ECONOMIC EVALUATION OF A TRANSPORT DEVELOPMENT PROGRAMME FOR SMALL-SCALE CANE GROWERS

by

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I hereby certify that, unless specifically indicated to the contrary in the text, this thesis is the result of my own original work.

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ABSTRACT

The recent deregulation measures in the South African sugar industry have the effect of removing most of the previous restrictions to entry faced by potential small-scale cane growers. To accommodate the current and envisaged expansion the Government of KwaZulu-Natal is implementing an infrastructure programme as part of a comprehensive Small-Scale Cane Grower Expansion Programme. This study uses Cost-Benefit Analysis procedure to determine the viability of the first phase of this infrastructure programme aimed at improving transport routes for small growers in ten mill areas.

Two representative mill areas were evaluated, namely Amatikulu and Sezela, situated on KwaZulu-Natal's North and South coasts respectively. Three models were constructed as the Sezela area was subdivided into the Kwa-Hlongwa (labour intensive) and Cabhane (plant hire) projects.

Both financial (reflecting returns to resources engaged before financing) and economic (reflecting the contribution to the total economy) results were computed, using a real discount rate of 8%. The financial Net Present Values (NPVs) calculated for Amatikulu, Cabhane (Sezela) and Kwa-Hlongwa (Sezela) respectively are: R3.2 million, R7.61 million and R911 thousand. The economic NPVs calculated for Amatikulu, Cabhane and Kwa-Hlongwa respectively are: R8.18 million, R7.91 million and R1.91 million. These results, reflecting the tangible costs and benefits, indicate that all the projects are viable as measured in both financial prices (before financing) and economic prices (after shadow pricing and transfer payment correction).

A sensitivity analysis was conducted as a risk analysis procedure to see what effect the changing of key variables would have on the investment criteria. Indications are that the economic NPV criterion (which measures the contribution to the total economy) is positive for a wide range of

discount rates for all projects. Indications are that the financial NPV becomes positive after 9, 13 and 18 years for Cabhane, Amatikulu and Kwa-Hlongwa respectively. It is expected that since the economic NPVs for the different projects are higher than the corresponding financial NPVs, the economic NPVs will become positive after a shorter period of time than that indicated by the financial NPVs.

The Amatikulu model was found to be sensitive to changes in yield and B Pool sucrose price (as measured by changes in the economic NPV criterion), while the Cabhane and Kwa-Hlongwa models were found to be sensitive to changes in yield, % cane adoption and the B Pool sucrose price. The economic NPVs of the Amatikulu and Cabhane models are, however, still positive after a 30% *ceteris paribus* decrease in the individual assumptions experimented with. Kwa-Hlongwa's economic NPV becomes negative if the base assumption of yield or B Pool sucrose price is reduced by 30%. It is, however, unlikely that the base assumptions of yield or B Pool sucrose price would drop by 30% for an extended period of time. In addition to this, the base results obtained for the Kwa-Hlongwa model could be seen as conservative as the delayed cane development projected for the base model could well be accelerated and the intangible benefits characteristic of the labour intensive construction method present at Kwa-Hlongwa are not accounted for in the results obtained.

In view of results obtained in the base models and sensitivity analyses, indications are that the benefits of the project will outweigh the costs by a considerable margin, making the project a viable investment decision.

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INTRODUCTION

The recent deregulation measures in the South African sugar industry have the effect of removing most of the previous restrictions to entry faced by potential small-scale cane growers. To accommodate the current and envisaged expansion a comprehensive Small-Scale Cane Grower Expansion Programme has been implemented. As part of this overall Expansion Programme the Government of KwaZulu-Natal is implementing an infrastructure programme. The objective of this infrastructure programme is to upgrade and expand transportation routes to small cane growers producing in ten mill areas. An emphasis will be placed on labour based technology and the support of small-scale contractors.

The proposed total sugar cane development programme involving 27 000 ha was appraised in 1992. On the basis of this appraisal the Development Bank of Southern Africa (DBSA) granted a loan to the former KwaZulu Government of R41 million to be spent by early 1996 for Phase I of the programme. Phase I represents 30% of the infrastructure programme and consists of the construction and upgrading, as per gravel design standards, of infield, field to zone and zone to mill roads. A further two phases, totalling approximately R90 million are envisaged and their commencement is dependent on the success of the first phase.

The objective of this research is to determine the viability of the first phase of the infrastructure programme. The cost-benefit analysis procedure is used to evaluate the costs and benefits of the programme. As the project is already in progress during the time of this study (1994) it is possible to base the model on actual cost data.

The different sugar mill areas involved in the programme are: Umfolozi, Felixton, Amatikulu, Ntumeni, Glendale, Maidstone, Noodsberg, Illovo, Sezela and Umzimkulu. Rather than evaluate all the projects involved in Phase I of the programme, it was decided that two mill areas would be studied closely and individual models would be constructed for them. The mill areas to be evaluated are Amatikulu and Sezela. Amatikulu is situated on KwaZulu-Natal's North Coast and the project in progress involves the upgrading of existing roads. Sezela is situated on the South Coast where there are two projects in progress *viz.* Cabhane and Kwa-Hlongwa. Both the Cabhane and Kwa-Hlongwa projects involve the construction of new roads as opposed to the upgrading of existing roads. The Cabhane project is a plant hire project (*i.e.* machinery based) and the Kwa-Hlongwa project is a labour intensive project. These mill areas were selected for evaluation as they are considered to be representative of the different areas and construction methods involved in Phase I of the programme. In addition to this, construction cost data were available for the projects within these areas.

Possible benefits to these areas resulting from the programme include: increased cane production, reduced transport costs and increased cane throughput to millers. In addition to these benefits, employment opportunities will be created in agricultural development, farming, road construction and road maintenance. Costs would include those of road establishment, upgrading and maintenance.

The outline of this study is as follows: Chapter 1 introduces the study area. An overview of cost-benefit analysis and the classification of costs and benefits is provided in Chapter 2. Chapter 3 gives a description of the analysis procedure, followed by the model explanation in Chapter 4. The cost-benefit results are presented in Chapter 5 and a sensitivity analysis of the effect of alternative assumptions on investment criteria is presented in Chapter 6.

CHAPTER 1.

THE SMALL-SCALE CANE GROWER SECTOR

Sugar Cane Agriculture has played an important role in the development of the coastal area of KwaZulu-Natal. During the last two decades rapid expansion has taken place and sugar cane has become the most important commercial crop in the region. The acceptance by Government of the Sugar Industry's deregulation proposals has led a further phase of expansion. Substantial financial resources are required to support, amongst other projects, the development of infrastructure in the former KwaZulu (KwaZulu Cane Grower's Support Programme Report, 1992).

The objective of the infrastructure programme (of which Phase I is to be evaluated in this study) is to support the development of various sugar cane growing areas through improving transportation routes and thereby the efficiencies in transportation. The creation of employment in the agricultural development and on-going farming activities, as well as through road construction and maintenance, emphasizing labour based technology and the support of small contractors, is aimed at. A further objective is to conserve the natural resources as the infield roads also serve as conservation structures (Naude, 1992).

It is a condition of the loan agreement that the proposed sugar expansion programme be monitored according to a time related framework so that the actual benefits/costs can be revised as the programme progresses and the investment decision can be reassessed (Naude, 1992). In order to fulfil the requirements of the loan agreement and to determine the success, or otherwise, of the first phase it is necessary to assess the nature, extent and distribution of the costs and benefits associated with the cane roads programme.

1.1 Changes due to deregulation impacting on the small-scale cane grower sector

"New provisions relating to small growers have the effect of removing most of the restrictions of the previous Agreement to entry into the sugar industry to prospective cane growers (Nourse, 1994:208)".

A small grower is now allowed to deliver up to 450 tons of A Pool sucrose (approximately 3 500 tons of cane) to his mill and as much B Pool as the mill is prepared to accept. The old Agreement effectively confined a small grower to a maximum of 200 tons of A Pool Sucrose (Nourse, 1994).

The A Pool sucrose price comprises mainly the price of domestically consumed sugar and is higher than the B Pool price which is determined by the export price of sugar on the world open market.

From the 1 April 1998, sucrose quotas will no longer exist and the industry will revert to a single average price for sucrose production. Growers will be able to deliver cane grown lawfully on any land to any mill willing to accept the cane (Nourse, 1994).

1.2 Market considerations

The Sugar Industry took the status of its markets into account when it decided to proceed with expansion. In the case of the expansion within the former KwaZulu, the projected area will offset those areas lost as a result of the purchase of 30 000 ha of sugar cane land in the in the commercial sector by the Timber Industry, the effects of the implementation of the Rorich Committee recommendations etc. (see 1.3) (KwaZulu Cane Growers' Support Programme Report, 1992).

For the purpose of the economic analysis in this study, it is assumed that the demands of the local market have been met and additional cane produced will be destined for the export market. Cane will therefore be valued at the B Pool sucrose price, which depends on the world price.

The South African Sugar Association (SASA) has long term contracts to supply certain countries with sugar. Any sugar remaining after meeting the commitments to the Southern African market and international contracts is placed on the open world market. The supply to this world market is very dependent on growing conditions in the various parts of the world, world economic conditions etc. The size of the total world sugar market is growing at 2% per annum (KwaZulu Cane Growers' Support Programme Report, 1992).

The sugar industry has been named most "world competitive" in a study of eight major sectors of South African industries, conducted by the Monitor Group, an international strategy consulting firm. The sectors studied were: metal products, vehicles, pulp and paper, textiles, tourism, housing, sugar and beverages (The South African Sugar Journal, 1994).

The South African Sugar Industry is seen as being internationally cost competitive on a sustainable basis. The long term effect of a successful GATT (General Agreement on Trade and Tariffs) is expected to favour South Africa as a low cost producer (Ridgway, 1994; Taylor, 1994; Oosthuizen, 1994).

1.3 The small-scale cane grower sector and the infrastructure programme in perspective

The total small grower registered sugar cane area has increased from approximately 4% of the Industry in 1970 to 23% in 1991/1992, while total small grower cane production increased from approximately 2.3% of the Industry total production to 9.7%, over the same period (KwaZulu Cane Growers' Support Programme Report, 1992).

The Sugar Industry's deregulation package was implemented as from 1 April 1990. At that time there were 31 384 registered small growers in the former KwaZulu. The small grower sector is a rapidly expanding sector of the Sugar Industry. The number of small growers increased from 32 000 at the beginning of 1990 to 38 000 in mid 1991 and is expected to increase to 48 000 within the next few years. To accommodate the current and envisaged expansion a comprehensive Small Grower Support Programme has been implemented (KwaZulu Cane Growers' Support Programme Report, 1992; Naude, 1992).

In many areas small growers have maintained continued pressure to enter the Sugar Industry to the extent that when the Industry permitted the registration of small growers who were delivering cane without Small Grower Entitlements and therefore illegally in 1990, 7 433 "pirate growers" were registered. Over and above the "pirate growers" registered, it is anticipated that an additional 13 500 new growers on 27 169 hectares will be registered as a result of the deregulation of the industry in the former KwaZulu. Assuming a conservative yield of 30 tons per hectare an additional 815 000 tons of sugar cane is estimated to be produced per annum. It is believed that actual development of additional land registered will take place when support services, including infrastructure, can be provided (KwaZulu Cane Growers' Support Programme Report, 1992).

While some of the new small growers will be located on existing sugar cane infrastructure, many growers will be located in new areas which will require access roads and conservation structures. Additionally, much of the existing infrastructure serving existing roads requires upgrading (KwaZulu Cane Growers' Support Programme Report, 1992).

The Minister of Trade and Industries appointed the Rorich Committee, to *inter alia,* look at the transport system which prevailed prior to 1985. Before 1985, all growers paid the same transport cost per ton of cane, irrespective of their distance to the mill, effectively resulting in the growers closer to the mill subsidising those further away. Once it had been agreed that all growers should be responsible for their own transport costs, and with the introduction of the A and B pool pricing system, those areas which could not produce cane economically due to their distance from the mill, began withdrawing their B pool cane land from production. This response to economic forces reduced the cane supply areas available to the mills who then experienced some reduced throughput (KwaZulu Cane Grower's Support Programme Report, 1992; Naude, 1992).

The sugar millers were unable to substitute sugar cane lost as a result of the transport rationalisation from KwaZulu areas close to the mill as they were restricted by the sugar quota system. Throughput in sugar mills was further jeopardised by the expansion of timber production into the traditional sugar growing areas (caused by the implementation of the Rorich Committee recommendations). The South African Sugar Association (SASA) estimate that 30 000 ha has been lost to timber since 1989. This is further exacerbated by urban, road and recreational expansion into sugar growing areas, especially along the Natal coast (Naude, 1992).

Because of the erosion of sugar cane supplies, excess milling capacity is currently experienced in KwaZulu-Natal. The additional sugar cane production projected for the programme will not utilize all spare capacity but will aid in keeping milling capacity and fixed costs per ton at current levels. Of strategic importance is the fact that the expansion in KwaZulu-Natal will go towards offsetting the 30 000 hectares of sugar cane land in the commercial sector, purchased by the timber industry (KwaZulu Cane Growers' Support Programme Report, 1992).

Socio economic problems in the KwaZulu-Natal region have been led by the fact that this region supports 25% of South Africa's population but only generates 15% of the economic activity. It is for this reason that benefits to the sub-region resulting from the expansion of the Sugar Industry could be significant. In addition to the financial benefits of an expected addition of 13 500 registered growers over the next five years, it is estimated that the expansion programme will create 15 000 new job opportunities in the growing and milling sectors. It is also expected that a large number of jobs will be created in the allied industries and the community through backward and forward linkages and the multiplier effect (KwaZulu Cane Growers' Support Programme Report, 1992).

Many towns in the KwaZulu-Natal sugar belt owe their existence and future prosperity to sugar cane and further expansion will have significant benefits for these communities. Economic development of rural areas could contribute to a reduction in the extremely rapid urbanization which is taking place (KwaZulu Cane Growers' Support Programme Report, 1992).

The KwaZulu Cane Growers' Support Programme Report (1992) quotes an example of how, in a particular community, a proportion of the money generated from cane production was used for the development of community projects. Further benefits include improved housing and additional disposable income. In addition to these benefits small grower development has stimulated the formation of small grower contractor services.

Sugar cane is a hardy crop which requires relatively low levels of technical expertise and management to farm successfully. Sugar cane is disease and drought resistant and as a plantation crop it does not have to be replanted each year or every time it is harvested. Tractors are also not necessary for many of the operations required. These characteristics ensure the suitability of the crop to the development of subsistence farmers. A high level of technical expertise in the crop is also available. It has been observed that the development of cane has not detracted from the areas cropped for home consumption, but that the area of grazing land has been reduced (KwaZulu Cane Growers' Support Programme Report, 1992; Naude, 1992).

The Small Growers' Financial Aid Fund (FAF) will only provide assistance in cases where the necessary conservation structures have been provided. Sugar cane is a member of the grass family and its ability to protect the soil, in conjunction with conservation practices like trashing, are well documented (KwaZulu Cane Growers' Support Programme Report, 1992).

The question could be posed whether small-scale forestry production or other cropping activities should be stimulated rather than the production of sugar. Arguments for sugar production would include: the demand for small grower registration, the fact that necessary support structures are in place and the suitability of the crop to the development of subsistence farmers. However, the question whether other crops should rather be stimulated was not researched as this was not seen as part of the terms of reference of this study.

1.4 The infrastructure programme and transport savings

The first phase of the infrastructure programme involves both the upgrading of existing roads and the construction of new roads. The projects on KwaZulu-Natal's North Coast are mainly involved with the upgrading of existing roads, whereas, the projects on KwaZulu-Natal's South Coast mainly involve the construction of new roads. The

Amatikulu mill area (North Coast) and Sezela mill area (South Coast) are evaluated in this study.

Significant transport savings are expected as a result of the upgrading of roads in progress on the South Coast. These benefits are likely to accrue to both the cane and non-cane users of the roads, in the form of vehicle operating-cost savings that would result from the improvement in the riding quality of upgraded roads. A traffic count conducted in the Amatikulu mill area by McIntyre (1994), indicated that the non-cane sector is the major road user. A large part of the total vehicle operating-cost savings are therefore expected to accrue to the non-cane sector.

1.5 The infrastructure programme and millers

Sugar millers commit substantial resources to the provision of inputs for small growers and play an integral role in the development of small grower cane. It has been calculated that during 1990/91 sugar millers expended R12,5 million on the small grower sector (KwaZulu Cane Grower's Support Programme Report, 1992).

The KwaZulu Cane Grower's Support Programme Report (1992) indicates that Mills provide some or all of the following services:

- Agricultural extension and liaison services
- Contracting services for land preparation, cane planting, ratoon management and the provision of transport.

- Facilitates the administration of FAF, monitoring of loan redemptions and payment of sucrose delivered.
- Field record systems for the improvement of small grower management.
- The co-ordination, maintenance and development of cane road systems to ensure that cane deliveries are not hindered.
- Assistance with the agricultural planning of the respective areas.
- Agents of the KwaZulu Finance Cooperation (KFC).
- Other community development projects/programmes.
- Finance for cane development and the provision of bridging finance.

