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Development and dissemination of agroprocessing technologies

DEVELOPMENT AND DISSEMINATION OF AGROPROCESSING TECHNOLOGIES

NRI Socio-economic Series 8

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Foreword

This series is based upon work carried out under the socio-economics and related research programmes at NRI. Its purpose is to provide an easily accessible medium for current research findings. Whilst it is hoped that the series will be of interest to those concerned with development issues worldwide, it may be of particular relevance to people working in the developing countries.

The topics covered by the series are quite diverse, but principally relate to applied and adaptive research activity and findings. Some papers are largely descriptive, others concentrate on analytical issues, or relate to research methodologies.

The present study was conducted under NRI's Agronomy and Cropping Systems programme with finance from the Natural Resources Research Department of the ODA.

The aim is to present material in as straightforward a fashion as possible so that it can reach a wide audience. We are interested in the views and opinions of readers and welcome any feedback to this series.

Alan Marter
Socio-economics Research Programme

Summary

Technology development (TD) can assist in the generation of small- and medium-scale agroprocessing for sustainable livelihoods in poorer communities. This is because of backward links to agriculture and foreward links to downstream processing. Although Northern- and Southern-based agencies have given substantial assistance to TD, their past performance with regard to support has often been weak.

It has been argued that this weakness suggests that TD would be better left to the private sector. However, although it has much to offer, there are circumstances, for example if the real or perceived risks are too high or if information on technology is limited, when the private sector would be unable or unwilling to take advantage of TD opportunities.

Therefore, although support for TD is clearly indicated, lessons learnt from past experience must be applied. The results of this study suggest that most of the previous failures have been due to relatively mundane shortcomings such as operational problems within TD agencies or inadequate application of appropriate TD procedures. The paper concludes with a review of institutional issues and methodological tools, and includes an appraisal of areas for future research.

Some issues in technology development

INTRODUCTION

The purpose of this study is to review current best practices and the lessons learnt from selected, recent projects. The focus is on technology development (TD) with respect to agroprocessing in the Third World. TD is defined here (after Appleton, 1993) as any change in skills, techniques, processes, equipment, type or organization of production which helps people to cope with, or take advantage of, particular circumstances. The intended audience of the study includes:

- those whose primary activity is TD
- donor agencies (bilateral and multilateral)
- agencies who are occasionally involved in the acquisition and/or development of a particular technology (e.g. non-government organizations) based in the North or the South).

The study has focused specifically on agroprocessing technologies for small- and medium-scale enterprises. A small enterprise is defined as one which can be undertaken principally by the utilization of household resources. Medium enterprise can be defined, rather arbitrarily, in terms of levels of employment, capital employed and so on. In this study it refers typically to indigenously funded and managed enterprises, whose operations are largely restricted to a specific geographical region within a single country. The technologies reviewed are largely those in which Northern development agencies have played a leading role. However, many of the findings are likely to be relevant to the development of technologies for other sectors, and to work of Southern development agencies.

The agroprocessing sector was chosen because of its great importance in most Third World countries. In most of sub-Saharan Africa, between one and two-thirds of value-added manufacturing is based on agricultural raw materials (Jaffee and Morton, 1995). Manufacturing and processing enterprises are important means of creating sustainable wealth for poor communities because they have backward linkages to agricultural production and forward linkages to downstream processing. Technology has a central role in these enterprises.

STUDY METHODOLOGY

The organizational structures of the Natural Resources Institute (NRI) and five other major agencies involved in the development of agroprocessing technologies, were examined. A selection of projects implemented by NRI and these five agencies was also studied. The agencies were:

- Appropriate Technology International (ATI)
- Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement (CIRAD)
- International Development and Research Centre (IDRC)
- Intermediate Technology Development Group (ITDG)
- Technoserve.

The aspects of organization which were considered included mandates, target groups, structure, areas of expertise, strategies for the agroprocessing sector, and planning and review procedures. Information about each agency was obtained from both documentation and interviews. Meetings were also held with members of other agencies involved in TD in the South. These included the bilateral donors Canadian International Development Agency (CIDA), Overseas Development Administration of the British Government (ODA) and USAID, and relevant staff of academic/research organizations such as Silsoe College, Silsoe Research Institute and Cranfield School of Management.

Desk reviews of a number of projects concerned with the development of agroprocessing technologies were also carried out. These projects were:

- Ram oil press in Tanzania
- Wool production in Guatemala
- Coffee in Central America
- The mechanization of gari processing in Togo
- Sorghum processing in Botswana
- Sorghum processing in Nigeria
- Tinytech Oil Mill in Zimbabwe
- Coconut drying in Bangladesh, using new drying tray
- Tomato processing in Sri Lanka
- Small-scale sugar production in Kenya
- Wood-wool cement slabs in Malawi
- Mini 40 Oil Expeller in Zambia
- Charcoal production
- Palm oil production in Ghana and Nigeria
- Fish drying kiln in Tanzania
- Shea butter extraction in Ghana.

The projects were selected for the following reasons:

(a) they were well documented and in some cases, had been independently evaluated;
(b) they had either already been completed, or were nearing completion;
(c) as a group, they contained both relatively successful and unsuccessful projects;
(d) as a group, they covered a wide range of countries and products.

WHY HAVE TECHNOLOGY DEVELOPMENT PROJECTS?

It can be argued that given the wide variety of technologies already available, TD is best left to the private sector and the forces of market competition. However, although the private sector has a major role in TD, various barriers may inhibit its contribution. Some of these are listed below and include adaptations from Jeans *et al.* (1991).

1. Indigenous inventors may not have the financial and technical resources needed to withstand the real or perceived risks of new product development.
2. For both cultural and economic reasons the female work force may represent a good market for TD, but a lack of understanding in the male population and the urban private sector has meant that this market is poorly served and is not, therefore, functioning properly.
3. The inadequate flow of information among and within less developed countries (LDCs) is a critical constraint to the upgrading of technology by enterprise.
4. Technology development has often occurred in the North to suit different factor availabilities and costs. The private sector in the South may recognize that certain technologies developed in the North require modification to suit local circumstances, but the resources or technical skills needed to promote the development of an appropriate technology may not be available.
5. The private sector may be unwilling to take up opportunities whose profit margins compared to those of other activities are modest, and/or where markets are relatively small or distant.
6. Even if entrepreneurs are convinced that a new technology is a worthwhile investment, they may have difficulty in convincing credit agencies of its viability and may therefore be unable to buy it.

There are thus several circumstances where additional support for TD may be justified. For example technological assistance can remove barriers to entry to particular processing sectors by:

(a) allowing local manufacture of a product which had previously been produced in large cities or overseas;
(b) raising the quality of production to serve a different market niche; and
(c) increasing output to the levels required to serve new markets.

Although aid can help to support the process of TD, it cannot be denied that such support in the small enterprise sector has been undistinguished. Most of the aid has been concerned with appropriate technology (AT) and as Stewart (1987) states:

> "Although the need for appropriate technology is widely agreed upon, as evidenced by the enormous literature . . . and the many institutions that promote AT . . . the achievements in terms of actual use of appropriate technologies have been relatively small".

