

9

ECONOMIC AND FINANCIAL CONSIDERATIONS

Economic factors are especially important when the viability of a new scheme for the use of excreta and greywater in agriculture is assessed, but even an economically worthwhile project can fail without careful financial planning.

Economic analysis and financial considerations are critical underpinnings for the promotion of the safe use of excreta and greywater. Economic analysis seeks to establish the economic feasibility of a proposed project in a broad macroeconomic context and allows economic comparisons between different options to implement the project. The costs transferred to other sectors — for example, as a result of health and environmental impacts on downstream communities — also should be included as distinct components in a cost analysis. This can be achieved through multiple-objective decision-making processes.

Financial planning looks at how the project is to be paid for. In establishing the financial feasibility of a project, it is important to determine the sources and flows of revenue and to clarify who will pay for what. The ability to profitably market the treated greywater and excreta or the products grown with them also needs analysis. Market feasibility assessment is discussed in section 9.3.

9.1 Economic feasibility

Economics looks at the optimal use of limited resources and at opportunities foregone by their use. In the context of excreta and greywater use for agriculture, economic analyses seek to establish whether resources invested in such projects have optimal returns, bearing in mind the resource value of excreta and greywater themselves. There are a number of methods that can be used to economically analyse projects, with cost-effectiveness analysis and cost-benefit analysis being the most important. The availability of reliable data sets and the setting of realistic and meaningful boundaries critically determine the quality of economic evaluations.

9.1.1 Cost-benefit analysis

Cost-effectiveness analysis has been frequently used for the economic evaluation of different health intervention options, offsetting costs against agreed, meaningful health indicators. Outside the health sector, planners are accustomed to cost-benefit analysis. Within the framework of a cost-benefit analysis, monetary values are assigned to all expected costs and benefits of a project. This allows decisions on whether and how to do projects, based on the internal rate of return. The introduction of the DALY as a composite measure of community health has made it possible to apply cost-benefit analyses to health interventions in an intersectoral context, such as is the case for the safe use of excreta and greywater in agriculture. The economic appraisal of an excreta and greywater use project is undertaken to determine the efficiency of the project, as a basis to decide whether it is worthwhile to proceed with it (Squire & van der Tak, 1975; Gittinger, 1982). This requires a calculation of the marginal costs and benefits of the project — that is, the differences between the costs and benefits of the project and the costs and benefits of the alternative. For any scheme to be economically viable, its marginal benefits should exceed its marginal costs.

The strength of cost-benefit analyses of sanitation schemes lies in the production of comparable data for a range of different sanitation options as a basis for decision-making. The comprehensiveness of the cost analysis component is critical, and it should therefore explicitly include direct costs related to the system hardware and software components, but also indirect costs incurred by other components, such as planning, administration, hygiene promotion campaigns and the health and environmental impacts on downstream communities.

9.1.2 Costs and benefits

Traditional economic evaluations of sanitation systems tend to face an important hurdle: the definition of the system boundaries often leads to substantial costs and/or benefits being completely overlooked. How substantial these costs can actually be becomes apparent from the example of a centralized wastewater treatment plant that discharges treated effluent to a surface water body. In addition to the investment, reinvestment and operation and maintenance costs of the sewer network and treatment plant, costs incurred by the environmental problems arising in the receiving water should be considered, as should those of the social loss of a recreational area, of the possible effect on subsequent drinking-water treatment, of the loss of natural habitats, of effects on coastal areas and of using drinking-water to flush the system. Each one of these indirect costs may in turn incur further costs.

For systems using excreta and greywater, the indirect costs may include those of the necessary transformation to adapt the existing sanitary infrastructure, additional awareness-raising activities to ensure its proper use and the need for continued research and development of the system.