The millers will benefit in that they receive a marginal milling profit for each additional ton of small grower cane that they process. The current milling capacity in KwaZulu-Natal is under-utilized due to the erosion of supplies caused by timber expansion. The additional small grower cane is not expected to utilize all the spare capacity. However, it will aid in keeping milling capacity and fixed costs per ton of sugar cane at current levels (KwaZulu Cane Grower's Support Programme Report, 1992).

CHAPTER 2.

OVERVIEW OF COST-BENEFIT ANALYSIS AND THE CLASSIFICATION OF COSTS AND BENEFITS

Any country or region's economic development is dependent on the efficient use of the available labour, capital and natural resources. The use of resources to attain a specific goal reduces the availability of those resources for the attainment of other goals. Both private operators and public agencies have limited resources, they therefore need the reassurance that limited funds are spent wisely. Cost-benefit analysis is a leading technique used in evaluating the economic prospects of development projects (Barlowe, 1986:172; Nortje, 1985:1).

2.1 Overview of cost-benefit analysis

When a private institution evaluates the merits of an investment option, it considers both the technical feasibility and financial profitability of the project. In the public sector, profit is not the main objective, but financial analyses, such as the analysis of the source and application of funds, are carried out to determine if the use of the limited resources is efficient. Some payments that appear in the financial analyses of private sector evaluations do not represent direct claims on the country's resources and merely reflect the transfer of resources from one member of society to another. Examples include subsidies and tax. What counts as a benefit or loss to one or more persons or groups (a part of the economy) does not necessarily constitute a benefit or loss to the economy as a whole. Certain aspects, such as the determination of the scarcity values of goods, are not considered in profit determination or in the analysis of the source and application of funds. It is for this reason that an economic analysis is required (Central Economic Advisory Service, 1989; Squire and Van der Tak, 1988).

A comprehensive cost-benefit analysis should include:

a) The financial analysis, to determine the project's financial viability based on the comparison of benefits and costs valued at market prices;

b) the economic analysis, which this study will emphasize, is used to calculate the net contribution of the project to the economy as a whole, based on the comparison of costs and benefits valued at economic prices; and

c) the social analysis, which looks into the social and distributional effects of the project (Van Rooyen, 1986; Central Economic Advisory Service, 1989).

Mishan (1988) contends that the economist engaged in a cost-benefit appraisal is not, in essence, posing a different question from that being asked by the accountant of a private firm. The same sort of question is being asked more searchingly about a wider group of people, who comprise society. Instead of asking whether the shareholders will become better off by the firms engaging in one activity rather than another, the economist asks whether society as a whole will become better off by undertaking a project rather than not undertaking it.

The realization of investment criteria (that account for costs and benefits through time) implies a concept of social betterment that amounts to a *potential* Pareto improvement. For a project to be considered economically feasible it must be capable of producing an excess of benefits over costs such that everyone in society could, by a costless redistribution of the gains, be made better off (Mishan, 1988).

2.2 The classification of costs and benefits

Costs and benefits can be classified as tangible or intangible. Tangible costs and benefits can be subdivided into different classes. These sub-divisions are illustrated in Figure 1 and discussed in this section.

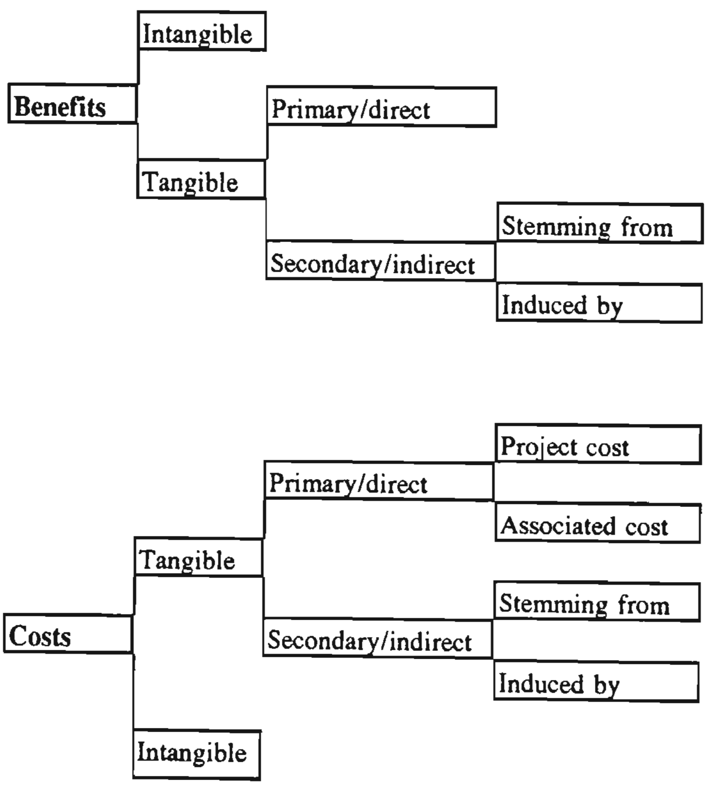

Figure 1: The different types of costs and benefits
(Adapted from Van Heerden, 1972:2)

2.2.1 Tangible costs and benefits

Tangible costs and benefits are those that can be expressed in monetary values. Costs are easier to identify and value than benefits. When examining costs, the question to be asked is whether the item reduces the net benefit of a farm or the net income of a firm (the objectives in financial analysis), or the national income (the objective in economic analysis) (Gittinger, 1982). Examples of tangible costs specific to transport projects include: road establishing, upgrading and maintenance costs.

"Tangible benefits of agricultural projects can arise either from an increased value of production or from reduced costs. The specific forms in which tangible benefits appear, however, are not always obvious, and valuing them may be difficult (Gittinger, 1982:56)". Examples of tangible benefits specific to this project are: increased cane production, and reduced transport costs.

2.2.2 Intangible costs and benefits

Intangible costs and benefits are real and reflect true values but do not lend themselves to valuation. Intangible factors have to be taken into account because the costs can be significant and the benefits can play an important role in meeting the objectives of rural development. Intangible factors are taken into account by means of a subjective evaluation. An example of an intangible benefit is the creation of new job opportunities. Examples of intangible costs are the disturbance of the ecological balance and the loss of scenic values (Gittinger, 1982:61-62).

The definitions of primary/direct and secondary/indirect benefits and costs adopted from the Subcommittee on Benefits and Costs of the Federal Inter-Agency River Basin Committee, by Circiacy-Wantrup (1955) are:

2.2.3 Primary costs

These are the value of goods and services that are used for the establishment, maintenance and operation of the project and that make the immediate products of the project available for use or sale. Examples are road establishment and maintenance costs in transport projects.

2.2.4 Primary benefits

These are the value of immediate products and services that result from direct costs incurred. For example the value of increased cane production that will result from the infrastructure project in this study.

2.2.5 Secondary costs

These are the costs of further processing and other costs (above the direct costs) that "stem from" or are "induced by" the project.

2.2.6 Secondary benefits

These are the values added to the direct benefits as a result of the activities that "stem from" or are "induced by" the project.

2.2.7 Sub-division of secondary/indirect benefits (costs)_(Circiacy-Wantrup, 1955).

2.2.7.1 Secondary benefits (costs) "stemming from" a public project.

These benefits (costs) accrue in connection with the processing of the immediate products. Examples of these, specific to the infrastructure project in this study, are the costs/benefits that result from the increased throughput of cane that millers will handle as a result of the increased cane production. It is expected that the secondary benefits "stemming from" this project will be significant as there is excess milling capacity in KwaZulu/Natal because of the erosion of sugar cane supplies that resulted from timber expansion. The KwaZulu Cane Growers' Support Programme report (1992) holds that additional sugar cane production projected for the programme will not utilize all spare capacity but will aid in keeping milling capacity and fixed costs per ton at current levels.

2.2.7.2 Secondary benefits (costs) "induced by" a public project.

These benefits/costs accrue because of expenditures by the producers of the immediate products (such as increased cane production) stimulating other economic activities.

2.2.8 Sub-division of direct/primary costs (Barlowe, 1986:174)

2.2.8.1 Project costs

Project costs include the full value of the land, labour and materials used in developing, maintaining and operating the project.

2.2.8.2 Associated costs

Associated costs arise with the expenditures of capital and effort needed to secure the primary benefits.

When cost-benefit appraisals are made, all expected benefits and costs (primary and secondary, tangible and intangible) should be carefully ascertained and examined. However, only the values of primary and tangible benefits and costs can be determined and calculated with a reasonable degree of accuracy. No values can be assigned to the intangibles and the determination of the values of the secondary benefits and costs are susceptible to wide inaccuracies and errors (Yang, 1980). In addition to the primary and tangible costs and benefits, the marginal milling profit on additional small grower cane (a secondary benefit) was included in this study, as this benefit was known.

CHAPTER 3.

ANALYSIS PROCEDURE

The procedure to be followed in a cost-benefit analysis is: (a) the determination of the quantity and value of the various kinds of costs and benefits, (b) the conversion of costs and benefits which take place in different periods, to a common time basis, and (c) comparisons of the total costs and benefits (Yang, 1980:232).

3.1 The determination of the quantity and value of the various kinds of costs and benefits.

3.1.1 The situation "with" or "without" the project.

The objective of cost-benefit analysis is to identify and value costs and benefits that will arise with the project and to compare them with the situation as it would be without the project. The aim is to calculate the incremental net benefit arising from the project. The situation without the project is not simply a continuation of the *status quo*, in many cases, but is the situation that is expected to persist if the project is not undertaken. In addition to this, some projects may have aims such as the prevention of future cost increases or benefit decreases. These need to be included in the "without" situation. The situation with the project compared to without the project may be difficult to determine and it does not normally correspond to the situation "before" and "after" the project (Squire and van der Tak, 1980:19; Gittenger, 1982:47).

If the total cane production before and after the road project is compared, the total increase in cane production will erroneously be attributed to the roads project. The production of cane is expected to increase because of the recent deregulation measures. There is therefore an expected increase in cane production independent of the roads project, as well as because of the roads project. Figure 2 illustrates a situation where the net benefit attributable to a project is only the percentage incremental increase in excess of the percentage increase that would have occurred anyway.

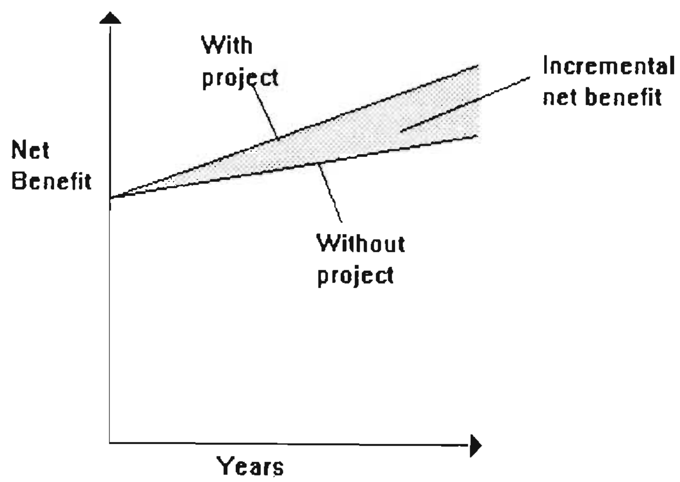

Figure 2: Illustration of the situation "with" or "without" the project.
(Adapted from Gittenger, 1982)

3.1.2 Valuation and shadow pricing

Once the project benefits and costs are identified the problem of their valuation arises. "Costs and benefits may be summed and compared only if they have been reduced to a common yardstick (Battiato, 1993:28)". The indirect and direct costs and benefits must be reduced to monetary values in order to arrive at an estimate of the current net benefits of the project (Peters, 1966).

Market prices may not indicate the relative scarcity of project costs and benefits. The reason being that authorities and large organizations frequently manipulate market prices to attain specific economic goals. Examples of these interventions that result in market prices differing from opportunity costs (the value of a good or service in its next best alternative use), include: price setting and import restrictions by statutory bodies (Bradfield, 1993:11). The market price of an item is normally the best estimate of its opportunity cost and is often the best price to use in valuing either a cost or benefit. The market price is always used in financial analysis. In an economic analysis a "shadow price" may be a better estimate of a good or service's true opportunity cost to the economy. The producer price of cane, for example, may be higher than the cane's net contribution to exports (real economic value). Financial prices are a starting point for economic analysis, they are adjusted as needed to reflect the value of costs and benefits to society as a whole. When a market price is adjusted to reflect its opportunity cost, the new value assigned becomes the "shadow price" (Gittenger, 1982).

3.2 The conversion of costs and benefits to a common time factor.

The benefits that result from investing in a project will arise in the future. Apart from the initial investment, costs that result from the project may also arise in the future. This results in a "complete time-profile of benefits and costs (Mishan, 1988:215)". The community would prefer to receive benefits today rather than in the future and deferred costs are more attractive than immediate payment. The money value of costs and benefits over time cannot simply be added together. It is necessary to convert all costs incurred and all benefits accrued, during the whole life of the project to a common time basis, in order to make calculations and comparisons possible. A weighting process must be used to account for the time preference of the community. This weighting by the community is done with the aid of a rate that reflects the time value of benefits and costs (Battiato, 1993:34; Central Economic Advisory Service, 1989; Yang, 1980).

The procedure by which the present value of benefits and costs are determined is referred to as discounting.

3.2.1 The rate used in the discounting process.

The evaluation of projects is highly sensitive to the discount rate used. Raising the discount rate favours investments with benefits occurring over a relatively short period of time, decreasing the discount rate would favour investments with benefits occurring over a relatively long period of time (Musgrave and Musgrave, 1973).

In profit determination a rate is used which reflects the cost of funds, uncertainties and risk. In cost-benefit analysis the rate used represents the time preference of the community and is referred to as the social time-preference rate (Central Economic Advisory Service, 1989). The Central Economic Advisory Service suggests that a real discount rate of 8% be used. This means that if the project's internal rate of return is equal to or exceeds 8%, or the net present value is zero or positive after discounting at 8%, the project is considered viable.

A method that can be used to account for society's time preference as it relates to agricultural projects is to determine the rate that expresses the ratio of land rent to land values.

The value of a fixed asset can be expressed as the present value of its expected income stream, as expressed in the following model:

$$PV = \frac{R_O(1+g)(1+k)}{(1+i)} + \frac{R_O(1+g)^2(1+k)^2}{(1+i)^2} + \ldots + \frac{R_O(1+g)^n(1+k)^n}{(1+i)^n} \qquad (1)$$

R_O = constant annual rent in real terms,

g = rate of growth in real profits,

k = inflation rate,

i = mortgage bond rate/discount factor (Nieuwoudt, 1980).

In cost-benefit analysis inflation is generally ignored as it is assumed to cancel out from future returns and the discount factors (Howe, 1972 as cited in Nieuwoudt, 1980)(see 3.6). Inflation can be disregarded in the above model by deducting inflation from the numerator and using a real discount rate in the denominator.

Equation (1) could be simplified in (2) where "d" is the real discount factor and g is ignored (equated to zero):

$$PV = \frac{R_0}{(1+d)} + \frac{R_0}{(1+d)^2} + ... + \frac{R_0}{(1+d)^n} = \frac{R_0}{d} \qquad (2)$$

The discount factor "d" in (2) includes both expected inflation and expected real increases in rents.

To determine the discount rate, if R_0 and the present value are known, simply rearrange the formula and solve for d:

$$d = \frac{R_0}{PV} \qquad (3)$$

In a study by Nieuwoudt (1980), it was shown that rental rates on agricultural land in South Africa varied between 3.7% and 5.5% of land value. The discount rate used in the base model will be a more conservative 8 % (the Central Economic Advisory Service's guideline). As there is a degree of subjectivity involved in determining society's time preference the approach that will be followed in this study is to experiment with different discount rates to see the effects on the net present value criterion (see Figure 6).

3.3 Comparisons of total costs and benefits

The aim of costs-benefit analysis is to compare the present value of the benefits with the present value of the costs. This is done by means of investment criteria.

3.3.1 Investment criteria

3.3.1.1 Net present value method (NPV)

The net present value (NPV) method is based on the principle of valuing projected cash flows for an investment at a point in time. The net present value criterion directly accounts for the timing and magnitude of projected cash flows (Barry, Hopkin and Baker, 1988). Barry, *et al.* (1988) stress that an important step in implementing the NPV method is the identification and collection of appropriate data and give a list of five types of data that are needed:

1. INV = the initial investment.
2. P_n = the net cash flows attributed to the investment that can be withdrawn each year.
3. V_n = any salvage or terminal investment value.
4. N = the length of the planning horizon.
5. i = the interest rate or required rate-of-return; also called the cost of capital or discount rate.

The net present value model is set up as follows:

$$NPV = -INV + \frac{P_1}{1+i} + \frac{P_2}{(1+i)^2} + \ldots + \frac{P_N}{(1+i)^N} + \frac{V_N}{(1+i)^N} \quad (4)$$

The model indicates that each projected cash flow is discounted to its present value and then they are all added together to yield a net present value. The acceptability of an investment depends on the sign and size of the NPV, with a positive NPV indicating a profitable investment relative to the required rate of return implied by the discount rate (Barry, *et al.*, 1988).

