OPTIMAL USE OF SUGAR CANE BY-PRODUCTS IN SUDAN.

EL-TOHAMI, ABDELRAHMAN MOHEMED

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OPTIMAL USE OF SUGAR CANE BY-PRODUCTS IN SUDAN

by

Abdelrahman Mohemed El-Tohami

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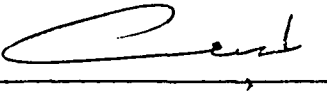
SIGNED: 

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ABSTRACT

The objective of this thesis is to determine the most socially profitable use of molasses in Sudan. Comparisons are made between animal feed and alcohol production for a variety of firm sizes. Animal feed mills are more efficient than alcohol distilleries in the use of Sudanese molasses. Feed mills demonstrate economics of scale while intermediate-size alcohol distilleries are the most cost-effective method of alcohol production. The location of plants near molasses producers is shown to be more efficient than alternative sites, because these plants will partially depend upon the sugar factories for their steam generation, storage facilities and administrative buildings, leading to significant savings in capital costs. While animal feed production is more socially profitable than alcohol, government taxes and subsidies cause negative private profitability in animal feed production. Thus, the most socially profitable investments will not be undertaken without some change in government policy.

CHAPTER I

INTRODUCTION

Sudan's total debt burden in 1981 was $4 billion. A major cause of the national debt was the imbalance between exports and imports. Table 1 shows Sudan's foreign trade deficit since 1976. Export values have declined while import costs have increased sharply. Cotton and livestock earnings, for example, accounted for $40 million and $26 million, respectively, less than half of their 1980 values. As a consequence, government development programs have begun to focus on diversification of the economy away from primary agricultural product exports and toward import substitution. One of these programs involves domestic sugar production. Two new projects (Kenana and Asalya) are expected to achieve full-scale production by 1985, and together with expanded production from the three projects currently in operation (New Halfa, Guneid and West Sennar), annual sugar production is anticipated to reach 850,000 metric tons. Achievement of this goal implies Sudan will become an exporter of about half of its production. Exportation appears plausible, as costs of production are estimated to be less than world prices and Sudan's proximity to the rapidly growing markets of the Middle East provides transportation cost advantages relative to other exporters.

The objective of this study is to determine the optimum economic use of molasses, one of the principal by-products of sugar

TABLE 1. Sudan's Foreign Trade 1976 - 1981

Item	1976	1977	1978	1979	1980	1981
			(000 Sudanese pounds)			
Exports	193.01	230.18	202.34	232.67	271.34	357.00
Imports	341.39	376.48	449.46	477.32	788.19	839.83
Deficit	148.38	146.30	247.12	244.65	516.85	482.83

Source: Economic Review, 1982.

production. Molasses is currently produced in quantities too small to warrant further use. However, by-product output will increase continually with sugar production, and current cane conversion rates suggest annual molasses production will reach more than 300,000 metric tons. Efficient utilization of this by-product can contribute to increased profitability and viability of the sugar refinery sector, increased income for cane producers, and further development of the agro-industrial sector and seasonal off-farm employment opportunities.

Alternative uses of molasses include exportation of the unprocessed by-product, or processing into ethanol or animal feed. Government interest in the latter two alternatives is particularly strong. Interest in ethanol production stems from a variety of factors. Increases in the price and consumption of petroleum has put strains on the balance of payments, the government tax/revenue position, and the efficient operation of irrigated and rainfed agricultural schemes dependent on government fuel allocations. While potential petroleum reserves have been found, these areas can supply at most 25 percent of Sudanese demand, and the feasibility of production of petroleum substitutes remains of interest to the government. Conversion into animal feed is a second alternative, important because of the prominence of the livestock sector. The animal population is estimated at 42 million head, and livestock and livestock products represent the second largest category of agricultural exports (after cotton).

Prices received are generally low due to poor animal quality. Export prices for Sudanese cattle in 1979, for example, were only two-thirds of the world average price. Increases in feed rations would

presumably result in increases in meat quality and thus increase f.o.b. prices. Further, molasses substitutes for grain in feed production and thus increases the quantity of grain available for human consumption.

Economic analysis of the alternative uses of sugarcane molasses will be based on the domestic resource cost and net social profitability measures. These measures are cost benefit methods and are particularly appropriate for this study because of their focus on foreign exchange earning power and the economic feasibility of import substitution or export expansion. In addition, these methods are able to rank alternative uses of a particular product and thus can identify the best use of molasses among the alternatives of raw product exportation, production of ethanol, or production of animal feed. These methods are described in detail in Chapter II.

The principal data required for the analysis involve input-output coefficients and domestic market and opportunity costs for inputs and outputs. No ethanol plants are currently operational in Sudan, and plans of the Sudanese Sugar Production Corporation will be modified with data from operations in other countries to simulate realistic input-output relationships. The University of Arizona's current research efforts on Brazilian gasohol production (from molasses, sugarcane and cassava) and the experiences of cane by-products processors in the Southeastern U.S. will be particularly useful in this regard. The data for animal feed production was collected from the Sudanese Public Animal Production Corporation and compared with the data from operations in the University of Arizona Feed Mill and the Arizona Feed Mills. Price data was collected primarily in Sudan,

with the assistance of the Public Sugar Production Corporation, The Public Animal Production Corporation and the Ministry of Agriculture. Additional economic data was obtained from World Bank publications, Chapter III describes seven different technologies for the production of alcohol and animal feeds, using different sizes and locations.

Chapter IV focuses on the empirical analysis of the results and sensitivity tests for both the alcohol distilleries and feed mills. The presence of economies of scale in processing facilities must be evaluated against transportation costs of intermediate inputs and final outputs, particularly in the contest of Sudan's limited infrastructure. Molasses is converted for use as a feed supplement in many countries, but again Sudanese infrastructural constraints may limit the effectiveness of potential feed use and its introduction into the process of exported meat production. Moreover, attention must be given to the private sector attractiveness of the potential new outputs. Social profitability is not a sufficient condition for the adoption of new production activities, and given the degree of price distortions in Sudan, social profitability need not imply private profitability. Finally a number of aspects additional to social profitability are important in the evaluation of project feasibility and optimal economic use. Institutional considerations represent one such category. The implications of new projects in terms of their impact on government revenues (taxes and subsidies) will be critical to the choice among new uses for sugarcane molasses.

CHAPTER II

METHODOLOGY TO COMPARE MUTUALLY EXCLUSIVE PROJECTS

Commercial profitability is an inadequate criteria for governments to use in the evaluation of industrial projects. A central reason is the presence of divergences between private and social costs. However, the governments of most less-developed countries influence the pattern of industrial investment through policies of direct investment in the public sector, domestic taxes and subsidies, tariffs and the rationing of capital. It follows that governments require a methodology for comparing and evaluating mutually exclusive projects. Three methodologies have been suggested for the analysis of industrial projects in developing countries: UNIDO (1972), Little-Mirrlees (1974), and the domestic resource cost method associated with Bruno (1967). The objective of this chapter is to evaluate and compare the advantages of the domestic resource cost method over the UNIDO and Little-Mirrlees methods.

The first section of this chapter focuses on the theoretical basis of each method. Project evaluation requires consideration of both non-economic objectives, such as inflation, employment, income distribution and economic independence, and microeconomic objectives of economic efficiency and income maximization. The second section discusses the different components of project analysis under each method. The net present value (NPV) of the project is the decision rule used,

and the methods are compared for their treatment of the time stream of benefits and costs, the relevant values of the various cost and benefit components, and the discount rate. The third section compares the various techniques for shadow price estimation and the treatment of taxes and subsidies. The final section contains a discussion of the main differences and similarities among the three methods, and justifies the use of the DRC method for this analysis.

The Theoretical Basis of Alternative Project Evaluation Methods

The UNIDO method relies on the level of aggregate consumption per capita as a principal welfare measure. Aggregate consumption is difficult to measure since a heterogeneous bundle of goods has to be converted into one homogeneous measure. This transformation can be achieved by weighing each good by its price. If P_1, P_2 ...., P_n are the respective prices of goods 1, 2, ... n, and X_1, X_2, ... X_n are the corresponding amounts of consumption of each good, then an aggregate measure of consumption is given by C, where,

$$C = \sum_{i=1} P_i X_i \qquad (1)$$

The relative weight on each commodity reflects the price that the consumer pays for it. These prices may be corrected to take externalities into account.

Another measurement problem involves adding consumption over time, thus creating problems of discounting. The appropriate social rate of discount is the rate at which decision-makers believe that future benefits must be discounted to equate them with present benefits. In

general, if a_t is judged by the planners as the value of a unit of aggregate consumption in year t, then the consumption level of year t has to be discounted at a rate i_t, where

$$i_t = \frac{a_{t-1} - a_t}{a_t} \qquad (2)$$

The parameter i represents the social rate of discount. Formally, if Q_t is the contribution to aggregate consumption from a project in year t and a_t is the va-ue of a unit of consumption in year t, then the contribution of this project to aggregate consumption can be written as the weighted sum:

$$a_o Q_t + a_1 Q_1 + \ldots\ldots + a_t Q_t = a_t Q_t \qquad (3)$$

Thus, the greater the value of expression (3), the greater is the project's contribution to aggregate consumption benefits weighted according to its marginal value at different times. Given the social rate of discount, the project evaluator may calculate the present value (PV) of all consumption, present and future, by discounting in accordance with formula 3.

The prices in equation 1 to estimate aggregate-consumption depend on income distribution, since prices are influenced by demand and demand is influenced by income distribution. Therefore, these prices should be corrected by attaching different weights to different individual's agregate consumption. The consumption of unskilled labor, for example, could be given an additional weight in the distribution of the total benefits of a project. Employment effects should also be weighted. The reduction of unemployment also has an impact on aggregate consumption and

distribution of income, and projects which increase unemployment may entail undesirable social costs.

The Little-Mirrlees method is also based on theoretical welfare economics. Future and present consumption is evaluated by attaching a number or "weight" to consumption in each time period. If C_0, C_1 ..., C_n are the anticipated values (at constant prices) of total consumption from year 0 to year (n), and if P_0, P_1, ..., P_n are the anticipated population, then C_0/P_0, C_1/P_1, ..., C_n/P_n will represent the anticipated consumption per head. The operational meaning of the weights, (W_0, W_1, ... W_n) is that a small change in consumption from (C_0, C_1, ... C_n) to (C_0', ... C_n') is taken to be desirable if $W_0 (C_0' - C_0) + W_1 (C_1' - C_1)$ t ... $W_n (C_n' - C_n)$ is positive. W_0 can be set to equal unity (present consumption as a measuring rod), so that the W falls from unity and gradually approaches zero.

The rate of decline of the W is $(\frac{1}{W} \frac{dw}{dt})$ and this number represents the social discount rate or the consumption rate of interest. This rate makes future consumption equivalent in value to present consumption, and reflects the importance of the welfare of different generations. The Little-Mirrlees method advocates separate rates of discount for future consumption and future savings since consumption and investment may not be of equal social value.

The attachment of different weights to the weighted average of consumption per capita for each year is required in order to measure the consumption of different income groups. It follows that the consumption benefits of a project need to be traced to different individuals

in order to deal with inequalities of wealth in project evaluation. The method deals with the reduction of unemployment by attaching higher weights to labor-intensive projects in both private and public sectors or by using wage subsidies and adjusting the price mechanism.

The domestic resource cost method depends on the standard theory of international trade to measure the opportunity cost of producing or saving foreign exchange. The country is assumed too small to influence world prices. Two goods, X_1 and X_2, are produced under linear homogenous production functions, yielding a production possibility surface concave to the origin. Two factors of production, labor (L_1) and capital (L_2) are utilized. Perfect competition, full employment, and fixed input supplies are assumed.

The justification of world prices follows because production at world prices leads to the maximum consumption possibilities frontier (Samuelson, 1962). The result is demonstrated in Figure (1). The bowed-out curve TT shows the maximum amount of X_2 that can be produced for each amount of X_1, subject to the constraints of technological knowledge and a fixed resource base. The world price ratio (P_1/P_2) is represented by the negative of the slope of line WBW. Domestic production possibilities are represented by TBT, with actual production represented by point B. The line WBW thus represents the consumption possibilities frontier and is a maximum opportunity set. Consumption under autarky (no trade) is limited to TBT, which is inferior to all points on line WBW except B. Production at prices other than world prices will result in an output mix somewhere along the sections WB or BW', passing through the chosen point on the production possibilities frontier. The

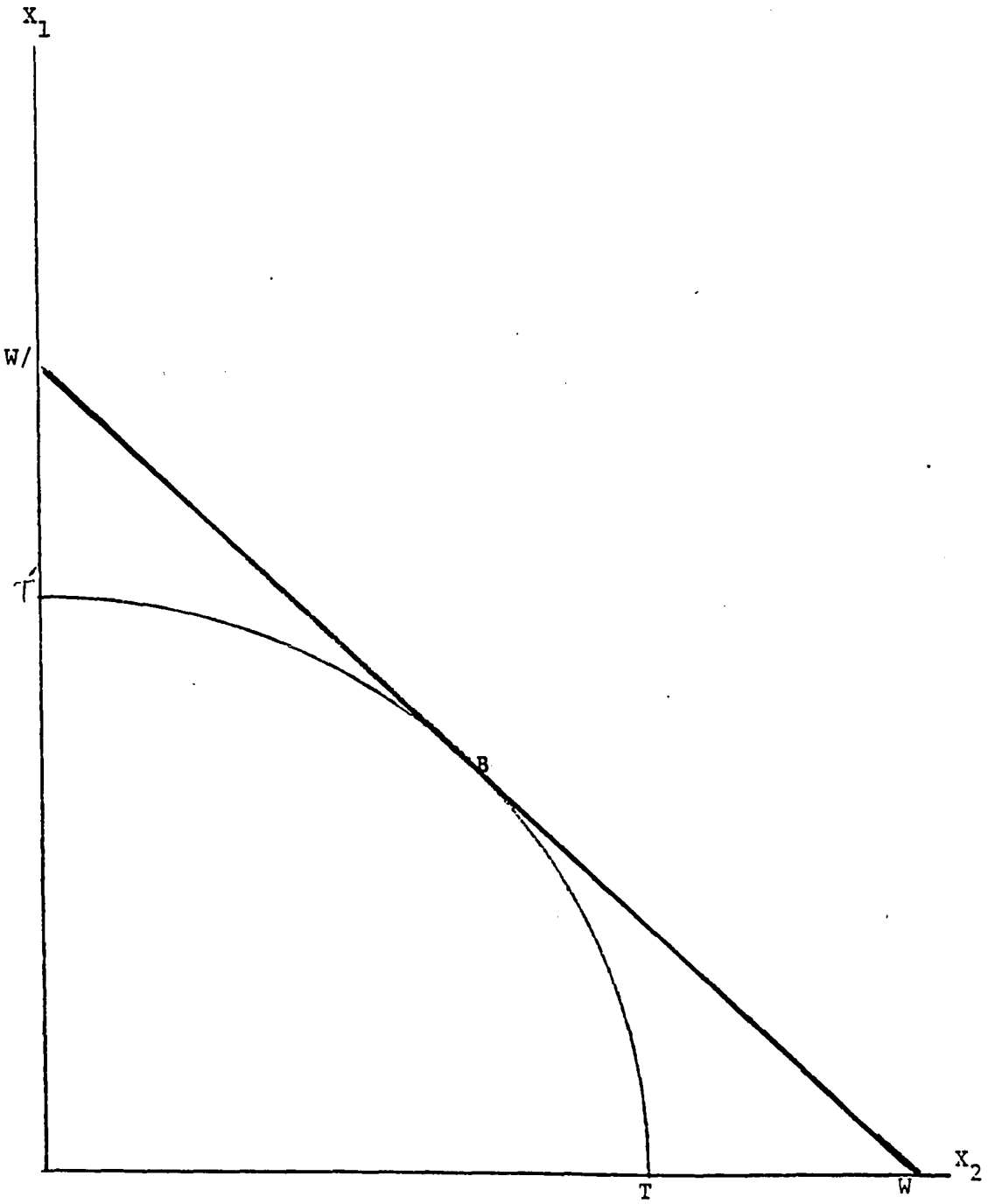


Figure 1. The Consumption Possibilities Frontier Under Free Trade

resultant consumption possibilities frontier is necessarily inside ABC, and thus inferior. The optimality of world prices in production also follows when countries are large enough to influence world prices, with the line WBW transformed into an arc, reflecting variation in the terms of trade.

These results show that national purchasing power is maximized at world prices. If a domestically-produced good is sold for less than the world price, export demand will expand until the price of the output and the prices of domestic factors of production increase. As a result, the incomes of consumers will increase. If the domestic price exceeds the world price of a good, import demand will increase and thus increases the purchasing power of consumers. As a result, demand for domestic production declines until domestic prices fall to world levels.

The optimum consumption point along the consumption possibilities could be determined by addition of community indifference maps to Figure 1 only if non-distorting lump-sum transfers are plausible, so that individual marginal utilities of income are equal everywhere along each indifference surface (Samuelson, 1962). In this case, the optimum consumption pattern can be determined by the tangency of an indifference surface with the line WBW.

The Classification of Inputs and Outputs

The "UNIDO" method divides project analysis into three components:

(I) Direct present benefits:

a. benefits from consumer goods,

b. benefits from producer goods,

c. benefits in earning foreign exchange.

(II) Direct present costs:

a. cost of producer goods,

b. cost of foreign exchange,

c. cost of labor,

d. cost of land and natural resources

(III) Indirect future benefits and costs which are not considered above.

Tables (2) and (3) describe the project evaluation process under the UNIDO method.

The "Little-Mirrlees" method identifies somewhat different components of a project:

(I) Tradable goods and services

a. Goods which are actually exported or imported (or their close substitutes actually exported or imported),

b. Goods that would be exported or imported had the country followed policies that would have resulted in optimum industrial development

(II) Non-traded goods and services such as land, capital and electricity,

(III) Unskilled labor. The reason for treating unskilled labor separately from non-traded goods rests on the fact that industrial wage rates often exceed labor's opportunity costs in developing countries.

