AN ECONOMIC EVALUATION OF THE KENYA SUGAR INDUSTRY, THE CASE OF MUMIAS SUGAR SCHEME

by

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DECLARATION

"This thesis is my original work and has not been presented for a degree in any other University".

Signed: .....
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Date: 26/9/79

"This thesis has been submitted for examination with our approval as University Supervisors".

Signed: .....
Prof. J.J. Oloya

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Dr. K.L. Sharma

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ABSTRACT

This thesis attempts to provide a comprehensive economic empirical analysis of the sugar industry in Kenya using Mumias sugar scheme as a case study.

The sugar scheme aims to increase the incomes of smallholders around Mumias, to provide employment, especially to unskilled labour, and to produce sugar which would substitute imports and thereby conserve foreign exchange. In this study, seven aspects of interest relating to the scheme are studied, namely an estimation of the degree of returns to scale on outgrower sugarcane farms, a determination of the price elasticity of sugarcane supply on outgrower farms; an estimation of the optimal sugar factory size; a comparison of actual and required levels of capital and labour utilisation; a comparison of value marginal products of unskilled labour with the average labour cost; an estimation of the foreign exchange impact of the scheme; and a social cost-benefit analysis of the scheme.

An econometric analysis of cost and production structures in the outgrower farms in the Mumias area was carried out and it reveals that the farms experience acute degrees of decreasing returns to scale. The sugarcane farmers on the other hand are very responsive to the price indicator, and the price

elasticity of supply of sugarcane was estimated at 2.45. Based on the constant 1972 sugar price equivalent of the current producer price of sugar, the minimum profitable factory size was determined as being around 50,000 tons throughput per annum. Since the average and marginal cost curves estimated were declining over a very wide range, the optimum factory size could not be determined. A comparison of actual and required levels of capital and labour utilisation indicated that these did not differ significantly. However, a comparison of the average unskilled labour cost with the marginal value product of labour revealed that unskilled labour is paid less than its marginal value product. On the foreign exchange impact of the project, estimates based on past trends and projections of usage and conservation or generation indicated that this is likely to be very favourable to Kenya. Similarly, the social cost-benefit analysis of the project indicated that it would be beneficial economically and would realise an internal rate of return of 19.4 per cent at current world prices of sugar.

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LIST OF ABBREVIATIONS

C.I.F. - Cost, Insurance and Freight.

M.S.C. - Mumias Sugar Company.

M.S.P. - Mumias Sugar Project.

O.D.I. - Overseas Development Institute.

S.C.B.A.- Social Cost Benefit Analysis.

S.W.R. - Shadow Wage Rate.

B.A.T.S.- Booker Agricultural and Technical Services Ltd.

A.R.I. - Accounting Rate of Interest.

S.C.F. - Standard Conversion Factor.

I.R.R. - Internal Rate of Returns.

TC/TS - Ton Cane / Ton Sugar.

M.V.P. - Marginal Value Product.

N.P.V. - Net Present Value.

F.T.C. - Farmer's Training College.

F.O.B. - Free on Board.

UNITS OF MEASUREMENTS

1 US$ = KShs.7.5

1 Hectare = 2.54 acres.
1 Km = 0.62 miles.
1 UKStg£ = KShs.16.0.

CHAPTER ONE

INTRODUCTION

1.1 Mumias Sugar Scheme:

Mumias Sugar Scheme is the largest sugar project in Kenya. It is located in the Kakamega District of Western Province. The life of the scheme goes back to 1967 when Booker Agricultural Holdings (a Booker McConnell Company) was asked by the Kenya Government to carry out a pilot project on 405 hectares for three years in Mumias to determine the suitability of the area for a large scale sugar factory. The feasibility study, carried out by Booker Agricultural and Technical Services Limited (B.A.T.S), another subsidiary of Booker McConnell, was completed and submitted to the Government of Kenya in 1971 (5). The Report showing that the project would be commercially and socially desirable was adopted by the Government.

The project initially consited of a processing cane factory, a nucleus estate of about 3100 hectares, and an outgrowers area covering about 7,500 hectares, within a 5 kilometre radius (See Map on page 8). The initial factory had a capacity to crush 80 tons per hour (80 tch), and was later expanded to 125 tch when it began to produce 80,000 tons of sugar per

annum. The planned capital cost was K£5.5m. In 1976, the cost of the project amounted to K£7.5m. Over 3,700 people obtain direct employment in the scheme. In addition, over 5,000 farmers participate in the scheme as outgrowers. The factory itself initially cost K£4.5m and was partly financed by a British Government loan of K£2.5m to the Kenya Government at 2½ per cent interest (31). It was built and supplied on a turn-key basis by Fletcher and Stewart, a Booker McConnell engineering subsidiary.

The Kenya Government acquired 69 per cent of the equity in Mumias Sugar Company which was set up to own the scheme. The other shareholders are: Commonwealth Development Corporation, 12 per cent; Kenya Commercial Finance Company, 9 per cent; East African Development Bank, 5 per cent; and Booker McConnell Limited, 5 per cent (31). The management of the project is under B.A.T.S. Limited on contract of seven years.

Earlier on in the agricultural history of Kenya, the Swynnerton Plan in 1954 had recommended the establishment of a sugar industry in Western Province. However, according to Holtham and Hazlewood the Mumias scheme "was the brainchild of the then Minister for Agriculture, B.R. McKenzie in 1965" (31,p.147).

The pilot project was began in 1967 and financed by the Kenya Government at a cost of K£450,000. On accepting the subsequent feasibility report which indicated that the project was feasible, the Government of Kenya asked Booker McConnell to invest heavily in the equity of the project "while the company wanted simply a contract to supply the factory via their subsidiary Fletcher and Stewart and a management contract for B.A.T.S. to run it" (31,p.147). B.A.T.S. have been awarded management contracts in many parts of Africa such as Juba in Somalia (14, Oct. 1977,p.10), Chemelil in Kenya and Sucrieres de Nossi Be in Malagasy. The financing of Mumias Sugar Scheme is one of Britain's biggest aid projects through the agency of the Overseas Development Ministry.

Negotiations were held with the British Government on setting up and running the factory and B.A.T.S. of London was awarded the management contract and a contract to supply and build the factory was awarded to Fletcher and Stewart. However, Booker McConnell had to buy a 5 per cent equity into the company and to agree to take over the management of Chemelil Sugar Company through their subsidiary B.A.T.S.

The factory was completed in 1973 ahead of schedule, and began to operate the same year. In the five months of July to December 1973, 20,891 tons of

sugar were made at a profit and a dividend was declared. Mumias Sugar Company has since exceeded all targets of output and realised a consistent return on investment above 10 per cent (Appendix 5). It is likely that apart from careful planning, the management experience of B.A.T.S. in Latin America and other tropical countries enabled the company to give Mumias Sugar Company a good take off.

It is because of the success of the Mumias Scheme, and the fact that Bookers managed to put Chemelil back into profitable and almost full capacity operations in two years after they took over its management, that a second project code named Mumias II was envisaged by B.A.T.S. to be built around Sudi station near Bungoma. In the event, the management of the Nzoia Sugar Company, as the Mumias II project became known, was won by a French firm, apparently because the Government of Kenya did not wish to give B.A.T.S. a semi monopoly over sugar manufacturing in Kenya.

As a result of the loss of the Mumias II project, not only was the planned expansion undertaken in 1976, but the Mumias Sugar Scheme was expanded by more than 100 per cent to produce 178,000 tons of sugar per annum. This latter expansion was started in 1977 and is due to be operational in 1979. No

social cost-benefit analysis could be found for this expansion which almost amounts to building a new factory. The implied assumption was that if the initial factory was desirable to the Kenyan economy, so was its expansion by more than 100 per cent. The expansion will make Mumias Sugar Company the largest sugar factory in Kenya for many years to come. Together with Chemelil's 60,000 ton capacity, B.A.T.S. will be overseeing the production of 240,000 tons of sugar per annum, over 50 per cent of total Kenya sugar output. The outgrower scheme, which will be doubled following the expansion, has been successful in supplying sugarcane to the factory and in attracting farmers to participate. It is expected to cover over 12,000 hectares or about 30,000 acres. The factory will provide employment to about 5,000 people, or twice its 70,000 ton capacity employment. Whereas the 1976 expansion cost K£1.722m, the 1977 expansion will cost at least K£30m when it ends in 1980. The total project capacity cost will therefore be approximiately K£38.7m by 1980, and the factory is projected to incur a recurrent capital net addition per annum of K£455,000 thereafter. Most of the additional sugarcane is planned to come from out-grower. The projected annual return on investment is 16 per cent (Appendix 5).

1.2 The People and Area of Mumias

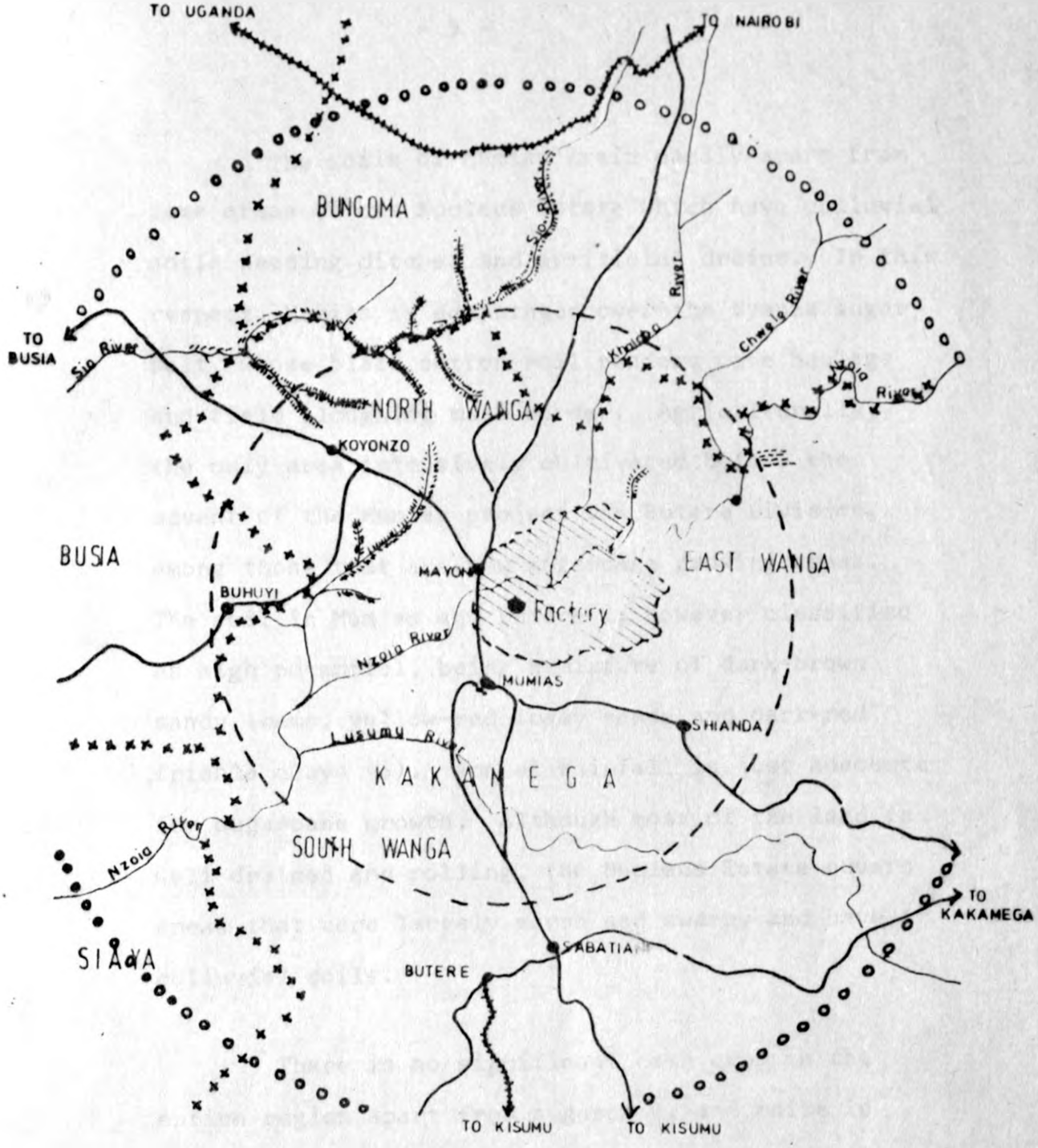
The area on which Mumias Sugar Scheme stands mainly covers what is known administratively as Mumias Division and parts of Butere Division, both located in Kakamega District of Western Province, Kenya. Mumias Division includes three locations i.e. North, South and East Wanga, while Butere Division includes Kisa and Marama locations. Only Marama falls squarely within the outgrower area of Mumias scheme in Butere Division. All of Mumias Division is either part of the Nucleus Estate or Outgrowers including parts of Bungoma, Busia and Siaya Districts. The 3,100 hectare nucleus estate covers the sub-locations of Mung'ang'a, Eshimuli and Busambe surrounding the factory (See the Map on Page 8). Mumias Division had an estimated population of 108,000 people in 1975 growing at 6.2 per cent as is indicated in Table I, and the distribution of population was then estimated as in Table I. The estimated population in Mumias Division is 129,400. The population displaced by the Nucleus Estate therefore approximated 5,000 people at least; or 1,000 families.

Table I - Population in Mumias Area

Area	Total Population	Growth Rate %	Area Sq. Km.	Density per Sq.Km
Mumias Division	108,000	6.2	597	180
N. Wanga	45,000		281	160
S. Wanga	35,000		153	228
E. Wanga	28,000		163	171
Butere Division	138,000	6.1	350	394
Kisa	73,000		140	521
Marama	65,000		210	309
Kakamega District	980,000	3.9	3,520	280

Source: Government of Kenya, Kakamega District Development Plan 1974-1978, Kakamega : Mimeograph, 1974.

Fig1 THE MUMIAS AREA



KAKAMEGA DISTRICT

- OUTGROWER 14 MILES RADIUS ZONE
- OUTGROWER 8 MILES RADIUS ZONE
- DISTRICT BOUNDARIES
- MAIN ROADS
- RAILWAY LINES
- RIVERS
- SWAMPS

The soils of Mumias drain easily apart from some areas of the Nucleus Estate which have colluvial soils needing ditches and artificial drains. In this respect, Mumias is advantaged over the Nyanza sugar belt, whose black cotton soil renders cane haulage and field ploughing much harder. Agriculturally, the only area intensively cultivated before the advent of the Mumias project was Butere Division, among those that are now sugarcane growing areas. The soil in Mumias and Butere is however classified as high potential, being a mixture of dark-brown sandy loams, yellow-red loamy sands and dark-red friable clays (5). Annual rainfall is just adequate for sugarcane growth. Although most of the land is well drained and rolling, the Nucleus Estate covers areas that were largely marsh and swampy and have colluvial soils.

There is no significant cash crop in the entire region apart from sugarcane, and maize is largely grown for consumption though some of it is sold. Before the creation of the large Mumias project, sugarcane was grown for sale to jaggaries spread all over the district. Thus the suitability of the area to sugarcane farming has been established for many years.

CHAPTER TWO

LITERATURE REVIEW

Many studies have been done on the sugar industry in Kenya. Charles Frank (18) made a general policy study of the sugar industry in East Africa. He provided useful information on demand, production and on the method then in operation for pricing sugar, namely the Commonwealth Sugar Agreement Price. Frank also undertook an econometric analysis and projection of the demand for sugar in East Africa, identifying major factors.

Frank's work was very comprehensive, covering aspects of the industry such as distribution and transportation costs, location and its future expansion. Of particular relevance to this study, Frank later discussed the issue of opportunity costs of developing a sugar industry in East Africa. He found the sugar industry efficient as an import substitution tool, but lacking in backward linkage, nearly all output being value added. On the whole, Frank recommended the vigorous expansion of the industry.