3.3.1.2 Internal-rate-of-return (IRR)

The IRR is that rate of interest which equates the net present value of the projected series of cash flow payments to zero. Acceptability of an investment depends upon the comparison between the IRR and the investors required-rate-of-return (RRR). If the IRR exceeds or is equal to the RRR the investment is accepted, subject to consideration of risk and liquidity. To find the IRR for an investment simply set up the NPV model and set the NPV equal to zero and solve for i, see equation (5) (Barry, *et al.*, 1988).

$$0 = -INV + \frac{P_1}{1+i} + \frac{P_2}{(1+i)^2} + \ldots + \frac{P_N}{(1+i)^N} + \frac{V_N}{(1+i)^N} \qquad (5)$$

INV is generally negative because of the cash outlay required for the initial investment. If more than one sign reversal occurs multiple IRRs result. An additional IRR exists for every sign reversal, caution is therefore needed when finding an IRR under these circumstances (Barry, *et al.*, 1988).

Comparing NPV and IRR

"The IRR method implicitly assumes that net cash flows from an investment are re-invested to earn the same rate as the IRR of the investment under consideration. The net present value method, on the other hand assumes that these funds can be reinvested to earn a rate of return that is the same as the firm's discount rate (Barry, *et al.*, 1988)".

The net present value rate is seen as being more realistic, as it is consistently applied to all investment proposals and its interest rate is determined by the opportunity cost of capital. The advantage of the IRR method is that the IRR from each investment alternative an be compared against a common required rate of return (RRR), and profitability can be represented in percentage terms, this is often preferred by business managers. The increase in wealth measured by the NPVs do, however, reflect the objectives sought by the firm more directly (Barry, *et al.*, 1988).

3.3.1.3 The discounted benefit-cost ratio (BCR)

The benefit-cost ratio (BCR) is a variant of the net present value measure. It is the ratio of the present value of the benefits as compared to the present value of the costs. If the net present value is positive the benefit-cost ratio will exceed unity. This ratio gives an indication of the amount of rands worth of benefits that result per rand of costs incurred (Baum and Tolbert, 1985:432).

Equation (6) expresses the BCR in mathematical form:

b_N = The benefit stream

c_N = The cost stream

i = The discount rate

$$BCR = \frac{\Sigma \frac{b_N}{(1+i)^N}}{\Sigma \frac{c_N}{(1+i)^N}} \qquad (6)$$

3.4 Transfer payments and the difference between financial and economic analyses

Transfer payments represent the transfer of claims to real resources from one person in society to another, they do not represent the use of real resources (Gittenger, 1982). "In agricultural projects, the most common transfer payments are taxes, direct subsidies, and credit transactions that include loans, receipts, repayment of principal and interest[1] payments (Gittenger, 1982:251)".

There is an important difference in the manner in which the incremental net benefit for an economic analysis is derived as opposed to a financial analysis. In economic analysis, taxes are transfer payments within the society, not payments for resources used in production. In financial analysis, duties and other indirect taxes are a cost like any other

[1]Nieuwoudt's (1994) contention is that interest is not a transfer payment, but the cost of capital. Interest payments related to the project are accounted for in the discount rate of a cost-benefit stream. Interest should therefore be excluded from the analysis but not for the transfer payment reason.

expenditure, and they are deducted to arrive at the net benefit before financing[2]. Discounting the incremental net benefit before financing will give the NPV, financial IRR or BCR to all resources engaged. Changing the financial prices to economic values and omitting transfer payments will give the incremental net benefit in economic terms (Gittenger, 1982).

3.5 The sensitivity analysis

Uncertainty is inherent in project analysis and this uncertainty increases when the estimates of costs and benefits are projected into the future, as the analysis requires. Sensitivity analysis is a standard part of project analysis. It is a simple technique in which different values are attached to uncertain variables so that the effect of the variations in the assumptions on the investment criteria (NPV, IRR and BCR) can be demonstrated (Nortje, 1985; Central Economic Advisory Service, 1989; Squire and Van der Tak, 1988).

3.6 Inflation

Howe (1971) concludes that, in the case of general inflation, it does not make a difference whether (1) costs and benefits are stated in construction period prices and a discount rate containing no inflationary premium is used, or (2) costs and benefits are stated in the prices of the period in which each is incurred and a discount factor that fully compensates for the rate of inflation is used.

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[2] Financing refers to loan receipts and debt service (interest payments and repayment of principal).

For the sake of simplicity then, inflation will not be considered in the costs, benefits and discount-rate in this study.

3.7 The effect of changes in the exchange rate

The intended phasing out of the financial rand and the abolishment of the dual exchange rate may lead to a reduced rand exchange rate. The effect on this study would be to increase the export price of sugar and the results obtained may be seen as somewhat conservative. Projections of further erosions in the rand exchange rate were not considered and it was assumed that exchange rates are largely affected by relative inflation rates and relative real interest rates in trading countries.

3.8 Analysis period, residual value and sunk cost

Values of benefits and costs expected to occur in the distant future generally have small present values. This consideration and the fact that future events can not be forecasted with great certainty, causes the shortening of planning periods. The planning period to be used must be as long as seems justified by one's ability to forecast with reasonable accuracy (Howe, 1971).

Schutte, Visser and Bester (1989) contend that the analysis period should not exceed 20 years and that if the life of the project is expected to be longer than this, the residual value of the facility should be considered at the end of the analysis period.

Twenty years is the base analysis period used for the model. However, it was decided that, rather than include a subjective residual value at the end of this period, the residual value would be ignored. This enables the model to be constructed in such a way that the NPV is calculated for each year up to a period of 30 years. The effect of project lifespan on NPV can thus be illustrated (see Figure 7).

The procedure in Cost-Benefit analysis is not to consider sunk cost (work completed prior to the evaluation that has no opportunity cost). However, since the determination of the "overall" viability of Phase I of the programme is required to motivate the funding of subsequent phases, sunk costs <u>will</u> be considered in this analysis.

CHAPTER 4.

MODEL EXPLANATION

The Amatikulu and Sezela mill areas were evaluated. Amatikulu is situated on KwaZulu-Natal's North Coast and the project in progress involves the upgrading of existing roads. The Sezela area is situated on KwaZulu-Natal's South Coast where there are two projects in progress *viz.* Cabhane and Kwa-Hlongwa. Both the Cabhane and Kwa-Hlongwa projects involve the construction of new roads as opposed to the upgrading of existing roads. The Cabhane project is a plant hire project and the Kwa-Hlongwa project is a labour intensive project. Spreadsheet models have been developed for the two mill areas with the Sezela model sub-divided into the Kwa-Hlongwa (labour based) and Cabhane (plant hire) projects. In essence, three spreadsheet models have been set up.

4.1 Financial analysis

The spreadsheet models for the different areas (included in Tables: 1A, 2A and 3A; with their corresponding assumptions in Tables 1B, 2B and 3B) show the flow of benefits and costs over time (before financing). These benefits and costs are valued in constant 1994 market/financial prices. Benefits include: incremental income to small growers as a result of new cane production and increased milling profit to millers as a result of increased cane throughput. Costs include road construction and/or upgrading costs and road maintenance costs. The vehicle operating-cost saving that results from the improvement in riding quality of upgraded roads, is a further benefit. This saving has, however, only been included in the economic analysis as the data available is in economic prices. In addition to this, the original study on the total development programme did not include these vehicle operating-cost savings. Excluding these savings would therefore ensure that the financial results obtained in this study can be compared to those of the original study involving the total development programme. The models subtract the costs from the benefits in each year to yield a net benefit/cost.

TABLE 1A: BENEFITS AND COSTS IN FINANCIAL PRICES BEFORE FINANCING FOR THE AMATIKULU MODEL

		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
NPV (8%)	**Year**	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Period=20yrs	**Technical Info.**																					
	Estbl./Re-establ. (ha)		184	184	285	285	286			184	184	285	285	286			184	184	285	285	286	
	Ratoon mgt. area			184	368	653	938	1224	1224	1224	1224	1224	1224	1224	1224	1224	1224	1224	1224	1224	1224	1224
	Additional tonnage		0	7102	14205	25206	36207	47246	47246	44879	44879	43579	43579	43567	47246	47246	44879	44879	43579	43579	43567	47246
	Tons sucrose/ha/an		0	893	1787	3171	4555	5944	5944	5646	5646	5482	5482	5481	5944	5944	5646	5646	5482	5482	5481	5944
	Small Growers																					
27498753	Grower turnover		0	626938	1253877	2224950	3053713	3984803	3984803	3785126	3785128	3675525	3675525	3674439	3984803	3984803	3785128	3785128	3675525	3675525	3674439	3984803
2497652	Vat suppl.		0	54688	109377	194085	278792	363797	363797	345566	345568	335561	335561	335462	363797	363797	345568	345568	335561	335561	335462	363797
29996405	Gross income		0	681627	1363254	2419035	3332506	4348600	4348600	4130696	4130696	4011086	4011086	4009902	4348600	4348600	4130696	4130696	4011086	4011086	4009902	4348600
-8021811	Crop establ. (every 7yrs)		-800400	-800400	-1239750	-1239750	-1244100	0	0	-800400	-800400	-1239750	-1239750	-1244100	0	0	-800400	-800400	-1239750	-1239750	-1244100	0
-17554924	Yearly expenditure		0	-384382	-768764	-1364138	-1959512	-2556975	-2556975	-2428848	-2428848	-2358517	-2358517	-2357821	-2556975	-2556975	-2428848	-2428848	-2358517	-2358517	-2357821	-2556975
4419671	Net income		-800400	-503155	-645260	-184853	128893	1791625	1791625	901448	901448	412819	412819	407981	1791625	1791625	901448	901448	412819	412819	407981	1791625
-289712	Opportunity cost (rent)		-5520	-11040	-19590	-28140	-36720	-36720	-36720	-36720	-36720	-36720	-36720	-36720	-36720	-36720	-36720	-36720	-36720	-36720	-36720	-36720
4129959	Incremental income		-805920	-514195	-664850	-212993	92173	1754905	1754905	864728	864728	376099	376099	371261	1754905	1754905	864728	864728	376099	376099	371261	1754905
	Millers																					
4958639	Marginal milling profit		0	113525	227050	402890	578729	755186	755186	717345	717345	696573	696573	696367	755186	755186	128	717345	696573	696573	696367	755186
	Construction Cost																					
	Field to zone (km)		51 45	17.15																		
	Zone to mill (km)		10	5																		
	Field to zone (cost)		-3585036	-1195012																		
	Zone to mill (cost)		-780400	-390200																		
-5401134	Total const. cost		-4365436	-1585212																		
	Annual Traffic																					
	Annual Field-Zone traffic		19163	19737	20329	20939	21568	22215	22881	23567	24274	25003	25753	26525	27321	28141	28985	29855	30750	31673	32623	33602
	Annual Zone -Mill traffic		27375	28196	29042	29913	30811	31735	32687	33668	34678	35718	36790	37893	39030	40201	41407	42649	43929	45247	46604	48002
	Incremental Maintenance Cost																					
	Field to zone			-26051	-35511	-36311	-37135	-37983	-38857	-39757	-40684	-41639	-42622	-43635	-44679	-45754	-46861	-48001	-49175	-50385	-51631	-52914
	Zone to mill			-8705	-13373	-13698	-14034	-14379	-14735	-15101	-15478	-15867	-16267	-16680	-17104	-17542	-17992	-18456	-18934	-19427	-19934	-20456
-490343	Total maint./regravel			-34756	-48884	-50009	-51168	-52362	-53591	-54858	-56162	-57506	-58890	-60315	-61783	-63295	-64853	-66457	-68110	-69812	-71565	-73370
3197121	**Net Benefit/Cost**		-5171356	-2020638	-486684	139887	619735	2457729	2456500	1527215	1525911	1015166	1013782	1007313	2448308	2446796	800003	1515616	1004562	1002860	996064	2436721
	NPV		-5171356	-6520664	-6907010	-6804189	-6382408	-4833621	-3400277	-2575170	-1811835	-1341616	-906823	-506805	393433	1226472	1478666	1921060	2192562	2443527	2674327	3197121
	FOR CALCULATION OF ECONOMIC INVESTMENT CRITERIA ONLY:																					
	Vehicle Operating Cost Savings																					
4133203	Field-Zone Saving			287562	394918	406766	418969	431538	444484	457816	471553	485700	500271	515279	530737	546659	563059	579951	597349	615270	633728	652740
1265228	Zone-Mill Saving			78768	121696	125347	129108	132981	136970	141079	145312	149671	154161	158786	163550	168456	173510	178715	184076	189599	195287	201145
5398431	Total VOC saving			366330	516614	532113	548076	564518	581454	598898	616865	635371	654432	674065	694287	715115	736569	758666	781426	804868	829014	853885

Fin. NPV	3197121
Eco. NPV	8181728
Fin. BCR	1.54
Eco. BCR	2.91
Fin. IRR	12.71%
Eco. IRR	22.25%

Determine economic IRR by experimenting with discount rate to see which rate sets economic NPV equal to zero

Table 1B: The Amatikulu model assumptions

Discount Rate	8%	(Source: Central Economic Advisory Service, 1989)
Sucrose price/ton A pool	701.68	(Source: Mean of last 9 and projected 3 years' real prices)
Sucrose price/ton B pool	478.51	(Source: Mean of last 9 and projected 3 years' real prices)
Sucrose price/ton A:B mix	670.44	(Source: D. Rossler; 1994; 86% A Pool + 14% B Pool)

Millers	
Margin/ton (After liaison)	22.2
(Source: Wiseman, 1994)	
Effective tax rate	28%
Margin/ton (after tax)	15.98

Small growers	
Cane adoption %	100%
Yield (tons/ha/an)	38.6
Sucrose %	12.58%
Vat suppl. r/ton	7.7
Crop Establishment r/ha	-4350
Ratoon mgt./ton	-22
Inf.harv&trans/ton	-22.23
Tranship & hilo/ton	-8.89
Levies/ton	-1
Yearly exp./ton	-54.12
(Source:G. Wiseman, 1994)	
Opportunity cost (r/ha/an.)	-30
(Rent for grazing land)	
(Source: Lyne, 1994)	

Construction	
Field to zone cost/km	-69680
Zone to mill cost/km	-78040
V.A.T proportion of total cost	12.28%
(Source: P. McIntyre, 1994)	

Maintenance & Regraveling	
Maintenance and regraveling =	(1850+100*ADT)/BC
Where BC : for Tertiary Roads =	3.3
for Local access Roads =	4.3
(Source: Dept of Transport, 1994)	

For Amatikulu the incremental cost would not be the full maintenance cost as these roads would have been maintained in the future any way, albeit not at the same level. The roads would have been maintained at what Dept of Transport (1993) refers to as a "danger funding level". This funding level amounts to approximately 70% of the needs". The Incremental Cost to Amatikulu therefore equals 30% of the requirements.

Traffic Data	
Traffic growth rate/annum	3%
Field to Zone ADT (halved)	52.5
Zone to Mill ADT (halved)	75
(Source: Traffic count, P. McIntyre, 1994)	

Vehicle Operating-cost Data

Operating-costs/1000 veh. km (Rolling terrain)

	Road Roughness		
	140 QI	100 QI	Saving/km
Car	1201.87	922.12	0.28
Bus	2357.12	2129.16	0.23
Lt truck	2568.47	2278.24	0.29
Hvy truck	3070.99	2722.76	0.35

(Source: Schutte, et al. , 1989; inflated to '94 prices)

Traffic split (Field-Zone)		Traffic split (Zone-Mill)	
	%		%
Car	95.00%	Car	70.00%
Bus	0.00%	Bus	15.00%
Lt truck	0.00%	Lt truck	5.00%
Hvy truck	5.00%	Hvy truck	10.00%
Total	100.00%	Total	100%

(Source: Traffic count, P. McIntyre, 1994)

