



**A SUB-SECTOR APPROACH TO COST-BENEFIT ANALYSIS:
SMALL-SCALE SISAL PROCESSING IN TANZANIA**

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Abstract: The paper proposes a way to adapt the standard cost-benefit analysis (CBA) technique to make it more suitable for analysing the feasibility of projects in new sub-sectors, when project success hinges on simultaneous investments in complementary activities to be undertaken by different private investors. New elements in the method include an estimation of expected profitability for a prospective new sub-sector as a whole, and an assessment of the sub-sector's technological capacity environment. The method could be used as a tool for project planners to gain insight into the likely feasibility of stimulating initiatives aimed at promoting viable private sector investment in new economic areas. It should also help them to direct their resources to those key areas within new sub-sectors where central intervention and central co-ordination is most needed to overcome critical constraints to innovation to private investors. The method is illustrated with an example of a small-scale sisal processing project in Tanzania.

Keywords: project appraisal; cost-benefit analysis, sisal decorticating technology, rural innovations, sub-sector analysis, small-scale production, Tanzania.

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1. INTRODUCTION

Cost-Benefit Analysis (CBA) has been a commonly used technique for ex-ante appraisal of investment projects ever since the early 1970s (see, for example, Little and Mirrlees, 1974; Squire and van der Tak, 1975; Behrens and Hawranek, 1991; Barnum et al., 2001; ADB, 1997; Kirkpatrick and Weiss, 1966; Brent, 1998). Initially it was widely applied as a project-selection tool in developing countries in particular, where many project-based interventions have been implemented as part of development aid programmes. However, the basic principles of the technique have since been adopted as a standard financial investment assessment tool by private sector companies world-wide.

Defining the effective scope or boundary of a proposed project has usually been a key issue, especially in countries at an early stage of development. An isolated scheme may fail because activities that are expected to produce necessary inputs for it, or use outputs from it, are locally non-existent. The production structure in poor countries is typically thin, to the point where entire sub-sectors may be lacking (Kubo et al., 1986). At the same time, these countries lack a well-developed transport, communications and information-technology infrastructure, which may make the importation of critical missing inputs cumbersome or costly. Therefore, complementary local investments often need to be forthcoming for a project in this setting to succeed (ADB, 1997, p. 4). In principle, the standard CBA method is equipped to deal with this kind of problem. When the core project activity will not be able to function properly in the absence of a certain complementary activity, the scope of the proposed scheme should be expanded, and the core and complementary activities simply should be appraised together as one large project (Little and Mirrlees, 1974, p.3).

However, complications of a practical nature may arise when the number of strong complementarities is large. The execution of a whole set of inter-linked sub-projects is bound to involve several different parties pursuing their own interests through their own separate activities. Each of these activities poses specific requirements and unique constraints. At the same time, the different actors need to interact with each other and they need to co-ordinate their actions effectively. Appraising a project of this type is bound to be a complex exercise.

Yet, it appears that not much explicit attention has been devoted to this issue in the CBA literature. Possibly, this has to do with the fact that the basic methodological principles were developed over three decades ago. At that time, large and complex development projects were designed and executed primarily by government departments and aid agencies themselves. Complex co-ordination issues and logistical problems were tackled through central planning, execution and control. In contrast, private stakeholders tend to play a much more prominent role in many projects nowadays. Even where projects are still being initiated by public bodies or development agencies, they are often used more as tools with which to stimulate private sector development, than as interventions aimed at filling major gaps in the country's input-output matrix through direct and sustained public sector involvement.

In this changed economic context, CBA should thus be a tool to help project planners to gain insight into the likely financial feasibility of stimulating initiatives aimed at promoting viable private sector investment in locally new economic sub-sectors. It should also be able to assist them in directing their resources selectively, to those key areas within new sub-sectors where central intervention and central co-ordination is most needed to overcome critical constraints to private investors. In other words, the technique should be well suited to appraising projects that have a market-stimulating orientation, and that involve economic activities run by several different private investors. The objective of this paper is propose a possible way in which the standard CBA technique could be extended for that purpose.

Our 'sub-sector method' will be illustrated with a case study about small-scale sisal processing in Tanzania. The case comprises three activities that constitute linked stages in a local sub-sector that does not yet exist locally. Each of the activities is to be carried out by a different private investor. One of them can be considered the core investment. The core activity, however, cannot function properly without the two complementary activities. Furthermore, each of the three new activities will in turn require various supplementary technological inputs and services, information, and so on. Some of these are essential for the proper functioning of the sub-sector, representing 'second-order' complementary inputs, so to speak. The core activity will be situated right in the middle of the

missing sub-sector. The case is therefore a useful illustration of how complementary investments of different kinds can be worked into the CBA method from different directions at the same time.

The paper is organised in six sections. The problems encountered when using CBA to appraise set of complementary activities involving several investors (i.e., sub-sectors) are highlighted in section 2. Remedies to deal with these problems are suggested in section 3. The sisal project is introduced in section 4, and the sub-sector approach is applied to the case in section 5. Conclusions are formulated in section 6.

2. STANDARD CBA AND ITS LIMITATIONS IN THE CASE OF MISSING SUB-SECTORS

The main aim of conventional financial CBA is to obtain insight into a project's expected financial profitability, in order to reach a decision about its implementation. A project's expected profitability depends on prospective costs (cash outflows) and benefits (cash inflows) generated during the project's anticipated lifetime. The forecasted net cash inflows and outflows in each project year (t) are discounted to their current value (in year t_0) by applying a discount factor $1/(1+i)^t$. The further into the future a cash flow occurs, the greater the discount rate 'i' that is applied to it. The discount rate is usually set equal to the interest rate on a common savings deposit, on the assumption that this would constitute the best alternative investment opportunity for the available funds.¹

After discounting, the cash flows across all project years (n) are summed to yield the Net Present Value (NPV). A positive NPV indicates that the project investment is expected to yield more profit than the next-best alternative investment opportunity for the money.² A negative NPV indicates an expected loss. Another widely used statistic is the Internal Rate of Return (IRR). It is defined as the rate of discount at which the sum of all discounted cash flows equals zero. The IRR is calculated by replacing the exogenous 'i' in the NPV formula with a variable 'IRR', which is determined by setting the NPV equal to 0. An IRR greater than the going interest rate 'i' is equivalent to an NPV greater than zero, and suggests that the project is likely to be profitable. When the IRR is lower than the going interest rate, the profit is expected to be loss-making.