In 1968, the National Christian Council of Kenya (NCCK) published an investigative report on ownership of industries in Kenya (47). Among the

industries studied was the sugar industry (47, pp. 6-14). The report raised the important question as to whether the sugar industry in Kenya is efficient, and recommended more government control and the lowering of sugar prices. The World Bank Mission to Kenya in 1963 (68, pp.130-131) also made a few policy recommendations to the Kenya Government urging the creation of only those factories with more than 50,000 ton annual production and giving support for the implementation of the Sugar Quality Equilisation Fund.* The Bank was more confident than C. Frank about Kenya's potential in cane sugar production relative to other countries in East Africa and in fact the Government of Kenya heeded the Bank's recommendations which have all been implemented.

Another study by Elly K. Owinyi (52) examined the effects of the compulsory acquisition of land for the sugarcane nucleus estate, affecting over one thousand families. Although the study was largely a legal treatise, it contains numerous cases of what happened to the displaced peasants, their futile attempts to resist eviction and their plight in

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* This was a fund into which a levy of Shs.89.60 per long ton of sugar produced locally was paid and was used to award quality premiums to th se manufacturers who produce sugar of a quality better than a certain minimum standard.

attempting to acquire alternative land within the existing outgrower area, made more difficult by the legal process of land transfer. Owinyi considered that the compensation which was paid for the land at a flat rate of Shs.450.00 per acre (about 1,100/= per ha.) was grossly inadequate, and the process of eviction was done with undue haste. Although the study also included an attempt at assessing the economic consequences of implanting the project at Mumias, it is cursory in its approach.

In 1975, the British Overseas Development Institute sponsored a study of various projects in Kenya supported by British Government aid, among them the Mumias Scheme (31). The study represents the first major re-evaluation of the Mumias scheme. Mildly critical of the sociological impact of the project, the report was careful to qualify the Mumias project as an overwhelmingly positive contribution towards Kenya's economic goals. Touching a little on the issue of appropriate technology, the authors compared the large modern plant at Mumias with the "Khasandri"* sugar plants in India,

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*This is the name of a powdery sugar produced in Indian cottage plants.

although there are local examples such as Yala and Kabras which they would have used. It is probable that they used the Indian examples because of their familiarity with them and also to point out the drawbacks of the Khasandri plants for illustrative purposes. The report however challenged the zero valuation of the opportunity cost of outgrower land or labour used in the cultivation of sugarcane from their previous use in the feasibility study. A summary impression of their viewpoint concerning the Mumias project can be seen in the quotation below where they attempt to foreclose the need for any subsequent re-evaluation:

> "Whether the project was backed for sound reasons, however, now appears a somewhat cold speculation for in fact subsequent events (meaning the 1974/76 rise in world sugar prices) have vindicated it absolutely" (31, p.151).

This assertion, based largely on the commercial success of a project with a profound socio-economic impact does not derive from their foregoing discussion. Moreover, the same authors assert later in connection with the outgrower scheme that:

> "It is too early to assess the developmental impact (of the project) on the neighbourhood because production started only in 1973 .... after 22 months farmers are receiving lumpsum payments, often of more money than they have seen in their lives" (31, p.154).

but the farmers have to wait for this amount of money over twenty two months without alternative sources of income. On the whole however, the O.D.I. study is a useful source of information regarding the project, especially during its formative period.

The major impetus which led to the selection of this topic for study is the feasibility report of the Mumias Scheme (5). The report, which is detailed, provides useful data on the technical and financial aspects of the project, even though there may be doubtful basis for evaluating the cost of out-grower land and labour, and the real cost of capital. These doubts justify the need to evaluate the project's performance critically.

In addition, Tate and Lyle (63) carried out a country wide economic study of the sugar industry in Kenya. The study was sponsored by the World Bank as a way of assessing the viability of a KShs.600 million sugar rehabilitation program for which the Kenya Government was seeking a World Bank loan.

Again, Albert Barclay (4) has recently completed a sociological study on the impact of the Mumias scheme within the area. This detailed socio-anthropological study provides a thorough critique of the sugar scheme from a socio-anthropologists' viewpoint.

Finally, the most recent study on the sugar industry in Kenya has just been completed by Mark Odhiambo (51). Mainly a study on the Nyanza Sugar Belt, Odhiambo looked at the operational efficiency of the three sugar factories in the sugar belt, namely, Miwani, Chemelil, and Muhoroni. The study also included a survey of farms supplying the factory with sugarcane. Useful comparative information is provided in this study not only for the three Nyanza factories but also for Mumias.

CHAPTER THREE

THE PROBLEM AND OBJECTIVES OF THE STUDY.

3.1 The Problem

As indicated earlier, the Mumias Sugar Scheme has been operational since 1973 and has been billed a success as a commercial project, earning profits from its first year of operation. The project has also been able to exceed all its set target goals of production and has not suffered any significant capacity under-utilisation. Teething problems, which normally cause many shut-downs were few, and the supply of cane has been regular. In addition, Mumias Sugar Company (MSC) enjoys the industry wide reputation for having the lowest ton-cane ton-sugar ratio in Kenya at 8.6, and now produces almost 40 per cent of total industry output of sugar (Tables 9, 10 and 14).

It would therefore seem that an evaluation study of such a seemingly successful project is not necessary. Indeed, Hotham and Hazelwood (31, p.147) give this impression in their review of British Government aid to Kenya. Many scholars and researchers interested in the performance of the Kenya sugar industry have concentrated on the Nyanza Sugar Belt, believing that Mumias Sugar Project (MSP) is either

too recent for meaningful evaluation or has few problems. Such scholars include Odhiambo (51) and to a lesser extent Odada (49). The Tate and Lyle group of consultants, who carried out a countrywide study of the sugar industry for the Kenya Government in 1975 argued for the restructuring of the industry in favour of the Mumias mode (63).

The present study attempts to evaluate MSP after five years of operations on the justification that proper and meaningful planning calls for periodic evaluation and continuous monitoring of projects whether they are successful or not. Secondly, it is believed that the benefits which are assumed to accrue may need some verification. Furthermore, the issue of efficiency in resource allocation within the sugar industry in Kenya and its model behaviour has neither been settled nor related to the theory of the firm by detailed study. There exists, therefore, a relevant need to carry out a detailed study of the entire industry from the farm level to the factory level. This study, which examines the production organization and efficiency of the MSP, is a contribution in this direction. It is generally agreed that the need for periodic evaluation and monitoring of development projects, and especially large ones like MSP,

cannot be overemphasised. Carruthers and Clayton (7), while being critical of the Little and Mirrlees methodology, had this to say regarding the need for ex-post evaluation of projects:

> "There are thus two purposes of ex-post project evaluation:
> (i) to provide feedback to the project itself. This enables an assessment of the project performance to be made- has it been a success or not? .....
> (ii) to provide feedback to the planning process ....." (7,p.305).

The economic evaluation of MSP would be complete if done against the criteria of effectiveness, efficiency, and the significance of its contribution to socio-economic goals (7, p.311). In order to do justice to these broad aspects, an enlarged study would be required.

3.2 Objectives

3.2.1 To Determine the Degree of Returns to Scale in Outgrower Farms

On average, a farmer who harvests a hectare of sugarcane at MSP earns a gross margin of about KShs. 7,000/= (Table 6). Most farms in MSP are small, averaging 5 hectares according to the sample used in this study. There are approximately 6,000 such farmers in MSP, and the individual output of one

farmer is therefore insignificant to the total cane output. The farmer at MSP may therefore be thought of as being a member of an atomistic market structure. Marc Nerlove (48, pp.15-16) has shown that a firm in an atomistic market situation cannot be expected to experience constant or increasing returns. The first objective of this study is therefore to determine whether the outgrower sugarcane farms in MSP experience decreasing returns. This is determined first by estimating a cubical cost function based by input output data, and second, by estimating a farm sugarcane production function. From the total cost function, an average cost function and a marginal cost function are derived by which it can be determined whether or not the farms experience decreasing returns (or increasing costs). From the production function, the degree of returns to scale can be easily determined by the sum of the partial elasticities of output with respect to the various factor inputs. Based on the first objective, the first hypothesis which will be tested can be stated as: "Farms in MSP experience diseconomies of scale".

3.2.2 To Determine the Price Elasticity of Supply of Sugarcane in MSP

The effect of sugarcane prices on the allocation of land to sugarcane farming is suspected to be strong

at MSP as Odhiambo (51, p.109) found it to be in the Nyanza Sugar Belt. It is useful to know the price elasticity of cane supply in MSP for planning expansionary or contractionary policies with respect to outgrower farm area at MSP and possibly elsewhere in Kenya. The second objective is therefore to obtain the price elasticity of supply (output) of sugarcane in MSP. The working hypothesis related to this objective is stated below:

> "that farmers in MSP are positively responsive to the price indicator".

3.2.3 To Determine the Optimum Size of the Mumias Sugar Factory

The Mumias sugar factory is currently undergoing an expansion which will double its 1978 output capacity. However, the known optimum sizes for sugar factories are engineering rather than economic. Empirical studies of the optimum capacities of various enterprises have shown that many firms operate below minimum capacity [See (51, p.251), (2), (34,p.168)] . Although the factory at MSC realises its engineering capacity, it is not to imply that it is operating at optimal capacity, or that the capacity (engineering) installed at MSC is optimal from an economic point of view. It is an objective of this study, therefore,

to determine by econometric and mathematical methods the economic capacity to which engineering capacity should be pegged rather than vice versa. The economic implications of the result on future expansion of the industry would be obvious. Accordingly, the third hypothesis is stated

> "that although the factory at MSC is very large, its size is justified because it realises economies of sale".

3.2.4. To Compare Actual and Required Levels of Capital and Labour at Mumias Sugar Factory

The production relationships within a sugar manufacturing enterprise have not been established in Kenya. Whereas these can be obtained from engineering production functions (9,pp.501-531) this study will attempt to obtain an econometric production function for sugar at MSC. On the basis of this production function, future decisions on factor combinations and rewards (rent and wages) can be made more objectively by both the management of MSC and trade unions. Since a Cobb-Douglas production function is used both on the sugarcane farms and sugar manufacturing enterprise, a periodic estimation of this type of function will be able to shed light on the level and direction of

change of technology and the level and direction of change of returns to scale of the MSC plant and outgrower farms over time. Cross-sectional industry wide studies of this type would also provide similar estimates for the country. Therefore, the fourth hypothesis which will be tested is

> "that Mumias Sugar factory is more capital intensive than its present capacity would demand, it employs more capital (and hence less labour) beyond the point where decreasing marginal value product of capital is equal to the price of capital".

3.2.5 To Determine Whether or Not Labour is Paid At Least Equal to Its Marginal Value Product at Mumias Sugar Factory

The production function which will be estimated for the sugar factory could be used as a basis for future productivity-based rewards to factors. Because MSC is a local monopsonist in buying labour within the Mumias area, we postulate in accordance with economic theory that the factor labour is paid a wage at MSC less than its marginal value product (29, p.241). In this study therefore, actual levels of average cost of labour at MSC will be compared to labour's marginal value product for each year so as to observe any differences between rewards

and productivity, if any. The fifth hypothesis therefore states

> "that since MSC is a monopsonist employer of the factor labour, the resource is paid less than its value marginal product".

3.2.6 To Estimate the Foreign Exchange Effect of Mumias Sugar Project

One of the major goals in the establishment of MSP was the conservation of foreign exchange which was being spent on imports of sugar. World prices permitting, and in the event of there being a surplus of production over consumption domestically, MSP would possibly even generate foreign exchange directly by exporting its sugar. Using available information, estimates will be made of how much foreign exchange MSP has used, generated or saved since its inception to date. Armed with the past estimates, projections can be made, within the visible future, of planned and probable expenditure, generation and saving of foreign exchange by MSP. In other words, this section will seek to answer the question as to whether or not MSP is an effective device for saving and generating foreign exchange. This section will not however delve into the problem of whether or not MSP sugar

is exported in future or not. The assumption would be that all MSP sugar is available and utilised domestically as substitutes for imports.

3.2.7 To Carry Out a Social Cost-Benefit Analysis of the Mumias Sugar Project

Having determined the economic efficiency or otherwise of the sugarcane and sugar production organisations at MSP and its foreign exchange contribution, real and potent, there would be a need to complete the evaluation from a national point of view by a social cost-benefit analysis.

The social cost-benefit analysis is necessary for various reasons. First, the use of market prices in the foregoing economic analyses renders the conclusions valid for allocative and distributive decision purposes only but not for social evaluation because of a marked divergence between market and true prices reflecting opportunity costs. A study which considers the overall benefit of a major project like MSP to the nation would therefore need to use shadow prices. This is especially relevant in the light of the now completed expansion which renders the pre-operative social cost benefit analysis invalid. The said analysis gave MSP an internal

rate of return of 12.6 per cent using shadow prices (5, p.12).

On the face of it, there seems to be some issues with respect to the methodology adopted in the feasibility report which was carried out by the present managing agents of MSP, Booker Agricultural and Technical Services (B.A.T.S.) Limited. In their derivation of the internal rate of return (see 5, Ch.12), they impute no opportunity cost to the 3,100 hectares under nucleus estate sugarcane or on the land in outgrower areas which subsequently came under sugarcane in the place of pasture land or land for other crops. The reason advanced for this omission is evidently that there was no land shortage in an area with a population density of 180 persons per square kilometre growing at 6.2 per cent per annum (Table 1). As a result of the introduction of cane farming to the MSP area on a commercial basis, land values have more than doubled in a space of five years, and so the cost of land has increased in MSP in real terms. In the same report, no account was taken of the displaced food crop(s) from the areas now under sugarcane. The major crop affected was maize. Again, the reason was given that the land was largely untilled. If at that time Mumias was a food surplus area and barely two years later

the smallholders began to buy most of their staples, the most likely explanation for this food deficiency must be that the value of sugarcane production became much greater than that of food crops produced. Therefore, a cost must be imputed to this loss of self sufficiency in the calculation.

Another drawback in the feasibility report lies in the zero valuation of outgrower farmer's labour input into their sugarcane enterprise. MSC records indicate that this would amount to 62.5 man-days per hectare of sugarcane harvested. There are over 6,000 hectares under cane. This is approximately equal to 375,000 man-days every 22 months.

Therefore, a social cost-benefit analysis should incorporate these neglected costs to obtain what is considered to be a more accurate internal rate of return. It is not to be assumed that the new internal rate of return, over the entire project life estimated at 30 years, will necessarily be lower. On the contrary, sugar prices have risen and the project has been expanded considerably, and therefore there can be no apriori reasons to anticipate a lower internal rate of return than that obtained in the initial feasibility report. Reasons however

exist for anticipating that the internal rate of return now obtained will be higher due to improved sugar prices. The working hypothesis advanced from the foregoing analysis is stated below,

> "that MSP is on the whole socially desirable, and its internal rate of return exceeds the opportunity cost of capital".

CHAPTER FOUR

METHODOLOGY AND MODEL FRAMEWORK

The economic evaluation of the Mumias Sugar project encompasses seven major aspects. Namely, to determine the degree of returns to scale in outgrower farms; to determine the price elasticity of supply of sugarcane in MSP; to identify the optimum size of the Mumias sugar factory; to compare actual and required levels of capital and labour at the Mumias Sugar Factory; to determine whether or not labour is paid its marginal value product equivalent at the Mumias Factory; to estimate the foreign exchange effect of the entire project; and to carry out a social cost benefit analysis of the project. The first five aspects of the study have been done largely by estimating cost and production functions for the outgrower farms and the sugar factory. The foreign exchange effect is estimated by projecting past trends in the use, generation and conservation of foreign exchange by MSP. The social cost benefit analysis is done using the Little and Mirrlees method. Each of these methods and procedures is now discussed in somewhat greater detail.