For a centralized wastewater treatment facility, the expected health benefits for those connected to the system are obvious. The safe use of excreta and greywater has a number of indirect benefits to be considered, including:

- preserving high-quality water sources for priority uses, such as drinking-water supply (through the possible use of treated greywater for irrigation water and by not discharging effluents to water sources);
- an improvement of soil structure and fertility;
- increased access to fertilizer, particularly for poor subsistence farmers (thus increasing harvests and food security);
- reduced energy consumption (both in the treatment works and for fertilizer production);
- possible energy production and resource conservation;
- creation of small- and medium-sized businesses, selling technologies or services associated with the collection, treatment and/or marketing of the products.

It is therefore essential that economic evaluations comparing these two options be of a sufficiently strategic nature and that they take into account economies of scale in decentralized systems.

Further economic and financial considerations guiding the choice of sanitation systems for the safe use of excreta and greywater include the following:

- Sewerage systems are expensive to build, operate and maintain — systems that can reduce the infrastructure needs (e.g. on-site dry sanitation, with or without urine diversion) may be much less expensive.
- The cost of pumping greywater or transporting excreta can be substantial — greywater and excreta treatment facilities should be planned where the greywater and excreta can be efficiently used with minimal transport (e.g. neighbourhood biogas digestors could be used to treat excreta from on-site systems in urban areas).
- Effective low-cost greywater and excreta treatment technologies are available.
- Combinations of different treatment technologies (e.g. composting toilets plus post-composting with organic material) may increase pathogen removal

efficiencies at low cost and provide flexibility for upgrading treatment facilities.

- Users of greywater and excreta may be willing to pay for the greywater and excreta.
- Greywater and excreta tariffs may help to foster cost recovery, and the sale of crops at a central facility may also raise revenues.
- Differential prices for treated greywater and excreta and freshwater or agricultural inputs may entice farmers to use greywater and excreta instead of high-quality freshwater sources or expensive imported fertilizers.

Excreta and greywater use systems can influence the economic status at the household level and at the national level. If excreta and greywater are treated and managed properly, health risks are significantly reduced. At the household level, the resources spent on caring for or curing a sick person may be allocated to other tasks, and time gained through reduced illness can be used for education or income-generating activities. At the national level, the burden on scarce financial and human resources in the health sector may be reduced and can be reallocated to other areas.

9.1.3 Multiple-objective decision-making processes

The information produced by economic evaluations helps support decision-making processes, but it should be combined with information that allows other factors and externalities to be taken into account. To be able to objectively compare different sanitation systems, there is a need for fully integrated cost–benefit or multiple-criteria analyses of all types of sanitation systems, performed over system life cycles or planning periods. This can be achieved using multiple-objective decision-making approaches. These involve establishing criteria that consider all key aspects of the system (e.g. health, environmental, sociocultural, economic and technical aspects) and using these to form a basis for decision-making.

A range of different quantification methods can be used in multiple-criteria approaches outside of estimated monetary values, with DALYs as a measure of health effects and various measurable indicators (e.g. the use of natural resources, discharge to water bodies, etc.) for the environment. Sociocultural aspects, such as the appropriateness of the system or its legal acceptability, can be qualitatively assessed, as can technical issues, such as system robustness or its compatibility with existing systems. The analysis of a specific proposed project should involve not only a comparison of one system with another, but also a comparison of the options to implement one particular scheme — for instance, the use of greywater for different purposes (irrigation, industrial, non-potable uses).

9.1.4 Empirical examples of cost analyses for reuse systems

One of the difficulties in the economic evaluation of sanitation systems that promote the use of excreta and greywater is that very few studies have so far been carried out and that when information is available, it is mainly from pilot or demonstration projects, which have additional expenses (e.g. for technology introduction costs, limited, small-scale fabrication of system elements, awareness-raising activities, etc.). Such studies have also tended to consider only a particular aspect of the system rather than adopt a holistic view. Studies that have considered only investment, reinvestment and operation and maintenance costs have shown, however, that systems designed to use excreta and greywater have a financial advantage over more conventional systems (see Box 9.1).