TABLE 2A: BENEFITS AND COSTS IN FINANCIAL PRICES BEFORE FINANCING FOR THE CABHANE MODEL

		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
NPV @ 8%	Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Technical info.																				
	Estbl./Re-establ.		500	300	300	87							500	300	300	87					
	Ratoon mgt. area		0	500	800	1100	1187	1187	1187	1187	1187	1187	1187	1187	1187	1187	1187	1187	1187	1187	1187
	Additional tonnage	0	0	20000	32000	44000	47480	47480	47480	47480	47480	47480	40813	43480	43480	46320	47480	47480	47480	47480	47480
	Tons sucrose/ha/an	0	0	2500	4000	5500	5935	5935	5935	5935	5935	5935	5102	5435	5435	5790	5935	5935	5935	5935	5935
	Small Growers																				
28654887.4	Grower turnover	0	0	1754200	2806720	3687399	3979039	3979039	3979039	3979039	3979039	3979039	3420342	3643821	3643821	3881826	3979039	3979039	3979039	3979039	3979039
2741119.64	Vat suppl.	0	0	161200	257920	354640	382689	382689	382689	382689	382689	382689	328955	350449	350449	373339	382689	382689	382689	382689	382689
31396007	Gross income	0	0	1915400	3064640	4042039	4361728	4361728	4361728	4361728	4361728	4361728	3749297	3994270	3994270	4255165	4361728	4361728	4361728	4361728	4361728
-6024616.8	Crop establishment	0	-2175000	-1305000	-1305000	-378450	0	0	0	0	0	0	-2175000	-1305000	-1305000	-378450	0	0	0	0	0
-19432702	Yearly Expenditure	0	0	-1142800	-1828480	-2514160	-2713007	-2713007	-2713007	-2713007	-2713007	-2713007	-2332074	-2484447	-2484447	-2646725	-2713007	-2713007	-2713007	-2713007	-2713007
5938688.47	Net income	0	-2175000	-532400	-68840	1149429	1648720	1648720	1648720	1648720	1648720	1648720	-757776	204822	204822	1229990	1648720	1648720	1648720	1648720	1648720
-287847.43	Opportunity cost	0	-15000	-24000	-33000	-35610	-35610	-35610	-35610	-35610	-35610	-35610	-35610	-35610	-35610	-35610	-35610	-35610	-35610	-35610	-35610
5650841.04	Incremental income	0	-2190000	-556400	-101840	1113819	1613110	1613110	1613110	1613110	1613110	1613110	-793386	169212	169212	1194380	1613110	1613110	1613110	1613110	1613110
	Millers																				
7345928.57	Marginal milling profit	0	0	432000	691200	950400	1025568	1025568	1025568	1025568	1025568	1025568	881568	939168	939168	1000512	1025568	1025568	1025568	1025568	1025568
	Construction																				
	Hilo (Zone-Mill) (km)	25	0																		
	Infield Infrastructure (km)	468.3	156.1																		
	Hilo (Zone-Mill) (cost)	-1957975	0																		
	Infield Infrast. (cost)	-2680259	-893419.62																		
-5060624.3	Total construction cost	-4638234	-893419.62																		
	Annual Traffic																				
	Hilo (Zone-Mill) traffic	9125	9399	9681	9971	10270	10578	10896	11223	11559	11906	12263	12631	13010	13400	13802	14216	14643	15082	15535	16001
	Maintenance Cost																				
	Hilo (Zone-Mill)		-33523	-34108	-34711	-35332	-35971	-36630	-37308	-38007	-38727	-39468	-40232	-41018	-41828	-14077	-43522	-44407	-45319	-46258	-47225
-330086	Total maint.		-33523	-34108	-34711	-35332	-35971	-36630	-37308	-38007	-38727	-39468	-40232	-41018	-41828	-14077	-43522	-44407	-45319	-46258	-47225
7606058.87	**Net benefit/cost**	-4638234	-3116942.3	-158508	554649	2028887	2602707	2602049	2601370	2600671	2599952	2599210	47950	1067362	1066552	2180815	2595156	2594271	2593359	2592420	2591453
	NPV	-4638234	-6966936.6	-7092765	-6685082	-5304255	-3664108	-2145837	-740398	560585	1764866	2879623	2898664	3291131	3654251	4341734	5099236	5800387	6449372	7050067	7606059
	FOR CALCULATION OF ECONOMIC INVESTMENT CRITERIA ONLY:																				
	Vehicle Operating Cost Savings																				
743888	Hilo (Zone-Mill) Saving		67661	69691	71782	73935	76153	78438	80791	83215	85711	88283	90931	93659	96469	99363	102344	105414	108577	111834	115189
743888	Total VOC saving		67661	69691	71782	73935	76153	78438	80791	83215	85711	88283	90931	93659	96469	99363	102344	105414	108577	111834	115189

Fin. NPV	7606059
Eco. NPV	7913109
Fin. BCR	2.41
Eco. BCR	3.07
Fin. IRR	18.33%
Eco. IRR	21.25%

Determine economic IRR by experimenting with discount rate to see which rate sets economic NPV equal to zero

Table 2B: The Cabhane model assumptions

Discount Rate	8.00%	(Source: Central Economic Advisory Service, 1989)
Sucrose price/ton A pool	701.68	(Source: Mean of last 9 and projected 3 years' real prices)
Sucrose price/ton B pool	478.51	(Source: Mean of last 9 and projected 3 years' real prices)
Sucrose price/ton A:B mix	670.44	(Source: D. Rossler,1994; 86% A Pool + 14% B Pool)

Millers		**Construction**	
Margin/ton (After Liaison)	30	Zone to mill (r/km)	-78319
(Source: A. Domleo, 1994)		Infield (r/km)	-5723
Effective tax rate	28%	V.A.T proportion of total cost	12.28%
(Source: Moolman, 1994)		(Source: V. Bonner, 1994)	
Margin/ton (after tax)	21.6		
Small growers		**Maintenance & Regraveling**	
Cane Adoption %	100.00 %	Maintenance and regraveling =	(1850+100*ADT)/BCR
Yield (tons/ha/an)	40	Where BCR : for Tertiary Roads =	3.3
Sucrose %	0.125	for Local access Roads =	4.3
Vat suppl. r/ton	8.06	(Source: Dept of Transport, 1994)	
Crop Establishment	-4350	**Traffic Data**	
		Traffic growth rate per annum	3.00%
Ratoon mgt./ton	-17.16	(Source: Henwood, 1994)	
Inf.harv&trans/ton	-18	Zone to mill ADT (halved)	25
Tranship & hilo/ton	-21.37	(Source: Domleo, 1994)	
Levies+chains/ton	-0.61		
Yearly exp./ton	-57.14		
(Source: A. Domleo, 1994)			
Opportunity cost (r/ha)	-30		
(Rent for grazing land)(Lyne, 1994)			

Vehicle Operating-cost Data

Operating-costs/1000 veh. km (Rolling terrain)					
	Road Roughness			Traffic split (Zone to mill)	
	140 QI	100 QI	Saving/km		%
Car	1201.87	922.12	0.28	Car	75.00%
Bus	2357.12	2129.16	0.23	Bus	5.00%
Lt truck	2568.47	2278.24	0.29	Lt truck	5.00%
Hvy truck	3070.99	2722.76	0.35	Hvy truck	15.00%
(Source: Schutte, et al. , 1989; inflated to '94 prices)				Total	100.00%

TABLE 3A: BENEFITS AND COSTS IN FINANCIAL PRICES BEFORE FINANCING FOR THE KWA-HLONGWA MODEL

NPV @ 8%			1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
	Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Technical info.																					
	Estbl./Re-establ.						213	300	229								213	300	229			
	Ratoon mgt. area							213	513	742	742	742	742	742	742	742	742	742	742	742	742	742
	Additional tonnage		0	0	0	0	0	8520	20520	29680	29680	29680	29680	29680	29680	29680	26840	25680	26627	29680	29680	29680
	Tons sucrose/ha/an		0	0	0	0	0	1065	2565	3710	3710	3710	3710	3710	3710	3710	3355	3210	3328	3710	3710	3710
	Small Growers																					
12682285	Grower turnover		0	0	0	0	0	714015	1719669	2487318	2487318	2487318	2487316	2487318	2487318	2487318	2249313	2152100	2231435	2487318	2487318	2487318
1219734	Vat suppl.		0	0	0	0	0	68671	165391	239221	239221	239221	239221	239221	239221	239221	216330	206981	214611	239221	239221	239221
13902019	Gross income		0	0	0	0	0	782686	1885060	2726539	2726539	2726539	2726539	2726539	2726539	2726539	2465644	2359081	2446046	2726539	2726539	2726539
-2976442	Crop establishment cost		0	0	0	0	-926550	-1305000	-996150	0	0	0	0	0	0	0	-926550	-1305000	-996150	0	0	0
-8943706	Yearly Expenditure		0	0	0	0	0	-503532	-1212732	-1754088	-1754088	-1754088	-1754088	-1754088	-1754088	-1754088	-1586244	-1517688	-1573636	-1754088	-1754088	-1754088
1981871	Net income		0	0	0	0	-926550	-1025846	-323822	972451	972451	972451	972451	972451	972451	972451	-47150	-463607	-123740	972451	972451	972451
-129694	Opportunity cost/rent			0	0	0	-6390	-15390	-22260	-22260	-22260	-22260	-22260	-22260	-22260	-22260	-22260	-22260	-22260	-22260	-22260	-22260
1852177	Incremental income		0	0	0	0	-932940	-1041236	-346082	950191	950191	950191	950191	950191	950191	950191	-69410	-485867	-146000	950191	950191	950191
	Millers																					
3268766	Marginal milling profit		0	0	0	0	0	184032	443232	641088	641088	641088	641088	641088	641088	641088	579744	554688	575136	641088	641088	641088
	Construction (km)																					
	Terrace		25	75	32																	
	Waterway		5	43.4	18.6																	
	Valleybot.		10	51.8	22.2																	
	Diagonal		3	17.5	7.5																	
	Crest (Field-Zone)		3	16.8	7.2																	
	Access			2.6	1.2																	
	Hilo (Zone-Mill)			11																		
	Loading zone			4.2	1.8																	
	River crossing			3.5	1.5																	
	Construction cost (R)																					
-3975793	Total const. cost		-929125	-2601549.4	-1114950																	
	Traffic (veh./km/an.)																					
	Hilo (Zone-Mill) Traffic		2738	2820	2904	2991	3081	3174	3269	3367	3468	3572	3679	3789	3903	4020	4141	4265	4393	4525	4660	4800
	Crest (Field-Zone) Traffic		2738	2820	2904	2991	3081	3174	3269	3367	3468	3572	3679	3789	3903	4020	4141	4265	4393	4525	4660	4800
	Maintenance																					
	Hilo (Zone-Mill)		0	-8742	-8819	-8898	-8980	-9065	-9152	-9241	-9334	-9429	-9526	-9627	-9731	-9838	-6200	-10062	-10176	-10299	-10423	-10550
	Crest (Field-Zonel)		-1814	-12076	-16612	-16762	-16917	-17076	-17239	-17408	-17582	-17761	-17945	-18135	-18331	-18532	-11680	-18953	-19173	-19400	-19634	-19874
-234277	Total Maint. Cost		-1814	-20817	-25431	-25661	-25897	-26141	-26391	-26649	-26915	-27189	-27472	-27762	-28062	-28370	-17679	-29015	-29352	-29699	-30056	-30425
910673	**Net benefit/cost**		-930939	-2622366.6	-1140381	-25661	-958837	-883345	70759	1564630	1564364	1564090	1563807	1563517	1563217	1562909	492454	39806	399764	1561580	1561223	1560855
	NPV		-930939	-3110237.2	-4015508	-4034370	-4686938	-5243595	-5202308	-4356987	-3574416	-2849940	-2179250	-1558356	-983564	-451454	-296212	-284593	-176544	214240	575994	910873
	FOR CALCULATION OF ECONOMIC INVESTMENT CRITERIA ONLY:																					
	Vehicle Operating Cost Savings																					
	Hilo (Zone-Mill)			0	4477	4611	4750	4892	5039	5190	5346	5506	5671	5841	6017	6197	6383	6574	6772	6975	7184	7400
	Crest (Field-Zone)			1185	8058	11318	11658	12008	12368	12739	13121	13515	13920	14338	14766	15211	15667	16137	16621	17120	17634	18163
150898	Total VOC Saving			1185	12535	15930	16407	16900	17407	17929	18467	19021	19591	20179	20765	21406	22050	22712	23393	24095	24818	25562

Fin. NPV	910673
Eco. NPV	1913345
Fin. BCR	1.22
Eco. BCR	1.72
Fin. IRR	9.85%
Eco. IRR	13.35%

Determine economic IRR by experimenting with discount rate to see which rate sets economic NPV equal to zero

Table 3B: The Kwa-Hlongwa model assumptions

Discount Rate	8.00%	(Source: Central Economic Advisory Service, 1989)
Sucrose price/ton A pool	701.68	(Source: Mean of last 9 and projected 3 years' real prices)
Sucrose price/ton B pool	478.51	(Source: Mean of last 9 and projected 3 years' real prices)
Sucrose price/ton A:B mix	670.44	(Source: D. Rossler, 1994; 86% A Pool + 14% B Pool)

Millers	
Margin/ton (After Liaison)	30
(Source: A. Domleo, 1994)	
Effective tax rate	28%
(Source: Moolman, 1994)	
Margin/ton (after tax)	21.6

Small growers	
Cane Adoption %	100.00 %
Yield (tons/ha/an)	40
Sucrose %	0.125
Vat suppl. r/ton	8.06
Crop Establishment	-4350
Ratoon mgt./ton	-17.16
Inf.harv&trans/ton	-18
Tranship & hilo/ton	-23.33
Levies+chains/ton	-0.61
Yearly exp./ton	-59.1
(Source: A. Domleo, 1994)	
Opportunity cost (r/ha)	-30
(Rent for grazing land)	

Construction Cost	
Total; 100%	-4645624
1994; 20%	-929125
1995; 56%	-2601549
1996; 24%	-1114950
V.A.T proportion of total cost	4.00%
(Source: H. Izzett, 1994)	

Maintenance & Regraveling	
Maintenance and regraveling =	(1850+100*ADT)/BCR
Where BCR : for Tertiary Roads =	3.3
for Local access Roads =	4.3
(Source: Dept of Transport, 1994)	

Traffic Data	
Traffic growth rate per annum	3.00%
(Source: Henwood, 1994)	
Field to Zone Road ADT (halved)	7.5
Zone to mill ADT (halved)	7.5
(Source: H. Izzett, 1994)	

Vehicle Operating-cost Data

Operating-costs/1000 veh. km (Rolling terrain)

	Road Roughness		
	140 QI	100 QI	Saving/km
Car	1201.87	922.12	0.28
Bus	2357.12	2129.16	0.23
Lt truck	2568.47	2278.24	0.29
Hvy truck	3070.99	2722.76	0.35

(Source: Schutte, et al. , 1989; inflated to '94 prices)

Traffic split (Zone-mill)	%	Traffic split (Field-Zone)	%
Car	95.00%	Car	95.00%
Bus	0.00%	Bus	0.00%
Lt truck	5.00%	Lt truck	5.00%
Hvy truck	0.00%	Hvy truck	0.00%
Total	100.00%	Total	100.00%

The following explanations refer to the models included in Tables 1A, 2A and 3A:

4.1.1 Expansion area

The mills have provided estimates on the areas of cane that are likely to come into production as a result of Phase I road construction/upgrading (they were asked to differentiate this area from possible expansion that would solely result from the new deregulation policies within the sugar sector). The mills have also provided information on the rate at which the development will take place and the number of years after which the sugar cane will have to be replanted. The figure provided by the Amatikulu mill totals 1224 ha (Table 1A), this development has been spread over a conservative 5 year period with a replanting cycle of 7 years (Wiseman, 1994). The figures provided by the Sezela mill for Cabhane and Kwa-Hlongwa respectively, based on 60% availability of area suitable for cane are: 1187 ha (Table 2A) and 742 ha (Table 3A). The Sezela mill expects to develop 500 ha of cane per annum, a conservative figure of 300 ha per annum has, however, been used in this analysis. The Sezela Mill will only develop the Kwa-Hlongwa area once the establishment at Cabhane has been completed. This will result in the commencing of cane establishment at Kwa-Hlongwa as late as 1998 (Table 3A) if cane is established at a rate of 300 ha per annum. A ten year replanting cycle has been used in the Sezela mill area (Domleo, 1994).

4.1.2 Ratoon management area

This is the cumulative area under cane resulting from the implementation of the project.

4.1.3 Additional tonnage

The additional tonnage, in each year, has been calculated by multiplying the ratoon management area (ha) by the expected yield (tons/ha). The production of cane to be replanted in the cycle falls to 2/3 in the years of replant (Frean, 1992). The yield used for the Amatikulu mill area is 38.6 tons/ha/annum (Table 1B) while the yield used for the Sezela mill area is 40 tons/ha/annum (Tables 2B and 3B). It could be argued that the yield of 40 tons/ha/annum is higher than that expected for small growers in the Sezela area. The Sezela Mill, however, aims to be actively involved in the development and management of the small grower crop, enabling this higher yield to be obtained (Domleo, 1994). Cohcrane (1994) contends that 40 tons/ha/annum would be a conservative yield for the Cabhane and Kwa-Hlongwa projects. The sensitivity to changes in yield is investigated in Chapter 6.

4.1.4 Tons sucrose/ha/annum

The tons sucrose/ha/annum has been calculated by multiplying the additional tonnage (tons) of sugar cane by the sucrose percentage provided by the mills.

4.1.5 Grower turnover (financial)

The small growers' turnover has been calculated by multiplying the cane tonnage in any one year (additional tonnage) by the sucrose price attributable to small growers. The small growers will receive the A pool price until 1 April 1998 and a blend between the

A and B Pool prices thereafter. The A:B Pool blend price used is the following: 86% A Pool and 14% B Pool (Rossler, 1994). The A and B Pool prices used are the means of the last 9 years' and the projected next 3 years' inflation adjusted prices (*i.e.* a 12 year period). The price data for the last 9 years were obtained from McGrath (1994) and adjusted for inflation using the CPI (Consumer Price Index) using 1994 as a base. The projected prices for the next 3 years were obtained from Bremner-Stokes (1994) and reduced to 1994 prices by using the inflation rates assumed. The mean A Pool price was calculated at R701.68/ton of sucrose, while the current (1994) A Pool sucrose price is around R830/ton. The relatively high 1994 price has resulted from depressed sugar production caused by the drought (Chadwick, 1994). The mean B Pool sucrose calculated was R478.51/ton, while the current (1994) price is higher, at around R640/ton.

4.1.6 V.A.T. supplementary payback (financial)

Small growers receive a V.A.T. payback for V.A.T. paid on their input costs. The total payback is calculated by multiplying additional tonnage by the V.A.T. supplementary payback figure (R/ton) provided by the mills.

4.1.7 Crop establishment cost

The cost of establishing the crop has been calculated by multiplying the area developed in a particular year (including the area replanted in the cycle) by a development rate (R/ha) provided by the mills.