Table 2. Estimation of Direct Benefits

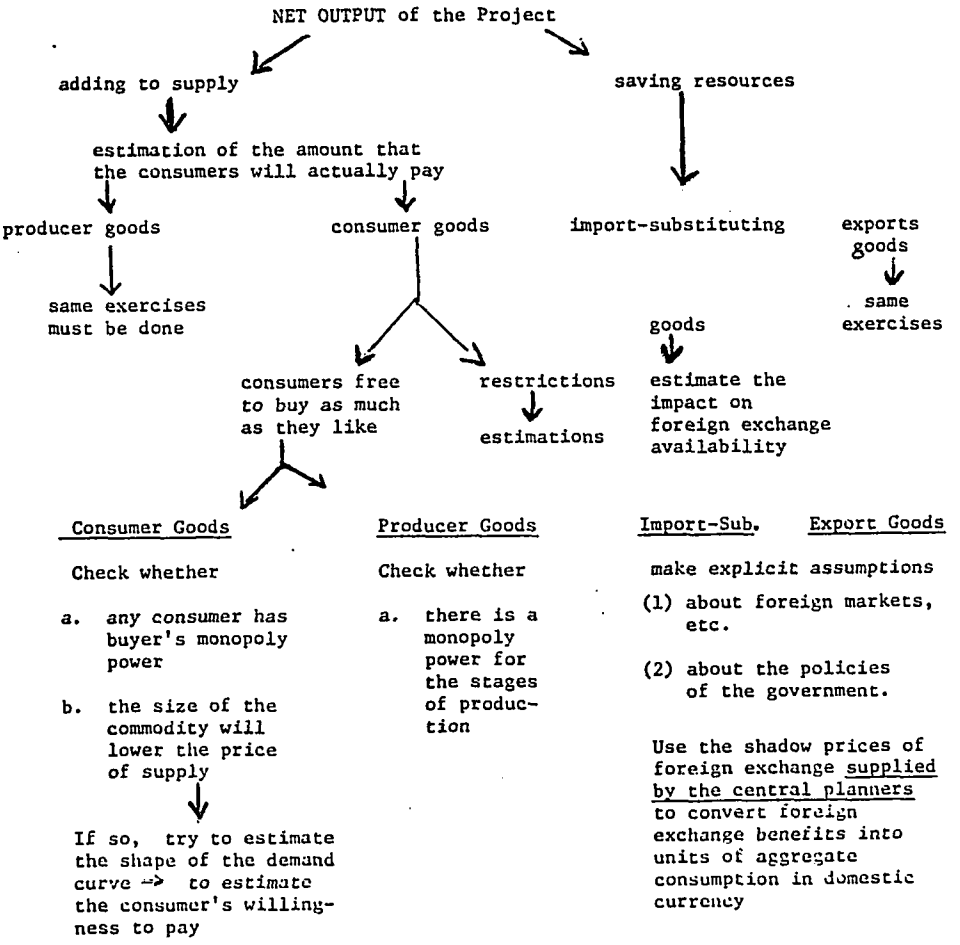
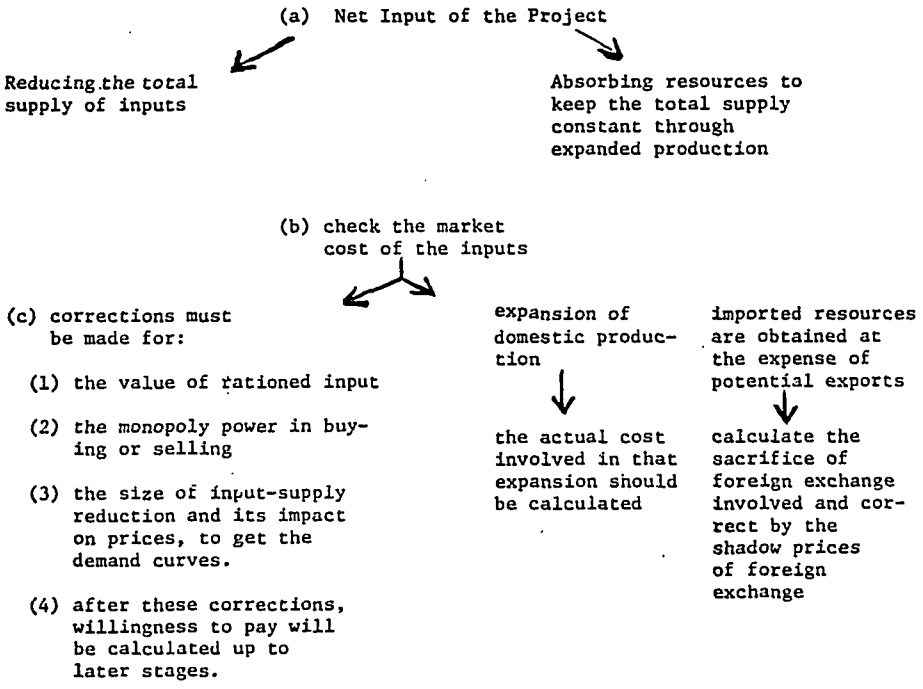


Table 3. Breakdown of the Estimation Procedure for Direct Costs Related to the Aggregate Consumption Benefits



(d) Direct future costs are discounted at the appropriate social rates of discount.

(e) Corrections for labor and land must be in terms of reduction of supply, as they cannot be met by expansion of production. Appropriate corrections will include all considerations of willingness to pay discussed in (B).

(f) Add up all these direct costs related to the aggregate-consumption objective.

Several techniques have been developed to evaluate mutually exclusive projects with the "DRC" method, including Bruno (1967); Pearson (1976); Findlay and Wellisz (1976); Srinivasan and Bhagwati (1978); Balassa and Schydlowsky (1972); and Monke (1982). Pearson (1976) and Monke (1982) have worked on the classification of outputs and tradable inputs under both the DRC and the net social profitability (NSP) methods. Both methods are conceptually related since each can be derived from the other. An economic activity is efficient (socially profitable) if social returns (measured by the c.i.f. price of a comparable import, or the f.o.b. export price for exported products) exceed social costs (measured by the sum of the border prices of tradable inputs and the social factors). Efficiency, social profitability and the efficient generation of foreign exchange are thus synonymous in this context since opportunity costs of tradable inputs and product values are measured in world prices.

Inputs are divided into components:

1. Fully traded (observed input is actually imported or exported).
2. Non-fully traded (if input is not imported or exported and expansion in demand is met by domestic production). This component is divided to:
    a. tradable components,
    b. non-tradable components which are finally divided to:
        1. tradable subcomponents
        2. domestic factors of production (labor, land and capital).

Shadow Price Estimation and the Treatment of Taxes and Subsidies Under Each Method

The breakdown of the perfectly competitive assumptions, (due to the existence of monopolies, taxes, and subsidies), results in market prices no longer equating the marginal social cost (MSC) and the marginal social value (MSV) of the relevant commodities. The recognition of these divergences in less developed countries has led these three methods of project evaluation to develop a set of "shadow" prices that would reflect the opportunity costs and returns of the inputs and outputs involved in a project. If neutral fiscal devices (lump-sum taxes and subsidies) are feasible, then a full Pareto optimum could be achieved if the government eliminates the divergences between (MSC) and (MSV) by lump sum tax-subsidy measures. However, if lump-sum transfers are impossible, the divergence may have to be taken as a constant and the "shadow" prices corresponding to this constrained (or "second-best") welfare optimum will need to be computed. All of the shadow prices which will be discussed are of this "second-best" kind.

The "UNIDO" method takes account of these divergences by differentially weighing the project's net benefits which are consumed and those which are saved, using the present aggregate-consumption as a numeraire. The costs of a project consist of its "net input" and its benefits consist of "net output". The marginal demand and supply prices are used for the costs and benefits. All foreign currency values of goods are converted into their domestic currency equivalents using the official rates of exchange, as this represents "willingness to pay".

Land, labor, and capital are treated separately. The appropriate measure of the cost of land is the ultimate consumers' "willingness to pay" for the aggregate-consumption made possible by the use of the land. The method corrects the market rental rate by applying the appropriate social rate of discount instead of the market rate of discount. The social opportunity cost of labor or the shadow wage rate (SWR) is used to measure the value of the alternative opportunity that society is losing by using the worker in the project. The "SWR" implies that the social opportunity cost of labor will be positive in the case of full employment and zero in the caose of unemployment. Capital as a primary factor input is measured by its social marginal productivity (SMP) using a social discount factor[1].

The "Little-Mirrlees" method uses current savings as the numeraire, and penalizes consumption. The numeraire evaluates all commodities in terms of uncommitted convertible foreign exchange. The social prices which better reflect social costs and benefits are called accounting prices (APS). If under perfectly elastic foreign demand or supply, a country can export 5 units of (A) at US $ 1 f.o.b. each, and import 1 unit of (B) at US $ 5 c.i.f., then the real opportunity cost of using a unit of (A) is 1/5 unit of (B). If the foreign demand or supply is not perfectly elastic, then the marginal export revenue (MER) from (A) and the marginal import cost (MIC) of (B) need to be substituted for the f.o.b. and c.i.f. prices.

If a country produces and trades to its own best advantage, the relative internal prices of traded goods (near a port) will be equal to the relative border prices. Therefore, the cost of an imported

[1]For more details, the UNIDO Guidelines, Chapter 4 and 14.

good is equal to the border price (or c.i.f. price) plus the cost of internal transportation, insurance, and purchase taxes. The return from an exported good is equal to the border price (f.o.b.) less the appropriate costs of transportation, distribution, and export taxes.

The (APS) of all tradable goods and services must lie between the import and export prices. Some things could not be traded, such as electricity, and thus the (APS) of electricity cannot be estimated from border prices. Nontradable goods are evaluated on the basis of local production costs which are broken down into foreign exchange (by the use of a "shadow" exchange rate or "conversion factor"), and rewards to domestic factors of production (labor, capital and land).

Unskilled labor is valued by its marginal product at border prices. The marginal value product is called the "shadow" wage rate. Capital is treated similarly, by applying an account rate of interest (ARI) to correct the difference between the social and the actual interest rates. The "shadow" rental rate of land is estimated as the amount that otherproducers would have been willing to pay for it, multiplied by a "conversion factor" (CF, discussed below). Figure 2, represents the classification system for tradable and non-tradable goods.

The "DRC" method relies on the international trade model to evaluate outputs and tradable inputs of any mutually exclusive projects. The results of this simple model can be extended to the general (nxn) case (Samuelson, 1967). Perfect competition and linear homogeneity of production ensures that:

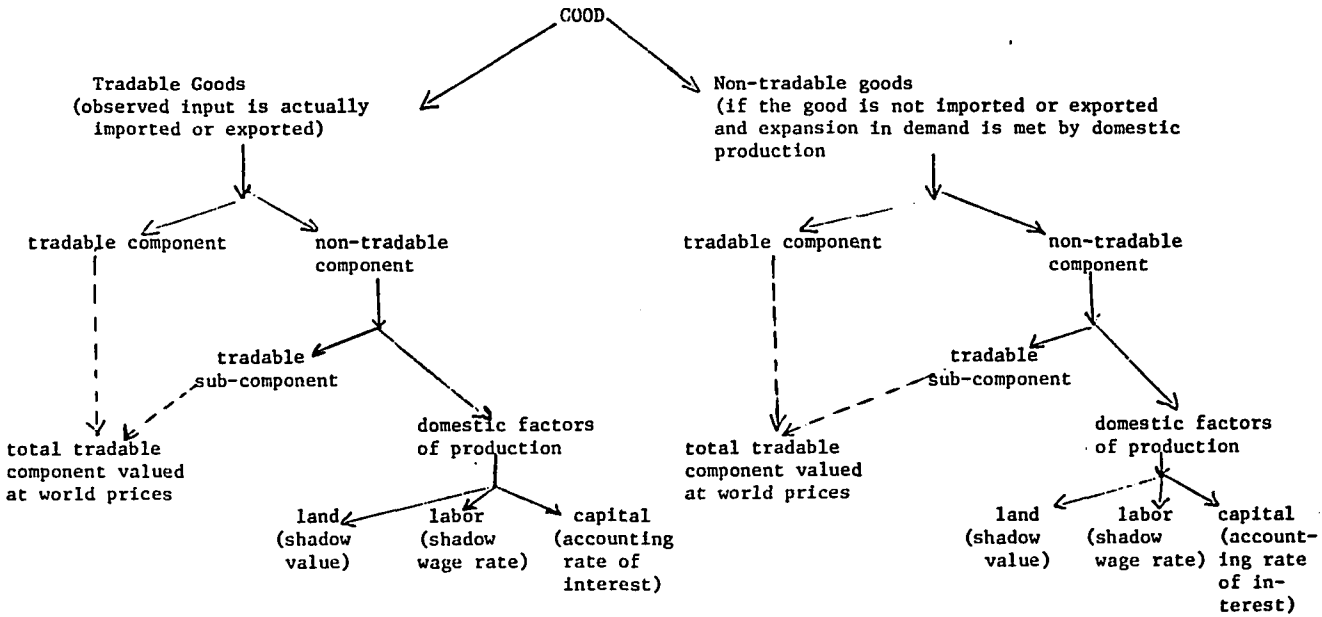


Figure 3. Classification System for Tradable and Non-Tradable Goods Under the Little-Mirrlees Method.

$$[W_1^* \ldots W_i^* \ldots W_m^*] \quad \begin{bmatrix} a_1^* \ldots a_{1i}^* \ldots a_{1n}^* \\ a_{i1}^* \ldots a_{ij}^* \ldots a_{in}^* \\ a_{m1}^* \ldots a_{mj}^* \ldots a_{mn}^* \end{bmatrix}_{(mxn)} = [P_1^* \ldots P_j^* \ldots P_n^*] \quad (4)$$

where w_i = price of the i^{th} factor

a_{ij} = the input-output coefficient, and

P_j = the price of the j^{th} output (X_j)

An asterisk (*) is used to denote the values of the various parameters under world prices. Since intermediate inputs are also produced outputs, world prices are optimal, and equation (1) can be rewritten, for the case of y intermediate inputs as:

$$[W_1^* \ldots W_{m-y}^*] \quad \begin{bmatrix} a_{11}^* \ldots a_{1,n-y}^* \\ a_{m-y}^* \ldots a_{m-y\ n-y}^* \\ (m-y \times n-y) \end{bmatrix} = [WVA_1^* \ldots WVA_{n-y}^*] \quad (5)$$

where $WVA_j = P_j - \sum_y^a yi\ Wy$, or value added at world prices. Intermediate inputs which have world prices are termed tradable inputs, and are at least potentially importable or exportable. The remaining inputs are not available on world markets, and are defined as non-tradable inputs. Thus equation (2) comprises (y) tradable inputs, (m-y) non-tradable inputs and (N-y) tradable final outputs.

Equation (2) provides a basis for the calculation of domestic factor prices. Shadow prices, or opportunity cost of inputs, are defined as the marginal value product of the input in its alternative uses. Given world prices for outputs and input-output coefficients, the shadow prices for domestic factors of production are calculated

by post-multiplication of both sides of equation (2) with the inverse of the matrix (m-y) x (n-y) input-output matrix, or

$$[\ W^*\ ] = [WVA^*][A.^*]^{-1} \quad . \tag{6}$$

The transformation is possible only if the input-output matrix is invertible. This condition requires that the determinant of the input-output matrix is non-zero, and that the number of tradable final outputs equal the number of non-tradable inputs, (m-y) = n-y).

The DRC of a new or existing production activity is thus determined by comparing value-added with the total cost of non-tradable inputs evaluated at their shadow prices. These shadow prices are calculated by excluding the activity from the estimation matrices of equation (2). Denoting the input-output coefficients for the new activity by b_{ih}, i=1,..., (m-y), the efficiency measures of the (DRC) are calculated as:

$$DRC_h = \sum_{i=1} b_{ih}\ W_i/WVA_h. \tag{7}$$

where h = 1, ... (n-y).

If DRC $\leq$ 1, the project is accepted, and if DRC $\geq$ 1, the project is rejected.

The calculation of the shadow prices from observable data is straightforward. Using a ^ for observed relationships, and assuming competition prevails within domestic markets, the observed input-output relationships are described by equation (4).

$$[\hat{W}]\ [\hat{A}_{ij}\ ] = [\hat{WVA}]$$

changes in output prices from domestic market prices to f.o.b./c.i.f. prices implies, for the j^{th} output,

$$\sum_i \left(W_i d\hat{a}_{ij} + \hat{a}_{ij}\, d\hat{W}\right) = d\hat{WVA}_i$$

Jones, (1965) has shown the above expression can be simplified, since by the Envelope Theorem, $\hat{\Sigma} W_i d\hat{a}_{ij} = 0$. Thus, a first-order approximation of the changes in domestic factor prices is:

$\hat{\Sigma}\, a_{ij}\, \Delta\hat{W}_i = \Delta\hat{WVA}_j$. This expression can be further transformed to:

$$\Sigma\theta_{ij}\, \frac{\Delta W_i}{\hat{W}_i} = \frac{\Delta\hat{WVA}_j}{\hat{WVA}_j} \qquad (8)$$

where $[\hat{\theta}_{ij}] = \dfrac{\hat{a}_{ij} W_i}{\hat{WVA}_j}$, the distributive share of the i^{th} factor in total value added.

Thus, first-order approximations of factor shadow prices can be estimated from the distributive shares and changes in world value added;

$$\frac{\Delta\hat{W}}{\hat{W}} = \frac{\Delta\hat{WVA}}{\hat{WVA}} \left[\hat{\theta}\right]^{\hat{}-1} \qquad (9)$$

The necessary data for DRC estimation comprises the sets of domestic and world prices for tradable outputs and inputs, and observed input-output coefficients of the production process. The prices of tradable goods may be defined in terms of any currency, as the shadow price of foreign exchange is already incorporated into the estimates of shadow prices for factors. Thus, the DRC measure is independent of currency valuation.

Differences and Similarities Among the Three Methods

Substantive differences among these alternative methods are in large part dependent on differing assumptions about the relevant aspects of the economic environment in which the investment decisions are being made. These assumptions are important for the practical problems of estimating the relevant values to be included in the NSP index. Given certain assumptions about the economic environment, the three methods are equivalent due to their common linkage-theoretical welfare economics. ONe of the basic results of welfare economics is that in a perfectly competitive economy, valuation of the changes in producers' and consumers' surplus at market prices will provide the correct indication of the net social benefits of the project. Market prices would then be the shadow prices used in project selection.

One area of difference among the methods concerns the matter of objectives. The "UNIDO" and Little-Mirrlees methods attempt to integrate non-economic objectives (income distribution, employment, inflation, self-reliance, and prestige) in their numeraires, while the DRC method concentrates on the microeconomic objectives of economic efficiency, and considers non-economic objectives independently of efficiency. The objective function which "UNIDO" and "Little-Mirrlees" tries to maximize is the present social value of consumption. This is done by differentially weighting the project's net benefits which are consumed and those which are saved. The only difference between the two methods in principle is the difference in numeraires. The "UNIDO" uses present consumption as the numeraire and puts a premium on savings, while the "Little-Mirrlees" method uses current savings as the numeraire, and penalizes

consumption. The DRC numeraire is simply the net foreign exchange earned or saved measured in foreign currency.

In the case of unskilled labor, the methods agree that the wage rate does not equal the social opportunity cost of labor in the economy. The UNIDO method distinguishes between the social values of government investment, government consumption, private investment, and private consumption. The method incorporates these four values in the calculation of the social opportunity cost of labor. As a result, the method develops three major components in the calculation of the shadow wage rate of labor; the direct opportunity cost of labor (including the direct opportunity cost of public-sector employment), the indirect costs (ebenficial effects on the rate of saving) and the redistribution of income (where unemployed and underemployed workers will generally be one of the groups whose consumption is accorded a greater social weight than consumption in the aggregate).

The Little-Mirrlees method also distinguishes between the proportion of the wage that is spent on consumption and that spent on saving. Thus, a project evaluation has to relate the value of uncommitted social income to the value of social income that is committed to consumption through the creation of additional employment. As a result, the method multiplies the actual wage rate of labor by a consumption conversion factor to make wage costs comparable to other costs and benefits. The shadow wage rate of labor under the DRC method is simply the direct social opportunity cost of labor. This opportunity cost is determined by the value of output foregone elsewhere in the economy as a result of employing labor on the project.

The use of border prices and domestic prices in the numeraire is one of the essential differences between the "UNIDO" method and the Little-Mirrlees and "DRC" methods. The "UNIDO" method uses domestic market prices to evaluate tradable and non-tradable goods. Thus, all the foreign currencies involved in the prices of inputs and outputs are revalued in terms of domestic currency using a shadow exchange rate "SER" to correct the difference between the official rate of exchange and the true rate. Little-Mirrlees adopts the reverse procedure (by conversion factors), while the "DRC" method uses world prices in the evaluation of outputs and intermediate inputs. The use of world prices is shown to imply a set of shadow prices for factors of production.

Another major difference is the calculation of the SER. The "UNIDO" method has a single shadow price of foreign exchange. Since all foreign currencies may be exchanged at an official set of exchange rates, the problem of valuing foreign currencies is reduced to finding a single price for a common unit of foreign exchange. This is estimated first by converting all foreign currency values into their domestic currency equivalents, using the official rates of exchange, and then calculating the domestic willingness to pay for an amount of foreign exchange officially equivalent to a unit of domestic currency. The Little-Mirrlees method has many conversion factors to convert domestic currency to foreign currency. As Little mentioned, "almost every traded good has a differenct conversion factor, i.e., a different ratio of the market price to the border price. In other words, we have dozens of rates of exchange" (1973). The DRC method estimates sets of domestic and world prices for tradable outputs and inputs, and observed input-output coefficients of

the production process. Since the prices of tradable goods may be defined in terms of any currency, the shadow prices of foreign exchange is already incorporated into the estimates of shadow prices for factors.

Another common concern among the three methods is the rate of discount. The "UNIDO" method has a shadow price for saving which is considered constant, and this leads to a unique rate of discount, the consumption rate of interest. The Little-Mirrlees method allows the shadow price of savings to vary over time. Thus, the method has a different rate of discount for different periods. This rate is called the accounting rate of interest. Under the "DRC" method, utilization of the value marginal product of capital at world prices as a measure for the shadow price of capital ignores the social rate of time preference, because the consideration of the social time preference rate will have no impact on the marginal value products of capital.