Since projects are subject to uncertainty, a sensitivity analysis is also usually carried out in order to gain insight into the extent to which the NPV and IRR estimates react to possible changes in cash flow values. This is done by studying the impact of variations in the values of individual cash flows (usually one at the time) on the NPV and IRR. Useful statistics are the switching values, which reflect the degree of change in income or expenditure required for the NPV to turn zero, and the IRR to become equal to the discount rate. When some switching values lie close to the base-line values used for calculating the original values of the NPV and IRR, it would be unwise to implement the project in question, even if its original NPV and IRR estimates are acceptable. Caution is needed especially when high uncertainty prevails about the expected values of those particular cash flow items.

Two important complications arise when the prospective feasibility of a new core activity hinges on the simultaneous initiation of complementary activities that are to be initiated by other investors. First and foremost, nothing will happen in the event that the expected profitability of these activities is considered to be too low to potentially interested parties. This would cause the core activity to be killed in its infancy. In order to avoid unpleasant surprises of this sort, the scope of the appraisal needs to be extended. As indicated in the Introduction, the prospective feasibility of the complementary activities needs to be analysed along with that of the proposed core project activity. However, when the different activities in a new sub-sector are expected to be occupied by separate private investors, one cannot simply lump all activities together and carry out the appraisal as if there is to be only one investor in the chain. The new sub-sector must offer sound financial prospects for *all* prospective investors. The way in which the NPV and IRR criteria are applied should reflect this requirement.

A second problem crops up in relation to the sensitivity analysis. The uncertainties surrounding the performance of a series of linked investments to be undertaken by different investors are obviously even larger and less amenable to quantification than would be the case for one centrally coordinated project intervention. We will argue below that the conventional quantitative sensitivity analysis can be at best only a partial risk assessment tool in these circumstances. An additional qualitative assessment is likely to be needed, in order to gain insight into the likely effects of numerous factors that defy easy quantification.

Solutions to these two problems are proposed in sections 3.1 and 3.2, respectively. The two parts of the method are synthesised into an overall appraisal method in section 3.3.

3.1 Assessing profitability in the case of multiple investors

For operational purposes a sub-sector is defined here as a series of strongly complementary sequential activities executed by different actors, in which inputs are transformed step by step from primary goods to intermediate goods to final outputs. A missing sub-sector composed of three actors is represented in Fig. 1. The product to be produced in this sub-sector is expected to be sold to an already established market by the third actor. As in a conventional CBA, the prices prevailing on the initial input market and the final output market are taken as given.

An obvious starting point is to treat all missing activities in the sub-sector as one single large project, and try to find out whether this ‘mega project’ is likely to be sufficiently profitable as a whole, so that there is likely to be enough room for *all* prospective investors to derive a satisfactory profit from their respective activities. If this basic condition cannot be met, it would be best to abandon the project idea³, as private investors will not establish complementary investments in the absence of profitable investment opportunities.

Restated in operational terms, the aggregate NPV, that is, the NPV relating to all investment activities needed to fill the missing sub-sector, should be *substantially* higher than zero, so that all investors stand a good chance of receiving an adequate return on their respective investments. A modestly positive NPV will generally not satisfy this requirement, even though it would suffice to approve an individual project in normal circumstances. The corresponding IRR would thus also have to be substantially higher than the going interest rate. In practice the minimum aggregate NPV and IRR that are deemed to be acceptable would depend on the risk assessment of the project developers and financiers in the specific context within which the project is designed to be implemented, but in general their level should probably allow for some leeway here and there. Since sustained central co-ordination of the entire prospective sub-sector is not intended, optimal coherence among the activities is unlikely to be achieved from the outset. Thus, target profit margins should be high enough so that an initial misbehaviour or misfortune occurring in one stage of the production chain will not immediately lead to the demise of the other players in the new production chain.

Figure 1 here

Aside from this stringent condition, the procedure for assessing profitability is similar to a conventional profitability analysis of a single project. In effect, the aggregate investments of all participating actors are simply considered as one. This ensures that any externalities that might accrue to a complementary investment as a result of the core investment (and vice versa) are internalised in the NPV calculations. The procedure further implies that all the profits are initially assumed to accumulate at the final stage of the missing sub-sector, from where the final output is sold onto the established market. All the other actors are assumed to sell their intermediate outputs on to each other without profit (i.e., the costs of inputs bought by actor 2 from actor 1 are set equal the total production costs of actor 1, as shown in Fig. 1). Thus, the total costs incurred in the sub-sector as a whole are set equal to the total costs for the actor who will be investing in the last stage of the missing chain. Calculating the aggregate NPV thus involves an estimation of these total costs and confronting them with the revenues received by this final actor.

3.2 Extension of the sensitivity analysis

Introducing a project investment involving the emergence of a whole set of related economic activities entails much larger uncertainties than an isolated project intervention, mainly because of problems surrounding the successful introduction and application of new technologies in entirely new sub-sectors. As noted by Lall and Teubal, ‘In developing countries, not only is the internal base of knowledge for mastering technologies relatively weak, the supporting network of other enterprises, institutions and human capital is also underdeveloped. This makes even relatively “easy” tasks difficult, costly and unpredictable’ (1998, p.3). Thus, if a project involves the introduction of new

technology in a new field of economic activity, it is highly unlikely that all major elements of technological capacity will be locally available from the outset. Ignoring this fundamental characteristic of underdevelopment may lead to the unfounded assumption that a new technology can be controlled and used to its optimal potential, irrespective of its environment.⁴

The possibility of inadequate technological capacity was ignored in the profitability assessment of the sub-sector in section 3.1. The aggregate NPV and IRR should be effectively considered technological best-practice estimates. When possible constraints emanating from inadequate local technological capacity could be taken into account in the estimation of costs and benefits, actual project performance would generally turn out to be some way below best practice. A decision about implementation of a prospective project based solely on the values of the technological best-practice NPV and IRR would thus be hazardous.