Box 9.1 Examples of investment and operation and maintenance cost comparisons

Germany

In Brandenburg, near Berlin, Germany, cost comparisons have been made for three different sanitation concepts for a planned new housing estate, where the population is expected to increase from 672 to 5000 inhabitants within 10 years. The three systems analysed were:

- 1) *Conventional*: Gravity sewer system, consisting of flush toilets, conventional gravity sewer system, pumping station with transport sewer to the existing sewer network, system operated by the public supplier.
- 2) *Gravity*: Source separation concept I (gravity, composting of faeces), consisting of gravity separation toilets, collection and storage of urine, transport and agricultural use on a nearby farm, faeces transported in gravity sewer with aerobic treatment in a compost separator, utilization of compost in horticulture, transport of greywater in gravity sewer system, treatment in a constructed wetland, transport to the receiving water body.
- 3) *Vacuum*: Source separation concept II (vacuum, digestion of faeces), consisting of vacuum separation toilets, gravity urine transport, storage of the urine and agricultural use on a nearby farm, faeces transported by vacuum sewerage, common treatment with organic waste in a biogas plant, biogas used to produce energy, transport of the digested sludge to nearby farms and utilization in agriculture, transport of greywater in gravity sewer system, treatment in a constructed wetland, transport to the receiving water.

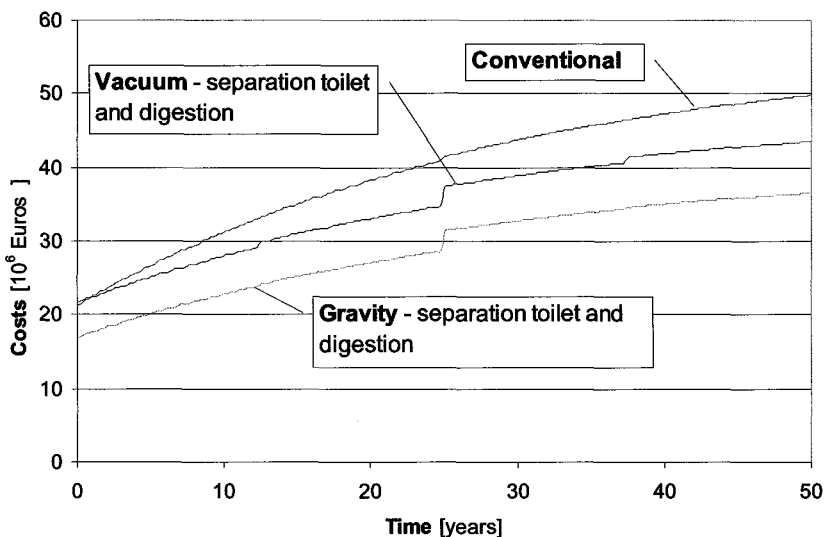


Figure 9.1

Cost comparison for the installation, operation and maintenance of the three systems for a population of 5000 in Brandenburg, Germany

The costs associated with the three systems were calculated over a lifetime of 50 years, with an annual interest rate of 3.5% per annum. The results of this cost comparison can be clearly seen in Figure 9.1, for the situation where 5000 inhabitants are served and the local Berlin water company is responsible for the operation of the system. Other service scenarios have been calculated with different population numbers and operational models, which also revealed a significant price advantage for the use-oriented systems over the system's lifetime.

Box 9.1 (continued)

Uganda

In Kalungu Girls Secondary School in Uganda, existing sanitation facilities were posing a risk to groundwater quality, the main source of potable water. In 2003, a project was implemented to renew and improve both water supply and sanitation facilities at the school. Additionally, a training programme aimed at ensuring an understanding and proper use of the new facilities was implemented.