4.1.8 Small grower yearly expenditure

This figure has been calculated by adding the expenditures per ton (provided by the mills) for ratoon management; infield harvesting and transporting; transhipment and hilo and levies (see assumptions in Tables 1B, 2B and 3B). The sum of the expenditures is multiplied by the additional tonnage in a particular year to yield a small grower (total) yearly expenditure.

4.1.9 Opportunity cost of land to be put to cane production

"The opportunity cost of land is the net value of production forgone when the use of the land is changed from its without-project use to its with-project use (Gittenger, 1982:256)". The KwaZulu Cane Growers' Support Programme Report (1992) contends that sugar cane has substituted for grazing land rather than cropping land. The opportunity cost of the land planted to sugar cane will therefore be the rent that grazing land could have realised, this rent is between R20-R30/ha (Lyne, 1994). A figure of R30/ha has been used in this study to account for the possible substitution of cane for other crops. The opportunity cost in each year is therefore calculated by multiplying the area under cane by R30/ha.

4.1.10 Small grower incremental income (financial)

Small grower incremental income is calculated by summing: grower turnover, V.A.T. supplementary payback, crop establishment cost, yearly expenditure and opportunity cost.

This is a measure of the value of the additional amount of sugar cane to small growers that they will produce as a result of the project (in financial prices, before financing).

4.1.11 Marginal milling profit (financial)

This margin provided by the mills, indicates the contribution to millers' profit after small grower liaison cost (see assumptions in Tables 1B, 2B and 3 B). After consultation with Moolman (1994) an effective tax rate of 28% has been subtracted from this margin to provide the after tax margin. The marginal milling profit (on small grower cane) in each year is calculated by multiplying the additional tonnage by the marginal milling profit after tax and liaison cost (R/ton).

4.1.12 Construction cost (financial)

The consulting engineers involved with the different projects have provided information on the total construction/upgrading costs for each year of Phase I of the project.

4.1.13 Traffic

Schutte, *et al.* (1989) contend that existing and future traffic play an important role in the economic justification of road development projects. The expected traffic growth rate in the Kwa-Zulu/Natal region is 3% per annum (Henwood, 1994). This traffic growth rate has been applied to the existing traffic for calculating the traffic over the analysis period. Traffic plays a role in the calculation of both road maintenance and regraveling costs and vehicle operating-cost savings. After consultation with Jurgens (1994), it was decided that existing traffic figures would be halved on the assumption that, on average, the traffic measured at a point on the road would only travel half the full length of the road.

4.1.14 Road maintenance cost (financial)

The Department of Transport (1994) uses the following formula for the allocation of maintenance and regraveling funds for gravel roads:

$$(1850 + 100 \times \text{Average Daily Traffic}) \div \text{BCR}$$

Where BCR = 2.3 for secondary roads
3.3 for tertiary roads
4.3 for local access roads

This formula is used to calculate the Maintenance and Regraveling costs for the purpose of this analysis. The BCR for tertiary roads is used for Zone to Mill roads and the BCR for local access roads is used for Field to Zone roads.

4.1.15 Net benefit/cost (financial)

Small grower incremental income, marginal milling profit, construction cost, and maintenance cost are summed to yield a net benefit or cost in each year.

These benefits and costs are valued at market/financial prices (before financing) and are discounted to yield a total financial NPV, IRR and BCR per project to all resources engaged. NPVs are also calculated to determine the contribution to resources engaged by the different "players" involved in a particular project (*i.e.* the small grower, miller, construction and maintenance sectors).

4.2 Economic analysis

By changing the financial prices to economic values and omitting the transfer payments in the financial models included in Tables 1A, 2A and 3A, the incremental net benefit in economic terms can be arrived at.

The models allow for shadow price assessments (included in Tables 4, 5 and 6) where the NPVs of the different sectors are multiplied by shadow factors converting market/financial prices to economic/shadow prices that reflect true opportunity costs and correct for transfer payments. In this way economic NPVs can be calculated for the different sectors and a total NPV can be arrived at. From these NPVs an economic BCR and IRR can, in turn, be calculated. The effect of the project on the total economy can thus be seen.

Table 4: Amatikulu model shadow price assessment

	Mkt Price NPV (R)	Shadow Price Adjustment	Value of Adjustment	Shadow Price NPV (R)	Shadow Price Factor Source:
Small Growers					
Grower turnover	27 498 753	0.71	(7 972 774)	19 525 979	See sucrose price factor calculation
V.A.T. supplementary	2 497 652	1	0	2 497 652	Transfer payment correction
Gross income	29 996 405				
Crop establishment	(8 021 811)	0.8	1 604 362	(6 417 448)	Factor for Agric.: Bradfield 1993
Yearly expenditure	(17 554 924)	0.8	3 510 985	(14 043 939)	Factor for Agric.: Bradfield 1993
Net income	4 419 671				
Opportunity cost (rent)	(289 712)	0.8	57 942	(231 770)	Factor for Agric.: Bradfield 1993
Incremental Income	4 129 959	0.332	(2 799 485)	1 330 474	Shadow Price NPV/Mkt Price NPV
Millers					
Marginal milling profit	4 958 639	1.157	778 231	5 736 870	See milling profit factor calculation
Construction Cost					
Total const. cost	(5 401 134)	0.727	1 473 645	(3 927 489)	See Construction Cost Table
Incremental Maintenance Cost					
Total maint./upgrade	(490 343)	0.727	133 785	(356 558)	Same factor as for construction cost
Transport Savings				5 398 431	Data from Schutte et al. = economic
Net Benefit/Cost	3 197 121	2.559	4 984 607	8 181 728	Shadow Price NPV/Mkt Price NPV

Table 5: Cabhane model shadow price assessment

	Mkt Price NPV	Shadow Price Adjustment	Value of Adjustment	Shadow Price NPV	Shadow Price Factor Source:
Small Growers					
Grower turnover	28 654 887	0.71	(8 312 872)	20 342 016	See sucrose price factor calculation
V.A.T.supplementary	2 741 120	1	0	2 741 140	Transfer payment correction
Gross income	31 396 007				
Crop establishment	(6 024 617)	0.8	1 204 923	(4 819 693)	Factor for Agric.: Bradfield 1993
Yearly Expenditure	(19 432 702)	0.8	3 886 540	(15 546 161)	Factor for Agric.: Bradfield 1993
Net income	5 938 688				
Opportunity cost	(287 847)	0.8	57 569	(230 278)	Factor for Agric.: Bradfield 1993
Incremental income	5 650 841	0.44	(3 163 839)	2 487 002	Shadow Price NPV/Mkt Price NPV
Millers					
Marginal milling profit	7 345 929	1.157	(1 152 903)	8 498 831	See milling profit factor calculation
Construction					
Zone-Mill (cost)	(18 12 940)	0.736	478 980	(1 333 959)	See Zone-mill roads Constr. Cost
Infield Infrst.(cost)	(3 247 684)	0.692	998 732	(2 248 952)	See Infield Infrastructure Cost
Total const. cost	(5 060 624)	0.708	1 477 712	(3 582 912)	Shadow Price NPV/Mkt Price NPV
Maintenance Cost					
Total maint./upgrade	(330 086)	0.708	96 386	(233 701)	Same factor as for construction cost
Vehicle Operating Cost Savings					
Total VOC saving				743 888	Data from Schutte et al. = economic
Net benefit/cost	7 606 059	1.04	307 050	7 913 109	Shadow Price NPV/Mkt Price NPV

Table 6: Kwa-Hlongwa model shadow price assessment

	Mkt Price NPV	Shadow Price Adjustment	Value of Adjustment	Shadow Price NPV	Shadow Price Factor Source:
Small Growers					
Grower turnover	12 682 285	0.714	(3 630 566)	9 051 719	See sucrose price factor calculation
V.A.T. supplementary	1 219 734	1	0	1 219 734	Transfer payment correction
Crop establishment cost	(2 976 442)	0.8	595 288	(2 381 154)	Factor for Agric.: Bradfield 1993
Yearly Expenditure	(8 943 706)	0.8	1 788 741	(7 154 965)	Factor for Agric.: Bradfield 1993
Gross income	13 902 019				
Net income	1 981 871				
Opportunity cost/rent	(129 694)	0.8	25 939	(103 755)	Factor for Agric.: Bradfield 1993
Incremental income	1 852 177	0.341	(1 220 597)	631 579	Shadow Price NPV/Mkt Price NPV
Millers					
Marginal milling profit	3 268 766	1.157	513 015	3 781 720	See milling profit factor calculation
Construction (km)					
Total const. cost	(3 975 793)	0.63	1 472 395	(2 503 398)	See Construction Cost Table
Maintenance					
Total Maint. Cost	(234 277)	0.63	86 762	(147 515)	Same factor as for construction cost
Vehicle Operating Cost Savings					
Total VOC Saving				150 898	Data from Schutte et al. = economic
Net benefit/cost	910 873	2.101	10 024 73	1 913 345	Shadow Price NPV/Mkt Price NPV

The following explanations refer to the Shadow Price Assessments included in Tables 4, 5 and 6:

4.2.1 Grower turnover (economic)

The financial NPV of Grower Turnover has been calculated by multiplying the additional tons of sucrose produced, by the sucrose price attributable to small growers (Tables 1A, 2A and 3A). This price is the A Pool price until 1998 and a blend between the A and B Pool prices thereafter. The value of additional sugar to the economy is what South Africa receives for its sugar on the world market. From an economic view point, sucrose should be priced at the B Pool sucrose price (which depends on the world price). The financial NPV is therefore multiplied by a factor which converts the financial NPV to an economic NPV which values sucrose at the B Pool price (see the calculation of the sucrose price shadow factor for the different models in Appendix 1).

4.2.2 V.A.T. supplementary payback (economic)

A shadow factor of 1 is used to include the value of the payback in the economic assessment. Including the payback in the model corrects for the original transfer payment made when V.A.T. is paid on the purchasing of inputs by small growers.

4.2.3 Crop establishment, yearly expenditure, and opportunity cost

The financial values of these costs have been multiplied by a figure of 0.8 to correct for price distortions, 0.8 is the shadow price factor calculated for agriculture in South Africa by Bradfield (1993). V.A.T has not been excluded from the Crop Establishment and Yearly Expenditure figures, as the transfer has already been corrected for by means of the V.A.T supplementary payback included in the economic assessment (see 4.2.2).

4.2.4 Incremental income (economic)

Incremental income is the sum of Grower Turnover, V.A.T. supplementary payback, crop establishment cost, yearly expenditure and opportunity cost. The incremental income was calculated (by summation) for both the financial and economic analyses.

4.2.5 Marginal milling profit (economic)

The marginal milling profit needs to be adjusted for transfer payments and price distortions. The marginal milling profit needs to be converted from an after tax figure to a before tax figure, as tax is a transfer payment. This is done by multiplying the financial figure by the marginal milling profit before tax divided by the marginal milling profit after tax. The price distortions are corrected for by multiplying the marginal milling profit by the Sugar Factories Factor provided by Bradfield (1993) (See Marginal Milling Profit Shadow Factor Calculation for the different models in Appendix 1).

4.2.6 Construction cost (economic)

The financial construction costs in Tables 4, 5 and 6 are multiplied by a "shadow factor" figure that is calculated in Appendix 1, where the financial construction costs are split into the percentages that plant; gravel haul; unskilled labour; establishment and general; materials; diesel; petrol; professional fees; other costs; and V.A.T, contribute to total construction cost. These figures are multiplied by shadow factors, provided by Bradfield (1993), Department of Transport (1992) and used in the 1994 Vaal Augmentation Study as indicated by Mullins (1994). V.A.T. has been excluded by multiplying it by zero, this corrects for the transfer payment. The total "shadow factor" used in Tables 4, 5 and 6 is calculated by dividing the sum of the economic cost components by the sum of the financial cost components (See the Calculation of the Economic Construction Cost Shadow Factor for the different models in Appendix 1).

4.2.7 Road maintenance cost (economic)

The financial value of the road maintenance cost is multiplied by the same factor as calculated for construction cost (see 4.2.6).

4.2.8 Vehicle operating-cost savings

Vehicle-operating-cost savings are included in the economic analysis. The Amatikulu project mainly involves the upgrading of existing roads and vehicle operating-cost savings are expected to play a large role in the Amatikulu model. The Cabhane and Kwa-

Hlongwa projects mainly involve the construction of new roads, some of the new roads constructed do, however, replace existing track. It is for this reason that a vehicle operating-cost saving has also been calculated for these projects. Vehicle operating-costs can be calculated as a function of road roughness (as measured in QI) for different terrain types. Table 7 contains information on QI values for unpaved roads:

Table 7: QI values for unpaved roads

Riding Quality	QI range	Average QI
Excellent	< = 40	40
Good	40 - 100	70
Average	100 - 150	120
Bad	150 - 200	170
Unacceptable	> 200	NA

(Source: Schutte *et al.*, 1989)

The upgrading of roads will result in the improvement of riding quality and therefore, a saving in vehicle operating-costs. A <u>conservative</u> improvement in riding quality from 140 QI to 100 QI (improvement from the bottom of "average" riding quality's QI range to the top of "average" riding quality's QI range in Table 7) would yield the savings in Table 8. For example, in Table 8, a reduction in road roughness from 140 QI to 100 QI would reduce the vehicle operating-cost per 1000 vehicle kilometres for cars from R1 201.87 to R922.12. Subtracting R922.12 from R1 201.87 and dividing the result by 1000 would yield a saving of R0.28/km. The vehicle operating-cost savings calculated in Table 8 are used in this analysis.

Table 8: Vehicle operating-cost savings (rolling terrain)

Vehicle operating-costs (R) per 1000 veh. km			Savings:R/km
	Road Roughness		
	140 QI	100 QI	
Car	1201.87	922.12	0.28
Bus	2357.12	2129.16	0.23
Lt truck	2568.47	2278.24	0.29
Hvy truck	3070.99	2722.76	0.35

(Source: Adapted from Schutte *et al.*, 1989; inflated to 1994 prices)

The calculation of the NPV of the vehicle operating-cost savings are included at the bottom of the spreadsheet models included in Tables 1A, 2A and 3A. Vehicle operating-cost savings in each year are calculated by multiplying the saving (R/km) by the annual traffic, which is in turn, multiplied by the number of kilometres of upgraded road.

4.2.9 Net benefit/cost (economic)

The economic NPVs of small grower incremental income, marginal milling profit, construction cost, maintenance cost and vehicle operating-cost savings are summed to yield a net benefit or cost, which shows the contribution of the project to the economy as a whole.

CHAPTER 5.

COST-BENEFIT RESULTS OF THE AMATIKULU, CABHANE AND KWA-HLONGWA MODELS

5.1 Investment criteria results

Given the assumptions (included in Tables 1B, 2B and 3B) of the different models, the models yield the investment criteria results included in Tables 9 and 10. The models all assume a lifespan of 20 years and a discount rate of 8%. Table 9 includes economic results (reflecting the contribution to the total economy) while Table 10 includes financial results (reflecting the returns to all resources engaged before financing).

Table 9: Economic investment criteria results for the Amatikulu, Cabhane and Kwa-Hlongwa models

Investment Criteria	Amatikulu	Sezela	
		Cabhane	Kwa-Hlongwa
NPV	R8.18 million	R7.91 million	R1. 91 million
BCR	2.91	3.07	1.72
IRR	22.25%	21.25%	13.35%

For a project to be considered viable, the benefits of the project must outweigh the costs of the project, from the view point of the economy as a whole. Thus to be viable, the economic NPV must be greater or equal to zero, the economic BCR must exceed unity and the economic IRR must exceed the RRR (a figure of 8%, implied by the discount rate). The economic results for Amatikulu, Cabhane (Sezela) and Kwa-Hlongwa (Sezela) respectively are, NPVs: R8.18 million, R7.91 million and R1.91 million; BCRs: 2.91, 3.07 and 1.72 and IRRs: 22.25%, 21.25% and 13.35%. On this basis, the results reflecting the tangible costs and benefits, shown in Table 9, indicate that all the projects are viable.

The lower results obtained for the Kwa-Hlongwa project (as compared to results for the other two projects) cannot be attributed to the construction method (labour intensive) but to the timing of the cane development, which is proposed to take place only once the development at Cabhane has been completed, *i.e.* in 1998. The benefits have, therefore, been delayed until 1999, while the major costs are being accrued from 1994-1996. The results for the Kwa-Hlongwa model could be improved by ensuring earlier establishment of cane, this would require liaising with the relevant mill. In addition to this, the development at Cabhane could be completed earlier than 1998 if cane is developed at the expected rate of 500 ha/annum as opposed to the conservative rate of 300 ha/annum used.

Table 10: Financial investment criteria results for the Amatikulu, Cabhane and Kwa-Hlongwa models

Investment Criteria	Amatikulu	Sezela	
		Cabhane	Kwa-Hlongwa
NPV	R3.20 million	R7.61 million	R911 thousand
BCR	1.54	2.41	1.22
IRR	12.71%	18.33%	9.85%

The financial NPVs for Amatikulu, Cabhane (Sezela) and Kwa-Hlongwa (Sezela) respectively are R3.2 million, R7.61 million and R911 thousand (Table 10). The results included in Table 10 indicate that the returns to all resources engaged are positive (as measured in financial prices before financing).