However, it would be very difficult to incorporate uncertainties associated with inadequate technological capability fully into the formal estimations of the cash flows. A more convenient and insightful option would be, to put the best-practice NPV and IRR estimates into a realistic perspective by supplementing them with a separate, mainly qualitative, analysis of local technological capacity relating to the activities in the new sub-sector. For this purpose we take recourse to the so-called THIO approach to technology assessment elaborated by the Economic Commission for Asia and the Pacific (ESCAP, 1989). THIO stands for the four main embodiment forms of technology, namely: object-embodied technology (Technoware); person-embodied technology (Humanware); document-embodied technology (Inforware); and institution-embodied technology (Orgaware). Technoware can be seen as the facilities available to back up the technology used in the production system. This aspect of technology is embodied in different forms, depending on the actors involved. It may encompass a broad range of elements. For example, in addition to the hardware support that is directly necessary for the technical upkeep of a newly introduced technology, general physical infrastructure facilities in the project area should also be included if these are likely to pose a major constraint on the project's successful implementation (as is often the case in less developed countries). Humanware is seen as the human abilities -- skills, knowledge and experience -- with respect to a certain task. It is partly uncodified and tacit. Inforware contains documented facts and information concerning a new technology, for example in the form of blueprints and technical manuals, while orgaware relates mainly to organizational ability and managerial competencies (Ibid., p 8.).

Gaps in any of these four 'wares' may affect the performance of any of the activities in a new sub-sector, and thereby influence the feasibility of a planned project intervention that is to be situated somewhere in that chain. For our purpose, then, technological capacity⁵ can be defined as the extent to which these four 'wares' are present or likely to develop in the near future with respect to the project at hand, as well as with respect to the prospective complementary activities that are expected to supply critical inputs to it, and/or function as a critical market outlet for it.

3.3 Synthesis

The results of the assessment of aggregate technological best-practice profitability (supplemented with a conventional quantitative sensitivity analysis) can be combined with the technological capacity assessment to show various possible appraisal outcomes (Table 1). The classification according to the NPV and IRR criteria is based on the conventional CBA decision rule, but they are applied in a more stringent way, as discussed in section 3.1. The state of the technological capacity has been classified by means of three categories: good (no major gaps), intermediate (exhibiting some specific gaps), or bad (seriously deficient overall). The interpretation of the categories and the scaling of a project on both criteria are inevitably subject to a subjective interpretation of the available information.

Table 1 here

A project for which aggregate best-practice profitability is high, and for which the technological capability assessment also yields positive results (= upper left cell) will have good implementation prospects in principle. The total size of the profit cake is expected to be large enough for all prospective investors in the chain to get a good slice each. Technological problems are unlikely to impede the realisation of this scenario in a major way. Of course one should still be sensitive to

possible co-ordination failure among mutually dependent private investors. Failure to do this may lock investors into a prisoner's dilemma situation, because neither party wants to risk being let down by the other by making the first investment move (Pack and Westphal, 1986). However, when overall profitability prospects are good, investors themselves face powerful incentives to sort out these problems for themselves as well (Little and Mirrlees, 1974).

A project should not be implemented when the aggregate best-practice NPV and IRR indicate anything less than high profitability (i.e., all cells in the lower row of Table 1). Even in the case of moderately positive profitability it will generally be wise to abandon the project idea, because the inducement effect may not work well in the absence of substantial profitability prospects.⁶ In fact, when the aggregate NPV and IRR are not sufficiently encouraging, there will be little point in proceeding with a full-scale qualitative technological capacity assessment. Only when it is evident that sufficient local technological capacity already exists, could one reasonably consider to go ahead with the implementation of a project with a modestly profitable aggregate NPV and IRR (lower left cell). However, such cases are likely to be few in practice.

Another highly problematic scenario is the one represented by the upper right cell in Table 1. In spite of the high aggregate profitability, this should generally be considered a negative outcome as well. Experience (particularly in African countries) has shown that it is extremely difficult to implement projects successfully when local technological capacity is seriously deficient, even if potential best-practice profitability appears to be very good.⁷

Major missing THIO-elements that show strong complementarities to the main economic activities in the prospective sub-sector are likely to form a hitch in this scenario. The problem is essentially analogous to that of strong complementarities in the sub-sector itself, as discussed earlier. When these missing elements cannot easily be procured from far away places, local facilities must be established at the time when the core project is expected to come on stream (Hirschman, 1958, p.68-9). While one might try to expand the project scope in order to deal with some of these problems, this carries a risk of projects becoming so large and complex as to make them unwieldy and unmanageable (Carvalho and White, 1996). Besides, some of these missing inputs may constitute public goods that simply cannot be supplied by the project itself, such as good technical education facilities or a local laboratory where essential tests can be performed. Such services do not emerge overnight. Building up a well-functioning science and technology infrastructure is normally a costly and long-term affair.

Much will depend on the strength of the complementarities. A. O. Hirschman argued that many relationships between economic activities do not take a rigid form. He emphasised so-called *entrained wants*, where '... the increased availability of one commodity does not *compel* a simultaneous increase of the supply of another commodity, but *induces slowly*, through a loose complementarity in use, an upward shift in its demand schedule.' (Hirschman, 1958, p.68). He quotes the example of parking facilities, restaurants and cafes, hairdressers, and so on, which are bound to get established after the construction of a new office block. These are the sort of relationships where the principle of spontaneous induced investment can be expected to operate once the main activities in the new sub-sector have been established. Still, major induced investments cannot be expected to occur overnight, which means that projects in this setting are likely to show long technological learning curves.

In sum, the likelihood of project success would be slim, particularly in the liberal economic environment that is currently prevailing in many low-income developing countries. Donors currently put considerable pressure on projects to become financially sustainable at an early stage, as they are themselves under pressure to show quick and tangible results from the assistance they provide. Not much allowance can be made for protracted technological learning in these circumstances.

The outcome represented in the upper middle cell of the table, finally, will depend upon the level of aggregate best-practice profitability. If it is sufficiently high, implementation of a project of this kind may be successful, provided that any co-ordination problems among investors in the sub-sector are addressed. A few specific critical gaps in technological capacity may have to be dealt with up front. Other weaknesses in relation to technological capacity can be expected to sort themselves out in the manner depicted by Hirschman, under the influence of pressures emanating from the newly established activities in the production chain. The prospects of gradual technological learning and incremental expansion of the local technological support infrastructure are good when there is expected to be considerable financial surplus in the prospective sub-sector, because this will give the

project (and its complementary activities) some financial staying power to ride out its initial learning phase. However, some temporary external support may be needed to cover some of the costs of the learning process and thereby reduce risk to investors. We will revert back to policy implications in the concluding section.