4.1 The Sampling Procedure

The sampling procedure only applied to the small scale outgrower farmers who number well over 6,000. MSP has only one central factory which is examined as a separate entity.

4.1.1 The Sample Size

The population (N) from which the sample was chosen was that group of farmers who harvested plant cane in 1977/78. These number 840. A sample (n) was chosen such that n/N was at least equal to or greater than 5 per cent. This was equal to 42.

4.1.2 The Sample Selection

The sample of 42 respondents was chosen randomly from the register of farmers provided by the Mumias Sugar Company. No regard was paid to their spatial distribution as long as they fell within the sample area which was the entire outgrower area of MSP*. Table 2 shows the distribution of respondents obtained and interviewed.

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* See Map on page 8.

Table 2 - Sample Distribution of Respondents

Area/Place	No.	Area/Place	No.
Shibale	2	Imanga	6
Sabatia	1	Lubinu	2
Shianda	2	Kholera	1
Butere	4	Khalaba	2
Namamali	1	Mayoni	3
Mun'gan'ga	5	Koyonzo	4
Example (Butsotso	2	Mumias	2
Ugenya	1	Eluche	2

Source: Farm Survey Questionnaire.

As Boyd and Westfall (6, pp.372-374) show, the sample of 42 will enable us to make accurate inferences regarding the population N within an 85 per cent confidence interval estimated by

$$CI = \bar{x} \pm \hat{\sigma} / n^{\frac{1}{2}} \qquad (4.1)$$

$$= 20 \pm 0.07715 / 6.48$$

$$= 20 \pm 0.011906.$$

assuming that at least 50 per cent of the population have the same characteristics and $\hat{\sigma}_{\bar{p}} = (pq/n)^{\frac{1}{2}}$.

4.1.3 Questionnaire Administration

A questionnaire of the format in Appendix I was administered with the assistance of two field research assistants over a discontinuous period of two months. Most respondents were found to be warm and willing to answer questions. Information so gathered was later checked for inconsistencies and corrections were made.

The main points which interested this study as far as the farm aspect was concerned were the following: the total farm hecterage under sugarcane during the 1977/78 harvest, the gross cash recoveries by Mumias Sugar Company on the cane harvested, other sugarcane related expenditures, yield in tons of cane and gross revenues, and total labour input on sugarcane (either in costs or man-days). When a farmer could recall the total labour cost, he would usually be able to confirm it with the prevailing casual wage rate at that time.

4.2 The Sugar Factory Study

There was no formal questionnaire for the study of the sugar factory enterprise. Instead, questions were prepared before-hand and discussed with the relevant members of the Mumias Sugar Company

management. Often, the discussions did not conform to the previously handed in questionnaire which merely served as a springboard for further illuminating discussion. The members of the management of Mumias Sugar Company (MSC) were found to be knowledgeable, experienced and favourably disposed to interviews and discussions. In many cases they volunteered much detailed and useful information which had not been thought possible to obtain beforehand; for example balance sheets, income statements, cash flows, and labour statistics were readily supplied on request for all operative years 1973 to 1977 and projections in case of financial statements. Hence, secondary data was the major source of information for this part of the study. Since standard costing procedures are in use at MSC, we can expect that both actual and projected costs will show marked consistency. Under standard costing procedures, constant variable overhead and fixed overhead rates are applied to levels of output.

4.3 The Postulated Market Structure

4.3.1 The Outgrower Sugarcane Farmers

The sugarcane farms in MSP outgrower area average 5 hectares each. There are about 6,000 such

farmers registered with MSC. None of the individual farmers can appreciably influence output or the price of cane. Entry and exit into the industry within the prescribed outgrower area is relatively easy. The price of sugarcane is regulated by the Kenya Government and is not dependent on supply-demand interaction of collective farms and a central factory. Indeed, it is cost rather than market determined. A farmer is free to contract to supply as much cane as he wishes to MSC at a guaranteed price to a guaranteed market. Since MSC does not pay premiums for higher sucrose content cane, the product 'cane' is for all practical purposes perfectly homogeneous. The market structure postulated for these farmers therefore is that of perfect competition. As in all perfect competition models, the individual producer is an output adjuster, and will maximise his profits where his marginal costs equal the marginal revenue. In this case, the marginal revenue is the fixed cane price. But a further condition is that the marginal cost must be rising and at least equal to or greater than the average cost for profit maximisation to occur. Under perfect competion, long run market equilibrium occurs when price equals average and marginal costs. In this instance, price is not altered by the number of entrants to the market, nor are costs. Depending on the level of costs and the

price of cane therefore, it is possible for farmers to experience permanent super-normal profits, though they cannot be postulated to experience the permanent converse for then they would quit cane farming. The fact that many potential farmers are known to be eager to become cane outgrowers may imply that they conceive the average costs to be still below the cane ton price. Profit maximisation would therefore lead us to expect that the observed average and marginal costs of farmers would lie to the right of the minimum average cost point since profit maximisation requires that marginal cost and revenue be equal when the former is rising*.

4.3.2 The Sugar Factory or Mumias Sugar Company

Mumias Sugar Company (MSC) is the largest sugar producer in Kenya (Table 14), accounting for over 40 per cent of the domestic output. There are five large scale sugar factories which share the surplus 60 per cent output between themselves. In an uncontrolled market therefore, MSC would be able to lower or raise the price of sugar by manipulating its output. However, this is not so in Kenya as the product in fact belongs

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* The mathematical derivation of this result is shown in Appendix 7.

to the Kenya Government as soon as it leaves the conveyor belt into the bonded warehouse. The Government compulsorily purchases all sugar in Kenya through its agent, Kenya National Trading Corporation (KNTC). Sugar is sold at a uniform price of KShs.4,500 per ton (retail) and KShs.2,800 per ton (producer). No producer can manipulate the price of sugar to his benefit, and the K.N.T.C. guarantees to buy all the sugar produced by MSC and other factories, at least as long as there is still a need to import sugar to fill up the gap between domestic output and demand. However, the market structure that appropriately describes MSC's environment is not perfect competion. There are significant barriers to entry into the sugar industry in Kenya, mainly capital and legal, and it is plausible to imagine that the existing firms in the industry can exploit this for monopoly profits. We might more aptly describe the sugar industry as a "controlled industry". It is controlled in the price it can charge, the quality of the sugar produced, and even who to sell the sugar to. In a way, MSC and other producers of sugar in Kenya cannot play market. Their situation closely approximates oligopolies (9 of them) selling to a monopoly buyer (K.N.T.C.).

For a given market price of sugar, and as long as the domestic output cannot satisfy domestic demand, the model behaviour which MSC could be postulated to subscribe to is output maximisation. The model is slightly complicated by the fact that B.A.T.S. of London are the managing agents. The task of B.A.T.S. is to produce sugar (albeit profitably) at MSC. Their utility therefore can be seen in output i.e. "utility of output", on which basis they in fact receive commissions and bonuses from the Kenya Government. The main shareholder in MSC being the Kenya Government, it is not extreme to suppose that the output of sugar in itself would be a higher goal than profit attached to MSC. Secondary interests like E.A.D.B.** and Booker McConnell are keen on profit though. We may therefore call this "utility of profit". Let the utility of output be "a" and the utility of profit be (1-a) or "b". Under such circumstances, the model below which is adopted from Ames (1,pp.50-65) would be seen to apply to MSC.

Let $U = aQ + b\Pi$* (4.2)

where U = the utility of B.A.T.S.

a = the utility of output.

b = the utility of profit.

Π = profit

Q = ton sugar produced.

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* This model is expounded in Appendix 8.

** East African Development Bank.

There is no employer in the Mumias area who hires an equally large labour force. We can therefore expect that MSC is at least able to act as a monopsonist employer of labour and we would expect to find that MSC hires less labour than it could and pays it less than the value of its marginal product, because the marginal resource cost of a factor input increases as more of it is purchased. Although this would be expected to occur with respect to labour in MSC, the same is not true of sugarcane whose price is regulated (see 29, pp.240-242).

4.4 The Postulated Cost Behaviour

4.4.1 The Model

Much of the nature of the expected farm cost structure was already discussed in the market structure model i.e. that farms in outgrower areas are expected to show decreasing returns to scale. This was seen mainly in the context of maximisation of profit. Khusro (35) has found out in his studies on returns to scale in India that returns above cash costs either do not change i.e. are constant or decrease as size increases and concluded that a mere expansion of existing small holder farms was not automatically going to lead to increasing returns to scale unless

own labour was used more productively. Some research in Kenya has shown that productivity is higher on small-holdings than on estates, Maitha (42, p.27-29). Deny (13) has even argued that the efficiency differential in favour of estates (compared to smallholders) may be less than is generally believed. However, the official statistics from MSC indicate that the large nucleus estate has higher yields per hectare than the numerous outgrower farms. This is shown in Table 3.

Table 3

Gross Margins on Nucleus Estate and Outgrower Farms In Mumias Sugar Scheme

(Per hectare)

	Nucleus Estate		Outgrowers	
	Plant	Ratoon	Plant	Ratoon
Yield : Tons	135	110	116	97
Gross Revenue KShs.	17,955	14,630	15,428	12,901
Gross Costs KShs.	7,155	4,350	8,338	5,550
Gross Margin KShs.	10,800	10,280	7,090	7,351
Gross Margin/Ton KShs.	80	93.45	61.12	75.78

Source: Mumias Sugar Co. Records.

Assuming that the inputs are the same, we may infer that the nucleus estate has scale economies, and has a declining average cost curve with respect to size.

Heady and An-Yhi Lin (3) however found that real or significant economies of scale on paddy farms were exhausted typically below four hectares in Formosa. The declining average cost curves did not, in their opinion, indicate significant increasing returns to warrant the implied farm size.

The cost-output relationship on the outgrower farms can be identified on a priori reasoning to be as follows:

$$C(Q) = a + \beta Q + \beta_1 Q^2 + \beta_2 Q^3 + ei \qquad (4.3)$$

$$\text{or} \quad C(H) = a + \beta H + \beta_1 H^2 + \beta_2 H^3 + ei \qquad (4.4)$$

where Q and H are tons of cane harvested and hectares respectively. In their study, Heady and An-Yhi Lin (3) used the model (4.4). Both models can be used and the better one selected in terms of goodness of fit, the sign or magnitude of the constant term and the signs and significance of the coefficients. Theoretically, β is expected to have a positive sign, β_1 a negative sign, and β_2 a positive sign (38, p.114). The main tool of analysis used in the estimation of the

cost functions for the factory enterprise and the sugarcane enterprise is the regression model. Fitted regressions were run on the University of Nairobi's ICL 1902 Computer XDS 3 package and on the Ministry of Agriculture's Hewlett Packard Statistical package. For the sugar factory enterprise, equation (4.3) is estimated, with Q representing tons of sugar produced.

From the total cost functions, average cost curves are obtained, i.e.

$$\frac{C(Q)}{Q} = \frac{\alpha}{Q} + \beta + \beta_1 Q + \beta_2 Q^2 \qquad (4.5)$$

and $$\frac{C(H)}{H} = \frac{\alpha}{H} + \beta + \beta_1 H + \beta_2 H^2 \qquad (4.6)$$

Similarly, marginal costs are obtained by differentiating the total cost curves, i.e.

$$C'(Q) = \beta + 2\beta_1 Q + 3\beta_2 Q^2 \qquad (4.7)$$

and $$C'(H) = \beta + 2\beta_1 H + 3\beta_2 H^2 \qquad (4.8)$$

If total cost is the sum of capital and labour cost i.e.

$$C(Q) = P_k K + P_l L \qquad (4.9)$$

where P_k = rate of interest.

P_l = wage rate

K = capital units in shillings (for farmers) and £ (for the factory).

L = labour units in man-days (for farmers) and total labour force (for the factory).

a total cost curve is obtained for both the farm enterprise and the sugarcane enterprise simply by converting the Cobb-Douglas production function

$$Q = AL^{\alpha}K^{\beta} \qquad \begin{array}{l} Q>0,\ \alpha\geq 0; \\ K>0,\ \beta\geq 0; \\ L>0,\ A>0. \end{array} \qquad (4.10)$$

into a cost function of the form

$$C(Q) = P_k \left(\frac{\alpha + \beta}{\beta}\right)\left[\left(\frac{\beta P_l}{\alpha P_k}\right)^{\alpha} \frac{Q}{A}\right]^{\frac{1}{\alpha + \beta}} * \qquad (4.11)$$

in conformity with Walters (66, p.6).

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* The above formula is mathematically derived in Wallis (65, pp.25-56), and Koutsoyiannis (38,pp. 97-99), and in Appendix 10.

The above cost function, which is linear in the logarithms, applies to both the sugarcane and sugar enterprises.

In both cubic and Cobb-Douglas forms of cost functions, cross sectional data are used in the farm study and time series data for the factory study which are deflated to 1972 prices using the implicit GDP deflator. Where the above formula is applied to the sugarcane enterprise with hectares of cane rather than ton of cane as the argument, the letter "Q" is replaced by the letter "H", otherwise the formula remains the same.

4.4.2 In Defence of Empirical Cost Functions

It was previously thought that the shape of the cost curve was evident from the principle of diminishing returns. While expressing doubt about this, Menger (45, pp.39-40) says

> "In particular, the shape of the short run cost function was thought to be evident from the principle of diminishing returns, and this law was either accepted as axiomatic or proved by 'reducio ad absurdum' (quotes inserted) kind of arguments"

and continues to show that the proposition of

diminishing returns may not be a necessary consequence of the assumption that the production function is bounded and nondecreasing. Ménger argues that we can only deduce the law of diminishing average product.

A close examination of accountant's costing methods will disclose that they subscribe to the view that the average cost curve shows a wide flat bottom and is basin-like in the very long run, but L-shaped in the short run. These scholars and accountants believe that there is a reserve capacity (especially in factories) over which the rate of change of marginal cost is zero. Some of their works are quoted in Walters (66, pp.48-49). The reasoning behind these empirical results has been diverse from the spreading of risks to costs, but is most simply put by Andrews (2, pp.102) in these words*.

> "In general, average direct costs per unit of product will be expected to remain constant over large ranges of output, so long as the business continues to employ the same methods of production, and the total of such costs will vary proportionately with total output".

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*See also Walters (66, pp.48-49), Koutsoyiannis (39, pp.114-122), Johnston (33), Whitin (67), Johnston (34, p.70), Dean (11), Eiteman (15).

Vinod Gupta (28) found the same result on sugar manufacturing plants in India using cross sectional data as is shown below.

$$C(Q) = 85.0 + \frac{124}{Q} + 0.001Q$$

Under perfect competition, as is assumed for sugarcane farmers, since in the long run average costs equals average revenues, we could argue that the cost of producing one unit of output is the price. Chisholm (10, pp.282-290), and Friedman (19, pp.230-37) have used this approach to perfect competition situations.

Critics of the empirical method of deriving cost functions object to the use of accounting data on the following counts, Walters (66, pp.46-48) ; that the unit period for accounting purposes usually differs from the unit economic period, generally the financial year being longer than the economic short run, Smith (58); that the distribution of assets is determined by tax authorities rather than by the firm's economic criteria, Walters (66, p. 43); capital services are valued at historical rather than current prices; and the valuation of stock is based on some routine e.g. LIFO (last-in-first-out), FIFO (first-in-first-out). Johnston (33) has effectively

reduced the fatality of these criticisms in defence of empirical results.

Whereas the farm cost function derives from cross sectional data, the factory cost function derives from deflated time series data, which are charged with being biased towards producing linear cost curves*, but again Johnston (33) has shown that the bias resulting is not specifically linear or curvilinear, but that it could be either.