The results reflecting the tangible costs and benefits, shown in Tables 9 and 10, therefore indicate that all projects are viable as measured in both financial prices (before financing) and economic prices (after shadow pricing and transfer payment correction).

The financial (reflecting the returns to resources engaged before financing) and economic (reflecting the contribution to the total economy) NPVs for the different sectors as well as the total NPVs for the different models are graphed in Figures 3, 4 and 5. The values were taken from the shadow price assessments (included in Tables 4, 5 and 6). The first bar of each sector shows the financial NPV (in millions of rands) while the second bar of each sector shows the economic NPV (in millions of rands). Vehicle operating-cost savings have only been included for the economic NPVs.

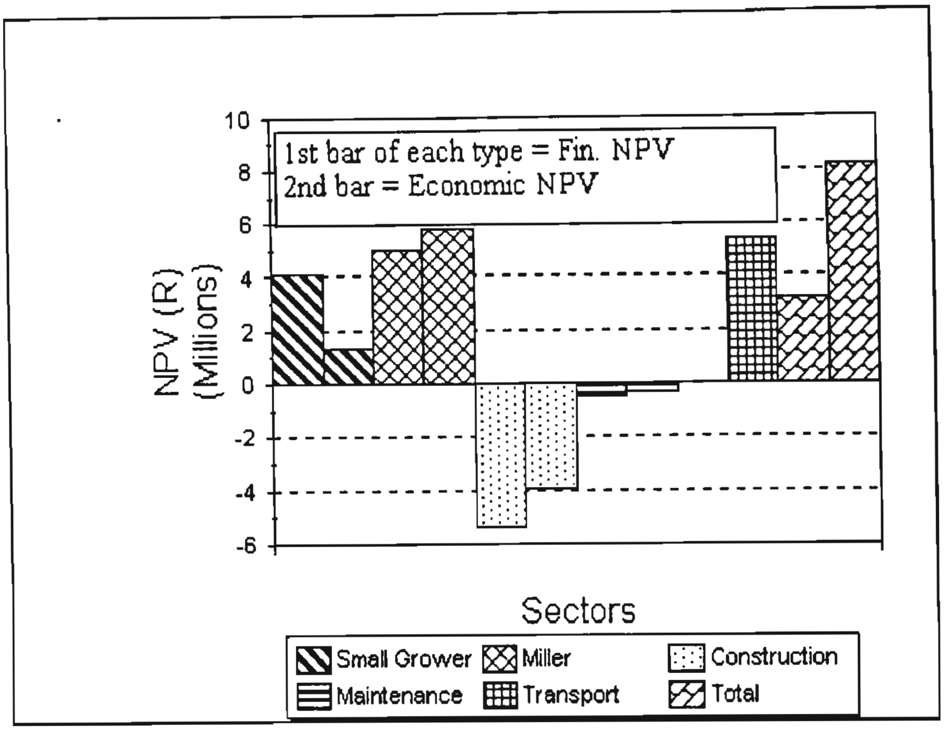

Figure 3: Financial and economic NPVs of the Amatikulu mill area

For the Amatikulu model (Figure 3) transport savings play a large role in contributing towards the economic NPV. The Amatikulu project involves the upgrading of existing roads as opposed to the construction of new roads, hence benefits are expected to result from vehicle operating-cost savings. Only miller and small grower benefits appear to play a large role in the Cabhane and Kwa-Hlongwa models (Figures 4 and 5). These projects are mainly involved with the construction of new roads, therefore, vehicle operating-cost savings are not expected to play a large role.

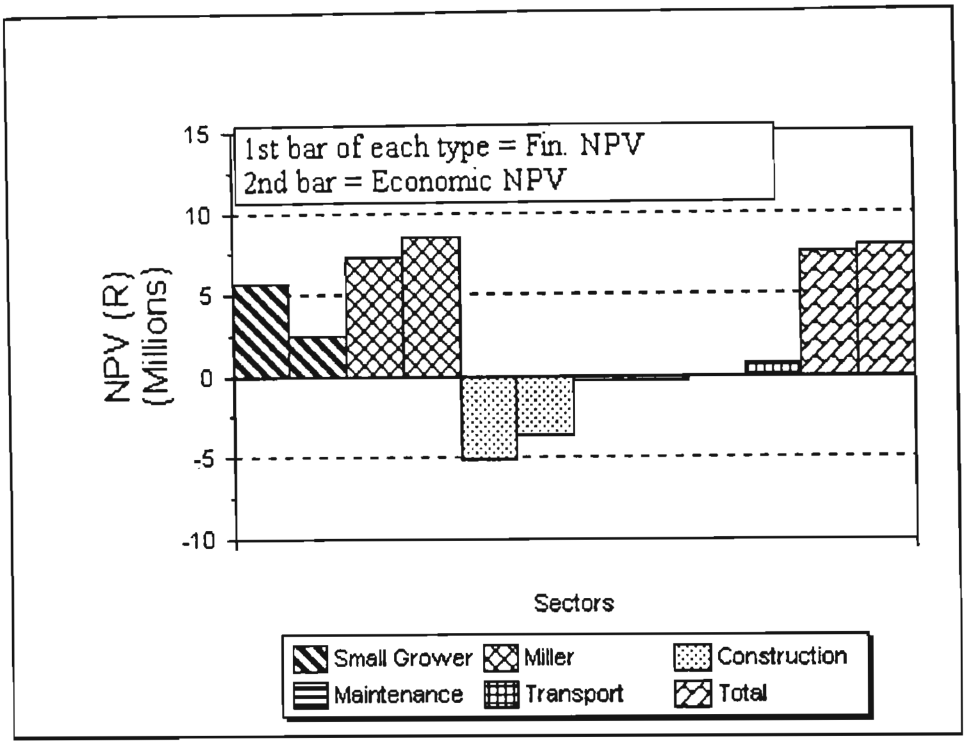

Figure 4: Financial and economic NPVs of the Cabhane Project (Sezela mill area)

For all the mill areas, small growers receive a higher return to resources engaged before financing (financial NPV) than they contribute to the economy (economic NPV). This is because they will receive the A pool price until 1998 and a blend between the A and B Pool prices thereafter, whereas, their contribution to the economy is measured in terms of the lower B pool price. The difference between the price that small growers receive and the B Pool price is therefore a transfer payment, this transfer payment appears to be quite large as there is a considerable difference between the small growers' financial and economic NPVs for all the projects.

Millers, on the other hand, contribute more to the economy than they receive for their resources engaged. This is largely due to the fact that they pay an income tax, which is a transfer payment (income tax being a cost to the miller but a benefit to the national economy). The different graphs illustrating the tangible costs and benefits indicate that, apart from the Amatikulu model where large transport benefits accrue to the community as a whole, millers are the major beneficiaries of the road development projects evaluated. There are, however, numerous intangible benefits that would accrue to the rural communities in the areas evaluated, these could not be accounted for in the results obtained. Intangible costs and benefits are discussed later in this section (5.1).

The Kwa-Hlongwa project, in contrast to those of Amatikulu and Cabhane is labour intensive and it therefore has a greater employment creation effect. However, it has not been possible to account for this intangible benefit in the results obtained. This consideration and that of the delayed cane development proposed for Kwa-Hlongwa needs to be taken into account when comparing the results obtained for Kwa-Hlongwa to those of the other projects.

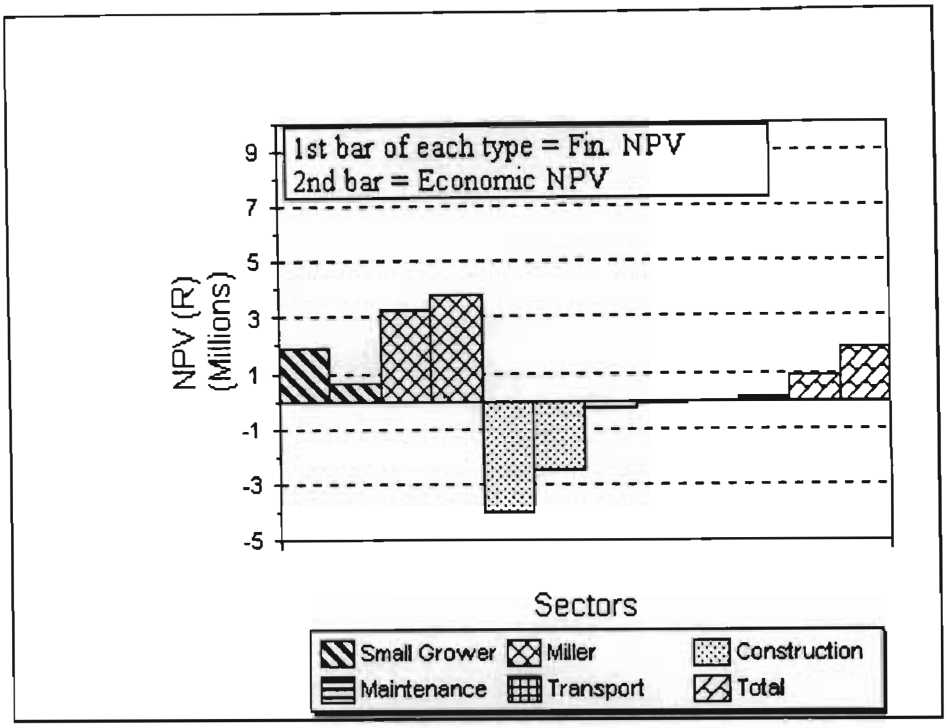

Figure 5: Financial and economic NPVs of the Kwa-Hlongwa project (Sezela mill area)

From Figures 3, 4 and 5 it is evident that if the transport savings are deducted from the total economic NPVs, the economic NPVs would still be positive for all projects. The results can therefore be considered viable purely on the basis of the expected increase in small grower cane production (*i.e.* independent of vehicle operating-cost savings). Sugar millers have played an integral role in the development of small grower cane in the past and they have indicated continued commitment. This involvement is necessary for the results projected in this study to materialize.

Intangible benefits and costs, which by definition cannot be included in the analysis, need to be identified (Schutte, *et al.*, 1989). An intangible cost specific to this project is its possible impact on the environment. Examples of intangible benefits specific to this project include the creation of job opportunities in the road construction, maintenance, cane production and small contractor sectors; travel time savings; accident cost savings; increased accessibility to: markets (with particular reference to perishables), schools (with impacts on education) and hospitals (with impacts on health) and an improvement in the general quality of rural life.

5.2 Results compared to those of the original (1992) appraisal

The proposed total sugar cane development programme involving 27 000 ha was appraised in 1992. On the basis of this appraisal the DBSA made a loan available for Phase I of the programme. This appraisal indicated a financial IRR of 17.38% and a financial NPV discounting at 6% per annum of R 16 000 000. The economic rate of return (ERR) was calculated as 13.30% and the economic benefit-cost ratio calculated at 6% was 1.32 (Tyndale-Biscoe, 1994).

The original (1992) appraisal of the proposed total sugar cane development programme stated that the economic results would increase further as a result of the inclusion of additional benefits derived for non-sugar traffic (Tyndale-Biscoe, 1994). The economic models in this (1994) study include additional benefits derived for non-sugar traffic in the form of vehicle operating-cost savings and in addition to this they account for the effects of shadow pricing. The economic results obtained for the Amatikulu, Cabhane and Kwa-Hlongwa models are, therefore, not comparable to those of the original (1992) appraisal as the original appraisal does not consider the effects of shadow pricing and vehicle operating-cost savings.

The financial results obtained in this (1994) study for the Amatikulu, Cabhane and Kwa-Hlongwa models exclude vehicle operating-cost savings. The financial IRRs for these models are compared with the financial IRR obtained in the original appraisal (see Table 11).

Table 11: Financial IRR results compared with those of the original appraisal

Original appraisal on total development programme (1992)	Amatikulu (1994)	Cabhane (1994)	Kwa-Hlongwa (1994)
17.38%	12.71%	18.33%	9.85%

From Table 11 it is evident that the result for the Cabhane project compares favourably with that of the original appraisal. The Amatikulu and Kwa-Hlongwa projects, however, indicate lower financial IRRs than that obtained for the original appraisal. The lower result obtained for the Kwa-Hlongwa project can be explained by the delay in cane development proposed (see 5.1). The lower financial result for Amatikulu could be attributed to the fact that this project only involves the upgrading of existing roads, while, the original appraisal on the total development programme considers projects that involve both the construction of new and the upgrading of existing roads. Projects incorporating the construction of new roads would be expected to show higher financial results than pure upgrading projects, as the they open up completely new areas to cane production. Vehicle operating-cost savings which are characteristic of pure road upgrading projects are not accounted for in the financial analyses of both the original (1992) appraisal and the projects evaluated in this (1994) appraisal and would therefore not affect the financial IRRs of these two appraisals.

CHAPTER 6.

A SENSITIVITY ANALYSIS OF THE EFFECT OF ALTERNATIVE ASSUMPTIONS ON INVESTMENT CRITERIA

In sensitivity analyses different values are attached to uncertain variables so the effect that variations in assumptions have on the investment criteria (NPV, IRR and BCR) can be demonstrated (Central Economic Advisory Service, 1989).

6.1 Sensitivity to changes in the construction of the models

As explained in Chapter 3 (Analysis Procedure) a given discount rate and analysis period needs to be assumed for the calculation of investment criteria results. The discount rate used was 8% (as suggested by the Central Economic Advisory Service, 1989) and the analysis period used was 20 years (as suggested by Schutte *et al.*, 1989). The following two figures illustrate the sensitivity to changes in these two variables.

Figure 6 illustrates the effect of different discount rates on the total economic NPV calculated for a period of 20 years. The economic NPV has been used as it reflects the contribution to the economy as a whole (the objective in cost-benefit analyses). The discount rate used in the main spreadsheet is 8%. According to the KwaZulu Cane Growers Support Programme Report (1992) the DBSA have indicated that agricultural development projects should yield a return in excess of 3% to be considered viable on a purely economic basis. Nieuwoudt (1994) suggests a rate of between 4% and 5% based on the ratio between observed rent and land value data. Raising the discount rate favours investments with benefits accruing over a relatively short period of time, decreasing the discount rate would favour investments with benefits accruing over a long period of time (Musgrave and Musgrave, 1973). A lower discount rate significantly increases the NPV of the projects in this study, as shown in Figure 6.

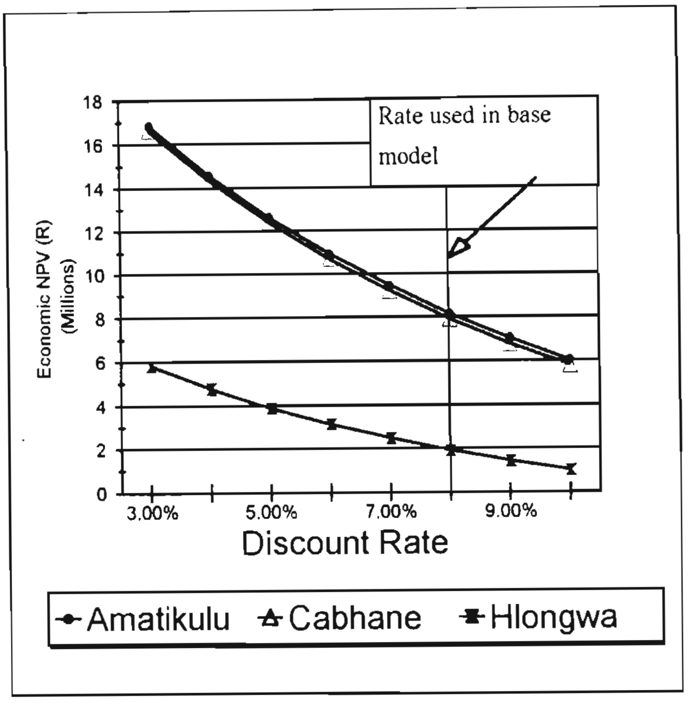

Figure 6: The effect of discount rate on economic NPV for the Amatikulu, Cabhane and Kwa-Hlongwa projects.

Indications are that NPV is positive for a wide range of discount rates for all projects, with the NPVs of the Amatikulu and Cabhane projects following each other closely. The NPVs decrease at a decreasing rate as the discount rate increases.

Fig. 7 shows the effect of project lifespan on <u>financial</u> NPV using a discount rate of 8% (the salvage values of the roads are ignored so that this effect can be demonstrated)(see

3.8). The financial NPVs had to be used as the model is constructed in such a way that the economic NPV can only be determined for a lifespan of 20 years. Indications are that the NPV (in financial prices) becomes positive after 9, 13 and 18 years for Cabhane, Amatikulu and Kwa-Hlongwa respectively.