4. INTRODUCTION TO THE SISAL CASE STUDY

Agava Sisalana was introduced in Tanzania at around 1900, mainly for its fibres. Sisal production increased gradually, and in the 1950s and early 1960s Tanzania was the world's biggest sisal producer. In the industry's heyday in 1964, 190 sisal estates consisting of plantations and decorticating facilities together produced 230,000 tons of fibre on 280,000 ha (Bolton, 1985).⁸

The situation changed dramatically when the global sisal market collapsed midway the 1960s. An important cause was the introduction of polypropylene, a synthetic substitute material used for rope making, a major application for sisal. Another contributing factor was the increasing competition on the world market, mainly as a result of subsidised Brazilian sisal production. Domestic problems also played a role. Sixty per cent of the industry was nationalised After the Arusha Declaration in 1967 (Ibid.), causing a severe loss of managerial and financial resources due to the departure of many foreign investors. Efficiency in the state enterprises also suffered due to high bureaucracy. A severe and long downward trend in the production of Tanzanian sisal followed. By the mid 1980s, production levels has fallen to about 40,000 tons per annum.

A slow recovery only set in since the introduction of the Economic Recovery Program (ERP) in the second half of the 1980s. The ERP heralded the liberalisation of the greater part of the economy, including the sisal sector. The majority of the assets of the government-run Tanzanian Sisal Authority were taken over by a foreign-owned private investor group in 1998. The group negotiated a five-year sisal rehabilitation programme with UNIDO, aimed at identification of new sisal end-uses, and identification and assessment of alternative production technologies.

Initial inspiration for this programme was drawn from the current production system as used in Brazil, the world biggest sisal producer for the last three decades. In spite of the difficulties facing the global market, Brazil's production has remained fairly stable over the years. It was suspected that this has to do with the organisation of its production system and the technologies in use, which differ radically from the Tanzanian ones. While Tanzanian sisal plantations and processing facilities are concentrated on a few large estates, the Brazilian system is highly decentralised (Rinck, 1999; Nkuba, 1999). Miniature hand-fed decorticating machines, driven by small combustion engines and mounted to a set of wheels, are towed by donkeys and pick-up trucks to the farms where sisal is grown. The sisal leaves are decorticated on the spot and the fibres are transported to commercial middlemen, who sell them on to the export market after pressing and baling them.

Tanzanian smallholders in the Mwanza, Shinyanga and Mara regions near Lake Victoria grow hedge-sisal to demarcate fields and to prevent animals from destroying crops, but their sisal currently does not have commercial end-uses. On the face of it, it would seem attractive to develop a commercial use for the hedge sisal by introducing a production system modelled on the Brazilian one. The programme therefore included a smallholder component supporting the introduction of small-scale sisal decorticating equipment. A technical and financial feasibility study was carried out for the proposed project by one of the authors of this paper (Brenters, 2000). The case study in section 5 is based on this work.

5. APPLICATION OF THE ADAPTED CBA METHOD TO THE SISAL PROJECT

In this section, the modified CBA methodology proposed in section 3 is applied to the sisal project. First, the actors and activities constituting the missing sub-sector are identified (section 5.1). The cash flows in the prospective sub-sector are estimated and aggregate best-practice profitability is calculated (section 5.2). Following a standard financial sensitivity analysis (section 5.3), we conduct a technological capacity assessment (section 5.4). The various parts of the assessment are synthesised in a final section (5.4), which follows the format of section 3.3.

5.1 The missing sisal sub-sector

The Brazilian sisal production system which serves as the model for the proposed project involves three main actors: the smallholder, the entrepreneur and the merchant. The smallholder is expected to grow and provide sisal leaves. The entrepreneur will own the small-scale sisal-decorticating unit and roam the farms to process the leaves on the spot. The merchant will further prepare the sisal for sale to the market. The entrepreneur is expected to take the initiative in establishing the new production chain, but (as will become clear below) he cannot do so without some degree of co-operation from smallholders and a merchant. The missing sub-sector thus consists of one core investment (the decorticate unit) situated in the middle, and two complementary activities that are forwardly and backwardly linked to it.

The sources of all prospective cash flows are listed in Table 2. For the purpose of estimating aggregate profitability of the sub-sector, the cash flows associated with all intermediate deliveries between the actors (that is, items 2 & 3, and 5 & 6 in the table) are simply excluded from the calculations, as they cancel each other out.

A decorticator modelled on the Brazilian prototype was specifically designed for the project in Tanzania. The machine is capable of decorticating as well as brushing. Decorticating refers to the extraction of the fibres from the sisal leaf (which can grow between 1.5 - 2 metres in length) using fast rotating knives to scrape the leaf in a longitudinal direction, removing the leaf-tissue. Brushing is the second, more gentle decorticating process that is applied after the decorticated fibres have been dried. It removes the last green from in-between the fibres by stroking them, and makes them soft and shiny. The machine is mounted on a carrier tri-cycle. It uses a small 5 Hp combustion engine that drives the decorticator drum. The machine's throughput is around 4,500 sisal leaves per day, with two operators feeding the leaves manually. This is equivalent to around 40 kg. dry fibre. A special feature is that decorticating is done without water (Brenters, 2000, p. 61).

Table 2 here

We define the initial scope of the project as the introduction of one such decorticating-unit. This is the most realistic scenario, since the average investor is likely to be an owner-operator of modest financial means. All he is likely to be able to afford is an assistant (most likely a family member) to help him operate his machine. The operational life span of the project is set at 12 years; equal to the estimated technical life span of the equipment assuming it is operated full-time.

In the technological best-practice scenario, one entrepreneur-team can visit a maximum number of 40 smallholders annually. This figure leaves time for necessary technical services and repair.⁹ Accordingly, the missing sub-sector is defined as 40 smallholders; one operator-unit consisting of a machine, an entrepreneur and an assistant; and one pressing/baling merchant.

5.2 Estimation of cash flows and aggregate best-practice profitability

The main cost items involved in sisal cultivation for 40 smallholders consist of maintenance and cutting. Maintenance requirements for commercial exploitation would consist of six annual immature weeding operations during the first three years after planting, followed by mature weeding operations throughout the rest of the plant's life span. Cutting is needed to harvest the leaves and keep the plant in shape. Although the sisal plants will be cut annually, they will still be capable of protecting the farmyard from animal intruders. Cutting begins three years after planting. It can only be done by hand and is highly labour-intensive (Rinck and Mduruma, 1999).

Estimated maintenance and cutting costs estimates per farm are based on estimates of time spent, average area under sisal per farm¹⁰, and local minimum wages (T. Sh. 962 per manday, plus a supervision surcharge of T. Sh. 1,500 per ha. sisal cultivated).¹¹ Total annual costs per farm work out to T. Sh. 14,807 for maintenance and cutting (in constant 2000 prices). Total annual maintenance and cutting costs for all 40 farms are thus T.Sh.592,267.¹²

The cost-items associated with the operation of the small mobile decorticator by the entrepreneur include: purchase of the equipment and its servicing, repair and transportation; and various costs related to the actual processing of the leaves, including decorticating; drying; brushing; and finally,

transportation of the fibres to the next actor in the chain. The cost of purchasing the leaves (item 3 in Table 2) is left out, as it is an intermediate transaction.