In the remainder of this study, the deficiencies in the TD process, including the activities of agencies seeking to support the sector, are examined and ways of improving both institutional performance and the application of analytical tools are suggested.

Common problems in technology adoption and operation

INTRODUCTION

In the 1960s, the Food and Agriculture Organization (FAO) undertook a study of about 70 agroprocessing plants which had not lived up to expectations (Abbott, 1988). All the plants appeared to be well designed from an engineering point of view, so the reasons for their losses or failures came from elsewhere. In several cases, planning had been deficient; either market demand for the product or the supply of raw materials had been over-estimated. In other cases, poor management had resulted in excessive operating costs to the extent that the businesses were unable to compete with other enterprises in the same market. During this study many of the same problems were recognized in more recent projects.

Several categories of the difficulties which may inhibit or prevent sustained technology uptake can be identified. These include:

(a) problems with the components required for production and the organization of production which may threaten sustained and financially viable operation of technologies;
(b) difficulties arising from markets for derived products;
(c) failure by implementing and/or disseminating agencies (including failure to anticipate and deal with difficulties under (a) and (b) above).

For each category of difficulty, there are factors which may be amenable to changes within the TD process or project, such as provision of effective equipment maintenance, and factors which may lie outside, such as the impact of negative government policy. The recognition of such internal and external problems is a fundamental component of TD.

The characteristics of the implementing agencies are clearly crucial; the extent to which they are able to deal with internal difficulties and adapt to external ones is particularly important. The ability of different agencies to react to internal issues varies. As an example, a private sector body may have little difficulty in accurately assessing product market options whereas a non-government organization (NGO) may have limited experience in this area. An example could be the withdrawal of a product by the private sector as soon as market reforms allow an influx of cheap alternatives while an NGO continues to try to sell products for which there is no longer a realistic market.

The scale of the enterprise or institution may also be of importance; an endogenous issue for a large-scale body

may be external to a small-scale enterprise. An example of this might be an insufficient supply of raw material because of controlled (inadequate) producer prices. A large-scale enterprise may be able to internalize risk by producing its own raw materials but, by contrast, a small private sector body may have to take that which external suppliers are prepared to offer.

It is evident that problems do not exist in a static context. Conditions within a particular country, locality, commodity or market sector may be experiencing considerable and rapid change such as the impact of structural adjustment policies, rapid population growth or urbanisation, the effects of the opening of a new trunk road, and major shifts in international commodity prices. The impact of change may greatly enhance or diminish opportunities within the development process, but in either case, the ability to recognize and react to change is a key characteristic for those attempting to maximize the effectiveness of TD.

The availability and quality of the components required in the production process, such as land, raw materials, equipment, finance, skilled and unskilled labour, may be of critical importance to the success or failure of the TD process. In developing countries, there are often constraints to the availability and quality of these components; poor infrastructure, for example, may inhibit raw material supply or the marketing of products. Although such difficulties are well recognized, a number of the projects reviewed in this study have failed because they have not addressed such issues adequately.

PROBLEMS WITH COMPONENTS REQUIRED FOR PRODUCTION

Raw materials

Difficulties arose with the supply of raw material in a number of the case studies. In Zimbabwe (see Box 1), the availability of raw materials was constrained partly because of limited working capital and limited credit to cover this deficiency. A second external factor was the impact of government regulations on the procurement and distribution of raw materials. Competition from other (large-scale) producers was also encountered.

The quality of raw materials may also be an issue. Poor quality (dirty) oilseeds, for example, may increase operating costs by causing wear on equipment and hence increasing maintenance needs, and/or by diminishing the revenue from sales because of low product quality. However, if raw material supply is outside the control of the project an allowance for realistic quality levels should, perhaps, be built into the design of equipment and maintenance regimes for example.

The Zimbabwe example highlights issues relating to the cost of credit, access to credit, the cost of storage, and the availability of storage which arise from seasonal raw

BOX 1 TINYTECH OIL MILL OPERATORS IN ZIMBABWE

Relatively low cost expellers were imported into Zimbabwe from India by ITDG for sale (with credit) to selected entrepreneurs.

In order to be viable, the expellers needed to be operated all the year round using raw material purchased at peak season (low) prices. Before the recent liberalization of markets in Zimbabwe, this was possible because the parastatal would store seed and sell it at roughly the same price throughout the year.

Following public sector and market reforms, free market prices prevailed. As a consequence, operators of the small-scale expellers found that during much of the year, the price of oilseeds was prohibitively high. However, they could not afford, or gain access to credit to buy all their seed requirements when prices were low.

material supply. These issues are frequently overlooked (they are almost invisible costs) and in the past, were often dealt with by loss-making parastatal marketing corporations.

Raw material storage and associated credit issues can affect viability in a number of ways. Many agro-processing plants can only be viable if operated year-round or during most of the year. This would not be a problem if the raw material was available at a roughly constant price throughout the year. However, if this is not the case, the working capital requirements for a year's supply of raw material could easily dwarf all other costs (fixed and variable). Even if this requirement could be met, the processor would then need access to storage, of the right volume and quality, which would add further to the cost.

These are real costs that should be considered when the plant is first planned. One solution might be to have a flexible operation which switches raw materials and output depending on the season. (Note, also, that proposals to process surplus fruit, for example, when it is plentiful would rarely be viable unless the plant could process other products during the off-season.)

Labour

Problems with labour requirements may also relate to design of technologies themselves. For example, a limited availability of skilled labour might be overcome either by training, or by designing equipment (if possible) which can be operated by unskilled labour.

The design of labour-saving technologies needs to be approached with caution. For example, although it may be a valid objective to reduce the drudgery of women's work, care is needed to ensure that this does not also remove their income earning activities; a new technology which replaces an operation formerly carried out by women may subsequently be taken over and managed by men to the extent that they appropriate the income from it.

Equipment

Equipment difficulties are often central to the problems arising in TD projects. Agroprocessing equipment may not work well, may be subject to frequent breakdowns, or may be costly or difficult to repair. In some cases, such problems can arise either because the hardware was developed from scratch (or was not designed for local conditions) with minimal field testing, or because the experience gained from earlier designs was not taken into account.

Difficulties can also arise from lack of finance to purchase equipment, especially if capital costs are relatively high. These are particularly likely when equipment is imported from developed countries; further problems may arise from limited access to foreign exchange.

Dissemination and uptake may be inhibited when equipment is imported with no domestic capacity for production; the situation may be exacerbated by lack of repair and maintenance facilities. The importation of spare parts can be delayed by supply and availability of foreign exchange. Projects may be established by agencies who provide an initial supply of spares but subsequent indigenous operators may later experience difficulty in obtaining imported replacements.

Even if the production of equipment has been established in-country, problems may still arise. One of the projects reviewed provides an example of a manufacturer whose capacity to provide the equipment was not sustainable. The only manufacturer engaged to produce the equipment was later taken over by another company. Unfortunately, the senior staff left after the takeover, and as no engineering designs had been passed on, the second company had difficulty in maintaining production of the equipment.