The Rationale for the Use of the 'DRC' Method

The "DRC" method has several advantages over the UNIDO and Little-Mirrlees methods. Among these advantages are the ease of calculation of the shadow prices of factors of production. The "DRC" method states that exports or import substitutes should be developed on the basis of comparative advantage. That is, a country should specialize in the products in which it has relative efficiency with respect to the rest of the world. This approach will allow selection of projects without resorting to a long-term economic framework. Such macroeconomic frameworks are adopted by the "UNIDO" and Little-Mirrlees methods. Both methods rely on the Project Evaluation Office to determine the national parameters, such as the SER, the SWR, the social rate of discount, and

the accounting rate of interest. The "DRC" measure is independent of currency evaluation, while the other two methods follow impractical and sometimes impossible techniques in the calculation of the SER. Similar considerations apply to the social rate of time preference and the SWR of unskilled labor.

Another advantage of the "DRC" method is the utilization of the value marginal product of capital at world prices as a measure of the shadow price of capital. the "UNIDO" and Little-Mirrlees approaches for the calculation of the social discount rate and the accounting rate of interest are lengthy and often impracticable. It is straight-forward to show that consideration of the social time preference rate will normally have no impact on the value marginal product of capital. Arguments in support of the use of an interest rate lower than the value marginal product of capital suggest that, for various reasons (such as insufficient consideration of future generations), consumption is "too large" and investment is "too small". But such arguments are concerned with macroeconomic rather than microeconomic allocations of resources, and equations 5 and 6 show that changes in the aggregate supply of capital will normally have no effect on the rate of return to capital.

In summary, therefore, the "DRC" method has several advantages over the "UNIDO" and Little-Mirrlees methods, and was consequently adopted for use in this study of alternative uses for molasses in the Sudan. While the "UNIDO" and Little-Mirrlees methods employ more convoluted and often impractical procedures for calculating the shadow wage rate of labor, the shadow prices of foreign exchange and the social rate of time preference, the "DRC" concentrates on microeconomic analysis,

independently of non-economic factors, it provides a more accurate yardstick of comparative economic efficiency.

CHAPTER III

INDUSTRIAL USES FOR MOLASSES

Two potential applications for industrial use of molasses exist in the Sudan--the production of alcohol and the incorporation of molasses into animal feed production. Alcohol would be used mainly for gasohol, since the market for alcohol in Sudan is small. The technology to produce alcohol is well known from extensive experience in other countries, such as Brazil and the United States. The animal feed industry is new in Sudan, but good results have been reported with feeding concentrates to dairy heifers at the Kuku Milk Plant, one of the largest milk production plants in Sudan. Molasses will allow a reduction in the carbohydrate portion of the ration since molasses is a partial substitute for sorghum, the main source of energy in the ration formula. Experimental results show that the cost of rations can be reduced by 25 percent per liter of milk for local consumers and the quality of meat exported can be improved considerably.

The first section of this chapter describes four alternative models of ethanol production plants. Certain advantages are claimed for distilleries and feed mills located in conjunction with sugar factories. These advantages are fuel self-sufficiency and reduced transportation costs for molasses and furnace oil. However, potential problems do exist, such as the proximity to consumption centers and the transport of supplementary fuels. On the other hand, independent

distilleries and feed mills have higher capital costs for storage, steam generation, administrative buildings and molasses transportation. Alternative firms and locations have been selected to allow a full assessment of the costs and benefits of alternative sites. The models represent three different sizes: A large scale plant of 170,000 liters of alcohol, two medium-size plants of 100,000 liters of alcohol per day, and a small-scale model with production equal to the quantity of molasses produced by the smallest of Sudan's sugar factories (about 20,000 liters of alcohol per day). Table 4 shows the different distillery sizes. Two of these plants are located at sugar processing sites and two are in a consuming center.

The second section deals with animal feed mills. The feed mills represent three different annual production capacities: A large-scale mill of 500,000 metric tons of feed pellets and bulk feeds, a medium-scale mill of 250,000 metric tons, and a small-scale mill of 100,000 metric tons.

Alcohol Production

About 200,000 tons of molasses is produced annually as a by-product of the sugar refining industry. Less than three percent of this amount is exported, with f.o.b. prices ranging from U.S. $40-$90 per metric ton. The exportation of molasses is often unprofitable and unpredictable due to the cost of storage in both the sugar factories and the seaports, the frequent unavailability of gasoline for molasses transport, the high cost of internal transportation, the taxes and duties levied on exported molasses, and the continuous fluctuations in world prices of

Table 4. Alternative Distillery Techniques

Item	Large-Scale Distillery 170,000 liter/day	Medium-Scale Distillery 100,000 liter/day	Medium-Scale Distillery 100,000 liter/day	Small-Scale Distillery 20,000 liter/day
Location	Rabak City	Rabak City	The Kenana Sugar Factory	New Halfa Sugar Factory
Source of Molasses	(1) Kenana Sugar Factory 120,000 t (2) Asalya Sugar Factory 30,000 t (3) Sennar Sugar Factory 20,000 t (4) Guneid Sugar Factory 20,000 t (5) New Halfa Sugar Fact. 25,000 t	(1) Kenana Sugar Factory 120,000 t (2) Asalya Sugar Factory 30,000 t	(1) Kenana Sugar Factory 120,000t (2) Asalya Sugar Factory 30,000t	(1) New Halfa Sugar Factory; (2) furnace oil from Port Sudan
Source of steam generation to distill alcohol	Furnace oil from Kosti-Oil Refinery	Furnace oil from Kosti-Oil Refinery	(1) The Kenana Sugar Factory (2) Furnace oil from Kosti-Oil Refinery	(1) New Halfa Sugar Factory (2) furnace oil from Port Sudan
Access to Consuming Centers	Tarmac road to: (1) Khartoum; (2) Medani; (3) Port Sudan	Tarmac road to: (1) Khartoum (2) Medani; (3) Port Sudan	Near Rabak City from Rabak Tarmac Road to Khartoum, Medani, and Port Sudan	Tarmac road and Railways from New Halfa City to Port Sudan, Medani, and Khartoum
Number of working days/year	300	300	300	300
Number of shifts/day	Three shifts. Each one 6 hours	Three shifts; each one 6 hours	Three shifts; each one 6 hrs.	Three shifts; each one 6 hours.
Capital equipment costs (LS)	5,350,000	4,400,000	4,400,000	1,680,000
Steam Generation Equipment (LS)	1,267,500	1,033,400	180,000	127,500
Storage Equipment (LS)	780,000	570,000	285,000	74,250
Building costs (LS)	804,000	620,250	322,500	165,000
Molasses storage capacity (mt) per year	72,800	50,000	25,000	4,170
Alcohol output mt/year	44,262	30,098	30,098	5,046

molasses. Table 4 presents estimates of total net revenues for exports of molasses from each sugar factory. The total net revenue ranges from $7-11/mt.

Low net revenues have led the Ministry of Industry, the Ministry of Energy and the private sector to search for more profitable uses. Interest in the use of molasses for the production of alcohol has also been spurred by increases in the price of petroleum. The price of regular gasoline was increased from LS 0.25 to LS 1.75 per gallon and the price of premium gasoline was increased from LS 0.45 to LS 2.00 during the last ten years. Alcohol production is envisioned as a partial substitute for petroleum.

Almost any type of sugar-containing mixture can be used as a raw material for alcohol production. The reaction to produce alcohol involves the conversion of glucose (sucrose or fructose) by various strains of yeast to ethyl alcohol and carbon dioxide. This reaction proceeds via the following equation:

$$C_6H_{12}O_6 \xrightarrow{\text{yeast}} \underset{\text{ethyl alcohol}}{2C_2H_5OH} + 2CO_2$$

The above reaction is a simplification of the total reaction involved in this conversion, but sufficiently descriptive for the purpose of this thesis. Figure 3 describes the fermentation and distillation process.

The prerequisites of a good yeast culture for alcohol production from molasses are the ability to efficiently ferment high sugar concentration, tolerance to high concentrations of non-sugar solids and

Table 5. Estimated Ex-factory Returns for Exporting Molasses by Road[1], LS per Metric Ton-1982.

Factory	Road Exclusive Use of Tankers	Road Backhaul Use of Tankers	Port Sudan Handling and Storage	Portage Costs LS[2]	Develop. Taxes 5%	Ex-Factory Costs Assuming Backhaul	Wholesale Price of Molasses at Port Sudan U.S. $[3]	Net Revenue Assuming Backhaul U.S. $	Total Net Revenue U.S. $
Guneid	30.00	15.00	3.600	2.37	0.50	21.47	40.00	9.78	195,600
New Halfa	28.00	14.00	3.600	2.37	0.50	20.47	40.00	10.88	217,600
Sennar	32.00	16.00	3.600	2.37	0.50	22.47	40.00	8.68	260,400
Kenana	35.00	17.50	3.600	2.37	0.50	23.97	40.00	7.03	843,600
Asalya	33.00	16.50	3.600	2.37	0.50	22.67	40.00	8.46	253,800

[1]25 metric ton tankers.

[2]LS 2.37 portage cost per ton.

[3]Feed molasses (79.5 Brix) wholesale f.o.b. price. Terminal, New Orleans, U.S.A., 1982 c.i.f. price $60.00 per metric ton.

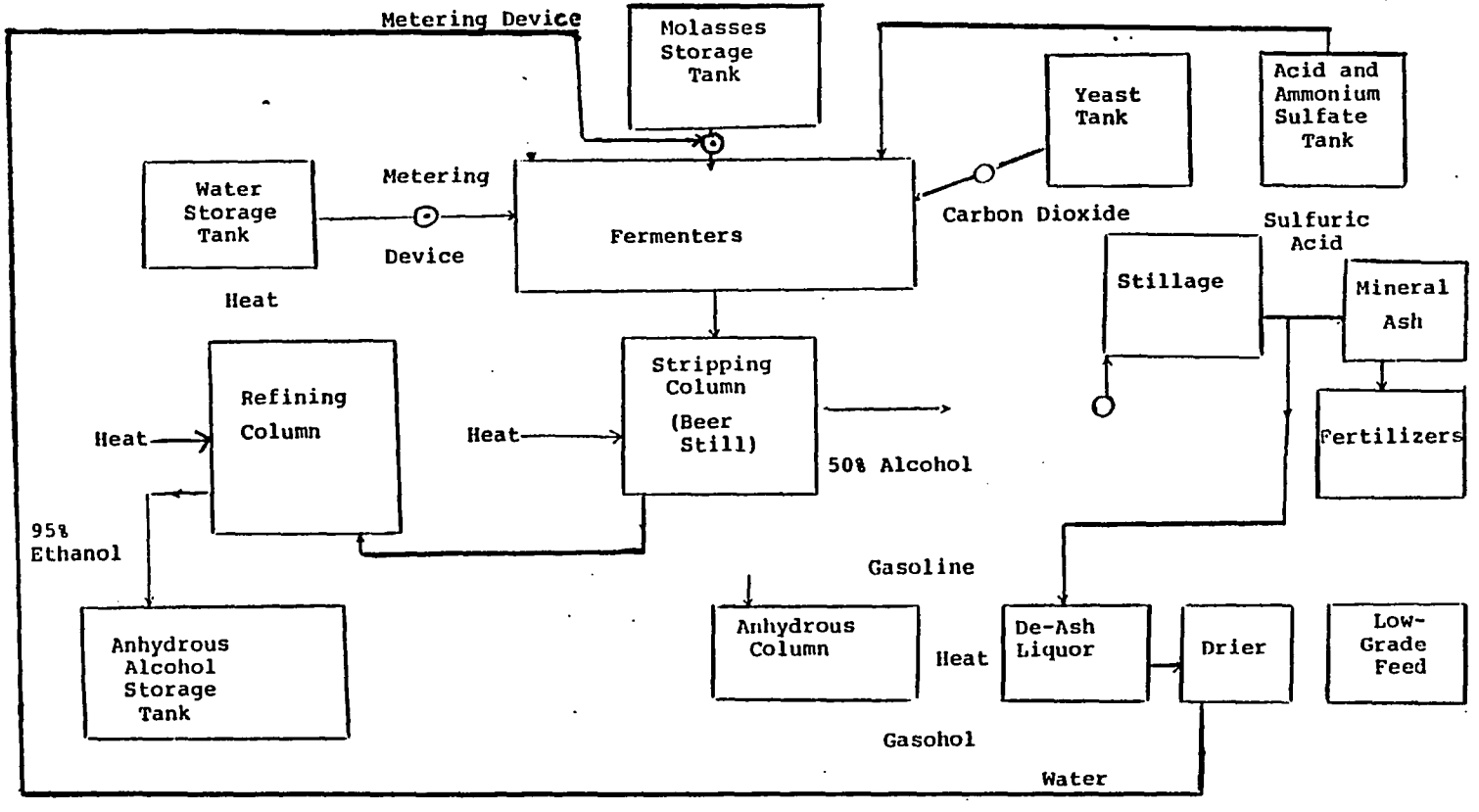


Figure 3. Fermentation Process

tolerance to high temperature. Yeast cultures are usually propagated in the laboratory. A two-step process is used for seeding the large fermenters. First, a working volume of mash aqueous solution is inoculated with yeast from the laboratory and grown out. The sugar concentration in this stage is usually 9% to 10%. The pH of the mash is adjusted to about 4.8 for maximum fermentation action, ordinarily with 12.5 kg of sulfuric acid per metric ton alcohol. In the second seeding stage, a volume of mash is inoculated with the pre-seed stage. Fermentation of this mixture is conducted until a suitable yeast concentration has been achieved. The contents are then ready for use as an inoculum for one or more large fermentation tanks.

The actively growing and fermenting yeast is added to the final fermenters. The usual volume of inoculum is 2% to 5% of the final volume. The active yeast is added to the fermentation tank at the same time the mash is being added to allow development of the yeast during the tank-filling period. This process provides additional fermentation time and at the same time helps prevent growth of contaminating organisms. By the time the fermentation vessel is filled, the fermentation is proceeding at a rapid pace. Cooling of the fermented mash is necessary for maximum fermentation efficiency and final product quality. Fermenters usually operate at a temperature between 70° and 80°F, maintained by the circulation of the mash through external coolers. The time necessary to complete a fermentation varies with the sugar used, the yeast types, and temperature, but usually requires 36 to 48 hours. During fermentation, the specific gravity of the mash decreases, and when the specific gravity has ceased to drop over a

period of three hours, the fermentation is considered complete. At this time, the fermented mash, now known as "beer", contains approximately 5% to 6% alcohol.

Once fermentation has ceased, the fermentation vessels are left to allow suspended solids, such as yeast cells, to settle to the bottom of the fermenters. The supernatant of the fermented mash is drawn off and pumped to the distillation house. (Alternatively, the total content of the fermentation tank is passed through a centrifuge without settling. The clarified beer is pumped to an overhead mash feed tank and the yeast and the muds are diverted to a separate tank. After settling and centrifuging, the clarified mash is pumped into a "beer" holding tank from where it will be pumped to the distillation plant).

The function of distillation is to separate the ethanol from the water. The lower boiling point of ethanol permits the alcohol vapors to be evaporated from the water or beer. However, in the distillation process water is driven off with the alcohol vapors which necessitates repeated evaporations. A distillation column with its series of plates facilitates repeated evaporations and condensation until alcohol-rich vapors are driven from the top of the column and water and solids are removed from the bottom. The mixture at this concentration has a lower evaporation point than either alcohol or water. Various types of distillation equipment are used, including continuous-type stills with combined rectifying columns, beer stills with doublers, and chambered stills. A continuous distillation still is favored by the majority of distillers.

The beer is introduced into the column as steam is injected into the bottom. The steam and beer injection rates are determined by the column design and size. As the ethanol vapors are driven upward, the water and solids progress to the bottom of the column. At the bottom of the column, the water and solids are removed via a sump pump and pumped to a holding tank exterior to the plant. The alcohol vapors driven from the top of the column pass through a condenser/ preheater where heat is transferred from the vapors to the beer being pumped into the column. The cooling of the vapors causes condensation to an ethanol-rich liquid approaching 190-200 proof.

The condensed alcohol is pumped to sealed tanks where the ethanol can be stored. Finally, the solid product collected in the centrifuges can be washed, collected and dried further in a drum dryer. This dried product is satisfactory as a fertilizer and as an animal feed.

Figure 4 describes the alternative technologies for alcohol production considered in this study. Three criteria are relevent to the choice of an optimal distillery size. Sugar production can be used to determine the potential distillery sizes since sugarcane consumption determines the amount of molasses produced. Second, distilleries located in conjunction with sugar factories can make use of the buildings, offices and steam generation centers of the sugar factories. Independent distilleries will thus have higher operating costs. Third, the cost of transportation of molasses, fuel and alcohol varies by site. This factor is particularly important since the internal transportation infrastructure is limited.

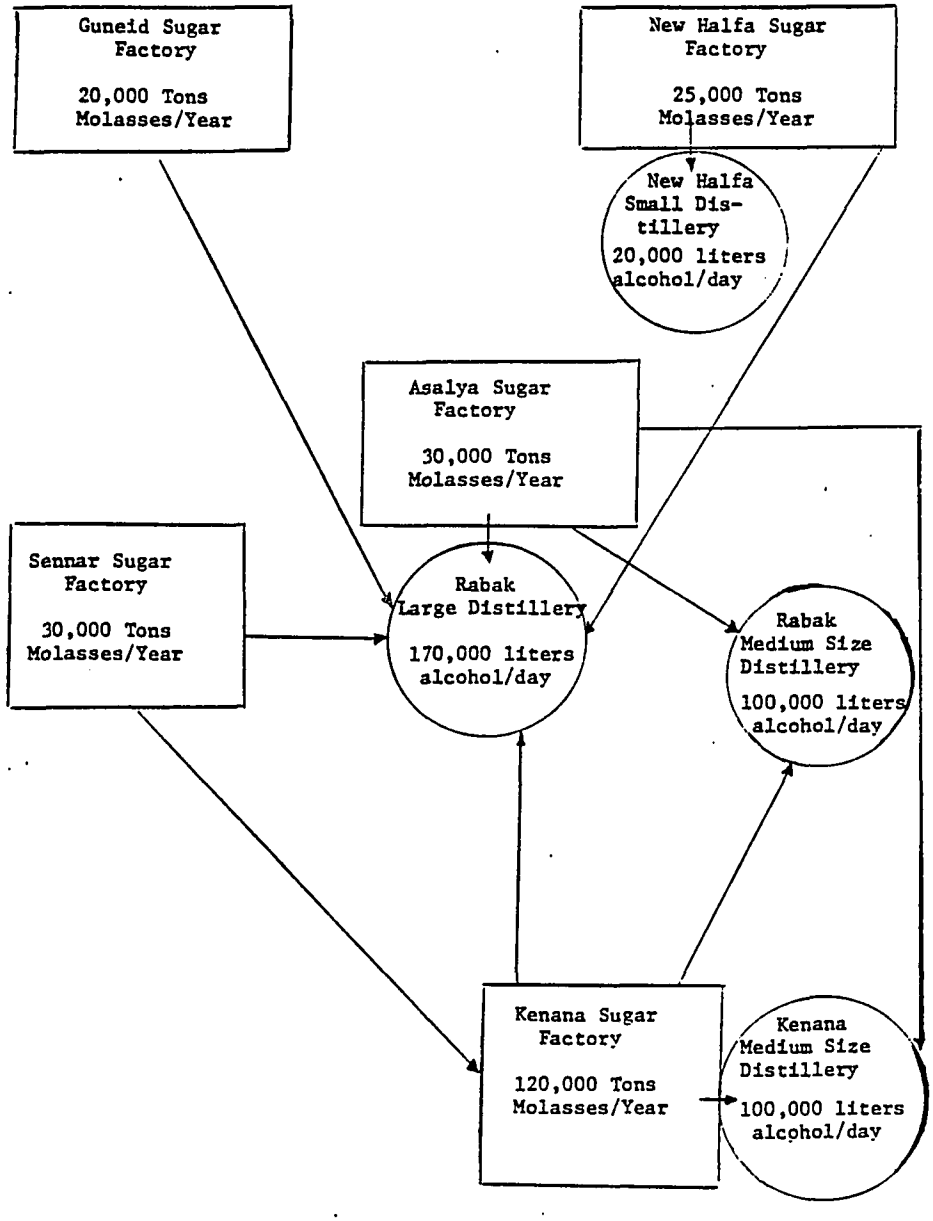


Figure 4. Classification System for Tradable and Non-Tradable Goods Under the Little-Mirrlees Method.