The equipment costs consist of the initial one-off investment of T. Sh. 2,769,361 in the preparatory year (2000), plus a replacement of the frame midway the lifetime of the project, leading to an additional cash outflow of T. Sh. 1,061,600 in year 2007 (in constant base-year prices).¹³ All other costs recur annually. Servicing costs (T. Sh. 87,400) and repair costs (T. Sh. 189,536) were estimated on the basis of common assumptions with respect to agricultural machinery maintenance and repair. Transportation of the machine (T. Sh. 79,635) was estimated using current costs for labour and fuel, as were the costs of decorticating (T. Sh. 1,048,583) and brushing (T. Sh. 18,128). After decorticating, the fibre must be dried, which involves some labour (T. Sh. 45,159); and when the brushed unprepared fibre is ready, it has to be transported to the merchant in a rented truck (T. Sh. 110,000).

The first costs incurred by the merchant are the expenditures associated with buying the 7.2 fibre tons of unprepared fibre from the entrepreneur (item 6 in Table 2), but this is left out as it is an intermediate transaction. Further cost-items include pressing and baling, resulting in box-shaped quantities of 250 kg suitable for export. Total annual pressing and baling costs are estimated at T. Sh. 72,918. However, the pressing and baling facilities in the target area used to be owned by Co-operative Societies, and these have been neglected since the collapse of the sisal industry in the 1960s. They need to be rehabilitated before they can be used again (Seng'enge, 1998). A Tanzanian Sisal Board representative estimated the amount of rehabilitation investment needed at T. Sh. 2,500,000.

The value of the cash inflows (item 8 in Table 2) will depend on the future world sisal price, since the export market is the only reasonably promising market opportunity for the proposed project.¹⁴ The price is still rather low, although it has recovered somewhat from the crash in the 1960s. Probably, declining world demand is beginning to induce commensurate cutbacks in supply. On the whole, it seems reasonable to assume that the slightly upward structural price trend of the past two decades or so can be taken as a reasonable indicator for near-term future conditions.

The fob US\$ sisal prices per metric ton for the duration of the project were estimated by extrapolating a linear price trend for 1980-99, estimated by performing an ordinary linear regression on the actual price data.¹⁵ These prices were converted into current domestic prices using predicted T. Sh. / US\$ exchange rates.¹⁶ The resulting prices start at T. Sh. 624,213 in 2001, rising to T. Sh. 1091,139 in 2012. These are the current prices at which the merchant can sell his 7.2 fibre tons.

All that remains to be done is to convert all cash flows associated with the cost items discussed above into current prices as well, using the average 1996-2000 domestic inflation rate of 13 per cent. The aggregate best-practice NPV and IRR are then calculated by applying a nominal discount rate of 24 per cent to the aggregate nominal cash flows. The discount rate chosen corresponds to the average domestic borrowing rate during 1996-2000 (IMF, 2001). The initial estimation results are encouraging. The aggregate best-practice NPV is + 2,852,428, which is substantially above zero. The IRR of 42 per cent is well above the discount rate.

5.3 Conventional sensitivity analysis

We concentrate the conventional risk assessment on the two most uncertain elements in the economic environment of the project, namely the rate of domestic inflation (which affects all project costs), and the commodity price of sisal (which affects all its revenues). The project's viability is to some extent affected by changes in these parameters, but the risks appear to be manageable (see Table 3). The proposed sub-sector would probably become unviable if the general economic climate were to deteriorate to the extent that the inflation rate would rise its pre-1995 level. However, under the current floating exchange rate regime, accelerated inflation would over time induce a faster decline in the value of the Tanzanian Shilling as well. This would have the effect of compensating the effect of the rising resource costs to some extent through increased export earnings (in T. Sh. terms).¹⁷ Stagnation in the sisal commodity price trend would also depress earnings in the sub-sector. At the same time, implementation would still be feasible if the commodity price were to get stuck at the average level of the 1990s, instead of continuing its long-term mild increase. Thus, we conclude that our sisal project fits into the top row of Table 2. The decision about project implementation will thus hinge upon the outcome of the technological capacity assessment.

Table 3 here

5.4 Technological capacity assessment¹⁸

Even though our project is an example of a low-tech project, the fact that it would involve the build-up of a completely new sub-sector introduces a large range of uncertainties. This is especially so since the project is planned to be executed in a region characterised by a low general level of economic development. This is clearly illustrated by the application of the THIO framework. The main results of the assessment are summarised in Table 4.

Technoware

The smallholder uses a knife (*panga*) for cutting the leaves and two types of hoes (*panga* and *jembe*) for weeding. These are simple and cheap devices, which are commonly used by the rural population. They can be bought and sharpened at any town market. Therefore, the smallholders' technoware is deemed sufficient. No production bottlenecks are likely to arise in case of breakdowns.

However, the situation is different for the entrepreneur. The decorticator requires a combustion engine. In a study of oil press technologies in Tanzania, Hyman (1993) observed that motorised expellers are susceptible to frequent breakdowns and that the availability of spare parts and skilled labour needed for maintenance and repairs may be a problem in rural areas. He concludes that experience with motorised expellers in Africa has generally been poor.

Furthermore, the workshop belonging to the private sisal investor group in charge of the proposed smallholder project is located at a five-days' travelling distance from Musoma rural district where the project is meant to be implemented. This is the same workshop where the prototype was developed, and from where technical support is supposed to be provided in case of major breakdowns. The machine would have to be returned to the workshop in the event of a major breakdown that cannot be fixed locally, causing further costs and lost time and earnings for the entrepreneur. Higher than expected maintenance and repair costs resulting from such problems would no doubt depress aggregate profitability considerably.

More technoware problems could be expected in respect of the workshop's role as a *manufacturer* of decorticators. Newly developed technical devices will typically undergo some design changes as teething problems experienced by users are being ironed out (e.g., Simalenga, 1994; Johnston and Kilby, 1975; Cortes, 1979; Basant and Subrahmanian, 1990). It will be hard for the workshop's personnel to monitor these problems effectively from a large distance. Furthermore, although the workshop is formally an independent enterprise, breakdowns of the equipment belonging to the sisal company on whose estates it is located were seen to be always treated with priority.