Most empirical studies have shown that the long run average cost curve is L-shaped and not U-shaped, and that in the short run, the marginal cost is constant. So far, it appears that only Friedman's criticism of the regression fallacy with respect to cost-output relationships has survived (19). In a nutshell, Friedman has argued that cross section studies are bound to produce L-shaped average cost curves simply due to the fact that the output produced by a firm is usually a random variable and the variations of output about the mean value is not controlled by the firm. The firm will find the best way of producing this distribution of outputs. But in the absence of variable costs, Friedman says

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* See Walters (66, p.47), Staehle (61, pp.321-333).

> "... a cross section study would show sharply declining average costs. When firms are classified by actual output, essentially this kind of bias arises. The firms with the largest output are unlikely to be producing at an unusually low level; on the average, they are likely to be producing at an unusually high level, and conversely for those which have the lowest output".

It would then appear that Friedman's death-knell criticism obviates the L-shaped result which would come from the outgrower cross section studies. However, the essential argument in Friedman's criticism does not really apply to the outgrower farm situation, namely, the randomness of a firm's output, for in the case of outgrower farmers, output is predetermined, just as the sale of all output is a certainty by legal contract.

4.5 The Production Function

The production function is a technical input-output relationship that assumes constancy of technology. Its technical efficiency, which is a matter of utilisation, is not really an economic problem, but

> "The selection of the best input combination for the production of a particular output level depends upon input and output prices and is the subject of economic analysis" (29, p.54).

The existence of a production function, which can be the subject of much controversy [See Griliches Zvi (26, p.283)] is assumed both for outgrower farms and the sugar factory.

A general production function may be written as

$$Q = f(X_1, X_2, \ldots, X_n) \qquad (4.12)$$

where Q is output in physical units and X_i, i = 1, n are factor inputs.

Ordinarily, production functions are estimated using capital (K) and labour (L) as the factor inputs, so that we can write

$$Q = f(K,L) \qquad (4.13)$$

The production function is non-negative, bounded, continuous, non-decreasing, single valued, and twice differentiable i.e. for Q, K, L > 0;

$$\partial Q/\partial L = f_L, \quad \partial^2 Q/\partial L^2 = f_{LL} \quad (\text{for } f_L > 0,\ f_{LL} < 0) \qquad (4.14)$$

$$\frac{\partial Q}{\partial K} = f_K, \quad \frac{\partial^2 Q}{\partial K^2} = f_{KK} \quad (\text{for } f_K > 0,\ f_{KK} < 0) \qquad (4.15)$$

Therefore marginal products are positive and decreasing. If K and L are increased in some proportion "a", Q increases by some proportion "n", equal, smaller, or larger than "a".

$$f(aK, aL) = a^n f(K,L) = a^n Q. \qquad (4.16)$$

and "n" is a parameter which measures the degree of homogeneity of the function.

Another property of the production function is that it adheres to Euler's Theorem i.e. that factor shares exhaust total output

$$f_K Q + f_L Q = nQ \qquad (4.17)$$

Deflated time series data was used to obtain the factory production function while cross sectional data was used on the outgrower farm production function.

4.5.1 The Choice of the Functional Form

Three rules appear to bear heavily on the choice of the functional form chosen for any production study (70, pp.48-49). The first rule is that the functional form must relate to the logic or basic

mechanics of the production process. For example, all production processes are known to involve the use of at least two factors of production. This logical requirement rules out single variable functional forms (27, 30, p.74). We also know that no output of sugar or sugarcane or any other product can be obtained from zero input of factors i.e. we cannot obtain anything from zero input of factors (i.e. we cannot obtain something out of nothing). For this reason, it would be illogical to obtain quadratic forms which usually have a constant term. When the constant term is zero or insignificant, the quadratic form, which is normally of the form

$$Q = a + bK + cL + dK^2 + eL^2 \qquad (4.17)$$

becomes

$$Q = bK + cL + dK^2 + eL^2 \qquad (4.18)$$

but using a quadratic form, one could still have output out of one factor if the other is zero, and again this is illogical.

The second rule bears on the theoretical fruitfulness of the functional form. The chosen form should afford easy manipulation and derivation of useful economic statements. To use the quadratic form as an example, it allows both a declining

and negative marginal product which flouts a basic property rule of production functions. As equation (4.18) above shows, it is possible to obtain negative additions to output should any coefficient 'b' or 'c' be negative. The quadratic functional form also allows us to input negative values of K and L and obtain either total negative Q or positive marginal products where 'b' or 'c' is negative, or negative marginal products where 'b' or 'c' is positive.

Finally, the third rule is that of feasibility i.e. the computational ease of the function. The general functional form in (4.20) can be converted into linearity via logarithmic transformations, so that

$$Q = AL^{\alpha}K^{\beta}ei \qquad (4.20)$$

becomes

$$\log Q = \log A + \alpha \log L + \beta \log K + \log e_i \qquad (4.21)$$

and this can be used to obtain the estimator

$$\log \hat{Q} = \log \hat{A} + \hat{\alpha} \log L + \hat{\beta} \log K + \log \hat{e}_i \qquad (4.22)$$

The single equation ordinary least squares method is attractive because it facilitates estimation, its coefficients have small standard errors and it is efficient in predicting output from given sets of inputs (70, p.175). These benefits derive directly from the tenets of ordinary least squares*. It will not be necessary to engage into a detailed examination of statistical method as long as results obtained by this method do not display significant autocorrelation i.e. all the assumptions concerning the random term's distribution are not violated. The requirement that the observations of the regressors be measured without error is impossible to meet in this instance where capital and labour inputs are at best estimates. For the purposes of this study though, perfection is assumed, and specification errors and biases are either absent or deemed to cancel each other.

Constant returns to scale would be expected to obtain if we assume full divisibility of all factors of production, but this assumption is not necessary in this case, and anyway, it would be untrue. However, where such an assumption is made, the

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* See for example : Wonnacott (69, pp. 40-47), Koutsoyiannis (38, pp.109-116).

difference between unity and the sum of the partial elasticities of output would nepresent the contribution of management.

Since the factor inputs are complementary and vary with output, we expect high multicollinearity between factors, and with output. However, it is not expected that the independent parameters will approximate indeterminacy (i.e. perfect multicollinearity) or orthogonality (i.e. zero multicollinearity). As there is no proof concerning the degree of collinearity which seriously affects the parameter estimates, the interpretation of multicollinearity will be intuitive rather than refined [Farrar and Glauber (16)].

The Constant Elasticity of Substitution (CES) type of production function (8) is a possible alternative which could have been tried, but fails to qualify under the criteria of computational ease. It is often preferred to the Cobb Douglas type of production because it is not subject to the restrictive assumption of unitary elasticity of substitution. The form of the CES production function is presented below

$$V = \gamma \left[\delta K^{-\rho} + (1-\delta) L^{-\rho} \right]^{\frac{1}{\rho}} \qquad (4.23)$$

where γ is the efficiency parameter,

ρ is the elasticity of substitution

δ is the distribution parameter

and is estimated by Maitha (50) using the form

$$\log \frac{K}{L} = a + b \log \frac{W}{r} + u \qquad (4.24)$$

where K and L are capital and labour inputs, (W/r) is the factor price ratio, and 'b' is the elasticity of substitution parameter.

Odada and Maitha (50, p.15) in their study found that there were mixed substitution possibilities for manufacturing firms i.e. the form of substitution is not "typically less than unity" (8, p.246) as the CES proponents postulated, and if anything, it varied around unity. Fucks (20, pp.436-438) shows that the data which Arrow, Chenery, Minhas and Solow used should really have given them results which would show unitary elasticity of substitution if properly categorised. Without dismissing the CES off hand, Fucks shows that Chenery and his friends had really not made a case for invalidating the unitary elasticity precept of the Cobb-Douglas production function. House (32) found elasticities of substitution which were slightly above unity and seemingly rejected the CES hypothesis altogether.

A more interesting study on the application of the CES hypothesis to Kenya was done by Maitha (43,44) where he tested the hypothesis that the elasticity of substitution for Kenyan firms using cross sectional data was significantly different from one (i.e. whether the relevant production function was a Cobb-Douglas or CES type) and found that it was not, and contends that therefore we cannot reject the Cobb-Douglas production function for Kenya.

It is because of the considerable popularity of the Cobb-Douglas production function, which has been widely used [See for example Murti and Sastry (46), Yotopoulus (70), Nerlove (48), Heady and Dillon (30, pp.585-643)], and its relatively simple computational requirements, backed by the arguments quoted above which make one question the relevance of the CES in Kenya that, to avoid complications, the Cobb-Douglas form has been selected for this study. Moreover, the Cobb-Douglas production function has the advantage that it satisfies the criteria outlined before for selection of functional form.

4.5.2 Identification and Specification

There are three major tasks undertaken under specification (30, p.197). First, is a decision

on whether to use a single equation or a system of equations. Evidence suggests that if the purpose of a model is to predict output for given quantities of input, the single equation approach is preferrable to the simultaneous equation approach (66, p.17). The second task is the choice of the set of variables to be included in the model. The assumption is made that the Cobb-Douglas form applies to both the outgrower farms in total and the sugar factory. The data obtained from the cross section study is considered to represent observations of one production function.

The chosen variables in this study are capital, labour and output. Capital is measured in identifiable cash outlay, labour in man-days on farms and man-units in the factory, and output in ton cane on farms and ton sugar in the factory. Since the role of stock capital in sugarcane farming could not be identified, the flow concept was used instead*. Labour input on farms is measured in man-days and where children under 15 years contribute to labour, it is converted to man-equivalents by reducing their input to 0.5 man-equivalents. No discrimination was made with regard to sex, colour or creed. The issue

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* See Yotopoulus (70, pp.116-126) on Stock versus flow concepts of capital.

of creed is relevant in Islamic Mumias where the non-Islamic communities and extension workers of MSC claimed without proof that the Islamic outgrower farmers tend towards greater indolence than their non-Islamic counterparts. Some of these Islamic people are of distant mixed Arabic descent. For a factor to have been included, it had to show a correlation with the output not less than 0.6 i.e. significantly over half. This was a rule of thumb. Thirdly, specification problems involve the making and testing of hypotheses regarding the most appropriate algebraic form of the equation. This was not done in this study.

However, the production equation is strictly only identified if the observations measure an input-output relationship. If there are exogeneous variables in the system such as acts of God, a necessary condition in identification is that the number of variables in the system excluded from the function must be at least equal to one less than the number of equations (i.e. endogeneous variables) in the system (66, p.17). This criterion is irrelevant here as no such exogeneous variables are deemed to play a role in the production process. The OLS has already been noted for its simplicity of computation, small standard errors of the coefficients and efficiency in prediction of output*.

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* See Youtopoulus (70, p.175), Walters (66, pp.18-19).

Its main weakness is that estimates of coefficients are hardly ever unbiased or consistent. Although there is much controversy on what concept of capital would be used in the analysis of firm production*, the book value is taken to represent the stock, while variable costs are taken to represent flow. The sum of stock and flow is deflated to 1972 prices as detailed in the methodology. This conceptual problem is only relevant here with respect to the factory production function. The use of accounting data such as balance sheets finds support in the work of Murti and Sastri (46). Both for outgrowers and the sugar factory, a t-test can then be applied to the coefficients to test if they are significantly different from zero.

Marc Nerlove (48, pp.1-16) and Wallis (65, p.35) have shown that it is inconsistent for profit maximising enterprises whose production functions are estimated using a Cobb-Douglas form to have $\alpha + \beta$ equal to or greater than one under perfect competition. Therefore we expect to obtain output elasticities for sugarcane farms such that $\alpha + \beta < 1$. In the same studies, Nerlove and Wallis separately

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* See Solow (59, 60), Robinson (54).

prove that under imperfect market structures, such as the controlled sugar market in Kenya, constant or increasing returns are not inconsistent with profit maximisation.*

4.6 The Direct Foreign Exchange Impact of the MSP.

Although the Little and Mirrlees Procedure** does not call for an estimation of the foreign exchange impact of a project due to its use of the accounting ratio as a numeraire, it is felt necessary to isolate those flows which will have immediate and direct influence on the foreign exchange reserves of Kenya.

This estimate will be done with respect to all imports relating to MSP, capital and consumable, payments of management and other fees overseas, receipts for sale of molasses, and sugar import equivalents replaced by MSP supplies.

Actual expenditures were obtained for 1973 to 1978 and forecasts made up to 1986 for which period data was available.

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* Wallis' and Nerlove's proofs are summarized in Appendix 9.

** See 4.8.

4.7 Social Profitability of Mumias Sugar Project

Mumias Sugar Project (MSP) can only be seen to be socially profitable if social benefits accruing from the project exceed social costs. Since both costs and benefits are functionally related to time, the above notional criteria may be restated as meaning that the net present value of the stream of costs and benefits must be positive, formally stated as

$$NPV = \sum_{n=1}^{N} \left[\frac{Bn}{(1+r)^n} - \frac{Cn}{(1+r)^n} \right] > 0 \qquad (4.25)$$

where B is the flow of benefits, C is the flow of costs, r is the social rate of discount, n is years, N is the project life.

The social cost of MSP is its opportunity cost in terms of consumption foregone. The interesting point about MSC, which is a part of MSP, is that it operates like a private commercial firm and yet it is 69 per cent owned by the Kenya Government. It represents a good case for analysis on the effects of transferring a certain amount of money from the public sector to the private sector. The funds so transferred to the private sector (MSC) are assumed to be engaged in the pursuit of profit. Indeed, the policy of the Kenya Government is that publicly owned corporations should earn profits, and MSC is no exception.

If MSC makes a profit from the invested funds, some of that profit is distributed as dividends, some is retained for increased reinvestment, and some is paid as tax to the government. For the years when MSC has been operational, it has consistently made profits, declared and paid dividends, retained some proportion of profits, and paid some in taxes from 1975. Table 4 shows the distribution between 1973 and 1977.

Table 4

Distribution of Surplus at Mumias Sugar Co.

K£'000.

	1973	1974	1975	1976	1977
Profit before tax	153	751	1291	1702	3019
Taxation	-	-	111	605	1330
Dividends	116	348	580	290	1279
Retained Profits	37	403	600	807	410

Source: Mumias Sugar Co. Annual Income Statements

Like most new industries in Kenya, MSC enjoyed a tax holiday in its first two years of operation i.e. 1973 and 1974. The profits which are reinvested will add to the basic scenario of profits-tax-dividends-retained profits until wind-up.

The following analysis is adopted from Scott, MacArthur and Newbery (55, pp.130-140) and Newbery in Scott (56, pp.154-204) who tackle the problem using £1 as the value of transfer. We assume a simplistic model of MSC distributing its profits in the three ways already discussed, i.e. profit is either consumed by the owner through dividends (c), saved through retained earnings (s), or paid in taxes (t), so that

$$c + s + t = 1 \qquad (4.26)$$

The data available on MSC would suggest that, over the period 1973 to 1977, these parameters would be estimated as

$$c=0.235,\ s=0.35,\ t=0.43^{*}$$

(see Table 4).