Questions of intellectual property rights and patents, for example, may be raised when assessing availability of technology design material from development agencies. There is a danger that some agencies, particularly those

under increasingly stringent financial regimes, will seek to impose costs on the transfer of information. They may also impose other constraints; for example, during field implementation they may insist on by their own management as they believe (rightly or wrongly) that the technology would otherwise be misapplied.

Overall, the limited effectiveness of technologies is often associated with an inadequate involvement of target beneficiaries, limits to multi-disciplinarity in the TD process, and insufficient allowance for the adaptive fine tuning necessary to meet the end users' needs.

PROBLEMS WITH PRODUCT MARKETING

Carr (1990) states: "It is surprising how many Appropriate Technology projects are started without any thought being given to how the . . . goods involved will be produced and distributed in the event that demand for them is stimulated". Although the need for it would appear to be obvious, market research for both equipment and the products it produces is often poorly handled during the TD process; it may be underfunded, non-existent, or carried out too late to influence the design of the TD activity.

Lack of demand for the product is a problem which is frequently encountered. There may simply be a general lack of demand for the type of product concerned, particularly for non-food items, such as textiles. One of the projects analysed in this study experienced initial difficulty in marketing their product (wood-wool/cement slabs) because the construction sector at that time was in recession.

Lack of demand for food products is more likely to stem from competition with established producers or with imported products. For example, the Tinytech oil millers in Zimbabwe (Box 1) found that people in rural areas preferred to purchase oil from the large-scale producers.

Marketing problems may also arise if the product is slightly different, for example, in flavour or texture, or of a lower quality. In addition, products may be perceived to be less acceptable because of inferior packaging, or insufficient promotion or advertising. Large, well-known producers of processed products may have an advantage over new, small-scale processors as brand names and sophisticated packaging can exert a strong influence on consumer preferences. For example, in Kenya's bread-making industry, a premium has been placed on the market power, brand names and waxed wrappers (which require the use of expensive machinery) of the largest company (Kaplinsky, 1990). Consumers will often choose the well-known types of bread in preference to the cheaper, but equally good products of small-scale bakers.

PROBLEMS ARISING FROM THE CHARACTERISTICS OF ORGANIZATIONS

The characteristics of an organization may have a critical impact on its effectiveness in TD. The following sub-sections cover some of the major types of body involved, and the characteristics which may hinder TD.

Organizations based principally in the North

Multilateral and bilateral donors may provide substantial funding for TD projects as well as most of the funds for TD agencies based in the North. Sometimes, international donor agencies also have important roles in developing local technical capabilities through support of local research institutes (e.g. CIDA and EEC support for Ghana Regional Appropriate Technology Industrial Services (GRATIS) in Ghana), and in funding vocational/technical training centres and programmes.

Funding is clearly a key issue in TD but the financial planning frameworks of the donors, which often have a three- or five-year time span, may be insufficient to allow effective development and dissemination. Equally, if not more disruptive, are changes in donor objectives and priorities towards TD, target groups or geographical regions.

A further criticism concerning donors is that their policies "have tended to favour the sort of capital-intensive, large-scale production systems which benefit an already well-off élite at the expense of the masses of the rural and urban poor" (Carr, 1990). Negative effects also result from tying procurement to goods and services originating in the donor country. These have long been recognized and include the promotion of technological dependency (Carr, 1990; White, 1990). Edwards and Farrington (1993) note the inappropriateness of 'tying' with respect to earlier Overseas Development Administration (ODA) funded activity. Although tying has declined, past tying may be embodied in existing projects so the decline may take time to show any impact.

Government TD agencies in the North have traditionally had substantially more technical resources and expertise than NGOs, so their strength has tended to be in technical and hardware matters. However, in recent years they have begun to shift the emphasis from strategic research towards applied or adaptive work. This has been accompanied by a growth in concern about uptake and impact and associated economic issues, i.e. to 'development' rather than to research outputs (Edwards and Farrington, 1993). The change in focus has also extended to the recognition of 'soft' TD through training for example, and to the importance of environmental issues.

These changes may require those engaged in TD to re-orientate their views and approaches; such a process may not always be sufficiently recognized by Northern TD bodies.

Research institutions and technology centres in the South

Research and development (R&D) centres in Third World countries range from those in the formal sector with little interest in, or capacity to do anything about the needs of the poor, to those established by government, universities or NGOs with the specific purpose of working on technology appropriate for poorer target groups.

Formal technical centres specifically concerned with TD (both government and NGO) may be distanced from the rural and urban poor they are supposed to be assisting. As a result, potential beneficiaries are seldom involved in the development process. Such technology centres tend to lose sight of the ultimate aim of a project, becoming engrossed instead by technical matters at the expense, for example, of socio-economic or commercial considerations. Project objectives may also become ambiguous. Once the early technical agenda and specifications have been set, the self-interest of the technologists involved in the project may prevent subsequent changes.

NGO technology centres normally (though not always) have closer links with the intended beneficiaries. Although the ability to work closely with poorer target groups is an often emphasized attribute of NGOs, it is also accepted now that NGOs encompass bodies with a range of characteristics. With time, some NGOs have grown in their scale and breadth of operation; as a result, some have become more distant from target populations, thus taking on at least some of the characteristics of more formal bodies.

NGOs are less likely than government or university-based centres to have a comprehensive range of in-house skills and access to expensive laboratory equipment. Their strength, therefore, tends to lie more in adaptation and field-testing than in major technical work. In recent years, the development of field adaptation has led to an increasing involvement with the introduction of participatory approaches to technology identification and development.

The commercial sector

Commercial companies can play an important part in TD, providing, of course, that it is in their financial interests to do so. They may sometimes invest their own resources in R&D if the market potential seems great enough; they may however be unwilling to cover the risk if potential markets are relatively small-scale, uncertain, or dispersed.

Commercial companies may have a major role in the pilot, demonstration and dissemination phases. They are

often vital during the latter two phases for producing an adequate supply of the technology being promoted, but they would naturally have little interest in demonstrating and disseminating technologies to companies which may be, or may become, competitors. Differing objectives may therefore lead to conflicts when development agencies and commercial companies collaborate. A clear written agreement on their relationship and respective contributions may be needed to minimize problems.

A large proportion of those who adopt TD projects will require credit for fixed and/or working capital. TD organizations sometimes provide soft loans directly, but eventually, entrepreneurs will need to obtain credit; financial institutions are therefore of central importance to the TD process. The rationale for the provision of soft, as opposed to commercial, loans may in itself be questionable. In the longer term, enterprises will need to be self-sustaining and will therefore have to be able to operate under commercial credit terms.

TD organizations often have to act as brokers or facilitators between adopters and financing institutions. Generally, the more remote and small the enterprise, and the poorer the prospective borrower, the greater the need for the involvement of a development agency.