The technoware associated with the merchant's pressing and baling facility are better. Since these facilities were part of the conventional sisal processing system as used throughout 20th century, backup in case of breakdowns is available. Many spares have been collected and some mechanics are able to assemble the machines blindfolded. However, the spares and mechanics are to be found close to the currently operational facilities on or near the sisal estates. There are no operational estates anywhere near Musoma. A breakdown of a pressing and baling facility in that area will therefore be costly because of loss of productive time and high transport costs of spare parts.

Humanware

Smallholders in the Lake Zone have planted hedge-sisal to demarcate their plots since the mid 1960s (Bolton, 1985), so that sufficient humanware in planting can be said to exist. The situation is different with respect to plant maintenance and cutting, which so far has been done only with a view to ensure the health of the plant. Commercial cultivation will require more intensive and structured care. Sub-optimal maintenance and cutting will result in low plant yields and fibre quality. Smallholders have no experience in setting up an appropriate maintenance and cutting plan. In view of this, the Tanzanian Sisal Board estimates that actual hedge-sisal yields are only expected to reach about 75 per cent of on-estate yields. Moreover, no initiatives have been taken to help them get the relevant knowledge so far. The most obvious source of support would be the training currently being supplied by the MARA Region Farmers' Initiative Project (MARA-FIP), but this is targeted at smallholders who will intercrop sisal with other crops. It is uncertain whether the budget will allow

the training to be extended to hedge-sisal growers. Other possible forms of support could be governmental extension services or advice from a sisal expert to be appointed by UNIDO. However, establishing this support will take at least one year, and imparting the required knowledge and skills will take at least another two to three years. Even in the event of the quickest support option (MARAFIP), the smallholders will not be able to attain the yield levels as assumed in the best practice NPV calculations during first two to three project years. Not including training costs, the effect of sisal cultivation at 75 per cent of estate levels during the first three project years will cause the NPV to decline to T.Sh. + 1,976,368; and the IRR to fall to 34 per cent.¹⁹ If we further assume that maintenance and repair costs (discussed under Technoware, above) are likely to be at least double the amounts in the best-practice scenario, aggregate expected profitability will become marginal. The NPV will turn to T.Sh.+ 258,092, and the IRR becomes 25 per cent, which is almost the same as the discount rate.

Knowledge and skill requirements for operating the decorticator are not expected to form a major constraint. The purchasing price of the small mobile decorticator already covers costs of basic operator training, which can be imparted in about a half day. Aside from skills in how to handle the machine, basic functional aspects and routine maintenance functions need to be explained. This training can be supplied quite easily within about half a day at the time the machine is handed over to the entrepreneur by the manufacturer.

The rehabilitation of the pressing and baling facility is a one-off event, which can be carried out by the staff of the engineering workshop. No advanced capabilities are needed for pressing and baling. These skills can be transferred to the merchant by the workshop mechanics during rehabilitation.

Inforware

As smallholders have low levels of literacy, oral transfer of facts and information will have to be the most important way of communication. This can be expected to slow down the absorption of cutting and maintenance skills, and to raise training costs. Few smallholders will be able to get quick answers to their questions from a book off the shelf. The information will have to be imparted by an expert who has to travel to the farms in person. Further deviations from best practice can be expected to be associated in the dealings between the smallholders and the entrepreneur. Since the sisal leaf must be decorticated within one day after cutting, errors in the planning of the cutting regime are very costly. The best way to prevent such timing errors (and associated conflicts) would be, to have written agreements between the smallholders and the entrepreneur that unambiguously specify the terms and conditions of the transaction. However, few smallholders would be capable of using these.

Little written inforware will initially be available to the entrepreneur, since the small mobile decorticator is a new technical device. One session of pure oral instruction at the time of handover of the machine may not be entirely sufficient. The entrepreneur may need to refresh his knowledge by taking recourse to a simple manual when the need for maintenance or troubleshooting actually arises. These problems can be addressed over time, by letting the machine manufacturer prepare operating and maintenance manuals, but they are unlikely to be available within the initial project years.

Some other inforware problems could emanate from limited literacy of the entrepreneur in his dealings with the merchant, but we assume that the literacy level will generally be sufficient to carry out basic correspondence and draw up simple contracts. However, the entrepreneur will not necessarily possess adequate information concerning financial and legal matters that come up in relation to financing and purchase of the new equipment, nor will he necessarily possess the management experience needed to run his small business efficiently. In conclusion, the limited availability of inforware in relation to the entrepreneur's tasks will almost certainly constrain the performance of the production system during the initial project years.

The inforware situation with respect to the merchant is similar. The only difference is that documented technical information concerning pressing and baling facilities does exist in Tanzania. However, it may not always be ready to hand when needed.

Orgaware

Commercial hedge-sisal cultivation will demand new management, planning and control tasks on the part of the smallholders. In addition to being inexperienced with respect to the management and organisation of the new activity itself, problems could arise from adding yet another task to the bundle

of diverse activities they already undertake. It has been observed that increasing diversification may have a detrimental effect on professionalism (Seppälä, 1996). An important reason is that other tasks can interfere with the correct timing in the sisal harvesting process. It is crucial that the leaves be cut and moved to a central spot on the farm within less than a day (24 hours) before the arrival of the decorticating-unit. Good timing is particularly difficult because cutting is tough work which is generally disliked.²⁰ The smallholder will have a hard time finding cutters. In view of these anticipated logistical complexities, it is somewhat doubtful whether the intended target group could be expected to exhibit high motivation and enthusiasm for participating in the proposed project. This could well turn out to be a particularly crucial constraint on ultimate project success.

Similar orgaware problems are not expected with regard to the entrepreneur's role in the chain, since his time will be fully dedicated to decorticating only. The entrepreneur's performance is crucial, as he has to initiate the main activities necessary to initiate and run the whole production system. His orgaware-skills will vary depending on his background, but it is unlikely that he will be fully versed in all the managerial, organisational and control tasks needed for efficient operation, especially tasks in relation to time-planning and routing, arranging agreements with the smallholders and the merchant, and arranging transportation of the decorticated fibre. People who are fully qualified in these respects are unlikely to be attracted to this hard work, even at the best of times. Yet, no training programmes are available or planned to remedy skill-deficiencies in these areas.

The tasks of the merchant are relatively less demanding. Selling the fibre on the export market requires the right contacts and also some specific knowledge and experience. For example, taxes have to be paid, transport of the baled fibre to a harbour should be arranged and agreements have to be made with the foreign buyer. Finally, the merchant should be able to employ and manage a small workforce that operates the pressing and baling facility. The main danger to efficient organisation comes from the fact that he devotes only part of his time to sisal trading.

