, educators may be able to achieve some results, but they cannot make people change their behavior just by telling them they ought to, or even by just explaining why they ought to (White, 1981, Ch. VI). Often it is not a question of people not knowing that the protected source is healthier, for instance, but of their being prepared to make an extra effort; and they will listen politely to those who tell them to do so—but that may be all. Or it may be they would have to put up with water of a saltier, less pleasant taste, or with water needing much more soap, which they can ill afford or find difficult to buy because of cost or availability.

If this happens water agency personnel are tempted to think that they have done all they can, and if the people will not listen to reason that is their fault. The behavior of the people is, however, perfectly rational and does not need to be explained in terms of ignorance or a different culture. In this kind of situation, the only answer is for the water agency to be willing to meet people's actual requirements as far as possible, for example, by providing water sources at least as close as the contaminated ones, and not much more salty, hard, or otherwise objectionable. Where this is not possible, the difficulty should be discussed with the users with a view to arriving at an agreed solution; and in such a discussion it is essential that the water agency takes the objections seriously, and does not dismiss them as a manifestation of ignorance and backwardness.

Thus acceptance is closely linked with level of service, though this does not mean that people can always be provided with the level of service they want. Sometimes unrealistic statements are made to the effect that, for instance, water should be provided for economic as well as domestic purposes because this is what people want. There is the danger, as mentioned already, of setting standards so high that only a minority can be served at all. A compromise is necessary.

Whether a compromise has to be made or not, the new supply should always be introduced to the population through public meetings explaining the reasons for the technological choices made and consulting the people at least on the details including the rules the community should apply in the use of the system and such matters as the height of standpost taps (to facilitate or to prevent their use by children). It will often be possible to offer additional facilities, such as laundry places or public bathhouses, given a contribution by the community. The more people are involved in such discussions, the more likely the supply is to be used, valued, and maintained.

There are also cases when "exotic" cultural factors do have to be taken into account in technology choice. This applies particularly in the field of sanitation. Generally the strict cultural norms and taboos associated with excreta disposal are elaborations of concerns shared also by Western societies about privacy, avoidance of unpleasant smells, and the like, but there is no doubt they have to be given special attention in the design of sanitary facilities and programs. Consultation with the population will certainly be needed on the form of latrine seat or squat plate to be provided. There may be strong feelings against the use of composted fecal material on the land, ruling out the compost latrine. An apparently ideal solution for excreta disposal, the connection of the latrine directly to a biogas plant (using also other materials) has not been introduced yet, it seems, into any rural sanitation program, presumably because too great an opposition is expected (since the methane gase produced is used for cooking). Opinions on the likely degree of opposition may be the limiting factor here, however, since there is little evidence available on how much resistance to such innovations is *actually* encountered in different cultures.

In some countries, latrines of any sort seem to be extremely difficult to popularize. It does not appear to be clearly established how far this is for "nonexotic," universally rational reasons and how far it is linked to specific cultural traditions. It may be, for instance, that where village houses are close together and people have little space, they are understandably reluctant to fill any small available space with a smelly latrine. It is more often said, however, that people may like to chat together in public defecation grounds or that they want to avoid being conscious that family members of opposite sex are performing bodily functions which are distasteful. Or perhaps these are only excuses for not wanting to make an effort. It is very difficult to know what the real motivations are.

In the area of water supply, cultural factors need to be taken into account in designing systems.

1. Where the collection times are particularly concentrated (say in early morning and just before dusk, because women are working in the fields at other times), the supplies should be designed to cope with the extremely peaked demand;
2. Where women value the opportunity of meeting and talking and perhaps bathing at the traditional water source (say because they are otherwise kept at home by their husbands or fathers), there may be a good case for locating and designing new supplies where this is still possible. It is essential to consult the women themselves about this, or those who know their real wishes, since it may precisely be the aim of the men to control them;
3. Hand pumps should be designed in relation to the way local women and children will use them. This does not just mean they should be strong to cater for "unskilled" users and playful children, but that they should, for instance, be designed for short staccato strokes.

There are also factors related to social structure and group interest. An example is the question of whether there are social groups who may feel aggrieved at the new water supply and be disposed to damage or destroy it. This might include people who previously sold other water, people denied access to the supply who think they should have it (e.g., for their cattle, kept away by local people for whom the cattle are a nuisance), or people whose own water supply is reduced because the same limited source is used. In these cases it is essential to find out about such potential opposition at an early stage in planning the system, and to defuse it by doing something for those who have a legitimate grievance. It will be of little use to design a system to be foolproof in the face of determined vandalism. Where it is said that people take parts of the water systems for other purposes (e.g., hand-pump handles for ox plough axles, or even PVC piping for decorative armbands) it is likely that behind the appearance of extreme selfishness or an exotic taste in decoration there is a resentment against the water supply for reasons such as those mentioned. The overall moral for water supply personnel in designing systems to meet people's needs is to put oneself in their place and talk with them. For an empathic person it should not be too difficult then to understand which technological solution to choose.

GUIDING CRITERIA

It is hardly possible to translate the many considerations discussed into a specific set of concrete criteria. The circumstances to which they should form an answer are too varied; they have to be the result of too many angles of consideration. On the other hand, the implications of each of them are too manifold to fit the exact needs of their user. Moreover no listing of criteria for choice of technology is likely to be complete or definitive; any such listing is likely to contain overlapping criteria.

For the purpose of this book a list has been assembled as an attempt to concretize the considerations in this chapter. It should be used as a checklist rather than as a comprehensive guide. It may serve as a tool to trigger looking at technology choice a bit differently than before and result in adding subsequent criteria for use in the specific circumstances for which the user wishes to apply them. It is hoped that it may lead to a fuller understanding of the role and implications of technology in the attainment of the goals of the Decade.

- Make, to the extent possible, use of *locally available labor,* and be reluctant to substitute capital intensive equipment for labor, unless it is clearly imperative to do so.

- Employ *construction methods* compatible with local capabilities.
- Use, with preference, *locally available materials,* and avoid, where possible, imported equipment.
- Consider carefully the *foreign exchange requirements* of the water supply program and minimize them unless they are not difficult to obtain.
- Encourage *local manufacturers* to supply the needed equipment and parts.
- Be compatible with *local values, attitudes, and preferences.*
- Leave *operational control* with the users' community.
- Be *low in cost,* without jeopardizing the effectiveness of the water supply facilities installed.
- Accept an adapted *level of service* where necessary to spread benefits of safe water supply more widely.
- Adopt a *phased implementation* of the water supply sanitation programs, with subsequent upgrading of the installed facilities.
- Make sure that the *timing* of water supply sanitation projects allows for ready execution.
- Include a *measure of standardization,* so as to limit the difficulties of spare availability and storage.
- Design for *direct manual operation* rather than remote control with mechanical or electrical devices.
- Specify, where possible, *equipment not requiring power operation.*
- Select *treatment processes* with little operation requirements.
- Adopt a two- or three-tier system for *maintenance* including local involvement *and* agency support.
- Keep *maintenance requirements* within local capabilities.
- Where possible let *decisions* on the design of the facility be taken or at least shared *by the community,* in particular by the women.
- Develop a sound *revenue collection* system where this is needed and make sure it is in alignment with local opinions.

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