Government departments and agencies

Government bodies may have several functions. First, they have large resources which can be used in needs identification as well as in the pilot, demonstration and dissemination phases. Secondly, governments can establish TD committees or co-ordinating centres to act as a focus for technology promotion within the country. Thirdly, governments may be useful in removing the constraints experienced during the dissemination phase of a project, or in making policies more conducive; an example of this is provided in Box 6 (Section 3).

However, government bodies are generally less effective than NGOs at covering remote communities, and government personnel are less likely to develop long-term working relationships with the poor than NGO staff. In some countries, however, very few NGOs exist, and government workers may provide the only source of information on community needs; they may also be the only means of transferring a new technology or technique to more than one or two communities.

PROBLEMS ARISING FROM THE ACTIVITIES OF IMPLEMENTING AGENCIES

Some of the difficulties experienced in the TD process may arise from the characteristics of implementing bodies, or their failure to recognize and/or deal with problems in production and marketing. However, problems may also result from the way in which TD projects are developed and carried out by agencies, i.e., the manner in which the 'project cycle' is implemented.

Technology development and the project cycle

There are several possible definitions for the composition of the project cycle (e.g. MacArther, 1994), but project identification, implementation, monitoring and evaluation, and dissemination, are generally well recognized as the principal components by agencies concerned with TD. However, case studies indicate that deficiencies often arise during practical implementation.

Project preparation and implementation

An FAO review of 70 agricultural development enterprises showed that many faults in completed projects could be traced back to the identification and design stages (Edwards and Farrington, 1993). Carr (1990) argues that the identification of needs, markets and resources has also been weak in technology projects. She states: "All too often a technology is designed in a vacuum without due consideration being given to whether anyone needs or wants it or can afford to buy or use it".

Project preparation was also unsatisfactory in some of the projects reviewed for the following reasons.

(a) Inadequate specification of project objectives, without which subsequent management, monitoring and evaluation is likely to be ineffective. A recent review of renewable natural resource research projects (including some agroprocessing projects) found that inadequate specification of objectives was a common problem (Edwards and Farrington, 1993). Similarly, few of the projects reviewed in this study stated their objectives explicitly in published documentation.
(b) The intended users of the technology, and their requirements, were not adequately identified.
(c) The projects were seldom appraised to see if they would be financially viable. Those which were appraised sometimes made unduly optimistic assumptions.
(d) Insufficient attention was paid to the markets for the products which the technology would produce; questions of consumer tastes and competition from existing producers were not adequately considered.

Thorough and careful attention to project identification and design is required if these problems are to be avoided. The techniques required are described later (in Section 3).

Project monitoring and review

Experience has shown a need for considerable flexibility during the life of a TD project. Projects are likely to require modification as they progress, for example, in relation to hardware problems, or to changes in external circumstances such as drought, devaluation of a currency, or demand for more stringent product standards.

Although effective monitoring is essential to ensure that problems (and opportunities) are identified at an early stage and that necessary modifications are made, its implementation in practice may be ineffectual for the following reasons:

- inadequate provision for monitoring and review
- inadequate implementation of monitoring and review (including inappropriate timing and/or inadequate representation of appropriate disciplines)
- inadequate response by project managers to the recommendations of monitoring reviews and reports.

Perhaps the greatest difficulty with the implementation of monitoring arises from the relative inflexibility of technical design which can emerge at a relatively early stage of the project cycle. This suggests a need for a more participatory approach to TD as well as for effective monitoring procedures.

Dissemination and uptake

Dissemination and uptake require the involvement and collaboration of potential users of the TD. The limitation or lack of such involvement has been one of the most important and widespread reasons for the problems which arise in both the pre-harvest and post-harvest sectors. Problems experienced by Northern-based governmental TD agencies can sometimes be attributed to an over-long period of development in the developed country before 'demonstration' of the TD in the 'recipient' country. The need for earlier development of a technology in the country for which it is intended was highlighted in Edwards and Farrington (1993).

This practice of TD in the North contributed to problems in three of the projects; insufficient consideration was given to the circumstances of potential users. The importance of close collaboration with intended TD users is illustrated by the example of shea butter extraction given in Box 2.

The example given in Box 2 suggests that adaptations to technical specifications can be effectively achieved through participatory approaches. However, technical adaptation is only part of the issue; there is also a need to ensure that the equipment is economically viable and that it can be supplied at a cost which the intended recipients can afford.

BOX 2 SHEA BUTTER EXTRACTION IN NORTHERN GHANA

Shea butter produced from the shea-nut tree is widely used in northern Ghana as a traditional cooking oil. Women of the Dagomba tribe in the northern region use a very sophisticated traditional processing technology with a high extraction rate and a high quality product. However, the technology is very labour-intensive. The process involves several stages leading to the production of a paste which is then kneaded. Kneading is the most crucial step in determining the quality of the final product.

There was an attempt to mechanize the production process by using the Mali oil extractor. However, the Dagomba women abandoned the extractor after a few trials because it had a lower extraction rate than the traditional system and the quality of the final product was poor. A local NGO and two international development agencies then tried a different approach to mechanization. They employed a local engineering enterprise to produce machines to replace the traditional manual processes. The machines for milling, cracking and crushing the nuts were accepted, but the kneader was abandoned by most of the women.

The women had not been consulted over the design of these machines but in the next attempt, their full co-operation was sought. This time, the project team studied the traditional method, particularly the kneading stage, in depth. They learnt that the first mechanized kneader had been rejected because it stirred rather than kneaded. Subsequent efforts to mechanize the kneading process, based on guidelines provided by the women, are expected to produce a more effective kneader.

Source: Wallace-Bruce, 1991.

Approaches and methods for increased effectiveness

INTRODUCTION

The previous section highlighted some of the common problems which can arise in the TD process. The means for overcoming such difficulties appear to fall into two broad groups. The first group concerns the ways in which TD organizations conduct their activities. The second concerns the specific methodologies which can be used to improve effectiveness.

MAKING ORGANIZATIONS MORE EFFECTIVE

Various types of institutional strategy may contribute to the improvement of TD effectiveness; some common themes include:

(a) the need for a greater presence in the South of Northern-based bodies;
(b) a need for realistic objectives and effective targeting of potential recipients in the TD process;
(c) the development of in-country technology expertise as a key component of the TD process;
(d) more effective application of the components of the project cycle by institutions engaged in TD; and
(e) improved co-ordination between North-South and South-South institutions.

Effective presence in the South

It has become increasingly recognized that TD should take place largely within developing countries if it is to be well suited to the needs of the adopters and their operating environment; it is also desirable in order to build up an in-country manufacturing and technological capability. Consequently, TD agencies are increasingly addressing the need for a strong presence in the geographical area(s) for which the technology is being developed, either by a direct operational presence, or via collaboration with a reliable partner.

There has therefore been a trend among some TD agencies towards geographical specialization, rather than involvement in projects in a very large number of countries. This trend has become more apparent, however, amongst NGOs than amongst government agencies. To a large extent, the geographical coverage of government agencies reflects the coverage of the aid programmes of their governments. However, even here there are signs of an increasing emphasis on fewer geographical locations.