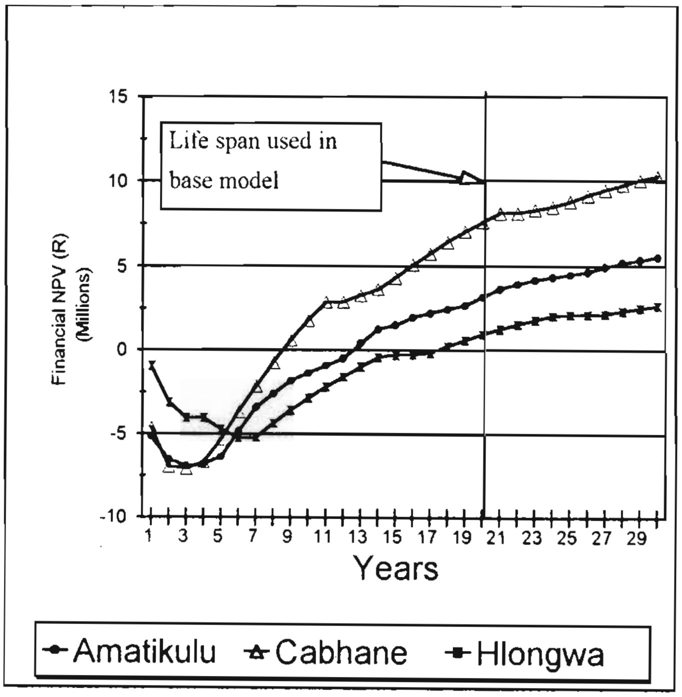

Figure 7: The effect of project life-span on financial NPV for the Amatikulu, Cabhane and Kwa-Hlongwa projects

Since the economic NPVs for the different projects are higher than the financial NPVs, it is expected that the economic NPVs will become positive after a shorter time period than indicated by the financial NPVs in Figure 7.

6.2 Sensitivity to changes in assumptions

Uncertainty is inherent in project analyses (Squire and Van der Tak, 1988). The sensitivity of results to assumptions made were therefore studied. As a risk analysis method it has been decided to experiment with variations in the assumptions made. The assumptions identified as possible sources of risk from an economic point of view, include: cane yield, cane adoption % and the B Pool sucrose price. The effects on results of reducing these base assumptions by 10%, 20% and 30% are investigated for the different models in Tables 12, 13 and 14 (only one variable is changed at a time). The corresponding economic NPVs for the different assumptions and the percentages by which they have decreased from the base NPV are given.

The cane yields (tons/ha/annum) used in the base models were provided by the millers. The millers play an active role in the provision of inputs and the development of cane, and therefore have some control over the small grower cane yield. By reducing the yields provided by the millers by up to 30% in the sensitivity analyses, a yield level of below 30 tons/ha/annum is experimented with in the different models. The KwaZulu Cane Grower's Support Programme Report (1992) contends that 30 tons/ha/annum has been the norm experienced in the small grower sector.

The % cane adoption assumption refers to a scenario of cane production relative to production expected by the millers. The % of cane adoption at base (100%) means that millers expectations will be realized in the sense that expected plantings will equal the eventual plantings. The millers have based their estimate on their own conservative assumptions. For example, the cane adoption figure provided by the Sezela mill is based on 60% of land available for cane production. Decreasing the cane adoption % for Sezela by 30% in the sensitivity analysis, in effect, means that 70% of the 60% (*i.e.* 42%) of land available for cane will enter production.

It is assumed that additional cane produced is destined for the export market. Cane has therefore been valued at the B Pool sucrose price (which depends on the world price) in the economic analysis. The base B Pool sucrose price used is the mean of the last nine and the projected next three years (*i.e.* a twelve year period). This mean price is R478.51/ton. A reduction in this price of up to 30% is experimented with in the sensitivity analysis. Prices on the world open market have been known to fluctuate widely and although it is possible that the B Pool sucrose price may drop by more than 30% in any one year, it is unlikely that it will drop by 30% for an extended period of time.

The effect of changing assumptions is measured in terms of changes in the economic NPV criterion. An economic criterion was chosen as it demonstrates the effect on the economy as a whole (the objective in cost-benefit analysis). The NPV criterion was chosen as it is seen as being more realistic than the IRR criterion because its interest rate is determined by the opportunity cost of capital (see 3.3.1.2).

6.2.1 Sensitivity to changes in the assumptions of the Amatikulu model

In Table 12, decreasing the base assumption for yield (38.6 tons/ha/annum) by 10%, to 34.74 tons/ha/annum, decreases economic NPV from R8 181 728 to R6 810 076. This amounts to a 16.76% decrease in economic NPV. The Amatikulu model is therefore sensitive to changes in yield, with a 10% decrease in yield resulting in a 16.76% decrease in economic NPV. The model is also sensitive to changes in the B Pool sucrose price with a 10% decrease in price resulting in a 23.86% decrease in economic NPV. The Amatikulu model is less sensitive to changes in the % cane adoption, with a 10% decrease resulting in a 8.64% decrease in economic NPV

Table 12: The effects of reducing key assumptions of the Amatikulu Model by 10%, 20% and 30%

Assumption	% Decrease From Base Assumption	Economic NPV (R)	% Decrease From Base Economic NPV
Yield (tons/ha/annum)			
(Base Assumption) 38.6		8 181 728	
34.74	10%	6 810 076	-16.76%
30.88	20%	5 438 425	-33.53%
27.02	30%	4 066 773	-50.29%
% Cane Adoption			
(Base Assumption)100%		8 181 728	
90%	10%	7 474 998	-8.64%
80%	20%	6 768 269	-17.28%
70%	30%	6 061 539	-25.91%
B Pool Price(R/ton Sucrose)			
(Base Assumption) 478.51		8 181 728	
430.66	10%	6 229 171	-23.86%
382.81	20%	4 276 614	-47.73%
334.96	30%	2 324 057	-71.59%

The effect of reducing the base assumptions of the Amatikulu model is illustrated in Figure 8, where the economic NPV is set against a 10%, 20% and 30% decrease in yield, cane adoption and B Pool price.

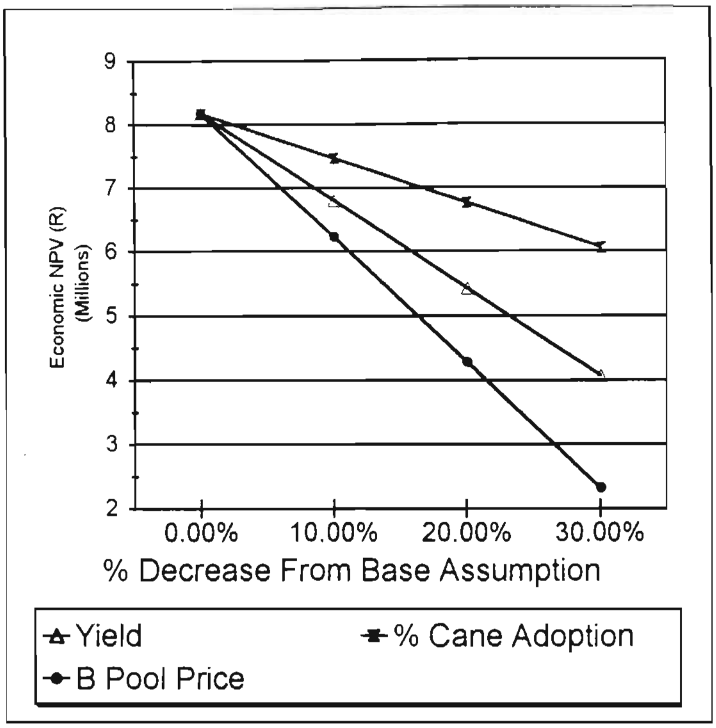

Figure 8: Sensitivity to changes in assumptions of the Amatikulu model

From Figure 8 it is evident that, of the 3 assumptions, the Amatikulu model is most sensitive to changes in the B Pool price. It is also evident that even if the individual assumptions are reduced by 30%, economic NPV is still positive (even though the Amatikulu model is sensitive to changes in the base assumptions of yield and B Pool sucrose price).

6.2.2 Sensitivity to changes in the assumptions of the Cabhane model

Table 13 indicates that the Cabhane model is sensitive to changes in yield, % cane adoption and the B Pool sucrose price. A 10% decrease in yield results in a 20.26% decrease in economic NPV, a 10% decrease in cane adoption % results in a 13.88%

decrease in economic NPV and a 10% decrease in the B Pool price results in a 25.71% decrease in economic NPV.

Table 13: The effects of reducing key assumptions of the Cabhane Model by 10%, 20% and 30%

Assumption	% Decrease From Base Assumption	Economic NPV (R)	% Decrease From Base Economic NPV
Yield (tons/ha/annum)			
(Base Assumption) 40		7 913 109	
36	10%	6 309 529	-20.26%
32	20%	4 705 948	-40.53%
28	30%	3 102 368	-60.79%
% Cane Adoption			
(Base Assumption)100%		7 913 109	
90%	10%	6 814 526	-13.88%
80%	20%	5 715 943	-27.77%
70%	30%	4 617 359	-41.65%
B Pool Price(R/ton Sucrose)			
(Base Assumption) 478.51		7 913 109	
430.66	10%	5 878 950	-25.71%
382.81	20%	3 844 791	-51.41%
334.96	30%	1 810 632	-77.12%

The effect of reducing the base assumptions is illustrated in Figure 9, where the economic NPV is set against a 10%, 20% and 30% decrease in yield, cane adoption and B Pool price.

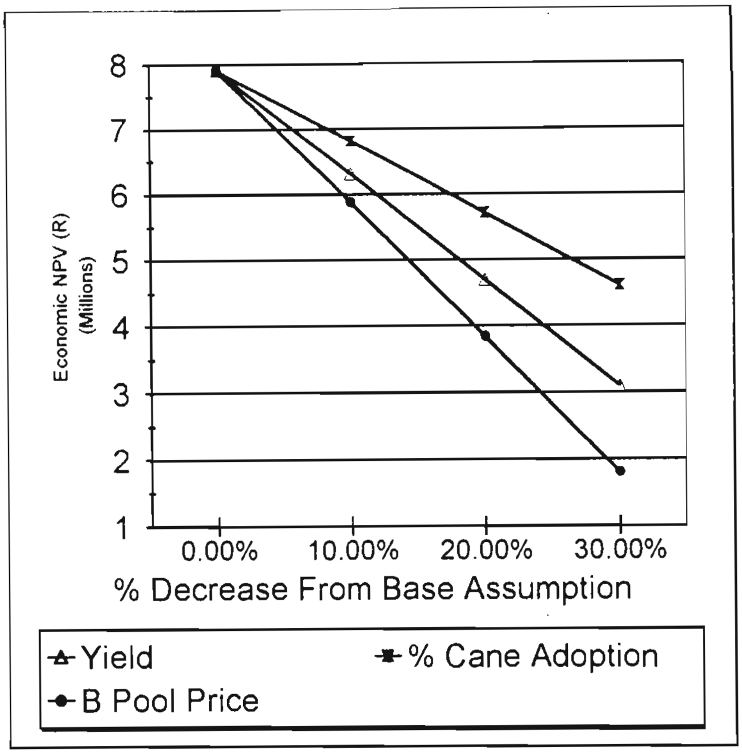

Figure 9: Sensitivity to changes in assumptions of the Cabhane model

From Figure 9 it is evident that, of the 3 assumptions, the Cabhane model is most sensitive to changes in the B Pool price. It is also evident that even if the individual assumptions are reduced by 30%, economic NPV is still positive (even though the Cabhane model is relatively sensitive to changes in assumptions).

6.2.3 Sensitivity to changes in the assumptions of the Kwa-Hlongwa model

Table 14 indicates that the Kwa-Hlongwa model is sensitive to changes in yield, % cane adoption and the B Pool sucrose price. A 10% decrease in yield results in a 36.05% decrease in economic NPV, a 10% decrease in cane adoption % results in a 16.9%

decrease in economic NPV and a 10% decrease in the B Pool price results in a 47.31% decrease in economic NPV.

Table 14: The effects of reducing key assumptions of the Kwa-Hlongwa Model by 10%, 20% and 30%

Assumption	% Decrease From Base Assumption	Economic NPV (R)	% Decrease From Base Economic NPV
Yield (tons/ha/annum)			
(Base Assumption) 40		1 913 345	
36	10%	1 223 518	-36.05%
32	20%	533 692	-72.11%
28	30%	(156 135)	-108.16%
% Cane Adoption			
(Base Assumption)100%		1 913 345	
90%	10%	1 589 918	-16.9%
80%	20%	1 266 491	-33.81%
70%	30%	943 063	-50.71%
B Pool Price(R/ton Sucrose)			
(Base Assumption) 478.51		1 913 345	
430.66	10%	1 008 192	-47.31%
382.81	20%	103 039	-94.61%
334.96	30%	(802 114)	-141.92%

The effect of reducing the base assumptions for the Kwa-Hlongwa model is illustrated in Figure 10, where the economic NPV is set against a 10%, 20% and 30% decrease in yield, cane adoption and B Pool price.

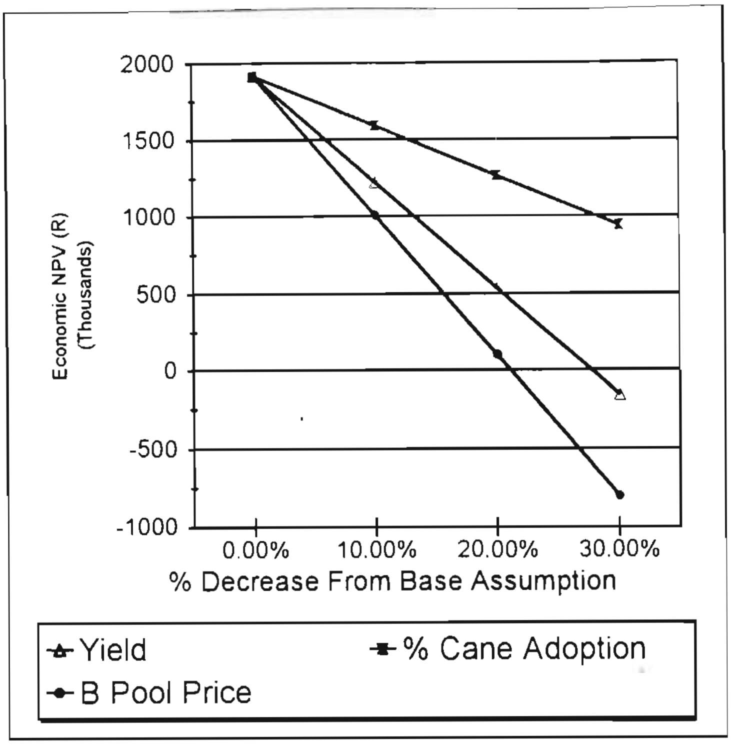

Figure 10: Sensitivity to changes in assumptions of the Kwa-Hlongwa model

From Figure 10 it is evident that, of the 3 assumptions, the Kwa-Hlongwa model is most sensitive to changes in the B Pool price. It is also evident that if the base assumption of yield or B Pool sucrose price is reduced by 30%, the economic NPV becomes negative. Although it is possible that the B Pool price or yield levels could drop by more than 30% in any one year, it is unlikely that they would drop by 30% for an extended period of time. In addition to this the base results obtained for the Kwa-Hlongwa model could be seen as conservative as explained in section 5.1 (the delayed cane development could be accelerated and the numerous intangible benefits characteristic of labour intensive projects need to be considered).

CONCLUSIONS

The Amatikulu and Sezela mill areas are evaluated using the Cost-Benefit Analysis procedure. These mill areas were selected as the projects in progress in these areas are considered representative of the different areas and construction methods involved in Phase I of the programme.

The financial Net Present Values (NPVs) calculated for Amatikulu, Cabhane (Sezela) and Kwa-Hlongwa (Sezela) respectively are: R3.2 million, R7.61 million and R911 thousand. The economic NPVs calculated for Amatikulu, Cabhane and Kwa-Hlongwa respectively are: R8.18 million, R7.91 million and R1.91 million. These results reflecting the tangible costs and benefits, calculated at a real discount rate of 8%, indicate that all the projects are viable as measured in both financial prices (before financing) and economic prices (after shadow pricing and transfer payment correction).

In view of the numerous intangible benefits specific to this project (the creation of job opportunities; travel time savings; accident cost savings; increased accessibility to: hospitals, schools and markets, and an improvement in the general quality of rural life) the results projected could be seen as conservative.

Indications are that transport savings play a large role in contributing towards the economic NPV of the Amatikulu project. In the Amatikulu area vehicle operating-cost savings are expected to play a large role as the project involves the upgrading of existing roads. This contrasts with the Cabhane and Kwa-Hlongwa projects which are mainly involved with the construction of new roads.

For all the mill areas, small growers receive a higher return to resources engaged before financing (financial NPV) than they contribute to the economy (economic NPV). This is because they will receive the A pool price until 1998 and a blend between the A and B pool prices thereafter, whereas their contribution to the economy is measured in terms of the lower B pool price. The difference between the price that small growers receive and the B Pool price is therefore a transfer payment, this transfer payment appears to be quite large as there is a considerable difference between the small growers' financial and economic NPVs for all the projects.

Millers on the other hand, contribute more to the economy than they receive for their resources engaged. This is largely due to the fact that they pay an income tax, which is a transfer payment (income tax being a cost to the miller but a benefit to the national economy). Apart from the Amatikulu model where large transport benefits accrue to the community as a whole, millers are the major beneficiaries of the tangible benefits evaluated in this study.

The lower results obtained for the Kwa-Hlongwa project (as compared to the other two projects) can largely be attributed to the timing of the cane development and not to the construction method (labour intensive). The cane development at Kwa-Hlongwa is proposed to take place only once the development at Cabhane has been completed. The results for the Kwa-Hlongwa model could be improved by ensuring earlier establishment of cane, this would require liaising with the relevant mill. It is also possible that the development at Cabhane and therefore at Kwa-Hlongwa could be accelerated if the Sezela mill develops the proposed cane at a rate of 500 ha/annum as expected and not at the conservative rate of 300 ha/annum used in the base model. In addition to this the Kwa-Hlongwa project, in contrast to those of Amatikulu and Cabhane is labour intensive and it therefore has a greater employment creation effect, however, it has not been possible to account for this intangible benefit in the results obtained.