Prior to deciding on the sanitation scheme, a detailed cost comparison was conducted and served as one instrument in the decision-making process. Two alternative sanitary solutions were compared:

- 1) *Option 1: Source separation concept:* Dry urine diversion toilets, sewer line for greywater and a horizontal subsurface flow constructed wetland. The treated products from the toilets are to be used to water gardens within the school grounds.
- 2) *Option 2: Conventional concept:* Flush toilets for the students, separate sewer system for wastewater, mechanical pretreatment, pumping station and a vertical subsurface flow constructed wetland.

The comparison considered investment and reinvestment and operating costs. The calculation was carried out over a 50-year time frame, with reinvestments depending on individual system parts and an interest rate of 8% per annum.

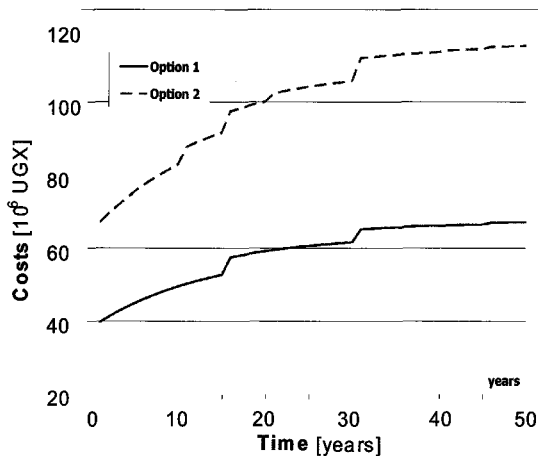


Figure 9.2

Cost comparison for the installation, operation and maintenance of the two systems for the school (exchange rate as of 22 September 2004: 1€ = 2060 UGX).

The cost comparison in Figure 9.2 shows that the safe use option is significantly less expensive. The main difference results from the significantly smaller wastewater treatment system for this option and the pumping station required for the conventional option.

9.2 Financial feasibility

To ensure sustainable services and cost recovery of excreta and greywater use systems, appropriate financing mechanisms are needed. A financial cost analysis should consider not only the investment, reinvestment and operation and maintenance requirements of the system, but also the indirect costs as well as the system's impacts on the environment, individuals and communities (Cardone & Fonseca, 2003).

Funds will be needed to ensure institutional capacity building and skills development, assessment and monitoring, policy formulation and the creation of an enabling environment for sanitation. The latter includes awareness-raising campaigns, hygiene promotion, public consultations and hearings, and informing policy- and decision-makers. Most of these activities are of a public nature, for the benefit of the community at large and individual households. Financing for sanitation mainly originates from two sources: the household and the public sector (Evans, 2001). Trying to mobilize individual household financial resources for activities targeted at the broader community has, however, proven difficult. This raises one of the main challenges of developing financing mechanisms for sanitation: How can the needs, interests and finances of individuals and households be effectively coordinated and reconciled with those at the community/national level? Ideally, this should be achieved in a way to recover costs, but also to ensure equitable access to sanitation, particularly for poorer members of society.

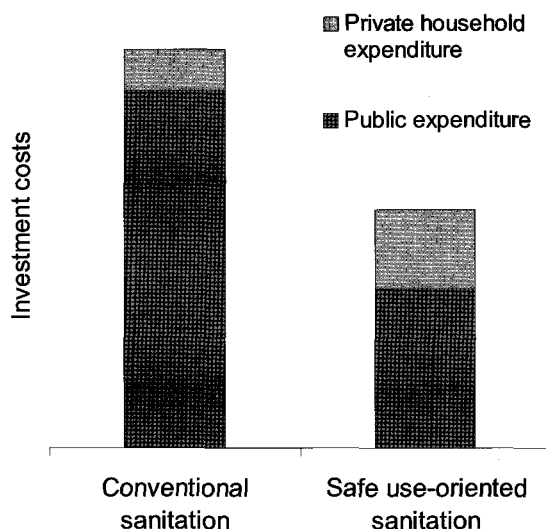


Figure 9.3

The cost structures of conventional and safe use-oriented sanitation systems (Werner et al., 2004)

Sanitation systems that recover excreta and greywater for use in agriculture generally have a different cost structure, and appropriate financing mechanisms may be needed to support private households in their decision to install them. As shown in Figure 9.3, the total costs to install such systems tend to be lower than for more conventional sanitation systems. In comparison with traditional decentralized sanitation (such as pit latrines or VIPs), they normally provide permanent solutions and thus do not have to be replaced when full, representing an incremental saving over an extended period of time. However, although the overall costs are lower, the initial costs to be covered by the private household may be higher as a result of having to replace or transform domestic sanitary facilities (e.g. by installing a urine diversion toilet).