The Intermediate Technology Development Group (ITDG) has approached the issue by establishing offices in priority / core countries. This was primarily because ITDG wanted to have a more in-depth understanding of local circumstances so that any interventions would be more effective. The Group also wanted Southern perspectives to be reflected more strongly in its work. Another perceived benefit of having an operational capacity in these countries is that a reliable local partner organization need not be found.

The establishment of an effective presence in the South is more difficult for Northern government agencies than for NGOs for at least two reasons. First, there may be factors which discourage Northern agencies from narrowing their geographical focus. Second, the government agencies in the Third World countries with whom they are expected to collaborate may not be very effective at TD. They therefore need to find ways of increasing their collaboration with NGOs and the private sector; this move is becoming increasingly evident in a number of agencies.

Targeting of adopters

At the inception of a project, the development of effective objectives entails the identification of target groups, their characteristics and their needs. In some cases, target groups may appear to be self-selecting. For example, if a project is to rely entirely on the private sector to disseminate equipment and technology, the adopters will be those entrepreneurs who decide to purchase the processing equipment and will thus be self-selecting. However, TD agencies may still wish to design technologies which require self-selected adopters to meet certain criteria such as the needs of a particular locality, income or social group.

In practice, TD agencies will normally wish to assess target groups carefully as part of the project identification phase. For example, if the agency promoting a project is offering some sort of support, such as loans or training, it may want to be selective about who is offered this support. If the objectives of a project focus on disadvantaged groups, an agency may also need to be selective when deciding on the beneficiaries of any added value derived from the processing of their primary products, and processed products may need to be made available to the poor in regions where those products are scarce or expensive.

With group-owned technologies, the dynamics of the group need to be determined first; reasonably homogeneous groups need to be selected, and the members of the groups must belong to whatever target group the project aims to benefit. Co-operative or group-owned ventures often experience problems because of organizational factors and inadequate individual incentives for members.

A pragmatic approach to the targeting of adopters may be desirable. If the value added by processing a crop is not high, there may be less justification for making

groups of producers the adopters, particularly if there is evidence that individual entrepreneurs can operate the process much more efficiently (Coulter, 1992). An example of a modification of criteria for adopters is presented in Box 3.

Individual entrepreneurs tend to be more successful at running processing businesses than community groups and are generally better placed to adopt new technologies. However, TD organizations (particularly NGOs) may still prefer to focus exclusively on the rural poor for reasons of equity, even if this slows down the dissemination of the technology or impairs business performance. It is therefore important that this trade-off is recognized and made explicit within the TD process.

The targeting of poorer groups is likely to be difficult for TD bodies. For example, even if appropriate technologies for these groups are developed, it may be difficult to generate private sector manufacture and distribution, because the 'markets' for the technology are small and/or dispersed. Under these circumstances, the strategy that can be adopted is to aim for multiple targets. This approach involves linking of the principal, poor target group to others which may be financially better off. The opportunities for selling technology to more affluent groups (e.g. in urban areas) may stimulate the private sector to manufacture and sell the technology, thus enabling diffusion to the poorer target group as well.

When defining appropriate targets during project design and appraisal, particular attention needs to be paid to gender issues (Appleton, 1993). Traditionally, women are usually responsible for food processing, and they may gain or lose from an agroprocessing project depending on its design. If they are to benefit, new technologies must either reduce their workload significantly, or be capable of being incorporated into the work without adding to the overall burden. If new technologies are replacing traditional ones, the quality of the product must be satisfactory to the women (as illustrated by the shea-nut butter example given in Box 2).

The mechanization of processing can benefit women by reducing their workload. However, mechanized processes are often managed by men, so in cases where food processing has traditionally provided women with an important source of income, they could ultimately be disadvantaged. For example, when modern power-driven palm oil mills were introduced in Nigeria, women demonstrated against them because the whole palm fruit was taken to the mill and the men received the money for the oil directly (UNIFEM, 1987).

UNIFEM's series of food cycle technology source books emphasizes the need to consider gender issues and provide check-lists of questions which need to be asked when planning a project/enterprise; these include questions related to gender. Increasingly, donor agencies are adopting procedures which should assist the incorporation of gender issues, but in many of the projects reviewed for this study, it was not clear whether a systematic gender analysis had been made.

BOX 3 SELECTED ADOPTERS OF THE RAM PRESS, TANZANIA

In the Arusha Village Sunflower Project, eligibility for loans to purchase the ram press was initially limited to village groups of 10 or more, and was primarily targeted to church members. These restrictions impeded the dissemination of the press. In 1987, after strong pressure from Appropriate Technology International (ATI) and the project staff, the Project Steering Committee allowed loans and technical assistance to be offered to individual farmers and entrepreneurs as well as to groups. According to ATI, the technology did not begin to spread rapidly until the criteria for participation were expanded.

Building up adopters' technological capabilities

The effective and sustained use of a new technology normally has to include a major element of capability building. The provision of 'hardware' in the form of equipment and operating instructions, patents, designs or blueprints, does not ensure that the technology will be properly used. These 'embodied' elements of a technology have to be accompanied by a number of 'tacit' elements which need to be taught and learnt.

In the past, TD organizations have not always paid sufficient attention to the building up of technological capability, but they are now tending to place greater emphasis on the training of adopters. Training needs associated with 'hardware' in the TD process may be managed in a variety of ways, including on-job training. As it is generally necessary to modify the technology in ways which require engineering, managerial or entrepreneurial skills, it may be crucial to focus on the adopter's capacity to adapt. The importance of the organization and the use of trained individuals within the bodies involved in TD, is now also being acknowledged.

Training is perhaps the main 'software' intervention; changes in skills, techniques, and the organization of production can promote TD without changes in hardware. Trainees may often be technology adopters, or manufacturers of processing equipment; however, in the example given in Box 4, they were field workers.

The development of technical capacity often requires a corresponding component of commercial skills in order to make TD effective. In this respect, it may be useful to learn from private sector practices and incorporate their procedures into TD. However, a common obstacle to this approach is the limited capacity or desire of many public sector agencies and NGOs to learn from the private sector.

A more systematic approach to the project cycle

The overcoming of difficulties attributable to the imperfect application of project cycle components is partly a function of the recognition of the project cycle as such, and of the scope of its component parts. Most TD bodies have, for some time, recognized the value of the variously defined project cycle concept. They are also evaluating the scope of the concept more often, with recent emphasis on the dissemination and evaluation components. The focus on dissemination has been accompanied by a desire to make TD more demand driven; this, in turn, has emphasized the importance of multi-disciplinary approaches. Although the latter has centred on the incorporation of social scientists in particular, the importance of dialogue between technologists from differing disciplines is also stressed.

Management systems which institutionalize project cycle components and multi-disciplinary approaches have become a preoccupation of TD bodies, especially those based in the North. Various documentation systems,

BOX 4 TRAINING OF FIELD WORKERS IN BANGLADESH

In 1989, ITDG carried out a survey of the agroprocessing sector in Bangladesh in order to identify where its inputs would be most useful. The survey identified a major need for a training course for field workers so that they would be better equipped to assist groups of poor people in establishing successful small-scale food-processing enterprises. The course was held and trained 55 field workers from 24 development organizations.