If the transport savings are deducted from the total economic NPVs, the economic NPVs would still be positive for all projects. The results can therefore be considered viable purely on the basis of the expected increase in small grower cane production (*i.e.* independent of vehicle operating-cost savings).

A sensitivity analysis was conducted as a risk analysis procedure to see what effect the changing of key variables would have on the investment criteria. Indications are that the economic NPV criterion (which measures the contribution to the total economy) is positive for a wide range of discount rates, for all projects. Indications are that the NPV (in financial prices) becomes positive after 9, 13 and 18 years for Cabhane, Amatikulu and Kwa-Hlongwa respectively. It is expected that since the economic NPVs for the different projects are higher than the corresponding financial NPVs, the economic NPVs will become positive after a shorter period of time than that indicated by the financial NPVs.

The Amatikulu model was found to be sensitive to changes in yield and B Pool sucrose price (as measured by changes in the economic NPV criterion), while the Cabhane and

Kwa-Hlongwa models were found to be sensitive to changes in yield, % cane adoption and the B pool sucrose price. The economic NPVs of the Amatikulu and Cabhane models are, however, still positive after a 30% *ceteris paribus* decrease in the individual assumptions experimented with. Kwa-Hlongwa's economic NPV becomes negative if the base assumption of yield or B Pool sucrose price is reduced by 30%. It is, however, unlikely that the base assumptions of yield or B Pool sucrose price would drop by 30% for an extended period of time. In addition to this, the base results obtained for the Kwa-Hlongwa model could be seen as conservative as the delayed cane development projected for the base model could well be accelerated and the intangible benefits characteristic of the labour intensive construction method present at Kwa-Hlongwa are not accounted for in the results obtained.

In conclusion, the models indicate that the benefits of the project will outweigh the costs by a considerable margin, making the project a viable investment decision.

SUMMARY

The DBSA has granted a loan of R41 million to the former KwaZulu Government for the implementation of the first phase of an infrastructure programme. The objective of the programme is to upgrade and expand transportation routes to small scale cane growers. A further two phases are planned and their commencement is dependant on the success of the first phase. The objective of this research is to determine the viability of Phase I of the programme. The cost-benefit analysis procedure is used to evaluate the costs and benefits of the programme. As the project is in progress it is possible to base the model on actual cost data.

The different sugar mill areas involved in the programme are: Umfolozi, Felixton, Amatikulu, Ntumeni, Glendale, Maidstone, Noodsberg, Illovo, Sezela and Umzimkulu. The proposed total sugar cane development programme, involving 27 000 ha, was appraised in 1992. On the basis of this appraisal the DBSA made a loan available for Phase I of the programme.

Rather than evaluate all the projects involved in Phase I of the programme, it was decided that two mill areas would be studied closely and individual models would be constructed for them. The mill areas evaluated are Amatikulu and Sezela. Amatikulu is situated on KwaZulu-Natal's North Coast and the project in progress involves the upgrading of existing roads. The Sezela area is situated on KwaZulu-Natal's South Coast where there are two projects in progress *viz.* Cabhane and Kwa-Hlongwa. Both the Cabhane and Kwa-Hlongwa projects involve the construction of new roads as opposed to the upgrading of

existing roads. The Cabhane project is a plant hire project and the Kwa-Hlongwa project is a labour intensive project. These mill areas were selected for evaluation as they are considered representative of the different areas and construction methods involved in Phase I of the programme, in addition to this, construction cost data were available for the projects within these areas.

Spreadsheet models have been constructed for the two mill areas with the Sezela model subdivided into the Kwa-Hlongwa (labour based) and Cabhane (plant hire) projects. In essence, three spreadsheet models have been set up.

The models show the flow of benefits and costs over time. Benefits include: incremental income to small growers as a result of new cane production; increased milling profit to millers as a result of increased cane throughput and vehicle operating-cost savings. Costs include: road construction and/or upgrading costs and road maintenance costs.

In the financial analysis costs and benefits are valued at market prices. By subtracting the costs from the benefits in each year a net benefit/cost is arrived at that shows the returns to all resources engaged before financing. In the economic analysis the financial prices from the financial models are converted to reflect economic values. This is done by means of "shadow pricing" and the omission of transfer payments. In this way the incremental net benefit in economic terms is arrived at.

The benefits and costs in the financial and economic models are discounted to give a financial and economic Net Present Value (NPV), Benefit-Cost Ratio (BCR) and Internal

Rate of Return (IRR) for the different "players" involved in a particular project *viz.* the small growers, millers, construction, maintenance and transport sectors. A total financial and economic NPV, BCR and IRR is also calculated for each project.

The models all assume a lifespan of 20 years and a discount rate of 8%. For a project to be considered viable, in terms of the different investment criteria used, the NPV must be greater or equal to zero, the BCR must exceed unity and the IRR must exceed the Required Rate of Return (a figure of 8%, implied by the discount rate). Given the assumptions made for the different models, the results reflecting the tangible costs and benefits indicate that all the projects are viable as measured in both financial (before financing) and economic (after shadow pricing and transfer payment correction).

In view of the numerous intangible benefits specific to this project (the creation of job opportunities; travel time savings; accident cost savings; increased accessibility to: hospitals, schools and markets, and an improvement in the general quality of rural life) the results projected could be seen as conservative.

The lower results obtained for the Kwa-Hlongwa project (as compared to the other two projects) can largely be attributed to the timing of the cane development and not to the construction method (labour intensive). The cane development at Kwa-Hlongwa is proposed to take place only once the development at Cabhane has been completed. The results for the Kwa-Hlongwa model could be improved by ensuring earlier establishment of cane, this would require liaising with the relevant mill. It is also possible that the development at Cabhane and therefore at Kwa-Hlongwa could be accelerated if the Sezela mill develops the proposed cane at a rate of 500 ha/annum as expected and not at the conservative rate of 300 ha/annum used in the base model. In addition to this the Kwa-Hlongwa project, in contrast to those of Amatikulu and Cabhane is labour intensive and it therefore has a greater employment creation effect, however, it has not been possible to account for this intangible benefit in the results obtained.

For the Amatikulu model transport savings play a large role in contributing towards the economic NPV. The Amatikulu project involves the upgrading of existing roads as opposed to the construction of new roads, hence benefits are expected to result from vehicle operating-cost savings. Only miller and small grower benefits appear to play a large role in the Cabhane and Kwa-Hlongwa models. These projects are mainly involved with the construction of new roads and vehicle operating-cost savings are not expected to play a large role.

For all the mill areas small growers receive a higher return to resources engaged before financing (financial NPV) than they contribute to the economy (economic NPV). This is because they will receive the A pool price until 1998 and a blend between the A and B pool prices thereafter, whereas, their contribution to the economy is measured in terms of the lower B pool price. The difference between the price that small growers receive and the B Pool price is therefore a transfer payment, this transfer payment appears to be quite large as there is a considerable difference between the small growers' financial and economic NPVs for all the projects.

Millers on the other hand, contribute more to the economy than they receive for their resources engaged. This is largely due to the fact that they pay an income tax, which is a transfer payment (income tax being a cost to the miller but a benefit to the national economy). Apart from the Amatikulu model where large transport benefits accrue to the community as a whole, millers are the major beneficiaries of the tangible benefits evaluated in this study.

If the transport savings are deducted from the total economic NPVs, the economic NPVs would still be positive for all projects. The results can therefore be considered viable purely on the basis of the expected increase in small grower cane production (*i.e.* independent of vehicle operating-cost savings).

On the basis of an original appraisal conducted in 1992 (involving the total development programme) a loan was made available for Phase I of the infrastructure programme. The economic results obtained in this 1994 study can not be compared to those of the original appraisal as the original appraisal does not consider the effects of shadow pricing and vehicle operating-cost savings. The financial results obtained for the Amatikulu, Cabhane and Kwa-Hlongwa models, exclude vehicle operating-cost savings and are compared to those of the original appraisal (1992). From the comparison it is evident that the result for the Cabhane model compares favourably with that of the original appraisal, while the Amatikulu and Kwa-Hlongwa projects indicate lower financial results than the original appraisal. The lower result obtained for the Kwa-Hlongwa project can be explained by the delay in cane development proposed. The lower financial result for Amatikulu could be attributed to the fact that this project only involves the upgrading of existing roads, while, the original appraisal on the total development programme considers projects that involve both the construction of new and the upgrading of existing roads. Projects incorporating the construction of new roads would be expected to show higher financial results than pure upgrading projects, as the they open up completely new areas to cane production. Vehicle operating-cost savings which are characteristic of pure road upgrading projects are not accounted for in the financial analyses of both the original (1992) appraisal and the projects evaluated in this (1994) appraisal and would therefore not affect the financial IRRs of these two appraisals.

Uncertainty is inherent in project analyses. The sensitivity of results to assumptions made were therefore studied. As a risk analysis method it has been decided to experiment with variations in the assumptions made. Indications are that the economic NPV criterion (which measures the contribution to the total economy) is positive for a wide range of discount rates for all projects. The NPV (in financial prices) becomes positive after 9, 13 and 18 years for Cabhane, Amatikulu and Kwa-Hlongwa respectively. It is expected that since the economic NPVs for the different projects are higher than the corresponding financial NPVs, the economic NPVs will become positive after a shorter period of time than that indicated by the financial NPVs.

The Amatikulu model was found to be sensitive to changes in yield and B Pool sucrose price (as measured by changes in the economic NPV criterion), while the Cabhane and Kwa-Hlongwa models were found to be sensitive to changes in yield, % cane adoption and the B pool sucrose price. The economic NPVs of the Amatikulu and Cabhane models are, however, still positive after a 30% *ceteris paribus* decrease in the individual assumptions experimented with. Kwa-Hlongwa's economic NPV becomes negative if the base assumption of yield or B Pool sucrose price is reduced by 30%. It is, however, unlikely that the base assumptions of yield or B Pool sucrose price would drop by 30% for an extended period of time. In addition to this, the base results obtained for the Kwa-Hlongwa model could be seen as conservative as the delayed cane development projected for the base model could well be accelerated and the intangible benefits characteristic of the labour intensive construction method present at Kwa-Hlongwa are not accounted for in the results obtained.

In view of the results obtained in the base models and the sensitivity analyses, indications are that the benefits of the project will outweigh the costs by a considerable margin, making the project a viable investment decision.

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APPENDIX 1
THE CALCULATION OF CONSTRUCTION COST, SUCROSE PRICE AND MARGINAL MILLING PROFIT SHADOW FACTORS FOR THE DIFFERENT MODELS

Table 15: Calculation of the construction cost shadow factor for the Amatikulu Model

	% OF COST	FIN. COSTS	SHADOW FACTOR	ECO. COSTS	Shadow Factor Source:
Plant	22.00%	1188250	0.84	998130	Dept of transport (1992)
Gravel Haul	12.00%	648136	0.833	539897	Other Transport Equipment: Bradfield, 1993
Unskilled labour	7.00%	378079	0.42	158793	Black Construction: Bradfield, 1993
Establ. + general	4.00%	216045	1.00	216045	
Materials	20.00%	1080227	0.909	981926	Cement: Bradfield, 1993
Diesel	5.00%	270057	0.67	180938	Vaal Augmentation Study; Mullins, 1994
Petrol	5.00%	270057	0.61	164735	Vaal Augmentation Study; Mullins, 1994
Professional fees	9.00%	486102	1	486102	
Other costs	3.72%	200922	1	200922	
V.A.T.	12.28%	663259	0	0	
TOTAL COSTS	100.00%	5401134		3927489	
Total Construction Cost (fin. NPV)		5401134			
Construction Shadow Factor			0.727		

Table 16: Calculation of construction cost shadow factors for the Cabhane model

Zone to mill roads:

	% OF COST	FIN. COSTS	SHADOW FACTOR	ECO. COSTS	Shadow Factor Source:
Plant	31.00%	562011	0.84	472090	Department of Transport (1992)
Gravel Haul	7.60%	137783	0.833	114774	Other Transport Equip.: Bradfield, 1993
Unskilled labour	5.03%	91191	0.42	38300	Black Constr.: Bradfield, 1993
Establishment + general	5.63%	102069	1.00	102069	
Materials	12.59%	228249	0.909	207478	Cement: Bradfield, 1993
Diesel	11.66%	211389	0.67	141630	Vaal Augmentation Study: Mullins, 1994
Petrol	0.00%	0	0.61	0	Vaal Augmentation Study: Mullins, 1994
Professional fees	11.55%	209395	1	209395	
Other costs	2.66%	48224	1	48224	
V.A.T.	12.28%	222629	0	0	
TOTAL COSTS	100%	1812940		1333959	
INPUT: Total Zone-Mill Const. Cost			1812939		
Total Zone-Mill Const. Shadow Factor			0.74		

Infield roads:

	% OF COST	FIN. COSTS	SHADOW FACTOR	ECO. COSTS	Shadow Factor Source:
Plant	36.50%	1185405	0.84	995740	Dept of Transport (1992)
Gravel Haul	2.00%	64954	0.833	54106	Other Transport Equipment: Bradfield, 1993
Unskilled labour	12.93%	419926	0.42	176369	Black Construction: Bradfield, 1993
Establishment + general	3.70%	120164	1.00	120164	
Materials	11.03%	358220	0.909	325622	Cement: Bradfield, 1993
Diesel	11.50%	373484	0.67	250234	Mullins: Vaal Augmentation Study, 1994
Petrol	0.00%	0	0.61	0	Mullins: Vaal Augmentation Study, 1994
Professional fees	8.36%	271506	1	271506	
Other costs	1.70%	55211	1	55211	
V.A.T.	12.28%	398816	0	0	
TOTAL COSTS	100%	3247684		2248952	
INPUT: Total Infield Construction Cost			3247684		
Total Infield Construction Shadow Factor			0.69		

Table 17: Calculation of the construction cost shadow factor for the Kwa-Hlongwa model

	% OF COST	FIN. COSTS	SHADOW FACTOR	ECO. COSTS	Shadow Factor Source:
Plant	6.00%	238548	0.84	200380	Dept of Transport, 1992
Travel	2.00%	79516	0.714	56774	Vehicles, parts and spares: Bradfield, 1993
Unskilled labour	54.00%	2146928	0.42	901710	Black Construction Bradfield, 1993
Est. + gen	8.00%	318063	1.00	318063	
Materials	2.00%	79516	0.909	72280	Cement: Bradfield, 1993
Skilled Labour	10.00%	397579	1	397579	
Contingencies	12.00%	477095	1	477095	
Miscellaneous Tools	2.00%	79516	1	79516	
Other costs	0.00%	0	1	0	
V.A.T	4.00%	159032	0	0	
TOTAL COSTS	100.00%	3975793		2503398	
INPUT: Total Construction Cost			3975793		
Total Construction Shadow Factor			0.63		

Table 18: Calculation of the sucrose price shadow factor for the Amatikulu model

	Financial NPV	Shadow Factor	Economic NPV	Shadow Factor Source:
Total fin. NPV of Small Grower Turnover	2 749 875			
NPV of Small Grower Turnover (1st 5 yrs, A Pool)	3 168 271	0.682	21 605 599	B Pool Price/A Pool Price
NPV of Small Grower Turnover (Next 15 yrs, A:B pool mix)	24 330 482	0.714	17 365 380	B Pool Price/A:B Pool Price Mix
Economic NPV of Small Grower Turnover			19 525 980	
Total Shadow Factor		0.71		(Eco. NPV/Fin. NPV)

Table 19: Calculation of the sucrose price shadow factor for the Cabhane model

	Financial NPV	Shadow Factor	Economic NPV	Shadow Factor Source:
NPV of Small Grower Turnover (Financial)	28 654 887			
NPV of Small Grower Turnover (1st 5 yrs, A Pool)	3 455 564	0.682	2 356 518	B Pool Price/A Pool Price
NPV of Small Grower Turnover (Next 15 yrs, A:B pool mix)	25 199 324	0.714	17 985 497	B Pool Price/A:B Pool Price Mix
Economic NPV of Small Grower Turnover			20 342 016	
Total Shadow Factor (Economic NPV/Financial NPV)		0.71		

Table 20: Calculation of the sucrose price shadow factor for the Kwa-Hlongwa model

	Financial NPV	Shadow Factor	Economic NPV	Shadow Factor Source:
NPV of Small Grower Turnover (Financial)	12 682 286			
NPV of Small Grower Turnover (1st 5 yrs, A Pool)	0	0.682	0	B Pool Price/A Pool Price
NPV of Small Grower Turnover (Next 15 yrs, A:B pool mix)	12 682 385	0.714	9 051 719	B Pool Price/A:B Pool Price Mix
Economic NPV of Small Grower Turnover			9 051 719	
Total Shadow Factor (Eco. NPV/Fin. NPV)		0.714		

Table 21: Calculation of the marginal milling profit shadow factor for the Amatikulu, Cabhane and Kwa-Hlongwa models

(1) Sugar factories factor: Bradfield, 1993	0.833
(2) Milling profit (before tax) ÷ milling profit (after tax) - this is a factor used to convert the milling profit after tax to a before tax figure	1.39
(1) × (2)	1.157