Innovative financing alternatives, including start-up funds, community-based finance programmes, micro-credit programmes or targeted subsidies, which are easily understood by households, may therefore be required. These should put particular emphasis on the possibility of financing the users' investment for on-site and

neighbourhood systems. Unlike rural areas, the systems for densely populated urban areas often cannot be left to the individual choice of the households. A common acceptable solution must be found, which may even be stipulated in legislation. Financial mechanisms will also be necessary in such cases to ensure that a uniform system can be adopted. Financing mechanisms should explicitly target the poorest, as they often pay higher costs for services than middle-class families (Mehta & Knapp, 2004). A sensitive use of these mechanisms is essential to ensure that proper support is given with maximum effect.

Experience from projects around the world has shown that subsidized installation of sanitation facilities does not guarantee their proper use and maintenance. Often the opposite is true, and toilets are converted into storerooms, households do not connect to sewers and wastewater treatment plants fail to work properly (Mehta & Knapp, 2004). Subsidies should therefore be focused on assisting households to obtain sanitation facilities that meet their needs, that they will use and whose maintenance they can afford. It is frequently more sustainable to spend financial resources on promotional efforts (including hygiene promotion) than to spend them on subsidies for sanitation hardware (WSSCC, 2005).

Households may be willing to pay up to 3% of household income for improved sanitary services, assuming that the household sees the service as necessary and that it actually does represent an improvement in the current situation (Rogerson, 1996). This expenditure also depends on other factors, such as who controls the household finances, ownership of the property where the family lives and the range of sanitary facilities on offer. Understanding what conditions encourage households to invest in sanitation and designing a range of options that respond to their wants and needs may help mobilize finances at the household level. It is clear from experience that household interest in sanitation is unlikely to be driven by health concerns. Comfort and convenience, prestige, permanence of the structure and, of course, costs are much greater motivating factors in the choice of a sanitation system. The additional benefits accruing from the safe use of excreta and greywater have also proven attractive to families engaged in agriculture or horticulture. Adopting a demand-driven approach to sanitation should therefore assist households in choosing the system that they want and can afford.

Distribution of excreta and greywater may be a separate operation from their collection and treatment. Separate charges may be applied to individuals or communities using them. The level of these charges should be agreed at the planning stage. The responsible authorities must decide whether they should cover only the operation and maintenance costs or whether the capital costs of the scheme should be recovered as well. There are trade-offs between the desirability of maximum cost recovery and maintaining incentives for the use of excreta and greywater. Some prior investigation of the willingness and ability to pay is therefore essential in determining not only the level of charges, but also the frequency, timing and means of payment. For instance, in many rural settings, an annual charge payable after the harvest season may be the easiest to collect.

Farmers intent on using excreta and greywater in their agricultural production system may be willing to share in the investment in treatment works that are a prerequisite to obtaining use permits. Their contribution may be in cash or in the form of land for treatment and storage facilities.

The possibilities for private sector participation in sanitation systems that safely recover and use excreta and greywater are considerable (see Boxes 9.2 and 9.3). These range from construction of facilities and providing specific elements for them

(e.g. urine-separating toilets) to the logistics of safely collecting, transporting and treating excreta and greywater through to their marketing and use. These market openings can also be stimulated and thus create business opportunities, particularly for small- and medium-sized enterprises.