An evaluation of the course, carried out in 1993, found that 62% of the field workers had used their acquired skills. They had trained or advised over 750 poor people in the food-processing operation, and at least 58 businesses had been set up as a direct result of the course.

BOX 5 ITDG'S PLANNING, MONITORING AND EVALUATION (PME) APPROACH

In 1990, ITDG introduced a Planning, Monitoring and Evaluation (PME) system. They had previously used a simpler system, introduced in about 1987, which did not require annual reviews.

The PME system covers strategic planning as well as projects. The output from the annual project reviews feeds into the strategic planning process. The PME procedures vary slightly from country to country, but there are no plans for standardization across all parts of the organization.

The key component is the project document which guides any of ITDG's 'projectized' work. A project document must be consistent with all the strategies to which it relates. These may include country, technology, influence, information and issue strategies.

The PMEs system has a lengthy set of guidelines.

notably the use of the logical or project framework, have grown in prominence. The logical framework can be of particular value at the project identification stage, and as a means of monitoring progress against project objectives.

An example of ITDG documentation is described in Box 5.

For some years, NRI has been using the project framework for all its projects and has recently published a report showing how it would apply the project cycle to the development of biomass energy technologies. The report states that:

> "the project cycle helps to focus on the methods of transfer with a view to assisting future developments of technologies by NRI. In particular, it will enable the development of an operational structure in which the approach to energy needs assessment and technology dissemination outlined here may be realized".

In principle, there is nothing unmanageable about taking account of, and responding to, external changes, or about responding to the problems identified as the project progresses. Rigorous use of a project framework during monitoring allows the assumptions underlying the project rationale (including external conditions) to be reassessed at regular intervals.

Plans for project monitoring should be determined at the project preparation stage, and should include the types of monitoring to be undertaken, their frequency, and the disciplinary composition of teams undertaking mid-term reviews etc. This was recommended recently by Edwards and Farrington (1993) for renewable natural resources research projects supported by ODA. It is important that a multi-disciplinary approach is adopted for the monitoring and review of projects, as well as for project preparation.

In view of the need for flexibility and modifications to projects as they develop, a process approach may be required. In a process project, although the objectives may be clear, the shape of the project activity cannot be defined at the outset. Such projects develop through defined stages, with future plans developed on the basis of the experience of the project to date. However, care should be taken to ensure that the use of a process approach does not result in poor planning and ill-defined objectives. The need for clear, specific objectives at the beginning is just as important; they can be re-defined, if necessary, as the project progresses.

Co-ordination between organizations

The number and complexity of institutional involvements in any TD process will hinge upon its scale and scope. The general trend towards a greater Southern presence in TD,

and the need to assure demand driven activity, have tended to increase the numbers of bodies involved. There is therefore a need for co-ordination, particularly between Northern and Southern bodies.

Co-ordination may be complicated by the differing aims and agendas of the institutions involved, and by the suspicion with which many NGO and government bodies regard the private sector. The successful implementation of a project usually involves the bringing together strengths and weaknesses from different types of agency, overcoming the weaknesses, and establishing institutional relationships when necessary. It is important that the lead agency for the project should be capable of co-ordinating all the various inputs; methods by which co-ordination can be achieved and maintained need to be identified.

NGOs may make better lead agencies for poverty-focused projects than research institutions, technology centres, government departments, or commercial banks or companies, if they can gain access to the technical, financial or commercial components which they themselves lack. They are more likely to identify appropriate project components (although they may not all be effective in this respect) because of their understanding of, and commitment to, poor communities. They may also have more interest in seeing a project through to the desired conclusion of widespread production and use of technologies by, and for, the poor.

METHODOLOGIES FOR TD

Methodologies for attaining TD are generally well known, but they may often, in practice, either not be applied, or be applied ineffectively. Some major examples of methodologies are listed below:

- *needs assessment* for establishing the priority needs of potential TD recipients
- *market analysis* for identifying opportunities to sell the products from TD
- *commodity systems analysis* for a systematic approach to analysing opportunities for TD within given sectors
- *technology choice and adaptation* for selecting and adapting technologies to meet a recipient's needs
- *financial and economic appraisal* for assessing the commercial viability of TD options and their significance to the wider economy.

These methodologies are briefly discussed below and comments on areas requiring further development are provided. The aim is to highlight key issues for effective TD rather than to provide comprehensive details of each methodology.

Needs assessment

The necessity for effective targeting and the adoption of demand driven procedures within TD have emphasized the importance of needs assessment. Recent developments in this method of approach are reported in another NRI Socio-economic series publication (Gilling and Cropley, 1993). The first stage of the methodology requires careful specification of TD objectives and includes any 'pre-focusing' of the TD agenda, on specific target groups or commodities for example. Selective use is then made of rapid rural appraisal techniques combined, if necessary, with more formal survey techniques to characterize target groups and their perceived key needs. Issues such as effective site selection and stratification, and the appropriate scale and composition of multi-disciplinary teams for field surveys, are incorporated into this process.

Needs assessment has gained prominence during the last decade in the context of a more participatory approach to development, particularly in relation to pre-harvest interventions and activities. This changing climate of opinion has inevitably affected post-harvest interventions as well. However, systematic needs assessments, based on discussions with potential technology users / adopters or potential product purchasers, are still far from universal.

A stronger presence of Northern TD bodies in the South is likely to lead to a greater emphasis on needs assessment.

ITDG indicate that needs assessment is already more effective in Kenya, Peru and Zimbabwe, and moves towards a more participatory approach are taking place. The Group argues that participatory TD techniques "result in better needs assessment, and a better guarantee that the users will adopt new technologies [as well as] bringing together indigenous knowledge with external technology options".

For agencies without a long-term operational presence in the country where a project is to be located, other ways will have to be found to ensure that the needs and views of intended adopters or product purchasers are taken into account at the project identification and design stage. Edwards and Farrington (1993) recommend that NRI project documents should begin by asking what steps have been taken to incorporate information from intended users into the proposal, and what measures will be taken to ensure dialogue with them as the project progresses.

The role of needs assessment can best be illustrated by reference to some examples. If mechanized processing technology is to replace a traditional, labour-intensive one, their must be a strong desire on the part of the potential purchasers/adopters to reduce the drudgery of the labour; the processors' (usually women) labour time should be highly valued (i.e., it should have a high opportunity cost). In recent years, a reduction in traditional processing has been evident; this can be illustrated by the sorghum dehulling project described in Box 6.

If traditional processing methods are still widely used, attempts to replace them with mechanized techniques are less likely to be successful. Processors may not be prepared to invest in the equipment, and the products of the mechanized process may be too expensive to compete with those made by traditional methods. It is important, therefore, to conduct a thorough needs assessment with potential adopters. One example of this is given in Box 6, and another example (shea-nut processing in Ghana) is described above in Box 2.