Three locations for the distilleries are considered: Rabak, the Kenana sugar factory; and the New Halfa sugar factory. The largest independent distillery would be located in Rabak with production of 170,000 liters of alcohol per day. Molasses would be drawn from all sugar factories, Kenana, Asalya, Sennar, Guneid and New Halfa. The annual production of molasses by each factory is estimated as 120,000 tons, 30,000 tons, 30,000 tons, 20,000 tons and 25,000 tons, respectively.

The advantages of the Rabak site are its proximity to the three largest factories of Kenana, Asalya and Sennar. These three factories account for 82 percent of national molasses production. Thus, the cost of transportation of molasses will be low. The price of furnace oil is also expected to be low, especially after the completion of a refinery at Kosti, a river port adjacent to Rabak City. Finally, Rabak is one of the largest consumption centers in Sudan and links the central and the southern parts of the country. The main disadvantages of this site are the cost of transportation of molasses from the small outlying areas, the dependence on oil as a fuel source. rather than the steam produced from the bagasses of the sugar processing industry, and the overhead costs involved in the operation of the distillery independently of all sugar factories.

Alternatively, a medium-size distillery with a scale of 100,000 liters of alcohol per day could be located in Rabak. Molasses would be drawn only from the Kenana and Asalya sugar factories. The main reason to analyze this alternative is to test the differences in energy costs between a medium-scale distillery attached to a sugar

factory and an independent one. The advantages of this distillery are similar to those of the large distillery, but would require lower molasses transportation costs than the large-scale distillery.

A distillery with a scale of 100,000 liters of alcohol per day could also be located at Kenana. Production would utilize the molasses of both the Asalya and Kenana sugar factories. The site has a major advantage in that a large proportion of the required molasses will require no transport. Technical and engineering facilities of the sugar factory could be used to operate the distillery. By the end of 1982 the Kenana-Rabak tarmac road will be completed and will link the distillery to both Khartoum and Rabak, the most important consuming centers for alcohol. This road would also provide access to Port Sudan for alcohol export.

The smallest distillery considered is attached to the New Halfa Sugar Factory, with production of 20,000 liters of alcohol per day. Molasses would be drawn exclusively from the sugar factory with an estimated quantity of 25,000 tons per year. The site's proximity to the Port and access to the tarmac road between Khartoum and Port Sudan means that transportation costs will be relatively low.

Molasses for Animal Feed

Cane molasses is used all over the world for animal feed and 60 percent or more of molasses traded in world markets is used for this purpose. Molasses may account for as much as 15 percent of total feed ration in U.S. feed mills, even though the cost of molasses is relatively high. In the Sudan, rations have contained as much as 25 percent molasses

without any nutritional problems. A number of factors explain the attractiveness of molasses. The total organic matter of molasses is digestible and can be substituted for other energy-supply sources in animal feeds such as cereals. Molasses is particularly valuable in feeding ruminants, such as cattle, as it stimulates the microflora of the rumen. In addition, the flavor and smell promotes appetite and helps to mask unpalatable elements of feed, such as poor quality cereals, minerals and urea. Molasses is also useful in preventing dustiness and crumbling in the manufacturing and transportation of pellets.

The standard feed formula is composed of carbohydrates, protein, and fats, together with small quantities of salt, limestone, protein-vitamin premix and urea. The following percentages of dry matter are used in the feed mix evaluated here: 45.8 percent sorghum, 15 percent molasses, 31.7 percent cottonseed cake, 4 percent wheat bran, 1.7 percent limestone, 0.70 percent salt, 0.1 percent urea and 0.45 percent protein-vitamin premix. Almost all required ingredients are available within Sudan. More than 200,000 tons of molasses is produced annually in the five different sizes of sugar factories. Sorghum is the major cereal grown in rainfed and irrigated areas. Other ingredients, such as cottonseed, salt and limestone, are available in abundant quantities. Urea and vitamin-premix are required in small quantities and would have to be imported.

A conventional feed production technology is evaluated in this study. Bulk deliveries are received through an intake hopper with conveyors to the processing buildings. However, as the major part of

the grains and cottonseed will be received in bags, raw material in bags are stored in a separate warehouse. The grain is transported to silos after cleaning and weighing. Molasses is stored in tanks in the mill warehouse.

Two hammer mills and an expeller grinder process the grains and cottonseed which are then conveyed to the proportioning bins. Wheat bran, urea and limestone are moved directly to the proportioning bins. Ground and unground materials are mixed with automatic long hopper weighing scales. The ingredients are mixed in batch mixers. Each mixing cycle takes approximately ten minutes and produces approximately ten metric tons of feed. Water as well as preweighed micro ingredients, such as vitamin and minerals, are added directly into the mixer. The feed is passed through a control sifter before it is conveyed to the bins for finished meals, or to the buffer bins for pellet production.

In the pellet mill, the feed meal is converted to hard pellets with the addition of steam and a maximum of 15 percent molasses. The pelleting process destroys most of the microorganisms, decreases handling losses, increases digestibility and saves volume. The warm, soft pellets are cooled in a vertical pellet cooler. The cooled pellets are then mixed and stored in bins.

The feed plant is designed for both bulk and bag distribution of finished products. For bulk distribution, trucks and railway wagons are filled with feed. The weight is measured by means of an automatic weighing scale. When distributing in bags, the feed is filled in bags

and manually stocked at a warehouse. The pellets are handled by electric fork-lift trucks in the warehouse for finished products.

Table 6 summarizes the characteristics of the three alternative feed mills analyzed in this study. Since their technologies are identical, economies of scale will result from differences in collection and distribution costs. Three criteria are relevant to the choice of an optimal feed mill size. First, location of the mill (i.e., whether or not is is attached to a sugar factory) is a key consideration. Kenana and Sennar feed mills are located in conjunction with sugar factories and thus can make use of the steam generation, buildings, storage facilities and administrative offices of the sugar factories. The Khartoum feed mill, as an independent operation, will have higher capital costs. A second consideration is the proximity of the mills to consuming centers. Kenana and Sennar, being located in the central region of Sudan where thrity percent of the livestock are raised, will benefit from low distribution costs of their outputs. The Khartoum feed mill will also benefit from low distribution costs since it is located in the most populous city of Sudan. A third criterion is the cost of transporting the necessary ingredients to the feed mills. Sixty percent of the sorghum, ninety percent of the molasses and sixty percent of the cotton are produced in the central region adjacent to the Kenana and Sennar mills,while Khartoum will have higher operating costs since it is more distant from the raw materials.

Table 6. Alternative Feed Mill Techniques

Item	500,000 metric ton per year Kenana Feed Mills	250,000 metric ton per year Sennar Feed Mill	100,000 metric ton per year Khartoum Feed Mill
Location	The Kenana Sugar Factory	The Sennar Sugar Factory	Khartoum North Town
Source of Molasses	The Kenana Sugar Factory	(1) The Sennar Sugar Factory (2) Asalya or Kenana Sugar Factory	The Guneid Sugar Factory
Source of Sorghum	(1) The Mechanized Rainfed Schemes (2) White Nile Schemes	(1) The Gezira Irrigated Scheme (2) Mechanized Rainfed Scheme	(1) The Gezira Irrigated Scheme (2) Mechanized Rainfed Scheme
Source of Steam Generation to Manufactured Animal Feeds	(1) The Kenana Sugar Factory (2) Kosti-Oil Refinery	(1) The Sennar Sugar Factory (2) Kosti-Oil Refinery	(1) Port Sudan Oil Refinery (2) Kosti-Oil Refinery
Access to Consuming Centers	Tarmac Road and Railways to: (1) Medani; (2) Khartoum; (3) Port Sudan	Tarmac Road and Railways to: (1) Medani; (2) Khartoum; (3) Port Sudan	Tarmac Road and Railways to (1) Medani; (2) Khartoum; (3) Port Sudan
Number of Working Days	300	300	300
Number of shifts/day	Three shifts; each one 6 hours	Three shifts; each one 6 hours	Three shifts; each one 6 hours
Capital equipment costs	214,160	1,070,800	535,400
Steam generation equipment (LS)	258,000	158,000	105,340
Storage equipment (LS)	395,000	295,000	263,360
Building Costs (LS)	695,550	464,357	309,568
Molasses Storage (mt per year)	------	7,500	15,000
Pellets Feeds (mt/year)	250,000	125,000	50,000
Bulk feeds (mt/year)	250,000	125,000	50,000

CHAPTER IV

EMPIRICAL RESULTS

This chapter contains a discussion of the empirical results for the optimal economic uses of Sudanese molasses. The chapter is divided into five sections. The first section describes the major government incentives, such as taxes and subsidies for both private and public sectors. The second section discusses private and social costs and benefits within each industry. The third section compares the private and social profitability results. The last section of the chapter focuses on non-efficiency objectives and constraints, and discusses how these factors may influence the choice of an optimal use for molasses.

Major Government Incentives

The central government affects all industrial production through trade policy instruments, price setting, provision of infrastructure and monopolization of certain import goods. The government is the sole importer for crude oil, sugar and wheat. Excise lump sum duties ranging between LS 20 and LS 68 are usually levied on these three imported goods. All commodities are subject to a 15 percent exchange tax, a five percent development tax and a ten percent import surcharge and quay dues. However, inputs for firms registered in the Ministry of Industry as development projects, such as raw material, equipment and machinery, are subjected to only five percent import

duties. Local production in the industrial sector is subjected to a 25 percent production tax.

Alcohol distilleries and animal feed mills are treated similarly with respect to fixed costs. The opportunity cost of capital is assumed to be ten percent for social investment and two percent for private investment. All imported capital goods are subjected to five percent import taxes, 20 percent sea freight and two percent insurance.

In addition, several indirect taxes, such as fuel taxes, vehicle registration fees, Social Security and other personal taxes are levied on private projects. The local markets of alcohol in Sudan are small; its domestic price will be compared with the domestic prices of gasoline. The gasoline market is partially monopolized by the government (more than 50 percent of the refinery industry is owned by the government). The c.i.f. price of alcohol is estimated to be about LS 417.00 per metric ton (mt), while the domestic price is LS 590 per mt. The production tax accounts for LS 147.5 per mt of the price difference. Additional divergencies are caused by the exchange tax, development tax, import surcharge and quay dues and the excise duty on petroleum.

Animal feeds (pellet feeds and bulk feeds) are classified as non-traded goods, rendering the determination of their "equivalent" world prices much more difficult. The domestic average price of animal feeds for 1980-81 were estimated as LS 200 per mt for pellets and LS 170 per mt for bulk feeds, while the prices of the similar outputs produced in the other countries, like the United States and Europe in 1980/81, were estimated to be about U.S. $250 and U.S. $330, respectively. Therefore,

the latter prices of the animal feeds are taken as equivalent world prices for the corresponding domestic prices of the Sudan's animal feeds.

If domestic feed prices are lower than in other countries, then these advantages will be reflected in relative profitability of the meat products. Low domestic prices of animal feed relative to prices in other countries will encourage comparative advantage in the meat exporting sector and, as a result, the social values of exported meat are expected to increase above present prices due to the quality improvement from increased feeding rates. Thus, the difference between domestic and world prices for feeds represents the contribution of animal feeds to the export earnings from meat and livestock.

Private and Social Costs and Benefits

Table 7 presents private and social costs for collection, processing and distribution for the seven systems. The difference between private and social collection costs is negligible because all the equipment and vehicles are imported with a very low import tax. This effect is offset by the difference between private and social interest rates (2% and 10%, respectively). Among the alcohol production systems, the Kenana distillery has the lowest costs of collection (about LS 4 per mt) because 80 percent of its required molasses is drawn from the Kenana Sugar Factory and the rest is transported from Asalya or Sennar sugar factories, 20 and 40 miles from the Kenana Sugar Factory, respectively. In addition, the Kenana distillery will need to transport only one-third as much furnace oil because being attached to the Kenana Sugar Factory will give it access to the surplus steam generated by the factory

Table 7. Cost of Production Techniques (LS per metric ton of output)

Alcohol Plants	Collection		Processing		Delivery to Consumer Centers	
	Private	Social	Private	Social	Private	Social
Rabak Large Dist.	6.47	6.93	237.76	239.64	47.79	45.02
Rabak Medium Dist.	6.17	6.44	245.92	247.25	49.30	46.50
Kenana Medium Dist.	3.62	3.68	213.33	215.21	50.63	47.95
New Halfa Small Dist.	13.70	14.09	299.43	315.10	53.40	53.49
Animal Feed Plant						
Kenana Feed Mill	0.62	0.64	175.93	149.32	19.44	18.58
Sennar Feed Mill	1.17	0.84	174.44	147.71	31.36	29.68
Khartoum Feed Mill	1.92	1.40	176.82	150.78	31.35	29.68

during the production season. Both independent distilleries at Tabak have collection costs of about LS 6 per mt due to the cost of transportation of molasses from the five scattered sugar factories. Moreover, independent distilleries must transport all the furnace oil required for alcohol processing from the Kosti Oil Refinery (not yet operational) near the Rabak distilleries. The New Halfa small-scale distillery had the highest cost of collection per mt (LS 14,000), as inputs must be transported 250 miles from Port Sudan.

Among the feed mill alternatives, Kenana has the lowest cost of collection (LS 0.60 per mt) due to its large-scale production and proximity to suppliers of sorghum (from mechanized rainfed schemes near the Kenana Sugar Factory) and molasses (all drawn from Kenana Sugar Factory). Cost of collection at the Sennar feed mill is LS 1.00 per metric ton because 20 percent of the molasses required must be transported from either Asalya or Kenana sugar factories. The Khartoum feed mill has to transport all molasses from the Guneid Sugar Factory (about 70 miles from Khartoum) and sorghum from even farther distances, and collection costs increase to about LS 2/mt.

Four systems for alcohol fermentation and three systems for animal feed manufacturing are compared in Tables 8 and 9. Among the two distilleries attached to sugar factories, labor costs at New Halfa are four times higher than those at Kenana. The reason for this difference is the scale of production -- Kenana distillery being five times larger than New Halfa. In addition, the distilleries attached to sugar factories absorb some of the off-season unproductive labor of the sugar factory, and thus the Kenana distillery has lower labor costs than the

independent alcohol mills.

Labor costs at the Khartoum feed mill are two times higher than at the Kenana and Sennar feed mills. Two factors account for this difference. Kenana and Sennar feed mills are attached to sugar factories so they can benefit from the off-season labor of the sugar factories. The Khartoum mill is independent and, hence, it has to hire labor all through the year, especially unskilled labor. The other factor is the scale of production. Since the three feed mills have identical technologies, the labor cost per unit of output for Khartoum feed mill is twice that of the Kenana and Sennar feed mills. The Khartoum feed mill operating at one-fifth that of Kenana and less than half that of Sennar.

Table 7 shows estimates for the fixed costs of the distilleries for steam generation, storage facilities and buildings. Kenana distillery has the lowest fixed costs per metric ton of alcohol for these three essential items in the processing stage. The distillery obtains two-thirds of its steam from the excess steam production of the sugar factory for the six months of the sugar processing season. The storage cost is low because 80 percent of the molasses is drawn from the Kenana Sugar Factory while only 20 percent needs storage. Since the distillery is annexed to the sugar factory, capital costs for buildings and offices are also low. The high fixed costs of New Halfa Distillery are due to its small scale of production compared with other distilleries. The independent distilleries have high fixed costs compared to the above models, since these models have to build their own steam generation system, storage facilities and administrative buildings.

Table 8 shows that the feed mills attached to sugar factories have low fixed costs for steam production when compared with the Khartoum independent feed mill. The fixed cost of steam generation for the Khartoum independent feed mills have higher furnace oil operating costs (about LS 31) than feed mills attached to sugar factories (about LS 21.0). This difference occurs because the attached feed mills can use surplus steam from the sugar factories. Similar results hold for the alcohol distilleries. However, storage costs of the Khartoum feed mill is 25 percent lower than that of Sennar and 40 percent higher than Kenana storage facilities costs. Since the Khartoum feed mill is independent of a sugar factory, it must construct its own buildings, which explains why its fixed costs are almost twice that of mills annexed to sugar factories.

The total cost savings realized by attaching the Kenana medium distillery to the Sugar factory is 10% compared with that of the Rabak independent distilleries. The private costs of tradable inputs for processing alcohol for all distilleries are higher than the social costs as tradable inputs are imported with a five percent import tax. The private costs for intermediate tradable inputs for all feed mills are also higher than social costs. Most of the intermediate inputs required for animal feed manufacutring are obtained from domestic markets. These markets are highly distorted and heavily taxed by the government. The budget tables of the processing costs in the Appendix show that the border taxes levied on the intermediate inputs are only two percent of the domestic taxes. For example, the domestic taxes on sorghum,

Table 8. Private and Social Costs of Animal Feed Manufacturing (LS/mt)

Distillery	Private Costs					
	Fixed Costs				Tradable Inputs	
	Labor	Steam Production	Storage Facilities	Buildings	Furnace Oil	Total Manufacturing Costs
Kenana Feed Mill	0.47	0.085	0.23	0.199	21.00	175.09
Sennar Feed Mill	0.46	0.121	0.30	0.266	21.00	173.41
Khartoum Feed Mill	0.98	0.955	0.242	0.450	31.00	184.17
	Social Costs					
Kenana Feed Mill	0.46	0.043	0.082	0.108	20.00	145.91
Sennar Feed Mill	0.44	0.066	0.164	0.144	20.00	145.19
Khartoum Feed Mill	0.93	0.641	0.131	0.250	30.00	155.50

Table 9. Private and Social Costs of Alcohol Processing (LS/mt)

Distillery	Private Costs					
	Labor	Selected Capital Cost Items			Tradable Inputs	Total Processing Costs
		Steam Production	Storage Facilities	Buildings	Furnace Oil	
Rabak Large Distillery	10.90	4.10	2.53	2.60	31.50	234.50
Rabak Medium Distillery	10.68	4.92	2.71	2.95	31.50	238.08
Kenana Medium Distillery	7.73	0.86	1.36	1.54	10.50	210.04
New Halfa Small Distillery	27.69	3.60	2.10	4.69	10.50	292.38
	Social Costs					
Rabak large Distillery	10.60	2.22	1.37	1.41	30.00	191.00
Rabak Medium Distillery	10.39	2.67	1.47	1.60	30.00	192.98
Kenana Medium Distillery	7.48	0.46	0.74	0.83	10.00	172.00
New Halfa Small Distillery	26.77	1.96	1.14	2.54	10.00	204.30

cottonseed, molasses and furnace oil are LS 25 metric ton of animal feed, while the border taxes are only LS 0.76.

The difference between the private and social costs of distribution is negligible. This is due to the same reason mentioned for the case of the costs of collection. However, independent distilleries have lower costs of distribution (about LS 47.00 per metric ton) than those annexed to the sugar factories (about LS 50 per metric ton). This difference is due to the proximity of independent distilleries at Rabak to the consumption point (Kostil Oil Refinery is close to Rabak City), while alcohol production of the Kenana Distillery must be transported to the Kosti Oil Refinery (20 miles from the Kenana Sugar Factory). Alcohol production of the New Halfa Distillery must be transported to the Port Sudan Oil Refinery (250 miles from New Halfa Sugar Factory).

Similar conclusions apply to the feed mills. The cost of distribution for the Kenana feed mill is about LS 19, while that for the Khartoum feed mill is about LS 30.00 per metric ton. One of the main reasons for this difference is the scale of production -- the Kenana mill being five times greater than Khartoum. The Sennar and Khartoum feed mills have similar distribution costs and this is due to the proximity of Khartoum feed mill to the urban consumption centers (around Khartoum and in North Blue Nile Province). This advantage offsets the economies of scale for the Sennar feed mill.