Because of reinvestment 's', the resulting extra investment exceeds 's' for two reasons. First, MSC obtains an investment allowance which reduces the tax burden. The Kenya Government allows a company to write off a fraction 'a' of the reinvestment for tax purposes. If 'v' is an assumed proportion of 's' eligible for tax grant, then tax saved

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* Scott, MacArthur and Newbery (55, p.134)
Use: s=0.22, c=0.22, t=56.

on that 's' is at the rate t_1 which is a tax rate composite of corporate tax (0.45) and capital gains tax (0.37). This allowance is over and above depreciation allowance. Let us assume that 'k' is the extra investment resulting from retained earnings 's'. Then the tax saved is $kvat_1$, to which extent 'k' can exceed 's'. The second reason why 'k' can exceed 's' is as follows. When MSC saves and invests, its equity is increased. King (36) has shown empirically that when Kenyan firms increase their equity, they increase their borrowing proportionately. If a firm is to maintain a stable debt-equity ratio (also known as the leverage ratio), it must borrow more as its equity increases. Bank willingness to lend to firms also increases as the firm's equity increases. Financial leverage involves the use of funds obtained at a fixed cost in the hope of increasing the return to common stock, earnings per share (EPS), and is essentially a relationship between earnings per share (EPS) and earnings before interest and taxes (EBIT) under various financial options. EPS may be calculated as:

$$EPS = \frac{(S-F-V-I)(1-t)}{N} \qquad (4.27)$$

where S is sales value, F is fixed cost, V is variable cost, I is interest payment, N is number of subscribed

shares. Accordingly, the debt advantage per share (DAPS) resulting from increased borrowing is formally defined as

$$DAPS = \frac{I - D\,(1-t)}{N} \qquad (4.28)$$

where D is debt.

Since (S-F- V-I) = EBT, (4.28) may also be written as

$$EPS = \frac{(EBT)\,(1-t)}{N} \qquad (4.29)$$

where EBT represents earnings before taxes but after interest.

King (36) further showed that increased company borrowing is at the expense of government borrowing, assuming that the stock of loanable funds is fixed at any one time. Assume that the fraction of investment financed by bank borrowing is 'b'. Then clearly

$$k\,(1-b-vat_1) = s \qquad (4.30)$$

or

$$k = ms \qquad (4.31)$$

if

$$m = \frac{1}{1 - b - vat_1}, \qquad (4.32)$$

and (4.32) is therefore the savings multiplier. Scott, MacArthur and Newbery (55, p.134) estimate 'b' at 0.20. Since the profits tax rate for MSC is 0.43, and the capital gains tax rate is 0.37, t_1 may be estimated as

$$t_1 = t + (1-t)\,(cgt) \qquad (4.33)$$

where cgt is capital gains tax.

Therefore

$$t_1 = 0.43 + (1-0.43)(0.37)$$

$$= 0.43+0.21$$

$$= 0.64.$$

Scott, MacArthur and Newbery (55, p.134) estimated t_1 at 0.56, but this was before cgt was introduced. Then t was 0.4 according to them. Therefore t_1 was t plus income tax on dividents at a mean rate of 26 per cent, so that

$$t_1 = 0.4 + (1-0.4)(0.26)$$

$$= 0.56.$$

The authors also estimate the following parameters:

Rate of investment grant, 'a'	= 0.2
Bank interest on loan, 'i'	= 0.05
Fraction of investment eligible for investment grant, 'v'	= 0.70
Consumption accounting ratio, f_c	= 0.82
Accounting ratio for capital, f_k	= 0.90
Accounting ratio for profits, f_p	= 0.85
Private rate of return, r	= 0.20
Accounting rate of interest, R	= 0.10
Accounting ratio for saving, f_s	=-1.41 (55 p.134)

Accordingly, the savings multiplier 'm' is obtained as

$$m = {}^{1}/\ 1-0.2 - (0.7)(0.2)(0.64)$$

$$= 1.4076$$

and $k = ms$

$$= 1.4076\ (0.35)$$

$$= 0.493.$$

In this way, $k > s$.

Because of increased investment 'k', MSC may earn more profits at a rate rk where 'r' is the rate of profits. Scott, MacArthur and Newbery (SMN) put 'r' at 0.2. The data on MSC, (see Appendix 5) show

that r = 0.1485 for MSC, and so rk = 0.1485 (0.493) or 0.0732.

Assuming that true and tax-purposed depreciation rates coincide [they rarely do. See Walters (66, p.43)], and that the resulting profits after interest (ibk) are distributed between c, s, and t, the profits lead to extra savings of the magnitude

$$sk\ (r-ib) \tag{4.34}$$

and extra investment of

$$m\ sk(r-ib) \tag{4.35}$$

representing a per annum rate of growth equal to

$$ms(r-ib) \tag{4.36}$$

In the case of MSC,

$$sk(r-ib) = 0.35(0.493)\ 0.1485-(0.069)(0.2)$$
$$= 0.0232.$$

$$msk(r-ib) = 0.0232\ (1.4076)$$
$$= 0.0327$$

$$ms(r-ib) = 0.35(1.4076)\ 0.1485-(0.069)(0.2)$$
$$= 0.066.$$

The rate of interest i = 0.069 for MSC differs from that used by SMN of 0.05 and is obtained from data at MSC (see Appendix 2).

We can now introduce shadow prices and value flows of inputs and outputs at shadow prices. The accounting ratio for capital goods purchased is f_k, that of investors' consumption f_c, and that of extra profits f_p. Subsequent to an additional investment 'k', the social benefit so accruing in that year is shown in SMN (p.132) as

$$B=rkf_p - ck(r-ib)f_c-msk(r-ib)f_k \qquad (4.37)$$

In other words,

> "the benefit accruing in that year is what remains from the extra profit at accounting prices after extra capitalists' consumption and extra private investment have been deducted from it, both valued at accounting prices" SMN p.132.

The benefit grows at the same rate as "k" which is 0.066 and therefore its NPV when discounted by the shadow rate of interest R is

$$NPV = \frac{\Sigma B}{R - ms(r-ib)} \qquad (4.38)$$

and substituting,

$$B=0.1485\ (0.493)(0.85) - 0.235(0.493)(0.1347)\ (0.82) - 0.0327(0.9)$$

$$= 0.0200022$$

$$\Rightarrow \quad NPV = \frac{0.0200022}{0.10 - 0.066} = 0.5882999.$$

Introducing a time element 'n' into the formula (4.49) for n = 1,30, then

$$NPV = \sum_{n=1}^{N} \frac{Bn}{R - ms(r-ib)^{n}}$$

when N = 30

and so

$$NPV = \sum_{n=1}^{30} \frac{0.0200022}{(0.10 - 0.066)^{n}}$$

which is obviously positive.

The theoretical analysis above shows that

we may expect MSP to be socially profitable since it has a positive NPV, hence the sixth hypothesis that MSP is socially desirable.

4.8 The Little and Mirrlees Procedure for Evaluation:

The essence of the Little and Mirrlees Procedure (41) henceforth referred to as L-M is that all output(s) inputs are classified as traded goods and services, untraded goods and services, and unskilled labour. Traded flows (inputs and outputs) are measured in world prices. Untraded flows are divided into traded components, untraded components, and unskilled labour until one ends up with only traded goods and services and unskilled labour.

The unit of account used is the accounting ratio, and is the ratio of accounting prices to market prices (55, p.10). The accounting price is the value of physical unit of flows in terms of the unit of account (foreign exchange). Thus, the accounting ratio (AR), is the ratio of world to domestic prices.

Although the L-M method attaches weights to income distribution effects of the project, these are ignored in the study due to the lack of objectivity in their derivation (55, pp.9, 49-63) and the computational difficulty of deriving them.

The flow of inputs and outputs is discounted over 30 years, which is the assumed life span of the MSP. A sensitivity analysis of the project is carried out to see if the project is sensitive to various rates of interest.

4.8.1 Traded Goods

These consist of inputs and outputs which can be imported or exported. They are valued CIF Mombasa (or CIF Jomo Kenyatta Airport) as importables and FOB Mombasa (or Jomo Kenyatta Airport) as exportables.

The total cost of tradeables is the AR times the market value. The ratio of world to domestic Kenya prices has been calculated by Scott (55, p.34) to be 0.8 on average. The main flow of traded goods involved in MSP are identified i.e. maize, fertilisers, sugar and industrial machinery. Molasses are also exported from Mumias to United Kingdom and U.S.A. There is hardly an established domestic market (hence price) for molasses, and so the AR would be 1.0, assuming that domestic and world prices are the same F.O.B. port of export.

4.8.2 Non-Traded Goods

The standard conversion factor of 0.80 is applied to those traded flows involved in MSP whose ARs are not available or significant to the evaluation. The standard conversion factor (SCF) of 0.8 is the mean accounting ratio for all categories, traded and non-traded, Scott (55, p.34).

The other non-traded inputs into MSP are unskilled labour and land. Labour is measured in terms of a shadow wage rate, and land in terms of opportunity cost. Sugarcane is a major non-traded input. It is measured in terms of maize foregone.

4.8.3 The Shadow Wage Rate

The Shadow Wage Rate (SWR) is the wage that equates the price of labour to its value marginal product realised in the sector from which unskilled labour is drawn. Skilled labour, it must be noted, is assumed to receive payment which is commensurate with its value marginal product. Due to chronic rural unemployed as exists around MSP, the opportunity cost of marginal units of labour from other or no activities to MSP are lower than the market wage that unskilled labour receives at MSP.

Scott (55, pp.100-101) has derived the SWR to be 0.75 of the market wage, and argues that the SWR will be constant for five more years from 1976 at least. His assumption of constancy was found to have been upheld by a computation of the SWR for MSP.

The SWR is obtained via the formula

$$SWR = c - (c-m)/s \quad (41, p.162) \qquad (4.40)$$

where c = urban (Kakamega) wage rate
m = the marginal product of labour at Mumias
s = the value of investment in terms of consumption.

To obtain the parameter "s", the L-M method (41, p.167) suggests the formula

$$s = [1 + 0.5 \ (R-i)]^T \qquad (4.41)$$

where R = the rate at which the investment is being discounted and is equal to 0.1.
i = the rate at which the value of consumption is discounted i.e. the Social Discount Rate.
T = the time span over which the investment will have been "consumed" i.e. the time

over which investment and consumption can be equally valued. This is equal to 30 years, the project life.

The parameter "i" is derived as follows:

$$i = (1 + g - n)^{e} \quad (1 + n) - 1 \qquad (4.42)$$

where g = the growth rate of future per capita consumption.

n = the rate of population growth in Kenya.

e = the elasticity of marginal utility of a constant elasticity welfare function with per capita consumption as the argument.

The rate of population growth in Kenya, "n", is estimated in the 1979-83 Development Plan (page 61) to be 3.5 per cent. Between 1974 and 1978, per capita consumption "g", grew at 4 per cent per annum. Deepak Lal (12, p.196) has estimated "e" to lie between 1 and 2 for Kenya. Accordingly, "e" is assumed to be 1.5 for the purpose of this study.

Therefore

$$i = (1 + 0.04 - 0.035)^{1.5} \quad (1 + 0.035) - 1$$

$$= 0.04277.$$

and

$$s = 1 + 0.5\,(0.1 - 0.0428)^{30}$$

$$= 2.33.$$

Since no econometric estimate of "m' has been made, it is estimated. The assumption is made that in the long run, Average Product of labour is equal to Marginal Product i.e. elasticity of output equals 1. The average yield per hectare of maize in Mumias area is 33 bags of 90 kg. weight*. This requires a labour input of 105 man-days, so that the average product per man day is 0.314. Assuming a local maize price of KShs.40 per bag, the daily rate can be estimated at 12/56 per day. There are two maize crops around MSP in a year. The local unskilled peasant farmer will be employed on his farm for 210 days to realise 50 bags of maize**. Since a working year has 312 days at Mumias Sugar Company (MSC), we have to obtain the daily value of "m" by the formula

$$9/52 \times \frac{210}{312} = 6/41$$

or £100 per annum.

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* See Table 5.

** Assuming that the short rains crop yields only 17 bags per hectare.

In 1976, the mean unskilled wage rate for labour in Kakamega was KShs.382/29 per month (21, p.300). The unskilled wage group was chosen to represent that group earning below KShs.799/= per month (21). Thus, the mean urban wage rate "c" is £229.37 and

$$SWR = c - (c-m)/s \quad \text{in K£} \qquad (4.43)$$

$$= 229.37 - (229.37 - 100.00)/2.33$$

$$= £173.846$$

which is 0.758 of the urban wage rate.

4.8.4 The Standard Conversion Factor

The standard Conversion Factor (SCF) has been estimated by Scott (55, p.34) at 0.80 and is the mean of all accounting ratios. It will be applied to all inputs and outputs whose individual composition or AR cannot be obtained. The SCF is only relevant to traded goods.

4.8.5 The Accounting Rate of Interest

The accounting rate of interest (ARI) is the mean shadow price of capital which some (55, p.48; 62, p.12) estimate at 0.1. This estimate is also adopted in the study.

4.8.6 The Opportunity Cost of Land

Much land in MSP has now been provided for the project for sugarcane, including the 3100 hectares of land under the nucleus estate owned by MSC.

For the purposes of this study, the opportunity cost of this land is the value of maize foregone. There are two maize crops in the MSP area in a year. The long rains crop is estimated to yield 33 bags per hectare (see Table 5), and the short rains crop about 17 bags per hectare if and when planted. The annual crop yield is therefore at 50 bags of maize per hectare. Since sugarcane takes at least 22 months before it is ready for harvest, it replaces about four crops of maize i.e. 100 bags of maize. It is known that not all the land now under sugarcane was under maize before the introduction of sugarcane. However, since maize is the staple food crop here, the imputed opportunity cost so obtained represents a maximum and will be valued at the official price of KShs.65 per 90 kg bag which is higher than the local glut price of KShs.40 but is otherwise reasonable.

4.8.7 Sensitivity Analysis

The ARI s applied in the sensitivity analysis are 15 per cent, and 20 per cent.

4.8.8 Decision Criteria

The MSP is deemed socially desirable if it shows a positive net present value (NPV) for various ARIs, and an internal rate of return greater than the cost of capital at various ARIs.

CHAPTER FIVE

EMPIRICAL ANALYSIS

5.1 An Economic Evaluation of the Small-holder Sugarcane Farms

As stated in Chapter Three, there are approximately 6,000 farmers who are registered with Mumias Sugar Company as outgrower farmers. The contractual relationship binds the farmer to provide an amount of land for sugarcane planting, to adhere to prescribed standards of crop husbandry and to sell the harvested crop to the company free-on-truck at the regulated price of 133/= per ton. The company on the other hand is contractually bound to provide all inputs except labour, to provide all machine services, to transport the cane ex-farm and to buy all the harvested crop immediately it is ready for harvest.

Normally, the prospective farmer approaches the field representative of Mumias Sugar Company to declare his intention to become an outgrower sugarcane farmer. If he has the land and the field representative feels that he is industrious, he takes the prospective farmer to the area supervisor or superintendent who normally has an office in

the locational administrative centre or near a school. The supervisor or superintendent is allocated a quota by MSC on which basis he decides whether or not he can enter into a contract with the prospective farmer on MSC's behalf. If he should decide that the prospective farmer is a suitable candidate, MSC surveys the land, clears and ploughs it, supplies seedcane, fertilisers and advice on the recommended farm practice. The farmer's plot must be at least 15 hectares, and if this is not possible, the farmer is encouraged to persuade his adjacent neighbours to team up with him and at least form a block of 15 hectares. MSC will only enter into a contract with a prospective farmer who has a title deed for his land.

The seedcane which MSC supplies to the farmer is heat treated to increase resistence to ants and other diseases and pests. All the inputs and services are supplied to the farmer on credit, to be recovered from his gross receipts at the time of harvest. Table 6 shows the sort of inputs, both material and labour that are reportedly required to operate one hectare of sugarcane in the outgrower area. The table shows that a farmer will earn an average of Shs.355.00 per month as an outgrower cane farmer per hectare. The labour requirements on the plant crop averages 846 man-days per hectare

over the 22 month crop life or only 106 days per year. For purposes of comparison, a gross margin analysis of maize per hectare is presented in Table 5 for the same area.

Table 5

Economics of Maize Cultivation in Mumias

	Maize Crop, 6 months
Yield/hectare (bags)	33
Gross Returns (KShs.) @ 65/=)	2,145
Plouging, Discing, Ridging etc (Shs)	203
Seed (KShs)	60
Fertiliser (KShs)	188
Spray/Dust (KShs)	18
Bags (KShs)	61
Transport (KShs)	25
Gross Margin (KShs)	1,590
Total Labour Input (days)	105
Gross Margin per unit of Labour	15.14
Gross Margin per Month (KShs)	265/=

Source: Tate and Lyle, The Sugar Industry in Kenya : Report to the Government of Kenya, London: Tate and Lyle Vol. II.