Market analysis

Until recently, market research for both plant and products in TD projects had often been neglected despite the fact that it is essential if market niches and opportunities are to be identified and the financial viability of the project appraised. A possible reason for this, which is perhaps significant for smaller TD bodies, is the cost of undertaking market research. If the product group for a technology is going to be competing with similar existing products, TD must be based on some potential comparative advantage in terms of price, quality, or reliability of supply.

BOX 6 NEEDS ASSESSMENT IN THE IDRC-SUPPORTED SORGHUM PROCESSING PROJECT IN BOTSWANA

Between 1974 and 1975, independent research was carried out, supported by Canadian University Services Overseas (CUSO), into the prevailing food system of Botswana. Two key issues were identified. First sorghum is the preferred food in rural Botswana, and second, rural food consumption patterns had undergone a significant change in the preceding years. It was also found that women were buying more imported, ready-co-cook, sifted maize meal and rice mainly because of the burden of home dehulling and pulverization by mortar and pestle. The results of this research were largely responsible for the IDRC's decision to start the sorghum processing project in Botswana.

In 1977, the independent research was followed up by a needs assessment survey in Botswana's Southern District; this involved one of the project partners, the Rural Industries Innovation Centre. The survey confirmed the findings of the original research, that the villagers frequently regarded the onerous nature of processing sorghum at home, using traditional methods, as a problem.

BOX 7 TOMATO PROCESSING IN SRI LANKA

Market surveys were carried out in 1991 for an ITDG project in Sri Lanka. A potential market for good quality tomato pulp for sale, at reasonable prices, to larger processing companies and large tourist hotels was identified. This market requirement amounted to over 600 tonnes per year. Four leading, large-scale, food-processing companies expressed an interest in tomato pulp, and one company guaranteed to buy 100 tonnes.

By opting for the production of tomato pulp, rather than a final, fully-packaged product such as tomato ketchup, various problems were avoided. For example, as many tomato products are liquid, they require glass packaging; as the production and transport costs of small consignments of glass bottles is high, the economies to be made by large-scale packaging and transport may put the small-scale producer at a considerable disadvantage.

Depending on the circumstances, market analysis can encompass a number of areas, such as local, national or international markets, the scope for expansion of existing product markets as opposed to new product development, rural and urban market characteristics, vulnerability of markets to key infrastructural constraints, and the significance of the structure of existing and potential marketing systems.

An example of ITDG's use of market research in project identification is given in Box 7.

TD agencies do not always have the necessary economic and technical expertise to undertake market research themselves. In these cases, commissioning research from a local, private sector, market research company is likely to be the best option, rather than involving the local university or technical research institute for example.

The results of market research should be used as part of the analysis of the financial viability of a TD proposal. They should provide data on the likely sales income from the potential TD project and include possible options for sales under different market assumptions. These components are essential to the financial and economic appraisal methodology discussed later.

Commodity systems analysis

Commodity systems analysis is an inter-disciplinary approach for identifying possible interventions, including TD, for a commodity or commodity group. Needs

BOX 8 WOOL PRODUCTION AND PROCESSING IN GUATEMALA

ATI used the commodity systems approach when developing, if not designing, this project. Project interventions occur at several different points in the marketing chain, i.e., primary wool processing, improved yarn production, improved weaving and improved marketing.

A survey of the current market for wool products was carried out. It showed that the various products produced (shawls, blankets etc.) were all sold. Market research showed that local consumers were willing to pay slightly higher prices for higher quality items. A lack of wool yarn meant that many items were made from half wool and half cotton. Items made from 100% wool attracted a higher price and were sold much more quickly. The market research also looked at the tourist market for wool products.

The survey concluded that wool prices could be expected to increase modestly in the foreseeable future.

assessment is applied throughout the production and marketing system with the participation of stakeholders in the subsequent identification of options and the actual TD process. As commodity systems analysis addresses both production and marketing components, it can be used to target TD at a range of potential user groups such as farmers, traders and processors (see Box 8).

The extent to which commodity systems analysis is required (as opposed, for example, to needs assessment) is a matter of judgement and may relate to the scale and scope of proposed activities and the capacity of the TD bodies concerned. If TD organizations already have a substantial knowledge of particular commodity sectors, and/or if 'niche' developments only are intended, there may be less need for a full systems analysis.

Technology choice and adaptation

The software component of the TD process has already been discussed. Technologists and engineers participating in TD also need to use their skills in 'hardware' identification and development. For effective TD, these decisions on hardware need to be developed in association with multi-disciplinary demand driven approaches. Although the types of decision-making required are well known, they are summarized below.

Decisions have to be made on the levels of capital and labour-intensity of technology. Labour requirement will need to relate to the targets of TD; for example, if poor rural producers are involved, more labour-intensive techniques may be justified as labour is more readily available than capital (i.e., the opportunity cost of their labour is relatively low). Similarly, decisions will need to be made about the relative 'sophistication' of technology (e.g. batch versus continuous or semi-continuous operation), as this may have an impact on management and other resources which are often in short supply.

Further choices have to be made with respect to raw material quantity and quality. Quality may affect the volume and characteristics of the output. Requirements for utilities such as water and power need to be assessed, and the trade-offs, or possible costs, associated with different effluent compositions and volumes need to be appraised.

Decisions need to be made about the source of supply of the chosen hardware. It may be advantageous to choose local suppliers, if they can meet the required technical specifications, in order to avoid problems with cost and access to foreign exchange. It may also be preferable to involve several manufacturers rather than relying exclusively on one; this would reduce the risk of a single manufacturer charging monopoly profits, or going out of business.

Box 9 provides an example of how manufacturers were chosen in one project.

BOX 9 CHOICE OF MANUFACTURERS IN THE SUNFLOWER PROJECT, TANZANIA

At the beginning of this ATI project in Tanzania, only one manufacturer was used. This manufacturer, however, was reluctant to change to the cheaper, manually-operated ram press because greater profits were expected from sales of the more expensive, but problematic, motorized equipment originally chosen by the project.

A different strategy was therefore adopted by the project managers. Competition between manufacturers was fostered by providing training in multiple, informal sector workshops, thus providing an incentive to produce the ram press. After successfully completing the training, the trainees were asked to tender for the production of a batch of five or 10 presses. In late 1992, three manufacturers in Arusha were producing the press, including the one which had initially been reluctant to do so.

One of the most important components of technical choice, especially for small-scale/households level TD, involves the adaptation of original designs to meet precise user needs. This may be difficult for TD agencies as it implies an iterative process of relatively minor (and hence, to the technologist, potentially uninteresting) changes over a relatively long time scale, probably a number of years. Donors may make unhelpful divisions between research and technology dissemination, and local agencies may lose momentum if donor assistance stops. TD may often be unsuccessful because inadequate attention has been paid to this iterative process of adaptation.

One of the functions of technical assessment as a whole is the provision of the specifications and operational parameters for the technology hardware which are most appropriate to target user needs. These data are essential components which can be fed into financial assessments of viability.