Private and Social Profitability

Table 10 includes a number of economic indicators to test the economic efficiency of the two alternative outputs from molasses: net

Table 10. Indicators of Private and Social Profitability

Activity	Private Cost LS/mt	Social Cost LS/mt	(NPP) Net Private Profitability LS/mt	(NSP) Net Social Profitability LS/mt	DRC
Rabak Large Distillery (170,000 L/day)	288.25	291.54	217.22	54.094	0.835
Rabak Medium Distillery (100,000 L/day)	297.24	300.19	208.23	44.374	0.949
Kenana Medium Distillery (100,000 L/day)	263.81	266.84	242.66	89.186	0.606
New Halfa Small Distillery (20,000 L/day)	361.56	382.68	147.91	-30.95	2.036
Kenana Feed Mill (500,000 ton/yr.)	194.87	168.54	-17.37	199.954	0.036
Sennar Feed Mill (250,000 ton/yr.)	204.97	178.23	-47.47	184.134	0.095
Khartoum Feed Mill (100,000 ton/yr.)	207.96	181.81	-50.46	200.252	0.105

social profitability (NSP), domestic resource cost (DRC), and net private profitability (NPP). All the distilleries have positive NPP, indicating that private alcohol producers have positive incentives to ferment molasses for commercial trade. The NPPs of alcohol distilleries range from LS 147.91 (New Halfa) to LS 252.66 (Kenana) per metric ton. Economics of scale account for 65 percent of the differences between the lowest and highest NPP. In contrast, all feed mills have negative private profitability, ranging from LS -17.37 to LS -50.46 per metric ton. The Kenana feed mill has the lowest negative NPP, followed by Sennar and Khartoum. Again, the scale of production is the main factor accounting for the difference, the Kenana feed mill being two times and five times greater than the other feed mills, respectively.

Several reasons account for the positive NPP of the distilleries and the negative NPP of the feed mills. Firstly, the domestic prices of alcohol is higher than the c.i.f. price of unleaded gasoline. The difference is LS 173 per metric ton, and actually results in increased profit for private producers. Secondly, low import taxes (ranging from LS 2.00 to LS 4.00 per metric ton) on the intermediate inputs, and high input subsidies (ranging from LS 6.00 to LS 24.00) for alcohol processing make that industry profitable. On the other hand, the domestic prices for feed pellets and bulk feed are lower than the equivalent world prices. Domestic and equivalent world prices for feed pellets are LS 250 and LS 300, respectively, while bulk feed prices are LS 170 and LS 200 per metric ton. Another factor contributing to the negative NPP of feed mills is the high border taxes (averaging LS .70) and domestic taxes (averaging LS 25.00) on the intermediate inputs.

While distilleries have much higher net private profitability than do feed mills, the reverse is generally true in the case of net social profitability. Three of the alcohol distilleries have positive (but relatively low) NSP, ranging from LS 44.374 (Rabak Medium) to LS 89.19 (Kenana Medium), while one (New Halfa) has a negative NPP of LS -30.95. The difference in range is largely attributable to the location of the distilleries. Kenana Medium (NSP LS 89 per metric ton), but the former is attached to a sugar factory while the latter is independent. This advantage of location even holds when the Kenana Medium distillery is compared to the Rabak Large distillery (NSP LS 54 per metric ton) whose production capacity is more than one and a half times greater. Thus, the advantage of location more than offsets the advantage of the economy of scale. This difference implies that a hypothetical distillery at Kenana similar in size to the Rabak Large would have, by far, the highest net social profitability.

The negative NSP at New Halfa implies that the advantage of being attached to a sugar factory still cannot offset the effect of the small scale of operation. However, a medium-scale distillery at New Halfa would show a positive NSP because production of 100,000 liters per day (five times greater than production at the present New Halfa plant) would result in lower collection, processing and distribution costs per metric ton.

On the other hand, all the feed mills are highly socially profitable, ranging from LS 200.25 at Khartoum to LS 184.13 per metric ton at Sennar. Most of the inputs required for alcohol production are subsidized, while most of the inputs for animal feed production are

taxed. Thus, the adjustments of outputs and inputs of the two activities to their corresponding border prices will reduce the NSP of the distilleries and increase that of feed mills.

Table 11 compares the total NSP that can be obtained if all molasses (226,000 metric tons) is utilized in either alcohol distilleries or feed mill models according to their different scales of production. Total NSP from distilleries ranges from LS 1,241,408 to LS 5,047,740. The largest contribution to national income from distilleries occurs if two medium-size distilleries are established to utilize all the molasses. The feed mills are highly socially profitable irrespective of the size of the mill. For example, the net national income generated from Kenana feed mill is sixty times higher than that of the Kenana distillery if all the molasses produced is utilized.

Another economic efficiency measurement is the domestic resource cost (DRC) ratio. This ratio provides a useful comparison of economic efficiency between activities since the DRC is a unit-free measure. Activities with a DRC ratio less than 1.0 are economically efficient because they employ domestic factors whose opportunity costs are less than the net income produced. To the extent that the government allocates resources among competing activities, it should first select activities with the lowest resource cost ratios.

Table 10 shows that three distilleries have DRC ratios less than 1.00, ranging from 0.606 to 0.949, while one (New Halfa) has a DRC greater than 1.0. The DRC ratios of the feed mills are lower than

Table 11. Comparison of the Total NSP of Molasses in the Two Techniques (220,000 mt)

Plant Size	NSP/mt[1] LS	NSP/plant LS	Quantity of Molasses per plant	Numer of Plants Required by total domestic production of molasses	Total NSP LS
Rab. L. Dist.[2]	54.00	2,390,148	220,000	1	2,390,148
Rab. M. Dist.	44.00	1,325,312	150,000	2	2,648,624
Kenana M. Dist.	90.00	2,708,820	150,000	2	5,417,640
New Halfa Small Dist.	-31	156,426	25,000	8	-1,251,408
Kenana FM[3]	200	100,000,000	77,500	3	300,000,000
Sennar FM	184	46,250,000	38,750	5	231,250,000
Khartoum FM	200	20,000,000	15,500	13	260,325,000

[1] Metric ton of alcohol for the distillery and animal feeds for mills

[2] 5 tons of molasses are required to produce 1 ton of alcohol

[3] 15% of the animal feed ration is molasses

the distilleries, ranging from 0.036 to 0.105. These ratios imply that animal feed manufacturing is more efficient than alcohol production in saving and providing foreign currency. Moreover, the DRC ratio, as a guide to the industry that should be encouraged, shows that government interventions have the opposite effect because the more costly industry (alcohol) receives the greatest subsidies, and the least costly industry is taxed.

Sensitivity Analysis

The sensitivity of the results to changes in social factor costs are analyzed to test for the importance of uncertainties in data. The sensitivity of the results to changes in assumptions is discussed within an elasticities framework. The values presented in Table 12 represent the percentage changes in social profitability that result from a one percent change in the value of the parameters listed in the column headings.

Net social profitabilities are insensitive to changes in skilled and unskilled labor as well as land rent. However, the NSP of the distilleries are more elastic than the feed mills with respect to changes in the cost of capital. Table 13 shows the effect of interest rate changes in the DRC ratio. At an interest rate of 18 percent, all distilleries except Kenana will be economically inefficient. The results for feed mills are insensitive to the interest rate changes.

Non-Efficiency Objectives and Constraints

The analysis has thus far been concerned primarily with indicators of economic efficiency. Sudan, however, is not interested solely

Table 12. Elasticities of NSP with respect to social cost of primary inputs. 1% change in NSP vs 1% in primary inputs.

Model	Elasticities			
	Unskilled Labor	Skilled Labor	Capital	Land
Alcohol Model				
Rabak L	-0.121	-0.132	-0.877	-0.021
Rabak M	-0.170	-0.137	-1.217	-0.026
Kenana M	-0.051	-0.068	-0.502	-0.013
New Halfa Small	-0.520	-0.613	-3.053	-0.090
Animal Feed Model				
Kenana FM	-0.0018	-0.0043	-0.0175	-0.0004
Sennar FM	-0.0022	-0.0048	-0.0571	-0.0005
Khartoum FM	-0.0037	-0.0054	-0.0622	-0.0007

Table 13, Changes in DRC Ratio at Selected Shadow Prices of Capital

DRC Ratio Interest Rates	Distilleries				Feed Mills		
	Rabak Large	Rabak Medium	Kenana Medium	New Halfa Small	Kenana	Sennar	Khartoum
1%	0.52	0.58	0.37	1.31	0.023	0.053	0.060
5%	0.64	0.73	0.46	1.60	0.028	0.069	0.078
8%	0.77	0.87	0.56	1.89	0.034	0.086	0.096
10%	0.83	0.95	0.61	2.04	0.036	0.095	0.105
12%	0.90	1.02	0.65	2.18	0.029	0.103	0.114
15%	1.03	1.17	0.75	2.47	0.044	0.120	0.132
18%	1.15	1.32	0.85	2.76	0.049	0.136	0.150
21%	1.28	1.47	0.94	3.05	0.055	0.153	0.168
24%	1.41	1.62	1.04	3.34	0.060	0.170	0.186

in generating more income, but is also concerned with income distribution and reduction in the risk of shortfalls in the availability of both petroleum and animal feeds. Self-sufficiency in these two outputs may hlep in the achievement of additional development goals, such as diversification of the Sudan's export sectors. Some of the relative merits of alcohol and animal feed production considered here include the generation of jobs, vulnerability to molasses shortages, technical efficiency, domestic demand and export feasibility.

The data in the budget tables of the Appendix show a similar degree of labor intensity of both activities, although independent systems have relatively higher labor intensity than systems attached to the sugar factories. This result is consistent with the idea that models attached to the sugar factories will absorb the excess labor of the sugar factories during their off seasons. However, feed mills, whether attached to sugar factories or independent, have advantages over distilleries if all molasses is utilized in the production of animal feeds. For example, the Kenana distillery can absorb 234 laborers while the Kenana feed mill can absorb up to 579 laborers. Thus, feed mills provide relatively abundant employment opportunities and a more equitable distribution of rural income than the distilleries. This effect occurs without any loss of economic efficiency since the feed mills are more socially profitable.

Alcohol distilleries are more vulnerable to a reduction in molasses production during a bad sugar season than the feed mills. While five tons of molasses are required to process a ton of alcohol, only

0.15 tons of molasses is required to process a ton of animal feed. For example, if the Kenana Sugar Factory reduces its molasses production by half (to 60,000 tons), it is still sufficient for the Kenana feed mill to produce at almost full capacity, but the Kenana distillery has to reduce its production capacity by about 50 percent.

The technical efficiency of using gasohol in Sudan has been investigated by a committee from the University of Khartoum, Ministry of Energy and Oil companies. An experiment was carried out in 1981 to test the performance of two popular cars in the Sudan using alcohol mixtures in the various amounts and under different road conditions. Several problems were identified. The first was the heavy carbon deposits found on the valves and on the piston crowns. The committee attributed these deposits to incomplete combustion due to the blend used. The second drawback was that gasoline and alcohol are two extremes as far as water affinity is concerned. Blends of gasoline and alcohol have intermediate values of miscibility (water tolerance). This water tolerance increases with the increase of alcohol ratio in the mix. A gasohol containing about 0.7% colume of water is practically certain to separate under any condition. It is, therefore, important to ensure that storage tankers are maintained in an essentially dry condition. The third technical problem is the metal corrosion with gasohol utilization even in the absence of phase separation. As a result, electrical equipment, such as submerged fuel pumps, may be expected to suffer major damage if immersed in the alcohol/water phase.

These problems will increase the degree of risk in gasohol marketing unless the government provides regulations and information to guide gasohol producers and marketers. The result of these precautions will increase the cost of alcohol distribution since a technical division is needed to test and disseminate this information. Conflicting interests between alcohol distilleries and the petroleum industry may affect the proper utilization of the gasohol. In sum, substantial coordination is needed in order to ensure the efficient utilization of gasohol.

Other uses of alcohol include potable alcoholic beverages (whiskey, brandy), intermediate chemicals (for use in pharmaceuticals and cosmetics), and as a feedstock for the production of other chemicals (acetaldehyde). However, these markets are small in Sudan. The sole distillery in Sudan is "Watania" distillery in Khartoum with a fairly small operation capacity. It uses 2,500 to 3,000 tons of molasses to produce 400 tons of alcohol. The market need is estimated at about 800 tons per year, the remaining requirements being imported[2]. These quantities are utilized for the pharmacy, perfumery, industry and educational needs. In addition, alcohol is imported (about 285 tons in 1980) for beverage purposes and production of date-based sherry.

World markets for alcoholic beverages are dominated by well-established and heavily advertised brands. Thus, the quality of alcohol to be exported should be considered in order for Sudan to compete in world markets. In addition, the quantity and port of shipment are important since alcohol requires careful handling and shipping which makes

[2]Source: Foreign Trade Statistics, Sudan, 1980.

it more expensive for exportation. Parcel tankers probably need a minimum of 1,000 tons to make a port call worth considering. The price trend in alcohol is very complex and affects its trade considerably, since fermentation alcohol tends to follow the price movement of molasses with a delay, and to exaggerate the savings of molasses prices. It is also affected by the synthetic alcohol situation. For example, the U.K. domestic prices of alcohol fluctuated between LS 150 in 1975 and LS 350 in 1981. Moreover, alcohol world markets are characterized by many regulations and agreements between alcohol producing countries and importing countries, making difficult entry into the alcohol trade.

Animal feed needs no government intervention in the urban markets and negligible effort in the rural markets. Local expansion of the animal feed markets will be faster than the markets for alcohol as the demand for animal feed is growing rapidly. For example, Khartoum's meat and milk suppliers have been unable to keep up with the growing population of the capital, and the quality of meat sold is low. Sudan's six year socio-economic plan (1977-1983) proposes several livestock and animal feed projects which will provide fattening stations, new transportation systems, and markets for the cattle of the west region (particularly on the Nyala-Khartoum railway line). These projects will increase the rural market of animal feeds, since 60 percent of the cattle and 80 percent of the sheep and goats are owned by nomads. The plan also calls for the establishment of an incentive livestock industry based on grains, molasses and fodder near Khartoum and Gezira. The estimated demand for animal feed is estimated at 1,900,000 tons of feed for cattle, and sheep fattening, 58,000 tons of concentrates for dairy

Production, and 10,000 tons of concentrates for poultry production. In sum, the local markets for animal feed are much more substantial than alcohol markets.

CHAPTER V

SUMMARY AND CONCLUSIONS

The imbalance of the Sudan's foreign trade has led the government to attempt to diversify the export sector and reduce imports. One of the national programs is the expansion of the sugar manufacturing industry, and sugar production is expected to reach 850,000 metric tons annually. As a result, more than 200,000 metric tons of molasses will be produced as a by-product of sugar milling. Molasses exports have proved to be unprofitable under the present infrastructure in Sudan, as more than 50 percent of the export value of molasses is lost to transportation costs.

The present economic efficiency analysis of alternative uses of molasses was based on the doemstic resource cost and net social profitability measures of social cost-benefit analysis. The methods are particularly appropriate for this study because they focus on foreign exchange earned or saved. In addition, the measurement of economic efficiency has important applications both as means of evaluating past policy initiatives and as a guide to future investment opportunities.

Two kinds of adjustments were made to convert private costs and returns into social prices. Firstly, outputs and tradable inputs are valued in comparable world prices to eliminate the transfers caused by government policies. Alcohol and animal feed outputs are measured

in terms of what the country must pay for their imports (or can receive for their exports) instead of the actual market prices that prevail domestically. Similarly, inputs that can be imported are valued at their true import costs in place of a subsidized (or taxed) market price. Secondly, labor, capital and land are valued with respect to their social opportunity costs, which represent the value in world prices of the output foregone from not using the resources in their best alternative employment. These adjustements make the comparison of social benefits with social costs possible and thus determine whether or not it is efficient to produce alcohol or animal feed. Economic-engineering approaches are used to develop model designs and costs for alcohol distilleries with plant sizes of 20,000, 100,000 and 170,000 liters per day, and for feed mills with production capacities of 500,000, 250,000 and 100,000 metric tons per year. As in any synthesis or budgeting approach, assumptions are inherent in their presentations. The Appendix tables provide collection, processing, and distribution budgets for each model of the two industries.

Net social profitabilities were positive for both activities since cost per ton of the outputs is less than cost per ton of imported comparable products. The feed mills, however, have the highest NSP and lowest domestic resource costs ratios, the Kenana feed mill being the most profitable. The Kenana Distillery is the most profitable among the four distillery models. The New Halfa small distillery is the only model having negative NSP, in spite of the fact that it is attached to the New Halfa Sugar Facotry. This result implies that a distillery with a size of production less than 20,000 liters/day is

socially unprofitable. Distilleries attached to sugar factories are more efficient than independent models, irrespective of the size of the distillery, since independent models have higher fixed and operating costs.

Feed mills are more economically efficient than alcohol distilleries. The highest net national income obtained from distilleries is forty times less than the lowest net national income from feed mills. Feed mills have negative private profitability, maninly because their input costs are higher than the social costs. The domestic price of sorghum is particularly important, as this commodity is highly taxed by the government. To avoid negative NPP in the animal feed industry, the government faces two options. It can further improve the efficiency of the new sorghum production technologies in the rainfed mechanized schemes and thereby reduce the domestic prices of sorghum through higher productivity per acre, or it can remove the quantitative restrictions and the high import duties on sorghum.

Non-economic objectives and constraints are considered in addition to economic efficiency. Feed mills will provide better employment opportunities than the distilleries if all the molasses is used in the animal feed industry. Feed mills will benefit local livestock producers and indirectly the livestock export sector. This will, consequently, increase foreign exchange earnings and improve the purchasing power of local livestock producers. In sum, income distribution goals will be better achieved in the animal feed industry. Finally, feed mills will increase government revenues through taxes while the alcohol industry receives input subsidies.

Gasohol production suffers from several technical problems accompanying its preparation and distribution. Blending of alcohol with gasoline raises the problem of water affinity which can result in reduced gasohol mileage efficiency and carbon deposits in automobile engines. Gasohol production also requires close coordination between the petroleum industry and alcohol distilleries which have somewhat conflicting interests in the separate stages of blending alcohol to gasolines. Animal feed needs less coordination among its relevant sectors compared with alcohol.

Alcohol production cannot offer more than a very partial solution to the energy problems of the Sudan. In the immediate future, practical difficulties in creating a successful agro-industry energy system, such as the technical problems accompanying alcohol production (in which the Sudan has no past experience), are likely to limit the processing of alcohol on a large scale. More importantly, total alcohol production would substitute for only about 20 percent of total gasoline consumption in Sudan.

On the other hand, the prospects for animal feed manufacturing are good if accompanied by complementary government policies. The promotion of this industry can be achieved with provisions for government financial support and appropriate incentives for agro-industrial research toward the improvement of the quality of meat for export, as well as extension and credit facilities in both the animal feed industry and the meat and livestock exporting sector. The government can also design a cohesive pricing system for animal feeds for use in the intensive fattening industry in order to overcome the large distortions

in agricultural, meat and livestock pricing, and to provide financial incentives to promote production of animal feeds as a substitute for the present low quality of the pastures.