Table 4 here

5.5 Synthesis and discussion

The majority of the THIO elements are deemed to be insufficient, and therefore it can be concluded with confidence that the project's technological capacity has to be considered 'seriously deficient' (right hand column in Table 2). Not all of the identified problems are equally serious, but even those problems that can be remedied over time will still cause major deviations from best-practice aggregate profitability in the initial years. If an entrepreneur were to take initiative by making a core investment into the decorticator, he will for sure fail to incite other investors to join in and start their own complementary activities (this would be so even if a suitable solution could be found for the hold-up problem that is likely to arise in his relationship with the merchant). In sum, the conclusions on the basis of the appraisal must be not to proceed with the implementation of the proposed project under the prevailing economic, technological and institutional conditions.

The current institutional technological capacity environment in the Tanzanian project area is clearly inadequate in many ways, while no definite plans exist to improve it. If the long-term financial profitability prospects for the project were good enough, some of these problems would probably take the form of entrained wants that could sort themselves out over time, such as basic local technical back-up for servicing and repair of the decorticating equipment. Other gaps could be filled by expanding the project scope a little, for example to ensure than a basic user manual for the equipment will be produced. However, others gaps are likely to require a major deliberate effort to get them established, which would require a significant expansion of the project's original scope. For instance, it would be highly unlikely that someone in the private sector would begin to offer technical and time-management training for resource-poor smallholders in a backward rural district like Musoma. Establishing an effective rural extension service for semi-literate and poor dispersed farmers is a difficult and specialised activity that should constitute a separate sub-project in its own right. Moreover, the analysis in the previous section exposed the need for technological, managerial and organisational learning on the part of the key stakeholders in the project. While many skill constraints could be overcome through learning-by-doing over time, it does mean that actual profitability in the initial project years is likely to be well below its potential.

One reason for the bad outcome of the technological capacity assessment is that too complicated a system was proposed for this particular project. The project design was characterised by considerable 'technology-push', formulated in a top-down manner by the big sisal company and UNIDO without involvement from the prospective stakeholders in the actual production system. These people have neither explicitly expressed the need for the technology, nor were they involved in the technology selection process (Brenters, 2000).

Taken together, the problems identified above add up to an enormous difference in the viability of the small-scale sisal production systems in Brazil and in Tanzania, in spite of the highly similar technology used. This clearly underscores the danger of pushing for the introduction of a new technology in a new context simply on the basis of its good performance elsewhere, without conducting a thorough project appraisal that points up the major pitfalls.

6. CONCLUSIONS

In view of pervasive market imperfections in developing countries, our extended cost-benefit method discussed in this paper is likely to be quite widely applicable. It also yields considerably more information than a standard CBA typically provides. Its scope of application is therefore also larger than that of a conventional CBA. In addition to being a tool for making investment decisions on the basis of an analysis of profitability and financial risk analysis, one can also use it to get a good feel for the various technological requirements and institutional constraints facing a project. In particular, through the distinction between rigid constraints and entrained wants, decision makers are guided towards critical internal and external bottlenecks that need to be addressed before the project could be implemented with any chance of success, and they can formulate effective strategic action on that basis. This feature is useful for would-be investors, policy makers and donor agencies alike.

The method obviously cannot provide easy and clear-cut answers to the question whether or not projects should be given the go-ahead in all cases. On the one hand, it could be argued that decision-makers in countries where experience in solving complex technological problems is limited should steer clear of projects that require advanced technological capabilities. But one could also defend the view that complex projects provide possibilities and inducements for mastering more complex skills and knowledge needed for technological advancement of poor countries. Hirschman even noted that 'A degree of local unfitness of the project becomes an additional and strong argument for undertaking it; for the project, if it is successful, will be valuable not only because of its physical output but even more because of the social and human changes it will have wrought' (Hirschman, 1967, p 129). These changes can be seen as the ultimate result of unbalanced growth, in which project-induced new investments in different activities contribute to sectoral, regional and national progress. But thirty-five years after this statement, the problem remains how one can see *in practice* whether a project is likely to exhibit good inducement prospects, or whether it is likely to be overly ambitious and risky.

Another limitation of the method is that it did not incorporate a way of assessing social, cultural and institutional constraints, as well as deficiencies in the sphere of financial markets. Many such problems are commonly encountered in addition to the technology-related problems highlighted in this paper. Further extensions to the CBA method would need to be made in order to take these kinds of problems into account as well.

Still, the matrix with the six project scenarios presented in this paper can be used as a practical tool by investors, policy makers and donor agencies to help them to make somewhat objective decisions. Through a detailed identification of many major constraints that a project is likely to face, the analysis can help decision makers to determine whether the technological, financial, and organizational gaps that are truly critical constraints on project success are amenable to remedial intervention (e.g., temporary subsidies to tide a project over an initial learning-phase), or whether some of these killing constraints are truly unavoidable. In this way, there will be less chance of rejection of seemingly difficult (but developmentally interesting projects) merely on the basis of their perceived complexity. Conversely, it may give rise to a reconsideration concerning the implementation of seemingly 'easy' projects, which turn out to have insurmountable difficulties after all, as the sisal project discussed in this paper illustrated.

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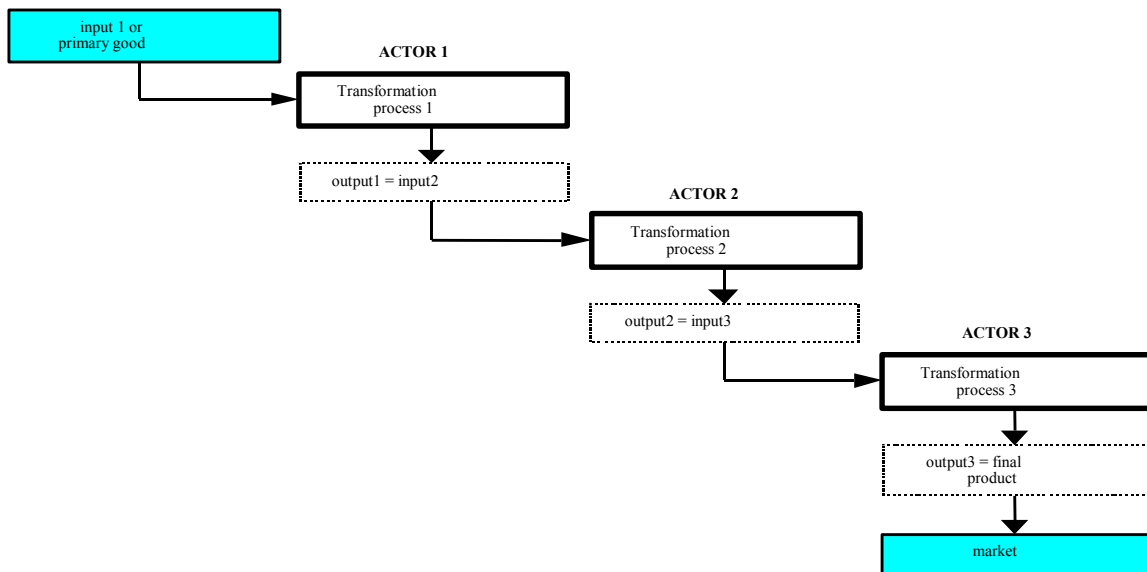