Table 6

The Economics of Outgrower Cane Production in MSP (1978)

	Plant Crop 116 tons/ha (22 months)			1st Ratoon (20 months) 97 tons/ha			2nd Ratoon (18 months) 80 tons/ha		
	KShs.	Man hours farmer	Man-hours MSC	KShs.	Man hours Farmer	Man hours MSC	KShs.	Man hours Farmer	Man-hours MSC
Land Preparation:									
Ploughing	306	10	10	-	-	-	-	-	-
Two Harrowings	301	6	6	-	-	-	-	-	-
Furrowing	103	4	4	-	-	-	-	-	-
Trash Raking	-	-	-	-	56	-	-	56	-
Seedcane	1,154	5	20	-	-	-	-	-	-
Planting	-	120	-	-	-	-	-	-	-
Gapping	-	40	-	-	-	-	-	-	-
Fertilising	836	16	2	836	16	2	836	16	2
Weeding	-	630	-	-	630	-	-	360	-
Harvest & Transport	4,176	20	692	3,492	20	542	2,880	20	440
Levies (@ 9/= per ton)	1,044	-	-	873	-	-	720	-	-
Interests (@ 3/60 per ton)	418	-	-	349	-	-	286	-	-
Total	8,338	846	734	5,550	722	544	3,886	-	-
Gross Returns @ 133 per ton	15,428	-	-	12.901	-	-	10,640	-	-
Net Return	7,090	-	-	7,351	-	-	6,754	-	-
Net Return per Farmers Man/hrs	8.48	-	-	10.18	-	-	14.94	-	-
Net Return per month	322.30	-	-	367.55	-	-	375.2	-	-

Source: Mumias Sugar Company, Outgrowers Department.

If the price of maize per bag is taken to be 85/= as it was until recently, the gross margin per month is Shs.375/= which is higher than that on sugarcane. Although the labour requirement per crop is about the same between maize and sugarcane, the intensity is higher with respect to maize. On the other hand, the return on maize is much quicker than on sugarcane, and so a time value of money could be imputed on the gross returns on maize which would bring it up to 390/= per month at 10 per cent interest. A rational farmer would therefore be indifferent between maize and sugarcane if he was not short of labour and was not risk averse*. However, he would prefer to be an outgrower farmer, hence the stiff competition among prospective farmers to become outgrowers. It must be noted however, that from an income distribution point of view, the outgrower scheme is to be preferred in that it provides the only possible source of cash income, and also on the grounds of providing adequate income. But even the question of there being no alternative employment is now debatable since MSC itself will readily offer employment to manual grades at Shs.11.85 per day which is Shs.308.10 per month on

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* There is a marketing risk in the case of maize.

a 26 day month. The closeness between sugarcane and maize farming incomes has been obscured by the almost total elimination of risk (both marketing, price and natural hazard risk) in cane farming added to the prestige and much freedom attached to being an outgrower which is seen as the better alternative.

The MSC transport department charges farmers the following rates to transport their sugarcane f.o.t. ex farm to the factory

	KShs.
0 - 8 kms from the factory	33.00 per tonne
9 - 16 kms " " "	36.00 per tonne
17 - 24 kms " " "	39.00 per tonne
25 kms and over	41.00 per tonne

Interviews with farmers (Table 4) seeking to determine their technical and managerial expertise or knowledge of sugarcane farming revealed that it was quite deficient. A number of farmers indicated that they would prefer to have some control over the management of their farms which virtually become the rented property of MSC for the period when the farm is under sugarcane. Farmers displayed a clear ignorance of their costs of production, which many claimed to be much lower

than MSC recovered from their gross receipts. Many farmers interviewed said they could obtain tractor services at lower machine rates than MSC charged them but did not seem to have done so. Although their pretentions to knowledge of better or equal but cheaper options to MSC services were not based on concrete or even credible proof, the farmers are entitled to make every decision regarding their farm which they have not relegated to MSC. If they received proper extension education, they might come to appreciate the logic behind the instance by MSC that they use a certain amount of fertilizers, weed so often etc. The benefit to Kenya arising from leaving the farmer to manage his farm will be realized when he is able to assimilate proper farming practices to enable him to plant other crops successfully. None of the farmers interviewed had been to a farmers training college of which there are two very near Mumias i.e. Bukura F.T.C. and Sangalo F.T.C.

Despite the apparent equivalent competitiveness of maize as an equally viable crop, a survey of Mumias Outgrower Area shows that the area is dominantly covered by sugarcane. Interviewed farmers had between 0.5 and 3.0 hectares of their land

either fallow or under maize and food crops, the rest being under cane. The mean outgrower farm size is close to 5 hectares. One could infer from this that either sugarcane is a very profitable crop as most farmers no doubt think, or the farmers resort to sugarcane farming because of the rapid transformation of the area from a subsistence to cash economy, hence the need for a medium of exchange. The gross margin analysis (Table 6) shows that the alleged high profitability of sugarcane is illusory. The only reasons why sugarcane is a popular cash crop is because of the need for cash, the absence of a distinctively more competitive crop and the lower intensity of labour requirement of sugarcane compared to maize.

A farmer's outgrower company has been registered under the name "Mumias Outgrowers Company" (MOC) which will be expected to advise farmers on the proper use of their sugarcane surplus earnings. Hopefully, MOC will extend some training to its members on how to manage a sugarcane farm. The management of MSC did not however see MOC taking over the complete management of outgrower farms as MSC has a vested interest in cane procurement for the factory which it is not willing to relegate to MOC or even the farmer himself, hence MSC's persistence on spoon-feeding the outgrower farmer if this will ensure it

a quick return of its credit and sugarcane. These however are legitimate fears and are understandable on the part of MSC. Over the years 1973 to 1978, the harvested crop area has increased as shown in Table 7.

Table 7

Cane Harvest and Payment Statistics

	1973	1974	1975	1976	1977	1978
Hectares Harvested	509.	1715	2819.	3893.	4224.	3743.
Cane Tonnage	70184	216393	263111	373434	490499	519887
Gross Income KShs'000	3645.5	13416.3	24206.2	39210.5	65236.4	59180
Gross Recoveries KShs'000	2345.5	8061.2	12697.1	22781.4	34274	27108.3
Net Payment KShs'000	1300.2	5355.1	11509.1	16429.1	30962.4	42071.7
Number of Farmers	408	1241	1886	2470	2775	2451

Source: Mumias Sugar Co. Records 1973-1978.

Among those 2451 who harvested cane in 1978, about 800 harvested plant cane. Those were scattered all over the outgrower zone, and were randomly selected as Table 4 shows.

The farm study questionnaire which was administered to the farmers is given in the Appendix 1. The mean farm size from the sample of 42 farmers was 5.06 hectares. On average, the sample yield per hectare was 92.2 tons of cane, and each hectare required 63.38 man-day inputs. A hectare of cane planted, harvested and delivered to the factory cost on average KShs.6,785.37. Table 8 shows this information together with correlations.

Table 8

Summary of Outgrower Cross Sectional Data

No.	Detail	Mean	Correlation
1	Cane Yield tons per Hectare	92.2	0.746 (1,4)
2	Labour Man-days/ hectare	63.38	0.748 (2,3)
3	Hectares under cane	5.06	0.794 (3,4)
4	Cross costs/hectare	6785.37	0.706 (4,2)
			0.689 (1,2)
			0.892 (1,3)

Source: XDS3 Computer Printout.

Although labour and cash inputs were expected to be positively correlated, no severe multicollinearity was observed. The correlation between cane yield per hectare and hectares was as high as was expected, as was the correlation between costs and hectarage.

The results produced above indicate that cane yields per hectare are lower than the official MSC estimate of 116 tons per hectare of plant cane (Table 6).

In an effort to identify the optimum farm size and cost-output behaviour of sugarcane farms, input output data was collected on 42 farmers randomly selected all over the outgrower zone. An econometric analysis of cost-output relationships was made based on the concept of diminishing returns to scale beyond a given farm size i.e. U-shaped average cost curves.

The mutliple regression model

$$TC = a + \beta Q + \beta_1 Q^2 + \beta_2 Q^3 + e \qquad (5.1)$$

subject to $TC, a, Q \geq 0 \quad ; \quad 0 \leq \beta, \beta_1, \beta_2$

was used to fit a function $TC = f(Q)$ where TC is total

cost and Q is tons of cane. The following result was obtained

$$TC = -2552.07 + 53.03Q + 0.021Q^2 - 0.000Q^3$$

s		(11.7) (0.01)	(-)
α		(0.01) (0.02)	(-)
R^2	0.8191.		

Because the above result violates the restriction that TC, a $\geq$ 0 by having a =-2552.07 contrary to economic theory, a total cost curve was fitted on the postulate that

$$Q = f(H)$$

therefore $TC = f(H)$

where H represents hectares. This ceases to be a cost output relationship and becomes a cost-hectare relationship such as E.O. Heady and An-Yhi Lin (3, pp.138-149) fitted for Formosa (Taiwan) in 1970, using the model

$$TC = a + \beta H + \beta_1 H^2 + \beta_2 H^3 + e \qquad (5.2)$$

for TC, a, H $\geq$ 0, $0 \leq \beta, \beta_1, \beta_2$

which again postulates diminishing returns to scale

after a certain farm size. The following result was obtained:

$$TC = 1081.95 + 746.73H + 749.94H^2 - 15.5H^3$$

s	(2588.4)	(337)	(11.91)
α	(-)	(0.05)	(0.2)

R^2 0.9556.

Although this time $a > 0$, the coefficient β_2, which is expected to be negative according to economic theory, is positive and significant.

Using TC = f(Q), the following average cost (AC) and marginal cost (MC) can be obtained.

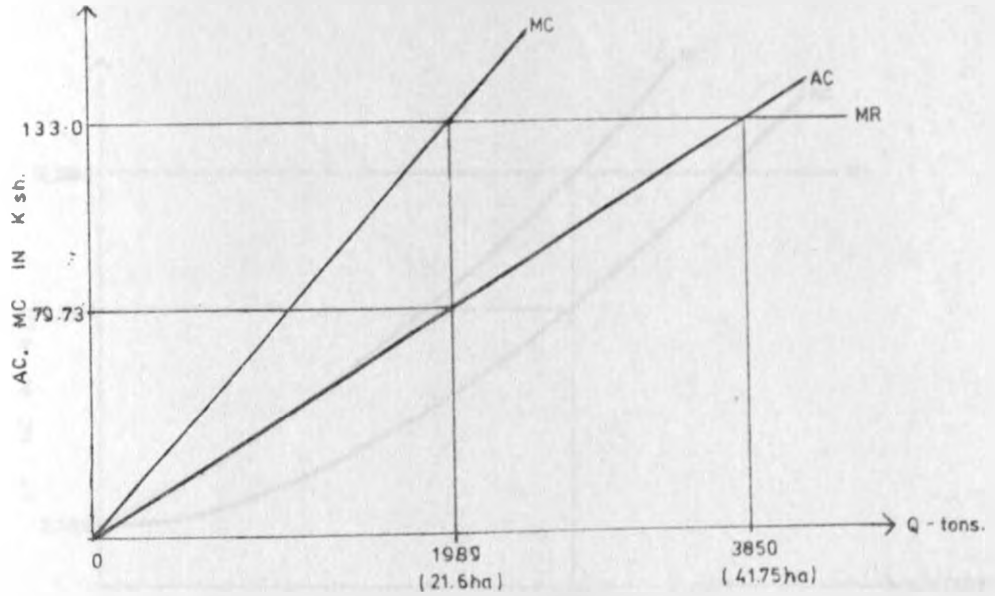
$$AC = \frac{2552.07}{Q} + 53.03 + 0.021Q$$

$$MC = 53.03 + 0.042Q$$

Since MC is rising, this means that both MC and AC rise from Q = 0 as depicted in Figure 2.

Figure 2

Farm Profit Maximisation Output



The function TC = f(H) gave the following average and marginal costs.

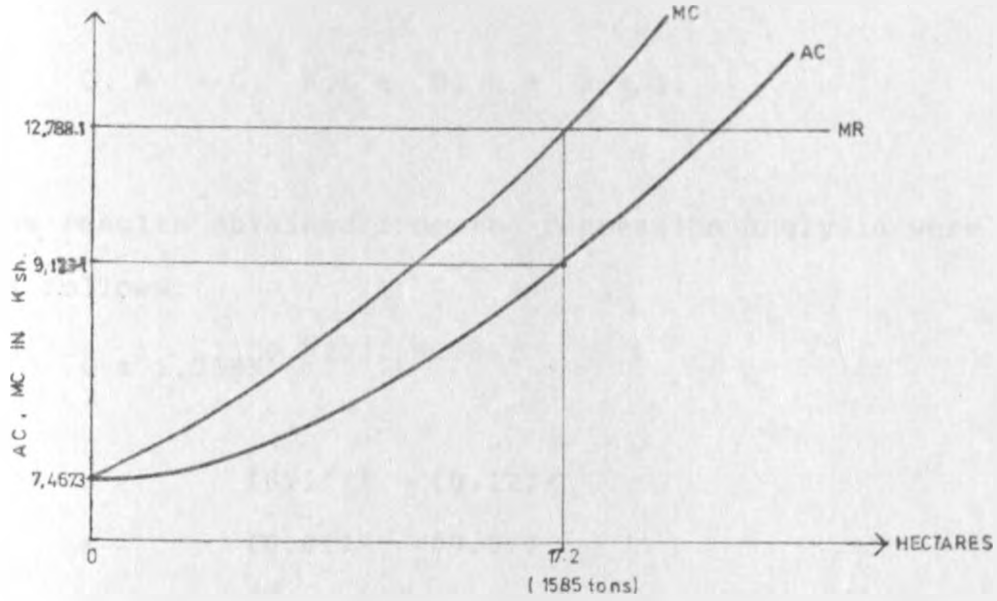
$$AC = \frac{1081.95}{H} + 746.73 + 749.94H - 15.5H^2$$

$$MC = 746.73 + 1499.88H - 46.5H^2$$

Similarly, the AC and MC are rising as shown in Figure 3.

Figure 3

Farm Profit Maximisation Size



The results show that there are no economies of scale and that it costs increasingly more to produce a marginal tonne of cane or to plant a marginal hectare of cane. In fact, the results reflect a severe degree of diseconomies of scale.

Since this result was not expected, it was decided to obtain the cost-output relationship via the tool of the production function, of the form,

$$Q = f(K,L)$$

where Q is tons of cane, K is capital (Shs), L is labour man-days and

$$Q = AK^{\alpha} \quad L^{\beta} \qquad (5.3)$$

subject to the constraint that

$$Q, A > 0; \quad K,L \geq 0; \quad \alpha + \beta < 1.$$

The results obtained from the regression analysis were as follows:

$$Q = 1.258K^{0.4223} \; L^{0.2842}$$

$$s = \qquad (0.117) \quad (0.122)$$

$$\alpha = \qquad (0.01) \quad (0.05)$$

$$R^2 \; 0.61.$$

The price of labour around MSC was estimated at 6/= per man-day on individual outgrower farms. The interest rate charged to farmers is on the basis of ton cane harvested i.e. Shs.3/60 per ton. This amounts to 8.5 per cent per annum. Accordingly, the long run cost functions were obtained using the formula:

$$TC = P_K \left(\frac{\alpha+\beta}{\beta}\right)\left[\left(\frac{\beta P_L}{\alpha P_K}\right)^{\alpha} \quad \frac{Q}{A}\right] \quad \frac{1}{\alpha + \beta} \qquad (5.4)$$

when $\alpha = 0.4223$ $P_K = 0.085$ p.a.