APPENDIX

1982 ALCOHOL PRODUCTION BUDGET (LS)
Distillery Name: Rabak Large-Scale
Location: Rabak City
Capacity: 170,000 liter/day

Item	Quantity		Wages		Capital	Tradable Inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct Labor									
Production Department	23	55	64,033	75,840				4,590	144,463
Engineering and Maintenance Dept.	40	78	106,476	154,560				7,100	268,136
Admin. and Management	13	5	34,529	10,400				1,290	46,219
Services Department	9	5	21,078	6,400				720	28,198
2. Fixed Inputs									
2. Land	70,000 m^2				49,421			-36,040	13,381
3. Buildings and Site Preparation					115,215		2,456	-55,228	62,443
4. Foundation and Erection					23,044		492	-11,046	12,490
5. Furniture					5,776		123	- 2,768	3,131
6. Equipment					858,131		20,818	-350,176	528,782
7. Storage Equipment					111,775		2385	-53,577	60,583
8. Steam generation equipment					181,635		3877	-81,065	98,447
9. Transport					33,682		817	-12,108	22,391
10. Training					4,581			- 2,196	2,386
3. Intermediate Inputs									
11. Molasses	220,000	ton				5,500,000		275,000	5,775,000
12. Sulfuric acid	262.5	ton				411,750	16,875		428,625
13. Ammonium sulfate	225	ton				150,975	6,188		157.163
14. Urea	315	ton				76,860	3,150		80,010
15. Furnace oil	13,279	ton				1,327,900		66,395	1,394,295
16. Electricity						60,000		-12,000	48,000
17. Processed water						24,000		- 4,800	19,200
18. Spare parts						902,495	36,988		939,483
19. Insurance					167,246				167,246
20. Working Capital			10.18	11.14	79,134				79,134
Total			473	316	629,640	8,453,980	94,169	-271,900	10,379,206
Total/mt			5.11	5.59	36.82	191.00	2.13	- 6.14	234.50

Output	Quantity	Domestic price per ton	Gross Domestic value GDV	Production Taxes 25% (PT)	Transport Costs to Consuming Centers TC	GDV+TC PT	F.O.B. Value	C.I.F. Value	Transport Cost to Seaport	Transport Cost From Seaport
Alcohol (100%) (ton)	5046	LS 590	17,757,820	2,977,140	151,380	2384235		1377558		151380
Stillage Fertilizer (MT)	6218	LS 40	1,483,600	248,720	186,540	373080	186540		124360	

Notes

1. Domestic taxes represent Social Payments of LS 80/year for skilled labor and LS 50/year for unskilled labor.
2. Land is valued at LS 5/m^2 for development projects. The market value is LS 7/m^2 with subsidy of LS 2/m^2. Land is depreciated over 40 years. Book value is LS 140,000.
3. Replacement cost depreciation values are calculated according to a 20 year building depreciation. Two capital recovery factors are applied: A 10% rate for the social calculations and a 2% rate for the market values. Border taxes are assessed at a 2% rate. Seasonal Labor Cost is added to the Department of Engineering and Maintenance. 300 operating days. US$ 1=LS 0.90 (exchange rate). Book value is LS 165,000.
4. Construction and engineering works are estimated at about 20% of the building and site preparation with the same capital recovery rates. Seasonal labor costs is added to the Department of Engineering and Maintenance. Book value is LS 33,000.
5. Furniture depreciates over 20 years with the same capital recovery rates. Book value is LS 16,000. .
6. Equipment depreciates over 15 years with the same capital recovery rates. Book value is LS1,680,000. .
7. Transportation depreciates over 15 years with the same capital recovery rates. Book value is LS 82,000. .
8. Training depreciates over 20 years with the same capital recovery rates. Book value is LS 18,000. .
9. Storage equipment depreciates over 20 years wit the same capital recovery rates. Book value is LS 74,250. .
10. Steam generation equipment depreciates over 20 years with the same capital recovery rates. Book value is LS127,500.
11. The molasses price per mt is LS 25 with a 5% domestic tax. 5 mt are required for a ton of alcohol.
12. Sulfuric acid is imported at LS 600 per mt + 20% sea freight + 2% insurance + a 5% border tax. 12.5 kg are required.
13. Ammonium Sulfate is imported at LS 550 per mt + same sea freight, incurance and border taxe rates . 5 kg are required per a mt of alcohol.
14. Urea is imported at LS 200 per mt + same sea freight, insurance, and border taxe rate. 7kg are required per a mt of alcohol.
15. Furnance oil is produced locally from the oil refineries at LS 100/ton + a 5% tax. 0.30 ton is required
16. Electricity is needed only for offices and buildings at LS 4.167 per month, of which 15% is subsidy from the market price.
17. Processed water is calculated at LS 1,250 per month, of which 15% is subsidy from the market price.
18. Spare parts are 10% of the book values of fixed inputs + 20% sea freight + 2% insurance + 5% border tax.
19. Insurance is 2% of the book values of fixed inputs.
20. Working capital includes labor cost + intermediate inputs cost, with a 10% interest rate.
21. The C.I.F. price of alcohol is equal the C.I.F. price of unleaded gasoline at the refinery gate (LS 417 per ton). Transportation cost from the sea port to consuming centers is LS 11/ton .
22. Stillage fertilizer (potussium oxide) has domestic price of LS 40 per mt, and f.o.b. price of LS 30 per mt minus transportation cots to the sea port (LS 26/mt) . 2.5 gallons of molasses mashed will produce 8 lbs. of fertilizer.

Output	Quantity MT	Domestic price per ton	Gross Domestic value GDV	Production taxes 25% (PT)	Transport Costs to Consuming Centers TC	GDV-TC-PT	F.O.B. Value	C.I.F. Value	Transport Cost to Seaport	Transport Cost to Seaport
Pellets feed	44,262	LS 590	26,114,580	6,528,645	1,150,812	9,247,133		2,083,526	1,150,812	
Bulk feeds	54,546	LS 40	2,181,840	545,460	1,418,196	3,054,576	1,636,380			1,418,196

Notes

1. Domestic taxes represent Social Payments of LS 80/year for skilled labor and LS 50/year for unskilled labor.
2. Land is valued at LS 5/m^2 for development projects. The market value is LS 7/m^2 with subsidy of LS 2/m^2. Land is depreciated over 40 years. Book value is LS 490,000.
3. Replacement cost depreciation values are calculated according to a 20 year building depreciation. Two capital recovery factors are applied: A 10% rate for the social calculations and a 2% rate for the market values. Border taxes are assessed at a 2% rate. Seasonal Labor Cost is added to the Department of Engineering and Maintenance. 300 operating days. US$ 1=LS 0.90 (exchange rate). Book value is LS 804,000.
4. Construction and engineering works are estimated at about 20% of the building and site preparation with the same capital recovery rates. Seasonal labor costs is added to the Department of Engineering and Maintenance. Book value is LS 160,800.
5. Furniture depreciates over 20 years with the same capital recovery rates. Book value is LS 25,400.
6. Equipment depreciates over 15 years with the same capital recovery rates. Book value is LS 5,350,000.
7. Transportation depreciates over 15 years with the same capital recovery rates. Book value is LS 210,000.
8. Training depreciates over 20 years with the same capital recovery rates. Book value is LS 39,000.
9. Storage equipment depreciates over 20 years wit the same capital recovery rates. Book value is LS 1,267,500.
10. Steam generation equipment depreciates over 20 years with the same capital recovery rates. Book value is LS 1,033,500.
11. The molasses price per mt is LS 25 with a 5% domestic tax. 5 mt are required for a ton of alcohol.
12. Sulfuric acid is imported at LS 600 per mt + 20% sea freight + 2% insurance + a 5% border tax. 12.5 kg are required.
13. Ammonium Sulfate is imported at LS 550 per mt + same sea freight, incurance and border taxe rates . 5 kg are required per a mt of alcohol.
14. Urea is imported at LS 200 per mt + same sea freight, insurance, and border taxe rate. 7kg are required per a mt of alcohol.
15. Furnance oil is produced locally from the oil refineries at LS 100/ton + a 5% tax. 0.30 ton is required
16. Electricity is needed only for offices and buildings at LS 4.167 per month, of which 15% is subsidy from the market price.
17. Processed water is calculated at LS 1,250 per month, of which 15% is subsidy from the market price.
18. Spare parts are 10% of the book values of fixed inputs + 20% sea freight + 2% insurance + 5% border tax.
19. Insurance is 2% of the book values of fixed inputs.
20. Working capital includes labor cost + intermediate inputs cost, with a 10% interest rate.
21. The C.I.F. price of alcohol is equal the C.I.F. price of unleaded gasoline at the refinery gate (LS 417 per ton). Transportation cost from the sea port to consuming centers is LS 11/ton
22. Stillage fertilizer (potussium oxide) has domestic price of LS 40 per mt, and f.o.b. price of LS 30 per mt minus transportation cots to the sea port (LS 26/mt) . 2.5 gallons of molasses mashed will produce 8 lbs. of fertilizer.

1982 BUDGET FOR COLLECTION (LS)

Item	Quantity		Wages		Capital	Tradable inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct Labor									
(1) Truck Drivers	6	6	20964	5280				780	27024
(2) Loading and Unloading	2	10	5846	8800				660	15306
2. Fixed inputs									
(3) Trucks (25 MT)					11228		272	-4690	6810
(4) Trucks (6 MT)					9625		233	-3928	5930
3. Intermediate Inputs									
(5) Spare parts						15860	650		16510
(6) Fuel (gasoline)						30000	1500		31500
(7) Insurance					2600				2600
(8) Working Capital					775				775
Total			26810	14080	24228	45860	2655	-7178	106455
Total/mt			0.89	0.47	0.80	1.52	0.09	-0.24	3.54

3. The 25 MT trucks are mainly for transporting molasses, furnace oil, and gasoline. Book value is LS 350,000.
4. The 6 MT trucks are for collecting other inputs such as urea, ammonium sulphate... etc. Book value is LS 75,000.
5. Spare parts are 10% of the book values.
7. Insurance is 2% of the book values. Two capital recovery factors are applied: a 10% rate for social costs and a 2% rate for private costs.
8. The working capital is the labor costs + intermediate inputs, with a 10% as interest rate. The plant will hold the cash for one month.

1982 BUDGET FOR DISTRIBUTION

Item	Quantity		Wages		Capital	Tradable Inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct Labor									
(1) Truck drivers	4	4	13,976	3,520				520	18016
(2) Loading and Unloading	2	10	6,988	8,800				660	16448
(3) Packing	2	10	6,988	8,800				660	16448
	8	24	27,952	21,120					50912
2. Fixed inputs									
(4) Truck (25 MT)	2				11,228		272	- 4581	6919
(5) Truck Hoist (6MT)	2				4,812		117	- 1963	2966
(6) Tractors (40 hp)	2				5,134		126	- 2104	3156
(7) Trailers	2				1,606		40	- 656	990
3. Intermediate inputs									
(8) Spare parts						12,400	500		12900
(9) Sacks	1,600,000					1,464,000	60,000		1524000
(10) Threads, marks, etc.						61,000	2,500		63500
(11) Fuel (gasoline)						30,000	1,500		31500
(12) Commission	5%				333,969				333969
(13) Insurance					2,800				2800
(14) Working Capital					16,881				16881
Total					376,430	1,567,400	65,055	- 7464	2050493
Total/mt			0.63	0.48	8.50	35.41	1.47	- 0.17	46.33

4. 25 MT trucks are for transporting alcohol and diesel. Book value is LS 70,000.
5. 6 MT trucks are for transporting fertilizer. The book value is LS 30,000.
6. (and 7.) tractors and trailers are for transportation of fertilizer and labor to near vicinity. Book value is LS 32,000.
8. Spare parts are 10% of the book values.
9. Sacks are LS 0.75 each.
10. Material is for fertilizer.
12. A separate marketing division is assumed to market both alcohol and fertilizer against a 5% commission.
13. Insurance is 2% of the book values.
14. Working capital is the labor cost + intermediate inputs with a 10% interest rate. The plant will hold the cash for one month.

1982 ALCOHOL PRODUCTION BUDGET (LS)
Distillery Name: Rabak Medium-Scale
Location: Rabak City
Capacity: 100,000 liter/day

Item	Quantity		Wages		Capital	Tradable Inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct Labor									
Production Department	15	45	40,764	72,880				3300	114,304
Engineering and Maintenance Dept.	9	62	26,004	119,520				3820	149,344
Admin. and Management	11	2	28,660	3,360				- 980	33,000
Services Department	7	2	18,010	3,360				660	22,030
2. Fixed Inputs									
2. Land	50000 m^2				35,301			-27345	7,956
3. Buildings and Site Preparation					888,883		1897	-42604	48,176
4. Foundation and Erection					19,897		483	- 7636	12,744
5. Furniture					3,583		77	- 1717	1,943
6. Equipment					705,753		17122	-287988	434,887
7. Storage Equipment					81,681		1743	-39152	44,272
8. Steam generation equipment					148.102		3160	-70991	80,271
9. Transport					17,323		420	- 7069	10,674
10. Training					4,602			1878	2,76
3. Intermediate Inputs									
11. Molasses	150000	ton				3,750,000		187500	3,937,500
12. Sulfuric acid	376	ton				275,232	11280		286,512
13. Ammonium sulfate	151	ton				101,321	4153		105,414
14. Urea	211	ton				51,484	2110		53,594
15. Furnace oil	9030	ton				903,000		45150	948,150
16. Electricity						50,000		- 7500	42,500
17. Processed water						15,000		- 2250	12,750
18. Spare parts						662,375	33119		695,494
19. Insurance					132,475				132,475
20. Working Capital					47,814				47,814
Total		3.77	6.62		1,285,414	5,808,412	75558	- 190820	7,165,738
Total/mt					42.71	192.98	2.51	- 6.34	238.08

Output	Quantity	Domestic price per ton	Gross Domestic value GDV	Production Taxes 25% (PT)	Transport Costs to Consuming Centers TC	GDV+TC PT	F.O.B. Value	C.I.F. Value	Transport Cost to Seaport	Transport Cost From Seaport
Alcohol (100%) (ton)	30098	LS 590	17,757,820	4,439,455	782548	14100913		8216754		782548
Stillage Fertilizer (MT)	37090	LS 40	1,483,600	370.900	964340	2077040	964340		782548	

Notes

1. Domestic taxes represent Social Payments of LS 80/year for skilled labor and LS 50/year for unskilled labor.
2. Land is valued at LS 5/m^2 for development projects. The market value is LS 7/m^2 with subsidy of LS 2/m^2. Land is depreciated over 40 years. Book value is LS 350,000.
3. Replacement cost depreciation values are calculated according to a 20 year building depreciation. Two capital recovery factors are applied: A 10% rate for the social calculations and a 2% rate for the market values. Border taxes are assessed at a 2% rate. Seasonal Labor Cost is added to the Department of Engineering and Maintenance. 300 operating days. US$ 1=LS 0.90 (exchange rate). Book value is LS 620250.
4. Construction and engineering works are estimated at about 20% of the building and site preparation with the same capital recovery rates. Seasonal labor costs is added to the Department of Engineering and Maintenance. Book value is LS 124,050.
5. Furniture depreciates over 20 years with the same capital recovery rates. Book value is LS 20,400.
6. Equipment depreciates over 15 years with the same capital recovery rates. Book value is LS 4,400,000.
7. Transportation depreciates over 15 years with the same capital recovery rates. Book value is LS 108,000.
8. Training depreciates over 20 years with the same capital recovery rates. Book value is LS 35,000.
9. Storage equipment depreciates over 20 years wit the same capital recovery rates. Book value is LS 570,000.
10. Steam generation equipment depreciates over 20 years with the same capital recovery rates. Book value is LS 750,000.
11. The molasses price per mt is LS 25 with a 5% domestic tax. 5 mt are required for a ton of alcohol.
12. Sulfuric acid is imported at LS 600 per mt + 20% sea freight + 2% insurance + a 5% border tax. 12.5 kg are required.
13. Ammonium Sulfate is imported at LS 550 per mt + same sea freight, incurance and border tax rates . 5 kg are required per a mt of alcohol.
14. Urea is imported at LS 200 per mt + same sea freight, insurance, and border tax rate. 7kg are required per a mt of alcohol.
15. Furnance oil is produced locally from the oil refineries at LS 100/ton + a 5% tax. 0.30 ton is required
16. Electricity is needed only for offices and buildings at LS 4.167 per month, of which 15% is subsidy from the market price.
17. Processed water is calculated at LS 1,250 per month, of which 15% is subsidy from the market price.
18. Spare parts are 10% of the book values of fixed inputs + 20% sea freight + 2% insurance + 5% border tax.
19. Insurance is 2% of the book values of fixed inputs.
20. Working capital includes labor cost + intermediate inputs cost, with a 10% interest rate.
21. The C.I.F. price of alcohol is equal the C.I.F. price of unleaded gasoline at the refinery gate (LS 417 per ton). Transportation cost from the sea port to consuming centers is LS 11/ton
22. Stillage fertilizer (potussium oxide) has domestic price of LS 40 per mt, and f.o.b. price of LS 30 per mt minus transportation cots to the sea port (LS 26/mt) . 2.5 gallons of molasses mashed will produce 8 lbs. of fertilizer.

1982 BUDGET FOR COLLECTION (LS)

Item	Quantity		Wages		Capital	Tradable inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct Labor									
(1) Truck Drivers	11	11	384,349	9,680				1430	49,544
(2) Loading and Unloading	2	7	5,848	6,160				510	12,516
2. Fixed inputs									
(3) Trucks (25 MT)	8				44,911		1,090	-18,326	27,675
(4) Trucks (6 MT)	3				7,217		175	- 1,495	5,897
3. Intermediate Inputs									
(5) Spare parts						39,650	1,625		41,275
(6) Fuel (gasoline)						40,000	2,000		42,000
(7) Insurance					650				650
(8) Working Capital					1,217				1,217
Total			2.77	.99	53,995	79,650	4,890	-17,881	180,774
Total/mt			1.47	0.53	1.79	2.65	0.16	-0.59	6.00

3. The 25 MT trucks are mainly for transporting molasses, furnace oil, and gasoline. Book value is LS 270,000.
4. The 6 MT trucks are for collecting other inputs such as urea, ammonium sulphate...etc. Book value is LS 45,000.
5. Spare parts are 10% of the book value.
7. Insurance is 2% of the book values. Two capital recovery factors are applied: a 10% rate for social costs and a 2% rate for private costs.
8. The working capital is the labor costs + intermediate inputs, with a 10% as interest rate. The plant will hold the cash for one month.

1982 BUDGET FOR DISTRIBUTION (LS)

Item	Quantity		Wages		Capital	Tradable inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct labor									
(1) Truck drivers	4	4	13976	3520				520	18016
(2) Loading and Unloading	2	5	5846	4400				410	10656
(3) Fertilizer, packing	2	5	5846	4400				410	10656
Fixed inputs									
(4) Truck (25 MT)	4				5614		136	-2290	3460
(5) Truck Hoist (6MT)	3				7219		175	-2945	4446
(6) Tractors (40 hp)	1				2567		63	-1052	1578
(7) Trailers	1				803		20	- 328	495
Intermediate inputs									
(8) Spare parts						12200	500		12700
(9) Sacks	1092000					999180	40950		1040130
(10) Threads, marks, etc.						24400	1000		25400
(11) Fuel (diesel)						40000	2000		42000
(12) Commission					238113				238113
(13) Insurance					2000				2000
(14) Working Capital					11663				11663
Total			1.61	37988	285977	1075780	44844	- 5275	1421314
Total/mt			0.85	0.41	9.50	35.74	1.49	- 0.18	47.22

4. 25 MT trucks are for transporting alcohol and diesel. Book value is LS 140,000.
5. 6 MT trucks are for transporting fertilizer. The book value is LS 45,000.
6. (and 7.) tractors and trailers are for transportation of fertilizer and labor to near vicinity. Book value is LS 32,000.
8. Spare parts are 10% of the book values.
9. Sacks are LS 0.75 each.
10. Material is for fertilizer.
12. A separate marketing division is assumed to market both alcohol and fertilizer against a 5% commission.
13. Insurance is 2% of the book value.
14. Working capital is the labor cost + intermediate inputs with a 10% interest rate. The plant will hold the cash for one month.