Financial and economic appraisal

Financial appraisal provides the means for assessing viability of TD options by building on the specification of technical components and performance. The components of the methodology are familiar; they involve the systematic analysis of the likely levels of costs and the potential returns from sales of products or services. A key issue is the extent to which the uncertainties arising during the TD process can be handled.

A 'sensitivity analysis' examines alternative assumptions relating to costs and returns where the outcomes are uncertain, either because of lack of information or because of risks such as climatic factors. Raw material characteristics (such as quality) and costs are usually key input variables, while product sales volume and price are naturally fundamental to potential income. The latter point emphasizes the importance of market assessment as discussed above. In highly marginal projects, changes even in relatively minor variables may have a critical impact on viability.

The appraisal process should include an analysis of the viability of a processing enterprise using the proposed technology. As in financial appraisals of any kind of project, it is important to use realistic assumptions as opposed to those based primarily on the theoretical capability of the technology. It is desirable, therefore, to involve economists in the determination of the values to be used in the analysis, and to carry out sensitivity tests.

A financial appraisal may involve comparisons between different types of processing equipment and serve as a guide to selection. If the equipment is available 'off-the-shelf' in the country concerned, information on capital costs should be easy to obtain. However, if the equipment is to be manufactured in the project country for the first time (either because it is new, or because it has previously only been manufactured elsewhere), the estimation of likely capital costs will be more difficult.

Fortunately, a methodology is available for estimating costs under these circumstances; it takes account of the costs of manufacturing other types of machinery in the country concerned, and of the complexity of manufacturing each significant component of the agroprocessing equipment under consideration. This methodology has been used, for example, to estimate the cost of manufacturing a whole crop harvester in Pakistan (Silsoe College).

A financial analysis, although relatively straightforward, may entail a variety of factors, which may affect the value of each 'line'. A non-exhaustive list is provided in Box 10.

Economic appraisal makes adjustments to financial (private sector) prices to ascertain whether the development of the products concerned is a good use of public resources. This type of analysis is of little interest to commercial bodies or NGOs, and may only be performed where national bodies or aid agencies are involved, especially with large-scale TD activities. However, the analysis has a significance at all levels. For example, it can begin to address issues of environmental cost and benefit which are conventionally outside financial analysis.

BOX 10 FINANCIAL ANALYSIS–A SELECTION OF KEY COMPONENTS

Raw materials
- Cost (at plant)
- Need for farm gate or rural collection
- Yield (e.g. oil from oilseed)
- Quality (mould, dirt etc.)
- Need for mixture with other materials to bulk up
- Volume of supply
- Seasonality
- Variability in any of the above in time or space

Plant
- Initial cost
- Availability of skilled labour to operate/maintain
- Availability and cost of spare parts
- Availability and cost of labour for repairs
- Number of people needed (operator skills)

Working capital requirement

Output targets
- Availability and reliability of electricity, water, and diesel
- Number of hours/days of plant operation
- Efficiency in feeding raw material to plant
- Daily time management (e.g. staggering of breaks)
- Downtime and speed of resolving problems
- Raw material factors (listed above)

Revenue
- Quantity of output
- Quality of final product (appearance etc.)
- Prices received

A number of attempts have been made to adapt financial analysis so that it includes components that test the environmental sustainability of projects, including TD. However, it is generally recognized that issues such as inter-generational equity pose quite intractable problems. Consequently, attempts are being made to develop new tools and approaches.

Although the analysis of environmental sustainability is currently in the process of development, concern over the environment is likely increase in importance as growing populations place further pressure on resources. Whilst a single household-level plant or medium-scale enterprise may appear to pose little threat to the environment, large numbers of such operations may represent a problem—even where apparently benign technology is involved. It is increasingly recognized that the encouragement of sustainable technologies will require a coherent policy environment that regulates resource use, for example, through systems of taxation, licensing and do on.

Conclusions

So far, TD has not been particularly successful. The principal conclusion drawn from this study is that many failures could have been averted by the application of well-recognized procedures for institutional operation, and/or by the application of well-known methodological tools. This conclusion, which is perhaps surprising, implies that TD agencies need to reconsider their practices with reference to the approaches and tools reviewed in this report.

There is also scope for further development of institutional operation and assessment tools. At the organizational level further developments are likely to take place in the establishment of Northern-based TD outlets in the South; many of these bodies are already

conducting, or are about to conduct, TD projects in the developing countries concerned. Procedures which result in more effective integration with institutions in developing countries and associated systems are being refined. These are often taking place within a more participatory framework which enables a more effective integration of the outputs of western science with the indigenous technical knowledge and capacity.

Targeting approaches represent an area which may previously have been underrated and which only recognized a simplistic division between poverty-focused TD and commercial (self-selecting) targets. Effective TD, even for the poorest groups, usually requires proposals which incorporate commercial criteria. The limited dialogue to date between differing categories of institution, particularly between government bodies and NGOs and the private sector, may have inhibited a more flexible and imaginative approach to targeting (such as the multiple targeting approach noted earlier).

The growing emphasis on the development of the adopters' technical capacity (soft technology) is partly linked to the recognition of the importance of participatory approaches. These, in turn, are linked to on-going efforts to develop a more effective integration between the institutions noted above.

Projects cycle components can be particularly useful to the internal operational effectiveness of TD agencies. The effectiveness of the component parts is often strongly correlated with the effectiveness of institutional management systems generally. Areas where management systems have not always been successful include the effective development of multi-disciplinary procedures. There could also be greater flexibility within systems, particularly at the project identification and early design stage.

Although institutional monitoring systems represent perhaps the most crucial component of project cycle activity, they are often amongst the weakest in terms of practical implementation.

Amongst the methodologies which should be applied in TD, it is recognized that the application of needs assessment in areas of post-harvest activity is less well developed than for production. Similarly, needs assessment is less well applied in urban localities. Both these areas may be of fundamental importance to TD agencies.

Needs assessment can be used as a component of commodity systems analysis which focuses on post-harvest as well as production issues. However, although commodity systems analysis is relatively well established in developed countries, it has only been applied on a limited basis elsewhere. There are therefore operational problems with the methodology in developing countries. In particular, the capacity of in-country institutions to use the methodology and to take up the conclusions of the analysis, both with regard to TD and other issues, needs to be determined.

With respect to choice and adoption of technology, further progress can be made in assuring flexibility in design throughout the TD process. This may require the development of more effective participatory approaches. There is also scope for integrating indigenous technical knowledge with the outputs of western science, particularly for TD directed at the household level.

The basic tools for financial and economic appraisal are well known, even though they are not often applied to their full effect within TD. However, the components of these analyses which seek to address environmental and sustainability issues are subject to review and development. The capacity of these methodologies to address environmental issues is likely to be limited, even with further development, and this has also led to a quest for new tools that can be more effective. Pressure on the natural resources arising from continued population growth and associated urbanization in developing countries means that environmental concerns will rapidly assume even greater importance. There is therefore a need for effective analytical tools with which to address these concerns.

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