Figure 1: A missing sub-sector consisting of three activities

Table 1: Possible outcomes of a project appraisal in the case of missing markets.

	Technological capacity		
	No major problems	Some gaps	Seriously deficient
Aggregate best-practice NPV $\gg 0$; best-practice IRR $\gg i$	Positive	Mostly positive	Negative
Aggregate best-practice NPV > 0 or NPV ≤ 0 ; best-practice IRR $> i$ or IRR $\leq i$	Generally negative	Negative	Negative

Table 2: Sources of prospective cash flows for all actors in the sisal sub-sector.

		Sources of cash outflows (costs)	Sources of cash inflows (benefits)
Smallholder	1	Cultivating sisal plants and cutting the leaves	
	2		Selling the leaves to the entrepreneur
Entrepreneur	3	Buying the leaves from the smallholder	
	4	Transforming the leaves into unprepared fibre* through decorticating, drying and brushing.	
	5		Selling the unprepared fibre to merchant
Merchant	6	Buying the unprepared fibre from the entrepreneur	
	7	Transforming the unprepared fibre into prepared fibre**	
	8		Selling the prepared fibre onto the final market

* Sisal fibre that has been dried, brushed and collected into loose bundles.

** Sisal fibre in a form required by the market. The export market requires bales of 250 kg of pressed fibres.

Table 3: Conventional sensitivity analysis.

Cash flow item	NPV	IRR (%)	Comments
domestic inflation rate			
15 %	+ 1,533,108	36	
17 %	+ 338,035	27	
20 %	+ 18,086	24	switching value
sisal commodity price			
remains at late 1990s level (US\$ 775 p. metric ton)	+ 2,847,794	43	
remains at average 1990s level (US\$ 698 p. m. ton)	+ 684,950	30	

Table 4: Summary of technological capacity assessment*

	Smallholder	Entrepreneur	Merchant
Technoware	+	-	-
Humanware	-	+	+
Inforware	-	-	-
Orgaware	-	-	+

* + Sufficient; - Insufficient.

ENDNOTES

¹ When a project will be executed with borrowed funds, the discount rate is set equal to the long-term borrowing rate.

² In case the project is to be financed with borrowed funds, an NPV greater than zero implies that it is expected to cover the costs of the loan and yield an additional profit.

³ We do not deal with the situation where projects receive permanent subsidies.

⁴ However, it could be argued that additional qualitative risk analysis would also be useful when a radically new technology is introduced in an already *existing* sub-sector. Particularly when the innovation is likely to necessitate major changes in institutional and organizational arrangements in the production chain as a whole. The risk assessment method developed in this paper could be applied to such cases as well.

⁵ ‘Technological capacity’ is thus a broader concept than ‘technological capability’, a term which is often used to denote the knowledge, skills and organization needed for effective acquisition, use, adaptation and improvement of new technology (e.g. Lall, 1992). Technological capability thus largely overlaps with the humanware and orgaware components in the THIO framework.

⁶ Unless we are dealing with non-commercial projects, in which case implementation decisions are taken on different grounds. These kinds of projects remain outside the focus of this paper.

⁷ Stewart et al. (1992) contains many examples of this.

⁸ Sisal production figures in this section are from Ministry of Agriculture (1984), pp.1-3, and (1992), pp.1-6.

⁹ The estimate is based on an average farm size of 2 ha. (IFAD, 1996, p.6), with each farm fully demarcated by sisal hedges. The area under sisal will then be 0.14 ha per farm. The time needed to service one 2 ha. farm depends on (a) the annual average leaf yield (assumed to be the equal to average on-estate yields of 17,837 leaves per 0.14 ha according to the Tanzanian Sisal Board); and (b) the time needed for processing this amount. Processing time was determined through technical trials, as follows: Decorticating one metre (3,300 leaves) takes 0.74 day (assuming 8 hour working days and two operators per unit), while brushing of one fibre-ton of decorticated fibre takes 0,63 day. Average decorticating time per farm is then four days. Another full day should be added for drying and brushing, resulting in a total processing time of five days per farm. Average travelling time from one farm to the next takes two days (estimate by the Tanzanian Sisal Board). After subtracting five days per annum for technical services and repairs, a total of 282 working days remain for working the machine and travelling with it. That means that 40 farms can be visited per annum.

¹⁰ See previous footnote for details.

¹¹ Estimates from Rinck and Mduruma (1999).

¹² Full details of the calculations are found in Brenters (2000).

¹³ Estimates by the local workshop that constructed the decorticator prototype.

¹⁴ Market information from Taquet (1998).

¹⁵ The sisal commodity price data were obtained from FAO (2000), UN (1992), and UN (1999).

¹⁶ The exchange rates for 2001-12 were estimated by extrapolating a linear trend line estimated with exchange rate data for 1990-2000 (IMF, 2000), using an ordinary linear regression. It showed a steady decline during the 1990s, which was assumed to continue during the project period.

¹⁷ This effect has not been taken into account in Table 3, as the effects of changes in the parameter values are normally assessed one by one, holding all others constant.

¹⁸ All the information in this section is based on own fieldwork by Brenters in 1999 (Brenters, 2000).

¹⁹ This is mainly because the output per farm decreases, so that the entrepreneur has to visit more farmers in order to be gainfully full-time employed. Furthermore, in spite of including an seven farm households, the aggregate physical output from the sub-sector will fall from 7,2 to 5,6 fibre tons per annum, which depresses aggregate earnings.

²⁰ In the past, estates have attracted cutters from Rwanda to fulfil the need.



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