Municipalities may also be able to operate profitable service providers for the management and treatment of faecal sludge in urban centres (see Boxes 9.2 and 9.3).

Box 9.2 Private sector providers of sanitation services

Factors influencing emptying service delivery for pit latrines and septic tanks

When the pits of on-site sanitation systems are full, they are emptied by cesspit trucks or manually. The financial, institutional and regulatory framework determines largely where and how the faecal sludges are deposited. To reduce cost, the truck drivers in many places sell the sludge to local farmers or dump the product on open spaces or into the drainage systems at the shortest possible distance.

Private cesspit emptying companies are often not legally recognized by the local authorities, even though they may constitute the only initiative catering for faecal sludge collection and disposal. In most cases, a fee structure and money flow procedures have become established without any legal control, resulting in emptying fees affordable to only a few and in indiscriminate dumping of faecal sludge. Experiences in the field show that the emptying service is cost-effective. Proper regulatory mechanisms, private sector competition and the development of economic incentives could help ensure that the collected sludge is delivered to a designated treatment site.

Faecal sludge emptying and haulage: a private sector “stewardship” business

Where the business opportunity exists, the faecal sludge emptying and haulage service is dominated by small-scale private entrepreneurs owning one or a few cesspit trucks. They often hold a share of >70% of this business, in spite of the lack of legal status. Table 9.1 highlights the importance of small-scale sanitation stewardship entrepreneurs, with examples from Ghana, Nepal, Senegal and Viet Nam, respectively, and illustrates the profit potential for faecal sludge removal services. The potential for strengthening the roles of private entrepreneurs in the safe management of faecal sludge exists. The policy framework should facilitate their role in providing safe services.

Table 9.1 Importance of small-scale private sanitation stewardship in faecal sludge management

	Kumasi	Dakar	Hanoi City	Kathmandu
Population (millions)	1.5	2.1	1.5	0.8
Share of population on on-site sanitation	60	60	90	–
Share of installations emptied mechanically (%)	90	70	90	64
Number of cesspit trucks in operation	25	± 100	40	8
Share of private business (%)	80	75	66	70
Total volume of faecal sludge hauled per day (m ³)	200–300	550	300–400	30–50
Average emptying cost per trip (€)	30–40	30–40	20–30	16–22
Yearly turnover/truck (k€)	30–60	20–30	10–20	10–15

Source: Data compiled from a field survey by Department of Water and Sanitation in Developing Countries (SANDEC) and its partners (Centre Régional pour l’eau Potable et l’Assainissement à faible coût (CREPA), Burkina Faso, Center for Environmental Engineering for Towns and Industrial Areas (CEETIA), Viet Nam, Environment and Public Health Organization (ENPHO), Nepal); prepared by Doulaye Koné and Martin Strauss, SANDEC / Swiss Federal Institute for Environmental Science and Technology (EAWAG); Strauss et al., 2003.

Box 9.3 Innovative money flows for improved faecal sludge management

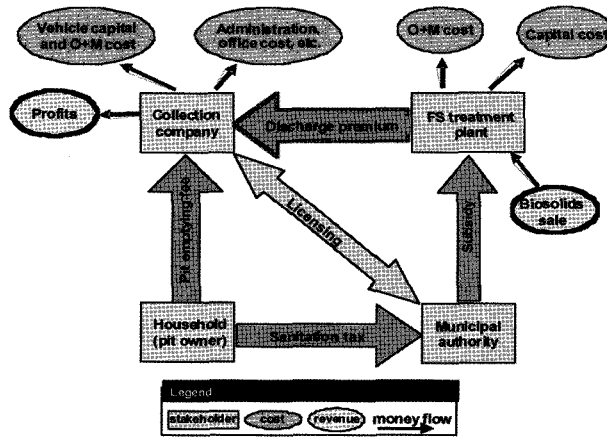


Figure 9.4
Scheme of innovative money flows in faecal sludge management
(O+M = operation and maintenance; FS = faecal sludge)

Sustainable environmental sanitation may be achieved or enhanced only by applying appropriate financial incentives and sanctions (Wright, 1997). Hence, municipalities must devise an effective sanctioning system (e.g. by imposing fines or non-renewal of faecal sludge collection contracts with entrepreneurs) and an incentive-based policy by, among others, paying entrepreneurs for delivering faecal sludge to the legally designated treatment or disposal site.