1982 ALCOHOL PRODUCTION BUDGET (LS)
Distillery Name: Kenana Medium-Scale
Location: The Kenana Sugar Factory
Capacity: 100,000 liter/day

Item	Quantity		Wages		Capital	Tradable Inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct Labor									
Production Department	15	30	35,318	41,578				2700	80596
Engineering and Maintenance Dept.	12	42	38,972	52,138				3060	91470
Admin. and Management	8	2	28,433	4,160				740	28339
Services Department	10	2	24,264	4,160				900	29324
2. Fixed Inputs									
2. Land	50,000 m^2				35,301			- 27345	7956
3. Buildings and Site Preparation					46,215		986	- 22152	25044
4. Foundation and Erection					9,243		197	- 4430	4010
5. Furniture					3,583		77	- 1717	1943
6. Equipment					705,753		17122	- 287988	434877
7. Storage Equipment					40,841		872	- 19576	22137
8. Steam generation equipment					25,795		550	- 12365	13980
9. Transport					17,323		420	- 7069	10724
10. Training					4,602			- 1878	2724
3. Intermediate Inputs									
11. Molasses	150,000	ton				3750000		187500	3937500
12. Sulfuric acid	376	ton				275232	11280		286512
13. Ammonium sulfate	150	ton				101321	4153		105637
14. Urea	210	ton				51484	2110		53594
15. Furnace oil	3010	ton				301000		15050	316050
16. Electricity						50000		- 7500	42500
17. Processed water						15000		- 2250	12750
18. Spare parts						632875	25938		658813
19. Insurance					103,750				103750
20. Working Capital					47,913				47913
Total					1,040,319	5176912	63705	- 184320	6321852
Total/mt					34.56	172.00	2.12	- 6.12	210.04

Output	Quantity	Domestic price per ton	Gross Domestic value GDV	Production Taxes 25% (PT)	Transport Costs to Consuming Centers TC	GDV+TC PT	F.O.B. Value	C.I.F. Value	Transport Cost to Seaport	Transport Cost From Seaport
Alcohol (100%) (ton)	30098	LS 590	17,757,820	4,439,455	812,646	16,213,416		8,216,754		812,646
Stillage Fertilizer (MT)	37090	LS 40	1,483,600	370.900	1,001,430	2,114,130	1,112,700		1,001,430	

Notes

1. Domestic taxes represent Social Payments of LS 80/year for skilled labor and LS 50/year for unskilled labor.
2. Land is valued at LS 5/m^2 for development projects. The market value is LS 7/m^2 with subsidy of LS 2/m^2. Land is depreciated over 40 years. Book value is LS 350,000.
3. Replacement cost depreciation values are calculated according to a 20 year building depreciation. Two capital recovery factors are applied: A 10% rate for the social calculations and a 2% rate for the market values. Border taxes are assessed at a 2% rate. Seasonal Labor Cost is added to the Department of Engineering and Maintenance. 300 operating days. US$ 1=LS 0.90 (exchange rate). Book value is LS 322,500.
4. Construction and engineering works are estimated at about 20% of the building and site preparation with the same capital recovery rates. Seasonal labor costs is added to the Department of Engineering and Maintenance. Book value is LS 64,500.
5. Furniture depreciates over 20 years with the same capital recovery rates. Book value is LS 20,400.
6. Equipment depreciates over 15 years with the same capital recovery rates. Book value is LS 4,400,000.
7. Transportation depreciates over 15 years with the same capital recovery rates. Book value is LS 108,000.
8. Training depreciates over 20 years with the same capital recovery rates. Book value is LS 26,400.
9. Storage equipment depreciates over 20 years wit the same capital recovery rates. Book value is LS 285,000.
10. Steam generation equipment depreciates over 20 years with the same capital recovery rates. Book value is LS 180,000.
11. The molasses price per mt is LS 25 with a 5% domestic tax. 5 mt are required for a ton of alcohol.
12. Sulfuric acid is imported at LS 600 per mt + 20% sea freight + 2% insurance + a 5% border tax. 12.5 kg are required.
13. Ammonium Sulfate is imported at LS 550 per mt + same sea freight, incurance and border taxe rates . 5 kg are required per a mt of alcohol.
14. Urea is imported at LS 200 per mt + same sea freight, insurance, and border taxe rate. 7kg are required per a mt of alcohol.
15. Furnance oil is produced locally from the oil refineries at LS 100/ton + a 5% tax. 0.30 ton is required
16. Electricity is needed only for offices and buildings at LS 4.167 per month, of which 15% is subsidy from the market price.
17. Processed water is calculated at LS 1,250 per month, of which 15% is subsidy from the market price.
18. Spare parts are 10% of the book values of fixed inputs + 20% sea freight + 2% insurance + 5% border tax.
19. Insurance is 2% of the book values of fixed inputs.
20. Working capital includes labor cost + intermediate inputs cost, with a 10% interest rate.
21. The C.I.F. price of alcohol is equal the C.I.F. price of unleaded gasoline at the refinery gate (LS 417 per ton). Transportation cost from the sea port to consuming centers is LS 11/ton
22. Stillage fertilizer (potussium oxide) has domestic price of LS 40 per mt, and f.o.b. price of LS 30 per mt minus transportation cots to the sea port (LS 26/mt) . 2.5 gallons of molasses mashed will produce 8 lbs. of fertilizer.

1982 BUDGET FOR DISTRIBUTION

Item	Quantity		Wages		Capital	Tradable inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct labor	5	5	17470	4000				650	22120
(1) Truck drivers	2	10	6988	8800				1300	17088
(2) Loading and Unloading	2	10	6988	8800				1300	17088
(3) Packing									
Fixed inputs									
(4) Truck (25 MT)	5				25078		535	- 12021	13592
(5) Truck Hoist (6MT)	3				7217		174	- 2945	4447
(6) Tractors (40 hp)	1				2567		63	- 1052	1578
(7) Trailers	1				803		20	- 328	495
Intermediate inputs									
(8) Spare parts						26840	1100		27940
(9) Sacks	1092000					999180	40950		1040130
(10) Threads, marks, etc.						40000	2000		42000
(11) Fuel (gasoline)						40000	2000		42000
(12) Commission					232615				232615
(13) Insurance					4000				4000
(14) Working Capital					12402				12042
Total					284322	1,106,020	46843	- 13096	1,477,135
Total/mt			1.04	0.72	9.45	36.74	1.56	- 0.44	49.08

4. 25 MT trucks are for transporting alcohol and diesel. Book value is 70,000.
5. 6 MT trucks are for transporting fertilizer. The book value is LS 30,000.
6. (and 7.) tractors and trailers are for transportation of fertilizer and labor to near vicinity. Book value is LS 32,000.
8. Spare parts are 10% of the book values.
9. Sacks are LS 0.75 each.
10. Material is for fertilizer.
12. A separate marketing division is assumed to market both alcohol and fertilizer againsts a 5% commission.
13. Insurance is 2% of the book values.
14. Working capital is the labor cost + intermediate inputs with a 10% interest rate. The plant plant will hold the cash for one month.

1982 ALCOHOL PRODUCTION BUDGET (LS)
Distillery Name: New Halfa Small Scale
Location: The New Halfa Sugar Factory
Capacity: 20,000 liters/day

Item	Quantity		Wages		Capital	Tradable Inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct Labor									
Production Department	7	33	18715	38488				2210	59413
Engineering and Maintenance Dept.	6	23	17947	27740				1530	47217
Admin. and Management	6	1	18298	1680				530	20508
Services Department	4	1	10512	1680				370	12562
2. Fixed Inputs									
2. Land	20000 m^2				14120			- 10939	3182
3. Buildings and Site Preparation					23645		505	- 11344	12816
4. Foundation and Erection					4729		101	- 2267	2563
5. Furniture					2017		43	- 968	1092
6. Equipment					269469		6537	- 109959	166047
7. Storage Equipment					10639		227	- 5099	5787
8. Steam generation equipment					18271		290	- 8757	9904
9. Transport					13153		319	- 5367	8105
10. Training					2467			- 1188	1284
3. Intermediate Inputs									
11. Molasses	25000					625000		+ 31250	656250
12. Sulfuric acid	63					46116	1890		48006
13. Ammonium sulfate	25					16775	688		17463
14. Urea	36					8784	360		9144
15. Furnace oil	505					50500		+ 2525	53025
16. Electricity						20000		- 3000	17000
17. Processed water						10000	10399	- 1500	8500
18. Spare parts						253730			264129
19. Insurance					40935				40935
20. Working Capital					10451				10451
Total			135060		409896	1030905	21459	-121958	1475363
Total/mt			12.98		81.23	204.30	4.25	- 24.17	292.38

Output	Quantity	Domestic price per ton	Gross Domestic value GDV	Production Taxes 25% (PT)	Transport Costs to Consuming Centers TC	GDV+TC PT	F.O.B. Value	C.I.F. Value	Transport Cost to Seaport	Transport Cost From Seaport
Alcohol (100%) (ton)	5046	LS 590	2,977,140	744285	151380	2384235		1377558		151380
Stillage Fertilizer (MT)	6218	LS 40	248,720	62180	186540	373080	186540		124360	

Notes

1. Domestic taxes represent Social Payments of LS 80/year for skilled labor and LS 50/year for unskilled labor.
2. Land is valued at LS 5/m^2 for development projects. The market value is LS 7/m^2 with subsidy of LS 2/m^2. Land is depreciated over 40 years. Book value is LS 140,000.
3. Replacement cost depreciation values are calculated according to a 20 year building depreciation. Two capital recovery factors are applied: A 10% rate for the social calculations and a 2% rate for the market values. Border taxes are assessed at a 2% rate. Seasonal Labor Cost is added to the Department of Engineering and Maintenance. 300 operating days. US$ 1=LS 0.90 (exchange rate). Book value is LS 165,000.
4. Construction and engineering works are estimated at about 20% of the building and site preparation with the same capital recovery rates. Seasonal labor costs is added to the Department of Engineering and Maintenance. Book value is LS 33,000.
5. Furniture depreciates over 20 years with the same capital recovery rates. Book value is LS 16,000.
6. Equipment depreciates over 15 years with the same capital recovery rates. Book value is LS 1,680,000.
7. Transportation depreciates over 15 years with the same capital recovery rates. Book value is 82,000.
8. Training depreciates over 20 years with the same capital recovery rates. Book value is LS 18,000.
9. Storage equipment depreciates over 20 years wit the same capital recovery rates. Book value is LS 74,250.
10. Steam generation equipment depreciates over 20 years with the same capital recovery rates. Book value is LS 127,500.
11. The molasses price per mt is LS 25 with a 5% domestic tax. 5 mt are required for a ton of alcohol.
12. Sulfuric acid is imported at LS 600 per mt + 20% sea freight + 2% insurance + a 5% border tax. 12.5 kg are required.
13. Ammonium Sulfate is imported at LS 550 per mt + same sea freight, incurance and border taxe rates . 5 kg are required per a mt of alcohol.
14. Urea is imported at LS 200 per mt + same sea freight, insurance, and border taxe rate. 7kg are required per a mt of alcohol.
15. Furnance oil is produced locally from the oil refineries at LS 100/ton + a 5% tax. 0.30 ton is required
16. Electricity is needed only for offices and buildings at LS 4.167 per month, of which 15% is subsidy from the market price.
17. Processed water is calculated at LS 1,250 per month, of which 15% is subsidy from the market price.
18. Spare parts are 10% of the book values of fixed inputs + 20% sea freight + 2% insurance + 5% border tax.
19. Insurance is 2% of the book values of fixed inputs.
20. Working capital includes labor cost + intermediate inputs cost, with a 10% interest rate.
21. The C.I.F. price of alcohol is equal the C.I.F. price of unleaded gasoline at the refinery gate (LS 417 per ton). Transportation cost from the sea port to consuming centers is LS 11/ton
22. Stillage fertilizer (potussium oxide) has domestic price of LS 40 per mt, and f.o.b. price of LS 30 per mt minus transportation cots to the sea port (LS 26/mt) . 2.5 gallons of molasses mashed will produce 8 lbs. of fertilizer.

1982 BUDGET FOR COLLECTION

Item	Quantity		Wages		Capital	Tradable inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct Labor									
(1) Truck Drivers	4	4	13976	3520				520	18016
(2) Loading and Unloading	1	5	3494	4400				330	8224
2. Fixed inputs									
(3) Trucks (25 MT)	2				11228		272	-4581	6919
(4) Trucks (6 MT)	2				4812		117	-1963	2966
3. Intermediate Inputs									
(5) Spare parts						12200	500		12700
(6) Fuel (gasoline)						20000	1000		21000
(7) Insurance					2000				2000
(8) Working Capital					516				516
Total			25390		18556	32200	1889	-5694	72341
Total/mt			3.46	1.57	3.68	6.38	.37	- 1.13	14.34

3. The 25 MT trucks are mainly for transporting molasses, furnace oil, and gasoline. Book value is LS 70,000.
4. The 6 MT trucks are for collecting other inputs such as urea, ammonium sulphate...etc. Book value is LS 30,000.
5. Spare parts are 10% of the book values.
7. Insurance is 2% of the book values. Two capital recovery factors are applied: a 10% rate for social costs and a 2% rate for private costs.
8. The working capital is the labor costs + intermediate inputs, with a 10% as interest rate. The plant will hold the cash for one month.

L982 BUDGET FOR DISTRIBUTION (LS)

Item	Quantity		Wages		Capital	Tradable Inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct Labor									
(1) Truck drivers	2	2	6988	1760				260	9008
(2) Loading and Unloading	1	4	2923	3520				280	6723
(3) Packing	1	4	2923	3520				280	6723
2. Fixed inputs									
(4) Truck (25 MT)	1				5614		136	-2290	3460
(5) Truck Hoist (6MT)	1				2807		68	-1145	1730
(6) Tractors (40 hp)	1				2567		63	-1052	1578
(7) Trailers	1				803		20	- 328	495
3. Intermediate inputs									
(8) Spare parts						6100	250		6350
(9) Sacks	180656					168800			168800
(10) Threads, marks, etc.						10000	500		10500
(11) Fuel (gasoline)						15000	750		15750
(12) Commission					33534				33534
(13) Insurance					1000				1000
(14) Working Capital					2066				2066
Total			2.54	1.74	48391	199900	1787	-3995	267,717
Total/mt					9.59	29.62	0.35	- 0.70	53.06

4. 25 MT trucks are for transporting alcohol and diesel. Book value is LS 35,000.
5. 6 MT trucks are for transporting fertilizer. The book value is LS 15,000.
6 (and 7.) tractors and trailers are for transportation of fertilizer and labor to near vicinity. Book value is LS 32,000.
8. Spare parts are 10% of the book values.
9. Sacks are LS 0.75 each.
10. Material is for fertilizer.
12. A separate marketing division is assumed to market both alcohol and fertilizer against a 5% commission.
13. Insurance is 2% of the book values.
14. Working capital is the labor cost + intermediate inputs with a 10% interest rate. The plant will hold the cash for one month.

1982 PRODUCTION BUDGET FOR ANIMAL FEED MILL (LS)

Name of Plant: Kenana Feed Mill
Location: The Kenana Sugar Factory
Capacity: 500,000 metric tons

Item	Quantity			Wages		Capital	Tradable Inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled		Skilled	Unskilled					
1. Direct Labor										
Production Department	13	31		32555	31100				2590	66245
Engineering and Maintenance Dept.	10	32		21460	32600				2400	56460
Admin. and Management	10	2		20560	3000				900	24460
Services Department	5	2		13010	3000				500	16510
									6390	163675
2. Fixed Inputs										
2. Land	50000	m^2				35301			-27345	7956
3. Buildings and Site Preparation						99882		213	-47878	54135
4. Foundation and Erection						19976		426	- 9576	10826
5. Furniture						3583		77	- 1717	1948
6. Equipment						306894		6549	-147104	166338
7. Storage Equipment						113208		2416	-54265	61359
8. Steam generation equipment						42283		966	-21705	21544
9. Transport						35713		436	-14573	21576
10. Training						4602		--	- 1878	2724
									-311469	351402
3. Intermediate Inputs										
11. Sorghum	229000		ton				34350000		+11450000	45800000
12. Molasses	77500		ton				1937500		+96875	2034375
13. Cotton seed	158750		ton				15875000		+793750	16668750
14. Wheat bran	20000		ton				1400000		+70000	1470000
15. Urea	500		ton				122000	5000		127000
16. Salt	3500		ton				245000		+12250	257250
17. Limestone	8500		ton				1700000		+85000	1785000
18. Protein-Vitamin Premix	2250		ton				6862500	281250		7143750
19. Furnace Oil	100000		"				10000000		+500000	10500000
20. Electricity							50000		- 7500	42500
21. Processed water							25000		- 3750	21250
22. Spare parts							387789	15893		403682
23. Insurance						63572				63572
24. Working Capital						716378				716378
Total				18157		1441392	72954789	315144	+12676973	87545584
Total/mt				0.32		2.88	145.91	0.63	25.35	175.09

Output	Quantity MT	Domestic price per ton	Gross Domestic value GDV	Production taxes 25% (PT)	Transport Costs to Consuming Centers TC	GDV-TC-PT	F.O.B. Value	C.I.F. Value	Transport Cost to Seaport
Pellets feed	250000	LS 250	62500000	15625000	10,000,000	43875000		75000000	10,000,000
Bulk feeds	250000	LS 170	42500000	10625000		28875000	62500000		

NOTES:

1. Domestic taxes represent social payments of LS 80 per year for skilled labor and LS50 for unskilled labor.
2. Land valued is at LS per m^2 for development projects. The market value os LS /m^2 with a subsidy of LS /m^2. Land is depreciated over 40 years. Book value is LS 490,000.
3. Replacement cost depreciation values are calculated according to a twenty year building depreciation. Two capital recovery factors are applied: a 10% rate for the social calculations, and a 10% for the market values. Border taxes are assessed at a 2% rate. Seasonal labor cost is added to the department of engineering and maintenance. Book value is LS695550, 300 operating days. LS $1 = LS 0.90 is the exchange rate.
4. Construction and engineering works are estimated at about 20% of the buildings and site preparation with the same capital recovery rates. Seasonal labor cost is added to the department of engineering and maintenance. Book value is LS 139112.
5. Furniture depreciates over 20 years with the same capital recovery rates. Book value is LS 25400.
6. Equipment depreciates over 15 years with the same capital recovery rates. Book value is LS 2,141,600.
7. Transportation depreciates over 15 years with the same capital recovery rates. Book value is 247,000.
8. Training depreciates over 20 years with the same capital recovery rates. Book value is LS 39,000.
9. Storage depreciates over 15 years with the same capital recovery rates. book value is LS 395,000.
10. Steam generation equipment depreciates over 15 years with the same capital recovery rates. Book value is LS 790,000.
11. Domestic market price of sorghum is LS 200 per mt, and the social price is LS 150 per met. LS 50 per mt. is domestic taxes. Sorghum represents 45.8% of the ration formula.
12. The molasses price per mt is LS 25 with a 5% domestic tax. Molasses represents 15% of the ration formula.
13. The domestic market price of cotton seed is LS 100 per mt; and the social price is LS 80 per mt. Cotton seed represents 31% of the ration formula.
14. The domestic market price of wheat bran is LS per mt, and the social price is LS per mt. Wheat bran represents % of the ration formula.
15. Urea is imported at LS 200 per mt and l 20% sea freight + a 2% insurance + a 5% border tax. Urea represents % of the ration formula.
16. The domestic market price of salt is LS 70 per mt, and the social price is LS 50 per mt. Salt represents % of the ration formula.
17. The domestic market price of limestone is LS 200 percent, and the social price is LS 150 per mt. Limestone represents % of the ration formula.
18. Protein vitamin premix is imported at LS 2500/mt + 20% sea freight + 2% insurance + 5% border taxes.
19. Electricity is needed for offices and buildings. 15% is a subsidy from the market price.
20. Processed water is calculated per month. 15% is a subsidy from the market price.
21. Spare parts are 10% of the book values of fixed inputs + 20% sea freight + 5% tax + 2% insurance.
22. Insurance is 2% of the book values of fixed inputs.
23. Furnace oil is produced locally from the oil refineries at LS 100/ton + 5% tax. 0.2 ton is required for amt. of animal feed.
24. Working capital includes labor cost + intermediate input cost, with a 10% interest rate. The plant will hold the ash for one month.
25. A proper animal feed price is not available locally except those prices of the small animal feed private plants around Khartonm. The local prices fluctuate and are unreliable, because local production is small. According to Arizona feed mill prices for feed pellets and bulk feed (U.S. $210, U.S. $190 respectively), LS 250 and LS 300 permit are assumed as local price and equivalent world prices for feed pellets respectively. LS 170 and LS 200 per mt are assumed as local price and equivalent world price for bulk feed respectively.