β = 0.2842 P_L = 380/40 p.a. (6/= x 63.4 days).

The cost functions obtained were as follows.

$$TC = 4.946908Q^{1.4154281}$$

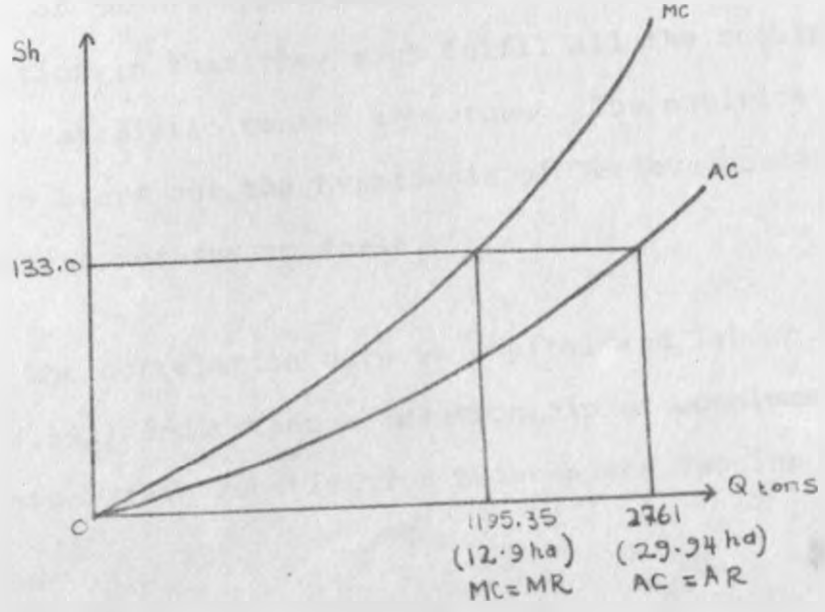
$$MC = 7.0019951Q^{0.4154281}$$

$$AC = 4.9469098Q^{0.4154281}$$

From the marginal cost function, we observe that MC = MR when Q (ton cane) is 1196.35. This represents 12.97 hectares assuming a mean yield of 92.2 tons per hectare. Thus, a profit maximising farmer at MSF will need 12.97 hectares of cane in order to equate his marginal costs to marginal revenues. These results compare unfavourably with those obtained from the cubic cost function. Figure 4 shows that both the AC and MC are rising from the origin.

Figure 4

Farm Profit Maximisation Size and Output



A profit maximising farmer will maximise his profits with a farm size of 12.9 hectares. The price of sugarcane per ton will equal the per ton average cost of production when the farm size is 29.9 hectares. Both of these farm sizes are large by comparison to existing farms in Mumias. The farm's maximum size is the limit where AC is equal to price.

Several conclusions can be made from these results. The production function analysis shows that the farms experience decreasing returns to scale, since the sum of the partial elasticities of capital and labour add up to less than one i.e.

$$\alpha + \beta < 1.$$

According to Nerlove (48, p. 10) atomistic market structures will always display decreasing returns to scale in their pursuit for profit. The sugarcane farmers of Mumias approximate the model of atomistic competition in that they each fulfil all the requirements of atomistic market structure. The empirical analysis bears out the hypothesis of Nerlove concerning diminishing returns to scale.

The correlation between capital and labour is high (0.692) indicating a relationship of complementarity rather than substitution between the two inputs.

However, there is much room for substitution between the two.

The point at which marginal cost equals price is a potential rather than real point of operation. The high cane price of 133/= pushes this point to 45.5 hectares, hence a large proportion of land is being turned over to sugarcane. Under permanent diseconomies of scale, it constitutes a serious violation of the rules of allocative efficiency to increase the prices of sugarcane, which will lead to more land being brought under sugarcane. The above results were also confirmed by Odada J.E. (49) both in Mumias and in the Nyanza Sugar Belt. Whereas Odada found the degree of returns to scale among farmers at Mumias to be 0.942 for the Cobb-Douglas function

$$Q = A\, L^{\beta}\, K^{\alpha}$$

this study found the sum of $\alpha + \beta$ to be 0.7065. His long-run cost functions were derived from CES and VES production functions and are therefore not directly comparable to our results here. However, since both CES and VES production functions indicated that the Mumias area had decreasing returns to scale, it is no wonder that he found the two types of

production functions showing increasing long-run average costs.

Using the Cobb Douglas production function, and its subsequent marginal cost curve, the price elasticity of supply of farmers in Mumias area was found to be 2.45 in this study which shows that farmers are highly responsive to the price indicator. The derivation of this short run price elasticity of supply is shown below.

$$MC = 7.0019951\ Q^{0.4154281}*$$

A firm's marginal cost is its supply curve, so

$$P = 7.0019951\ Q^{0.4154281}$$

Making Q the subject, we obtain for Q = f(P),

$$Q = \frac{P^{2.4071554}}{108.28797}$$

Let P_1 = 133/= and P_2 = 134.33 i.e. 101% of P_1 and Q_1 = 1196, then Q_2 = 1225.35.

The price elasticity of supply is the percentage change in output resulting from a one per cent change in price.

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* The Marginal Cost Curve (MC) is the supply curve which is mathematically derived in Appendix 11.

Accordingly, the hypothesis that sugarcane farmers have a price elasticity of supply equal to or more than one is accepted.

Because the marginal cost of production for cane is rising for all outputs on smallholder farms, we may conclude that sugarcane farming in its present structure and factor pricing constitutes misallocation of resources, which is aggrevated by increasing prices of sugarcane. By the same vein, large nucleus estates, which are much larger than small holder farms, are not justified on economic grounds.

5.2 An Economic Evaluation of the Sugar Factory Enterprise

The central factory at Mumias forms the focus of all activity within the entire scheme. The type of sugar produced at Mumias factory is known as mill white sugar. The process involves extracting juice from crushed sugarcane. A fibrous tissue known as bagasse remains after the juice has been extracted and is later used as fuel in the factory process. Sugar juice undergoes various chemical and heat treating processes such as liming, phosphating and sulphitation so that complex sugars are formed. A

precipitate results which is further evaporated at low temperatures in order to keep a white colour for the crystals forming. These crystals are fed into vacuum pans and the end process is a product of molasses and sugar crystals in formation. The crystals are led to open pans and centrifugals where they are rotated at high speeds, leading to their growth and separation from remaining molasses. These crystals, after being pumped through hot air for drying, are bagged and sold to the Kenya Government via the attached K.N.T.C. bonded warehouse.

The Kenya Bureau of Standards requires locally produced sugar to have 300 to 500 ICUMSA units, taking refined sugar to be 100 ICUMSAS . ICUMSA is the abbreviated form of International Commission for Uniform Methods of Sugar Analysis. The lower the ICUMSAs the whiter is the sugar as the more expensive it is to produce it. No differential prices are paid for sugars with lower ICUMSAs, and so most factories in Kenya only try to meet the standards.

The two main by-products of the sugar milling process are bagasse and molasses. Bagasse is used by the factory in its boiling process and constitutes a major saving in fuel costs. It can also be used in making fibre-board, paper and plastic paper, but this is not done in Kenya as yet. Molasses are the most

important by-product which are sold to U.S.A. and U.K. for animal feed and for manufacture of industrial spirits and alcohol. The current f.o.b. Mombasa price per tonne is Shs.320 on average, compared to Shs.2800 per tonne for sugar (producer price).
A minor by-product that could be mentioned in this context is mud-silt, which is used as manure on exhausted cane fields. Table 9 shows the performance of Mumias compared to its Kenyan counterparts and some countries with respect to the polarisation (Pol) percentage of cane, mill extraction, overall recovery and capacity utilisation in 1975.

A popular measure of technical efficiency often quoted on factories is the ton cane / ton sugar ratio i.e. how much sugarcane makes one ton of sugar. Table 10 shows comparative data for 1975 for some factories in Kenya and other countries. Also included is the ton sugar per hectare measure.

Table 9

Sugar Processing Technical Data

	Pol. % Cane.	Mill Extraction %	Overall Recovery %	Capacity(b) Utilisation %
Mumias	13.6	93.34	82.2	90.9
Chemelil	13.6	89.85	78.3	67.0
Miwani	12.2	89.37	70.8	45.0
Muhoroni	12.3	86.54	70.1	44.0
Ramisi	9.8	90.17	68.8	
Kenya Mean.	12.0	89.85	74.4	
Queensland	12.0	95.75	89.72	
Mauritius	-	95.8	97.0	
India	12.25	91.5	-	
Philippines	13.14	92.4	-	
Jamaica	11.76	93.89	-	

Source : Government of Kenya, National Sugar Research Station, Kibos : Mimeograph, 1976.

Table 10

Comparative TC/TS and TS/ha

Country/Factory	TC/TS	TS/ha
Mumias	8.7(b)	11.10*
Miwani	11.4(b)	6.5*
Muhoroni	11.7(b)	6.8*
Ramisi	14.8(b)	N/A
Chemelil	10.4(b)	9.2*
Kenya Mean	11.4(b)	N/A
Hawaii	12.2(a)	20.5(a)
Queensland	13.1(a)	8.5(a)
Puerto Rico	11.8(a)	7.8(a)
Mauritius	12.3(a)	7.1(a)
Jamaica	11.0(a)	5.9(a)
Cuba	13.5(a)	4.8(a)
South Africa	12.0(a)	7.0(a)
Taiwan	12.5(a)	9.6(a)
Florida (USA)	10.3(a)	6.5(a)

Source: (a) Timoshenko and Swerling, The World's Sugar, Stanford, Stanford University Press, 1958.

(b) Odhiambo M.O., The Structure, Performance and Conduct of the Kenya Sugar Industry, Nairobi.

* Derived.

Both of these tables show that Mumias factory is ahead of other factories and performs well compared with other factories on a world wide basis. The technical or engineering competitiveness of the Mumias factory is therefore superfluous in the Kenyan context and fair by world standards. It is the economic efficiency of the plant size, its operation and technology that are of closer interest to this study.

As a beginning point, the total cost of the project when it was initiated, as was stated earlier, was K£5.5 million* of which the installed (turn-key) cost of the factory itself was to be £3.03 million (3, p.110). In 1976, a further expansion added K£1.72 million to the capital cost, raising its crushing capacity from 80 ton cane per hour (tch) to 125 tch. In 1977, a massive expansion of the factory capacity was began to raise the crushing capacity to 300 tch. This expansion and subsequent capital additions will make the capital cost, as approximated by fixed assets, at Mumias £44,907,000 by 1986 at current prices. The cash flow is shown in Appendix 5. To compare the capital cost of the Mumias project with other projects around the world, Appendix 6 has been included in the study showing the country where the project is located and name.

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* M.A.W.S. Report p.110.

factory planned throughout, labour force and cost in US dollars, and the source of the information.

Appendix 6 gives the impression that the per ton sugar cost of the Mumias project, over an assumed life of 30 years is very moderate compared to those equally recent across the world. However, this figure does not reveal anything concrete about the cost-output behaviour of the Mumias factory. To obtain an idea about this very important relationship from which we could make definite statements about size efficiency, the efficiency of factor combinations and their reward etc, detailed production and cost studies of the Mumias sugar manufacturing enterprise was done.

A cubic cost function of the form below as fitted

$$TC = a + \beta_1 Q + \beta_2 Q^2 + \beta_3 Q^3 + e \qquad (5.5)$$

where TC = total cost in K£.

a = a constant

$\beta_1, \beta_2, \beta_3$ are coefficients

Q = Output in tons of sugar

and e an error term.

The following results were obtained:

$$TC = 260601.0211 + 79.385Q$$

$$s \qquad (3.258)$$

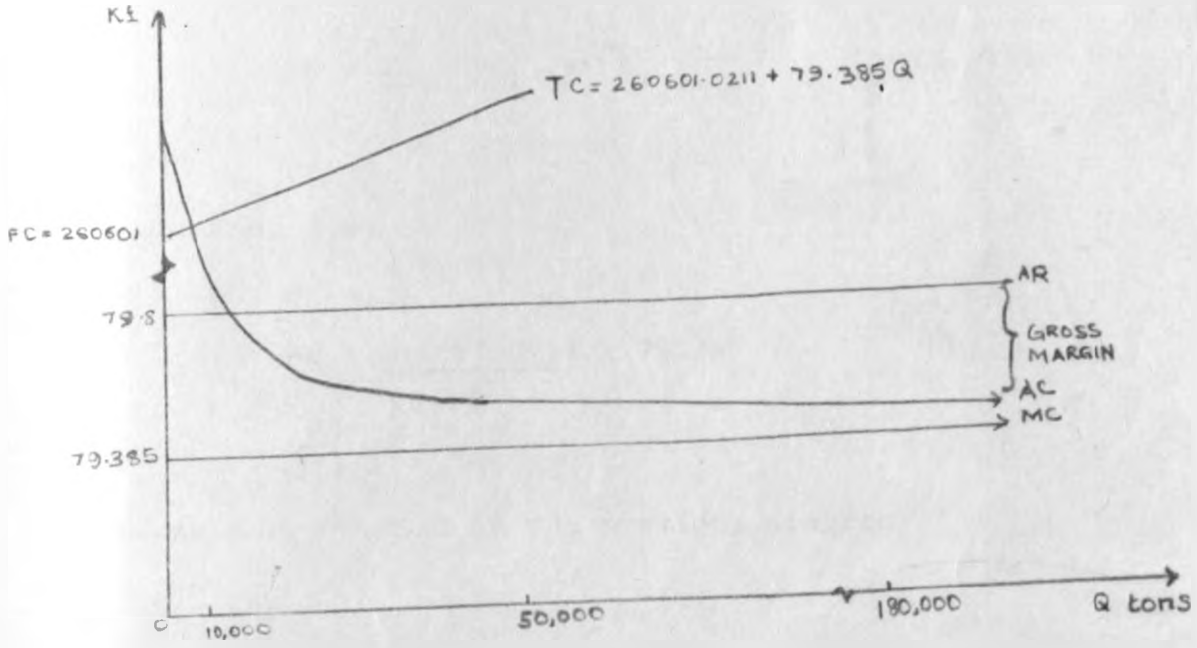
$$\alpha \qquad (0.01)$$

$$R^2 = 0.99 \qquad df = 11$$

i.e. the coefficients β_2 and β_1 were zero or thoroughly insignificant. This would portray a linear cost function as shown in the diagram in Figure 5.

Figure 5

Factory Cost Output Behaviour



In India, V. Gupta (28, pp.57-80) obtained similarly L-shaped average cost curves on the same fitting. His result for the sugar industry was

$$AC = 85.0 + 124/Q + 0.001\ Q.$$

Consequently, the marginal cost derived from the Mumias total cost curve was a constant i.e.

$$TC = a + \beta Q \tag{5.6}$$

$$MC = \frac{\partial TC}{\partial Q} = \beta = 79.385$$

and an average cost of the form

$$AC = \frac{TC}{Q} = \frac{a}{Q} + \beta \tag{5.7}$$

was obtained i.e.

$$AC = \frac{260601.0211}{Q} + 79.385$$

Both are superimposed on the previous diagram.

A perpertually declining average cost curve that never touched the marginal cost curve is a strange result to obtain since the literature on cost-output relationships depict a U-shaped average cost curve that derives from a cubic cost function. The literature on empirical cost studies however suggests that U-shaped average cost curves are hard to come by in reality*. The average cost function shows that there are no significant cost advantages to be derived from operating the factory at a capacity beyond 50,000 tons. At 50,000 tons, the average cost is £84.59 and at 180,000 tons, it is £80.83. For the cost of producing a ton of sugar at an extra £2.87 per ton, the Mumias factory could theoretically be split into three 50,000 ton capacity factories without a major loss in economies of scale.