The potential business opportunity is shown in Figure 9.4. It is based on a rigorous economic analysis of the business opportunities and potential of existing and expected future key players. It analyses conditions under which each player can make a profit, based on their operation and maintenance costs, capital costs, margins of profit and potential for improving the service delivery. The development of the money flow model presented in Figure 9.4 implies a participatory consultation with key stakeholders (households, entrepreneurs, authority representatives, technical services, farmers, etc.). Hence, the project development process should be guided by a thorough stakeholder analysis study and stakeholder involvement process study.

Figure 9.4 illustrates such a financial scheme, the most crucial element of which is the payment to collectors for faecal sludge brought to the treatment site (discharge premiums). The flux reversal principle is about to be introduced in the city of Danang, Viet Nam. The city of Ouagadougou, Burkina Faso, is planning to pay collectors the equivalent of €3.70 per standard truck load on delivery of faecal sludge to the new wastewater/faecal sludge treatment scheme to reduce illegal and illicit dumping of faecal sludge or use of untreated faecal sludge in agriculture. For faecal sludge management to function on a sustainable basis, national or municipal governments must consider providing subsidies, recoverable partly by a tax on water, wastewater or sanitation charged to households. The rationale for such a policy is to render pit emptying affordable to all urban dwellers, to enable entrepreneurs to operate faecal sludge services with adequate profit margins and to keep prices for biosolids usable in agriculture competitive. Intensive information, awareness raising and social/commercial marketing campaigns are needed to render new money flow procedures acceptable to the urban customers and to induce the demand of farmers for biosolids.

Sources: Wright (1997); CREPA-Senegal (2002); Strauss et al. (2003).

9.3 Market feasibility

In planning for greywater and excreta use, it is important that the market feasibility be assessed. Market feasibility may refer to the ability to sell (treated) greywater and excreta to producers, or it can refer to the marketability of agricultural products grown with the use of excreta and greywater (see Table 9.2). For selling treated greywater and excreta, it is important to have an idea of how much people are willing and able to pay. Assessing the marketability is particularly important when crop restriction in agriculture is being considered as a partial health protection measure. Producers should be consulted as to which crops can be restricted. If farmers or market gardeners cannot make a suitable return on their products, then produce or waste application restrictions are likely to fail. Equally, if the excreta are to be used for gas or energy generation, it should also be ascertained if this could be achieved at a competitive price compared with that of other sources of energy.

Table 9.2 Market feasibility: planning questions

Product for sale	Key questions
Greywater and excreta	<ul style="list-style-type: none"> - What is the price for the treated greywater and excreta that people are willing and able to pay? - What is the demand in the project area for treated greywater and excreta? - Are there extra costs required to get the treated greywater and excreta to where it will be used (e.g. pumping costs, transport, etc.)?
Produce	<ul style="list-style-type: none"> - Are products (e.g. plants, biogas) acceptable to consumers? - Can producers earn acceptable returns with restricted application and produce? - Is the project capable of supplying products that meet market quality criteria (e.g. microbial standards for products to be exported)?

Any agricultural product grown with the use of treated greywater and excreta must be acceptable to the consumers. If the public perception of these products is negative, even if the quality meets WHO or national performance criteria, then farmers still may be unable to sell their produce. If agricultural products require post-harvesting processing, the cost and availability of these services need to be considered. In some cases, it will be necessary to actively market products to increase demand and profit potential. Currently, however, the management and use of most treated excreta and greywater are decentralized, often at household level, and they are used in subsistence rather than commercial agriculture and horticulture.