1982 BUDGET FOR COLLECTION (LS)

Item	Quantity		Wages		Capital	Tradable inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct Labor	18	18	62892	15840				2340	81072
(1) Truck Drivers	2	10	5000	8800				660	14460
(2) Loading and Unloading									
2. Fixed inputs									
(3) Trucks (25 MT)	8				44912		1092	-18328	27676
(4) Trucks (6 MT)	10				24063		583	- 9820	14826
3. Intermediate Inputs									
(5) Spare parts						52460	2150		54618
(6) Fuel (gasoline)						90000		4500	94500
(7) Insurance						8600			8600
(8) Working Capital						2110			2110
Total				92532	68975	153170	3825	-20648	297854
Total/mt				0.19	0.14	0.31	0.01	- 0.04	0.60

3. The 25 MT trucks are for collecting molasses and fuel. Book value is LS 430,000.
4. The 6 Mt trucks after collecting the other ingredients.
5. Spare parts are 10% of the book values.
7. Insurance is 2% of the book values. Two capital recovery factors are applied: 1% for social costs and 2% for private costs.
8. Working capital includes labor costs and intermediate value and is charged a 10% interest rate. The plan will hold the cash for one month.

1982 BUDGET FOR DISTRIBUTION

Item	Quantity		Wages		Capital	Tradable inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct labor	48	48	167712	42240				6240	216192
(1) Truck drivers	6	30	16500	26400				1980	44880
(2) Loading and Unloading	4	20	11000	17600				1320	29920
(3) Packing			195212	86240					
Fixed inputs									
(4) Truck (25 MT)	6				40364		934	-14708	25590
(5) Truck Hoist (6MT)	30				86622		2100	-35357	52271
(6) Tractors (40 hp)	6				14438		350	-5892	8896
(7) Trailers	6				4814		116	-1734	3196
Intermediate inputs									
(8) Spare parts						96990	3975		100965
(9) Sacks	5500000					4125000	206250		4331250
(10) Threads, marks, etc.						366000	15000		381000
(11) Fuel (gasoline)						244000	10000		254000
(12) Commission						3937500			3937500
(13) Insurance					11000				11000
(14) Working Capital					75819				75819
Total			281452		233057	8769490	238725	-49145	9473579
Total/mt			0.57		0.47	17.54	0.48	-0.10	18.95

4. (and 5). Trucks are for transporting pellet feed sacks locally or for export. Book value is LS 660,000.
6. (and 7). Tractors and trailers are for transporting bulk feed to adjacent feed lots. Book value is 96,000.
8. Spare parts are 10% of the book values.
9. Sacks are for pellet feed.
10. Material is for cattle pellet.
12. A separate marketing division is assumed to market the product against a 5% commission.
13. Insurance 2% of book values. Two capital recovery factors are applied: 10% for social costs and 2% for private costs. The plant will hold the cash for one month.
14. Working capital includes labor costs + intermediate inputs values, and is charged a 10% interest rate.

1982 PRODUCTION BUDGET FOR ANIMAL FEED MILL (LS)

Name of Plant: Sennar Feed Mill
Location: The Sennar Sugar Factory
Capacity: 250,000 metric tons

Item	Quantity		Wages		Capital	Tradable Inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct Labor									
Production Department	9	21	19060	21800				1770	42630
Engineering and Maintenance Dept.	9	26	19160	24600				2020	45780
Admin. and Management	8	1	16250	1000				690	17940
Services Department	4	1	8520	1000				370	9890
2. Fixed Inputs									
2. Land	30000 m^2				21474			-15992	5484
3. Buildings and Site Preparation					66588		1421	-31919	36090
4. Foundation and Erection					13317		284	- 6384	7217
5. Furniture					2017		43	- 968	1092
6. Equipment					153447		3274	- 73553	83168
7. Storage Equipment					75474		1611	- 36177	40906
8. Steam generation equipment					30189		644	- 14470	16363
9. Transport					15078		366	- 6323	9121
10. Training					2467			- 1182	1285
								- 186968	
3. Intermediate Inputs									
11. Sorghum	114500	ton				17175000		+5725000	22900000
12. Molasses	38750	ton				968750		+ 48438	1017188
13. Cotton seed	79375	ton				7937500		+ 396875	8334375
14. Wheat bran	10000	ton				700000		+ 35000	735000
15. Urea	200	ton				61000	2500		63500
16. Salt	1750	ton				122500		+ 6125	128625
17. Limestone	4250	ton				637500		+ 31875	669375
18. Protein-Vitamin Premix	1125	ton				3431250	171563	+171563	3602813
19. Furnace Oil	50000	ton				5000000		+250000	5250000
20. Electricity						40000		- 6000	34000
21. Processed water						15000		- 2250	12750
22. Spare parts						209572	8589		218161
23. Insurance					34356				34356
24. Working Capital					35930				35938
Total			.25	0.19	450335	36298072	190295	+6302945	43353039
Total/mt			0.44		1.80	145.19	0.76	25.21	173.41

Output	Quantity MT	Domestic price per ton	Gross Domestic value GDV	Production taxes 25% (PT)	Transport Costs to Consuming Centers TC	GDV-TC-PT	F.O.B. Value	C.I.F. Value	Transport Cost to Seaport
Pellets feed	125000	LS 250	31250000	7812500	1,500,000	22187500		37500000	4,250,000
Bulk feeds	125000	LS 170	21250000	4250000		15750000	31250000		

NOTES:

1. Domestic taxes represent social payments of LS 80 per year for skilled labor and LS50 for unskilled labor.
2. Land valued is at LS per m^2 for development projects. The market value os LS /m^2 with a subsidy of LS /m^2. Land is depreciated over 40 years. Book value is LS 210,000.
3. Replacement cost depreciation values are calculated according to a twenty year building depreciation. Two capital recovery factors are applied: a 10% rate for the social calculations, and a 10% for the market values. Border taxes are assessed at a 2% rate. Seasonal labor cost is added to the department of engineering and maintenance. Book value is LS 470000, 300 operating days. LS $1 = LS 0.90 is the exchange rate.
4. Construction and engineering works are estimated at about 20% of the buildings and site preparation with the same capital recovery rates. Seasonal labor cost is added to the department of engineering and maintenance. Book value is LS 94,000.
5. Furniture depreciates over 20 years with the same capital recovery rates. Book value is LS 17,000.
6. Equipment depreciates over 15 years with the same capital recovery rates. Book value is LS 1,100,000.
7. Transportation depreciates over 15 years with the same capital recovery rates. Book value is 94,000.
8. Training depreciates over 20 years with the same capital recovery rates. Book value is LS 26,000.
9. Storage depreciates over 15 years with the same capital recovery rates. book value is LS 190,000.
10. Steam generation equipment depreciates over 15 years with the same capital recovery rates. Book value is LS 295,000.
11. Domestic market price of sorghum is LS 200 per mt, and the social price is LS 150 per met. LS 50 per mt. is domestic taxes. Sorghum represents 45.8% of the ration formula.
12. The molasses price per mt is LS 25 with a 5% domestic tax. Molasses represents 15% of the ration formula.
13. The domestic market price of cotton seed is LS 100 per mt, and the social price is LS 80 per mt. Cotton seed represents 31% of the ration formula.
14. The domestic market price of wheat bran is LS per mt, and the social price is LS per mt. Wheat bran represents % of the ration formula.
15. Urea is imported at LS 200 per mt and l 20% sea freight + a 2% insurance + a 5% border tax. Urea represents % of the ration formula.
16. The domestic market price of salt is LS 70 per mt, and the social price is LS 50 per mt. Salt represents % of the ration formula.
17. The domestic market price of limestone is LS 200 percent, and the social price is LS 150 per mt. Limestone represents % of the ration formula.
18. Protein vitamin premix is imported at LS 2500/mt + 20% sea freight + 2% insurance + 5% border taxes.
19. Electricity is needed for offices and buildings. 15% is a subsidy from the market price.
20. Processed water is calculated per month. 15% is a subsidy from the market price.
21. Spare parts are 10% of the book values of fixed inputs + 20% sea freight + 5% tax + 2% insurance.
22. Insurance is 2% of the book values of fixed inputs.
23. Furnace oil is produced locally from the oil refineries at LS 100/ton + 5% tax. 0.2 ton is required for amt. of animal feed.
24. Working capital includes labor cost + intermediate input cost, with a 10% interest rate. The plant will hold the ash for one month.
25. A proper animal feed price is not available locally except those prices of the small animal feed private plants around Khartonm. The local prices fluctuate and are unreliable, because local production is small. According to Arizona feed mill prices for feed pellets and bulk feed (U.S. $210, U.S. $190 respectively), LS 250 and LS 300 permit are assumed as local price and equivalent world prices for feed pellets respectively. LS 170 and LS 200 per mt are assumed as local price and equivalent world price for bulk feed respectively.

1982 BUDGET FOR COLLECTION (LS)

Item	Quantity		Wages		Capital	Tradable inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct Labor	10	10	34940	8800				1300	45040
(1) Truck Drivers	2	8	5000	7040				660	12700
(2) Loading and Unloading									
2. Fixed inputs									
(3) Trucks (25 MT)	4				22456		546	-9164	13838
(4) Trucks (6 MT)	10				24063		583	- 9820	14826
3. Intermediate Inputs									
(5) Spare parts						35380	1450		36830
(6) Fuel (gasoline)						70000	3500		73500
(7) Insurance									2600
(8) Working Capital									1422
Total					55980	105380	6079	- 17024	200756
Total/mt					0.22	0.42	0.02	-0.07	0.80

3. The 25 MT trucks are for collecting molasses and fuel. Book value is LS 140,000.
4. The 6 MT trucks after collecting the other ingredients.
5. Spare parts are 10% of the book value.
7. Insurance is 2% of the book values. Two capital recovery factors are applied: 1% for social costs and 2% for private costs.
8. Working capital includes labor costs and intermediate value and is charged a 10% interest rate. The plan will hold the cash for one month.

1982 BUDGET FOR DISTRIBUTION

Item	Quantity		Wages		Capital	Tradable inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct labor									
(1) Truck drivers	12	12	41928	10560				1560	54048
(2) Loading and Unloading	5	15	13750	13200				1150	28100
(3) Packing	5	15	13750	13200				1150	28100
Fixed inputs									
(4) Truck (25 MT)	3				19248		468	-7854	11862
(5) Truck Hoist (6MT)	5				12032		292	-4910	7414
(6) Tractors (40 hp)	2				4814		116	-1734	3196
(7) Trailers	2				1606		40	- 578	1068
Intermediate inputs									
(8) Spare parts						26840	1100		27940
(9) Sacks	5500000					5032500	206250		5238750
(10) Threads, marks, etc.						60000	3000		63000
(11) Fuel (gasoline)						65000	3250		68250
(12) Commission	5%				2021875				2021875
(13) Insurance					4400				4400
(14) Working Capital					62787				62787
Total				106388	2126762	4184340	214516	-11216	7620790
Total/mt				0.43	8.51	20.74	0.86	-0.04	30.48

4. (and 5.) Trucks are for transporting pellet feed sacks locally or for export. Book value is LS 35,000.
6. (and 7.) Tractors and trailers are for transporting bulk feed to adjacent feed lots. Book value is LS 20,000.
8. Spare parts are 10% of the book value.
9. Sacks are for pellet feed.
10. Material is for cattle pellet.
12. A separate marketing division is assumed to market the product against a 5% commission.
13. Insurance 2% of book values. Two capital recovery factors are applied: 10% for social costs and 2% for private costs. The plant will hold the cash for one month.
14. Working capital includes labor costs + intermediate input values, and is charged a 10% interest rate.

1982 PRODUCTION BUDGET FOR ANIMAL FEED MILL (LS)

Name of Plant: Khartoum Feed Mill
Location: Khartoum North
Capacity: 100,000 metric tons

Item	Quantity		Wages		Capital	Tradable Inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct Labor									
Production Department	9	17	18710	17640				1570	37920
Engineering and Maintenance Dept.	8	21	12499	20200				1930	34629
Admin. and Management	8	1	13650	1000				850	15500
Services Department	4	1	8100	1000				370	9470
								4720	97519
2. Fixed Inputs									
2. Land	20000	m^2			14316			- 10660	3656
3. Buildings and Site Preparation					44342		947	- 21279	24060
4. Foundation and Erection					8878		189	- 4256	4811
5. Furniture					1345		29	- 645	729
6. Equipment					76724		1637	- 36776	41585
7. Storage Equipment					75472		1611	- 36177	40906
8. Steam generation equipment					24152		515	- 11567	13105
9. Transport					10052		244	- 4215	6081
10. Training					1645			- 789	856
3. Intermediate Inputs									
11. Sorghum	45800	ton				6870000		+ 2290000	9160000
12. Molasses	15500	ton				387500		+ 19375	406875
13. Cotton seed	31750	ton				3175000		+ 158750	3333750
14. Wheat bran	4000	ton				380000		+ 14000	294000
15. Urea	100	ton				24400	1000		25400
16. Salt	700	ton				49000		+ 2450	51450
17. Limestone	1700	ton				255000		+ 12750	267750
18. Protein-Vitamin Premix	450	ton				1372500	56000		1428650
19. Furnace Oil	30000	ton				3000000		+ 150000	3150000
20. Electricity						30000		- 4500	25500
21. Processed water						10000		- 1500	8500
22. Spare parts						96674	4834		101508
23. Insurance					19335				19335
24. Working Capital					144336				144336
Total			0.53 92799	0.40	420647	15500074	67006	+ 2469681	18417000
Total/mt			0.93		4.21	155.50	0.67	24.70	184.17

Output	Quantity MT	Domestic Price Per Ton	Gross Domestic Value GDV	Production Taxes 25% (PT)	Transport Costs to Consuming Centers TC	GDV-TC-PT	C.I.F. Value	Transport Cost to Seaport f.o.b.
Pellets feed	50,000	LS 250	12,500,000	3,125,000		9,025,000	15,000,000	
Bulk feeds	50,000	LS 170	8,500,000	2,125,000	1,000,000.	6,025,000		12,500,000

NOTES:

1. Domestic taxes represent social payments of LS 80 per year for skilled labor and LS50 for unskilled labor.
2. Land valued is at LS per m^2 for development projects. The market value os LS /m^2 with a subsidy of LS /m^2. Land is depreciated over 40 years. Book value is LS 140,000.
3. Replacement cost depreciation values are calculated according to a twenty year building depreciation. Two capital recovery factors are applied: a 10% rate for the social calculations, and a 10% for the market values. Border taxes are assessed at a 2% rate. Seasonal labor cost is added to the department of engineering and maintenance. Book value is LS 309578, 300 operating days. LS $1 = LS 0.90 is the exchange rate.
4. Construction and engineering works are estimated at about 20% of the buildings and site preparation with the same capital recovery rates. Seasonal labor cost is added to the department of engineering and maintenance. Book value is LS 61,916.
5. Furniture depreciates over 20 years with the same capital recovery rates. Book value is LS 11,400.
6. Equipment depreciates over 15 years with the same capital recovery rates. Book value is LS 600,000.
7. Transportation depreciates over 15 years with the same capital recovery rates. Book value is 63,000.
8. Training depreciates over 20 years with the same capital recovery rates. Book value is LS 15,000.
9. Storage depreciates over 15 years with the same capital recovery rates. book value is LS 270,000.
10. Steam generation equipment depreciates over 15 years with the same capital recovery rates. Book value is LS 105340.
11. Domestic market price of sorghum is LS 200 per mt, and the social price is LS 150 per met. LS 50 per mt. is domestic taxes. Sorghum represents 45.8% of the ration formula.
12. The molasses price per mt is LS 25 with a 5% domestic tax. Molasses represents 15% of the ration formula.
13. The domestic market price of cotton seed is LS 100 per mt, and the social price is LS 80 per mt. Cotton seed represents 31% of the ration formula.
14. The domestic market price of wheat bran is LS per mt, and the social price is LS per mt. Wheat bran represents % of the ration formula.
15. Urea is imported at LS 200 per mt and 1 20% sea freight + a 2% insurance + a 5% border tax. Urea represents % of the ration formula.
16. The domestic market price of salt is LS 70 per mt, and the social price is LS 50 per mt. Salt represents % of the ration formula.
17. The domestic market price of limestone is LS 200 percent, and the social price is LS 150 per mt. Limestone represents % of the ration formula.
18. Protein vitamin premix is imported at LS 2500/mt + 20% sea freight + 2% insurance + 5% border taxes.
19. Electricity is needed for offices and buildings. 15% is a subsidy from the market price.
20. Processed water is calculated per month. 15% is a subsidy from the market price.
21. Spare parts are 10% of the book values of fixed inputs + 20% sea freight + 5% tax + 2% insurance.
22. Insurance is 2% of the book values of fixed inputs.
23. Furnace oil is produced locally from the oil refineries at LS 100/ton + 5% tax. 0.2 ton is required for amt. of animal feed.
24. Working capital includes labor cost + intermediate input cost, with a 10% interest rate. The plant will hold the ash for one month.
25. A proper animal feed price is not available locally except those prices of the small animal feed private plants around Khartonm. The local prices fluctuate and are unreliable, because local production is small. According to Arizona feed mill prices for feed pellets and bulk feed (U.S. $210, U.S. $190 respectively), LS 250 and LS 300 permit are assumed as local price and equivalent world prices for feed pellets respectively. LS 170 and LS 200 per mt are assumed as local price and equivalent world price for bulk feed respectively.

1982 BUDGET FOR COLLECTION (LS)

Item	Quantity		Wages		Capital	Tradable Inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
	Skilled	Unskilled	Skilled	Unskilled					
1. Direct Labor									
(1) Truck drivers	5	5	17470	4400				650	22520
(2) Loading and Unloading	2	7	5000	6160				450	11610
2. Fixed Inputs									
(3) Trucks (25 MT)	2				22456		546	- 9164	13838
(4) Trucks (6 MT)	4				4812		117	- 1964	2965
3. Intermediate inputs									
(5) Spare parts						15860	650		16510
(6) Fuel (gasoline)						60000		3000	63000
(7) Insurance					2600				2600
(8) Working Capital					969				969
Total			22470	10560	30837	75860	1313	-7028	134012
Total/mt				0.33	0.31	0.76	0.01	-0.07	1.34

3. The 25 MT trucks are for collecting molasses and fuel. Book value is LS 70,000.
4. The 6 MT trucks after collecting the other ingredients.
5. Spare parts are 10% of the book values.
7. Insurance is 2% of the book values. Two capital recovery factors are applied: 1% for social costs and 2% for private costs.
8. Working capital includes labor costs and intermediate value and is charged a 10% interest rate. The plan will hold the cash for one month.

1982 BUDGET FOR DISTRIBUTION

Item	Quantity Skilled	Quantity Unskilled	Wages Skilled	Wages Unskilled	Capital	Tradable inputs	Border Taxes and Subsidies	Domestic Taxes and Subsidies	Private Cost
1. Direct labor									
(1) Truck drivers	5	5	17470	4400				650	22520
(2) Loading and Unloading	3	10	8250	8800				740	19790
(3) Pellet feed, packing	3	10	8250	8800				740	17790
Fixed inputs									
(4) Truck (25 MT)	1				6416		156	-2618	3954
(5) Truck Hoist (6MT)	2				4812		117	-1964	2965
(6) Tractors (40 hp)	1				2567		63	-1052	1578
(7) Trailers	1				803		20	- 328	594
Intermediate inputs									
(8) Spare parts						10370	425		10795
(9) Sacks	220000					2013000	82500		2095500
(10) Threads, marks, etc.						40000	2000		42000
(11) Fuel (diesel)						50000	2500		52500
(12) Commission					752500				752500
(13) Insurance					1700				1700
(14) Working Capital					25109				25109
Total				55970	793907	2113370	87781	-3832	3047196
Total/mt				0.56	7.94	21.13	0.88	-0.04	30.47

4. (and 5.) Trucks are for transporting pellet feed sacks locally or for export. Book value is LS 35,000.
6. (and 7.) Tractors and trailers are for transporting bulk feed to adjacent feed lots. Book value is LS 20,000.
8. Spare parts are for pellet feed.
9. Sacks are for pellet feed.
10. Material is for cattle pellet.
12. A separate marketing division is assumed to market the product against a 5% commission.
13. Insurance 2% of book values. Two capital recovery factors are applied: 10% for social costs and 2% for private costs. The plant will hold the cash for one mohth.
14. Working capital includes labor costs + intermediate inputs values, and is charged a 10% interest rate.

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