A non-econometric plot of the average cost at different levels of output for actual operations showed that the lowest average cost was recorded in 1975 when Mumias produced 55,700 tons. This was compared with the reported unadjusted average cost of sugar produced in Chemelil Miwani and Ramisi. The

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* See for example: Johnston J., "Statistical Cost Analysis" p. 168.

Joel Dean, "Managerial Economics" pp. 292-296.

Koutsoyiannis "Modern Microeconomics" pp.114-142.

figures used are obtained from the Tate and Lyle Report on Kenya Sugar Industry (63).

In order to test this view in another way, a set of cost functions was obtained from a production function of the Cobb-Douglas type for the factory for

$$Q = a K^{\beta} L^{\alpha} \qquad (5.8)$$

where Q is output in tons of sugar

a is a technology parameter

K is a measure of capital inputs measured in K£s

L is the number of non-managerial labour input

α, β are elasticities of output with respect to K, and L.

The results obtained were as follows:

$$Q = 0.00757K^{0.5047} L^{1.029}$$

$$\sigma = (0.277) (0.1463) (0.3028)$$

$$\alpha \quad (0.01) \quad (0.01) \quad (0.01)$$

$$R^2 = 0.984 \quad df = 11.$$

Like the continually declining average cost curve derived from a cubic total cost-output function, the above production function displays increasing returns to scale i.e. $\alpha + \beta > 1$.

An expansion path can be derived from the production function if the prices of K and L are known. The price of K, denoted P_k is taken as 20 per cent i.e. the proximate commercial opportunity cost of capital. The mean cost of labour at MSC in 1977 was £648.5 at 1972 prices, excluding management. Scott (55, p.29) estimated that the average return on investment for private firms in Kenya is 20 per cent. If this is taken to be the cost of capital, and total cost

$$TC = P_k\left(\frac{\alpha+\beta}{\beta}\right)\left[\left(\frac{\beta P_L}{\alpha P_k}\right)^{\alpha}\ \frac{Q}{A}\right]^{\frac{1}{\alpha+\beta}} \qquad (5.9)$$

[see Walters (66, p.6)], where $P_k = 0.2$, $P_L = £648.5$, $\alpha = 0.5047$, $\beta = 1.029$ then

$$TC = 3336.9168Q^{0.6519}$$

$$AC = 3336.9168Q^{-0.3481}$$

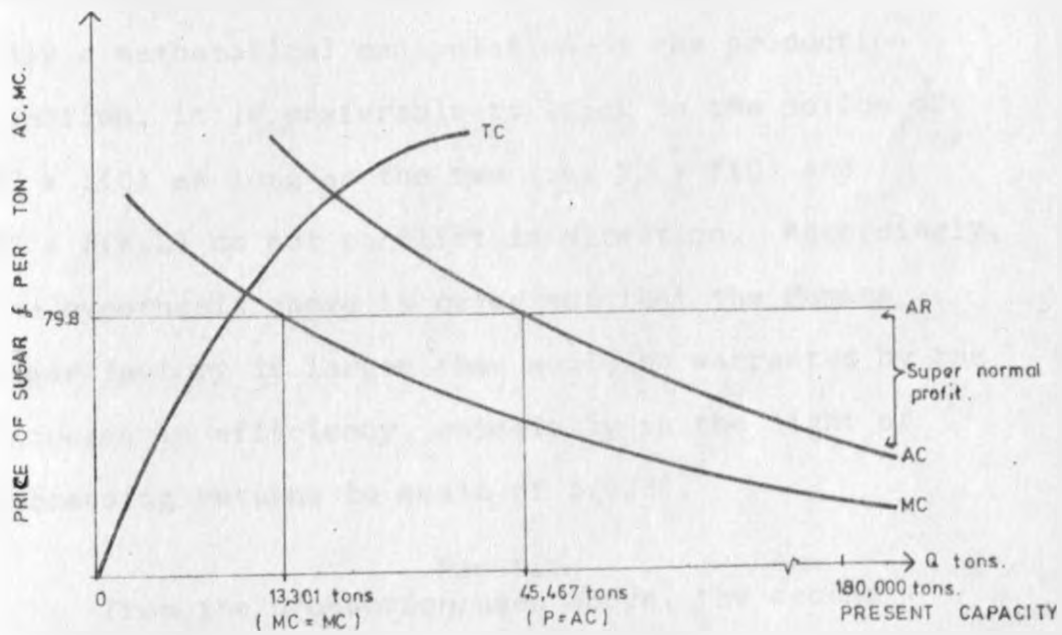
$$MC = 2175.336Q^{-0.3481}$$

Both AC and MC are declining and converging but never really reach zero. Their behaviour is depicted in Figure 6, and when the sugar price of £140 per ton

is adjusted to 1972 equivalent of £79.8, the MC = P_x, AC = P_x points are obtained.

Figure 6

Factory Cost-Output Behaviour II



Results show that there are very significant economies of scale. The third hypothesis, i.e.

> that Mumias sugar factory is too large and cannot be justified on grounds of efficiency.

can now be tested in the light of the above information.

Depending on whether we view total cost to be a function of output

$$TC = f(Q)$$

or to be the sum of factor costs

$$TC = f(K,L)$$

we may accept or reject the hypothesis. As the derivation of the TC from the production function is only a mathematical manipulation of the production function, it is preferable to stick to the notion of $TC = f(Q)$ as long as the two i.e. $TC = f(Q)$ and $TC = f(K,L)$ do not conflict in direction. Accordingly, the hypothesis above is rejected; that the Mumias sugar factory is larger than would be warranted by the increase in efficiency, especially in the light of increasing returns to scale of 1.5336.

From the production function used above, the second hypothesis can now be tested i.e.

> Mumias sugar factory is more capital intensive than its capacity would demand, it employs more capital beyond the point of its value marginal product $MVP_k = P_k$

If $Q = 0.00757K^{0.5047} L^{1.029}$ and $P_k = 0.1$ we can obtain the marginal value product of capital

by obtaining the marginal product of capital and multiplying by the ton price (producer) of sugar which currently stands at £140.

$$MP_K = \frac{\partial Q}{\partial K} = \alpha \frac{Q}{K}$$

just as

$$MP_L = \frac{\partial Q}{\partial L} = \beta \frac{Q}{L}$$

Thus

$$MP_K = 0.5047 \frac{Q}{K} \quad \text{and} \quad MP_L = 1.029 \frac{Q}{L}$$

Table 11 shows how much capital ought to be employed at Mumias at given levels of MVPs assuming the price of capital varies for the period 1974 to 1977.

The cost pf capital is calculated as profit before tax to capital employed in the previous year. K_2 represents the amount of capital which Mumias Sugar Company ought to employ given its production function and the particular output in a given year.

Table 11

Employment of Capital, Actual vs Required

	1974	1975	1976	1977
Output	55,700	59,207	63699	81,275
Capital (K)	£4,924,000	£4,851,000	£6,460,000	£8,909,000
MP_K (tons)	0.005709	0.00616	0.004976	0.0046
Net Revenue/ton	£60.93	£90.65	£114.71	£138.91
MVP_K	£0.3478	£0.558	£0.5708	£0.639
Labour Units	2467	2712	2849	3152
Capital (K_2)	£4,892738	£4,552560	£4,759329.8	£6,276698.9
Cost of Capital (P_K)	0.023	0.106	0.155	0.152

Source: Mumias Sugar Company Except MP_K, MVP_K, K_2

Since in no case is the $MVP_K < P_K$, we cannot uphold the hypothesis. In fact, if more output was required, more capital will be employed until $MVP_K = P_K$

For the factor labour to be exploited, we need to show that it is paid, during a particular year, less than the value of its marginal product. Table 12 compares the MVPs of labour at Mumias between 1974 and 1977 and the total renumeration paid to that labour, which excludes supervisors and managers.

Note that MP_L is $\beta \frac{Q}{L}$ and that $\beta = 1.029$

Table 12

A Comparison of Labour Cost and its MVP I

	1974	1975	1976	1977
Output (Q)	55700	59207	63699	81275
Labour (L)	2467	2712	2849	3152
MP_L	23.23	22.46	23.006	26.53
Net Revenue per ton	£60.93	£90.65	£114.71	£138.91
MVP_L	£1414.404	£2036.416	£2639.106	£3685.697
Labour Cost	£535,500	£802,300	£997,500	£1,376,000
Per Unit Labour Cost	£217.06	£295.8	£350.123	£436.55

Source: Mumias Sugar Company Records, except for MP_L and MVP_L.

Table 13 is a repetition of the above analyses if all labour, including management, were taken to be the value of L.

Table 13

A Comparison of Labour Cost and its MVP II

	1974	1975	1976	1977
Output (Q)	55,700	59,207	63,699	81,275
Labour (L)	2574	2840	2983	3336
MP_L (tons)	22.26	21.45	21.97	25.07
Net Average Revenue	£60.93	£90.65	£114.71	£138.91
MVP_L	£1356.3	£1944.4	£2520.18	£3482.47
Labour Cost	£829,100	£1,224,000	£1,474,000	£2,044,000
Per Unit Labour Cost	£322.1	£430.985	£494.13	£612.71

Source: Mumias Sugar Company Records, except for MP_L and MVP_L

Assuming that these labour cost figures do not include housing which Mumias Sugar Company provides to its employees, and free medical services for out-patients, we could multiply the per unit labour cost by as much as twice what the tables show and yet not approximate the marginal value products. The hypothesis that labour is underpaid at Mumias because it is not paid its value marginal product equivalent is upheld on the basis of these

The high degree of concentration within the Kenya sugar industry has previously been alluded to. Table 14 substantiates this claim, and identifies Mumias Sugar Company as the culprit.

Table 14

Domestic Production of Sugar 1975 and 1978

	1975		1978	
Plant	Sugar Tonnage	Market Share %	Sugar Tonnage	Market Share %
Mumias	59,207	37	92,500	41.8
Chemelil	39,921	25	47,408	19
Muhoroni	26,356	16	42,331	17
Miwani	26,772	17	36,417	15
Ramisi	7,505	5	11,450	4
Nzoia	-	-	7,339	3
Yala & Kabras	-	-	700	0.2

Source: Odada J.E.O., "The Role of the Sugar Industry in the Kenyan Economy, A Case Study of Lake Victoria Basin", Nairobi : IDS, Seminar Series on Lake Victoria Basin Development No. 4, University of Nairobi, 1979.

With the planned expansion being operative in 1979, Mumias will gradually contribute over 60 per cent of total sugar output in Kenya by about 1983/84. Looking at it from another perspective B.A.T.S. will have say over the production of at least 80 per cent of Kenya's sugar output. It is therefore necessary to determine the effect of this concentration into few hands of a major industry. Our knowledge of economic theory gives us a priori reasons to frown upon increased concentration except where it is the only structure from which considerable technological progress could ensue. Concentration here is defined as an index C, such that

$$C = A \frac{Q}{Q + M} \qquad (5.10)$$

where

C = Concentration index

Q = Domestic output in tons of sugar

M = Imports in tons of sugar.

A = The percentage of total output in Kenya of sugar accounted for by the largest sugar factory in Kenya (Mumias).

Concentration may be justified on the basis of efficiency, and one may argue this in favour of an expanded size for

Mumias. However, there must be a limit within which this concentration is truly beneficial to Kenya in terms of efficiency, which may be termed ECR (Efficient Concentration Ratio), defined as the percentage of total industry output represented by an efficient firm. It is by comparing the ECR with actual concentration ratio that we could obtain a degree of concentration at Mumias not justified by efficiency, based on the concept of an optimum factory size as approximated by the long run average cost curve previously fitted. The empirical results show the average cost curve declining speedily up to about 60,000 tons but is gradual thereafter.

This study's results on average cost indicate to us that the concentration which will result from the expansion of Mumias sugar factory is in the interest of efficiency, although it may be inequitable regionally. In apparent recognition of this fact, the government seems to have started to expand existing plants rather than building new ones. But in view of the under-capacity operation of many existing plants, this policy would seem contradictory except in the case of Mumias.

5.3 An Estimation of the Direct Foreign Exchange Impact of the Mumias Project

As we indicated in Chapter Three, one major goal of the Mumias Sugar Project (MSP) is to substitute imports of sugar for domestic supply, thereby saving a considerable amount of foreign exchange. Table 15 shows the quantity and value of sugar imported into Kenya between 1973 and 1976.

Table 15

Kenya Sugar Imports, Quantity and Value

Year	Quantity Tons	CIF Value K£	US $* Equivalent	Price Per ton KShs.
1973	77485	6,732,000	19,513,043	1,738
1974	70703	8,876,000	24,852,302	2,511
1975	12709	2,600,000	6,295,399	4,092
1976	45501	7,470,000	17,969,689	3,283.

Source: *Derived

Government of Kenya, Statistical Abstract, Nairobi : Government Printer, 1977, pp.75, 78, 89.

Based on the initial planned capacity of the factory at 70,000 tons per annum, the feasibility report on MSP made a forecasted estimate of foreign exchange saving expected to arise from MSP. This forecast is reproduced next page.

There was considerable difficulty in obtaining records showing the amount of foreign exchange expended on the project to date. Obvious areas of expenditure include capital equipment procurements, managing agency fees, import payments to Crown Agents, imports of spare parts, debt servicing overseas payments, dividends, and transfers of expartriate salaries. To these must be added imports of fertilisers and other agro-chemicals, factory chemicals, fuel costs, imports of motor cars and imported building equipment which may not be directly paid for by MSC in foreign exchange but by importing local dealers.

Payments to Crown Agents, who are the importing agents for MSC between 1976 and 1978 amounted to UKStgf1,612,828.6 according to records at MSC. No figures could be found for the operative years 1973 to 1975, but from reasonable estimates these could possibly amount to Stg£1,000,000. Payments to Crown Agents represent overseas purchases and commisions. These are for spare parts and factory chemicals.

Table 16

Planned Foreign Exchange Effects of MSP K£'000

Year	Foreign Exchange Expenditure on			Savings from Sugar (4)	Net Balance
	Factory (1)	Other Equipments (2)	Maintai-nance (3)		
1971	200	180	170	-	(550)
1972	1120	90	190	-	(1400)
1973	1120	350	370	520	(1320)
1974	10	10	500	1550	1030
1975	20	30	500	1870	1320
1976	20	80	500	1980	1380
1977	30	120	500	2000	1350
1978	540	130	500	2000	830
1979	50	120	500	2170	1500
1980	60	120	500	2380	1700
1981	70	90	500	2700	2040

Source : Booker McConnell, Feasibility Report on Mumias Sugar Scheme, London, 1971.

(1) Includes F.O.B. price of factory equipment and buildings.

(2) Includes agricultural implements and vehicles.

(3) Includes fertilisers.

(4) Sugar price used in K£40.4 per ton.

The Agricultural Department alone has capital equipment amounting to over K£3.1 million according to the management of MSC. This is approximately equal to UKStg£4.0 million. All agricultural equipment is imported into Kenya duty free. Since almost all the agricultural equipment at MSC is imported, for example crawlers, winch loaders, tractors and land rovers, we could safely assume that the entire capital cost was incurred in foreign exchange. Due to their heavy usage, these equipment have to be replaced very often. The amount of money spent on replacement could not be estimated accurately but the management of MSC put it at about K£500,000 or UKStg£600,000. Whereas MSC imports some of these directly (especially cane allied equipment), some are bought from local representatives of UK companies (such as CMC for Land Rovers, Construction Equipment for Caterpillars, etc.).

The capital equipment attached to other sections or departments of MSC are modest compared to those in the Agricultural Department (except of course the factory, the value of residential buildings and offices). These are roughly estimated in total to amount to UK£3.0 m.

Accurate records were available for fertiliser and petroleum usage which could be directly converted to sterling equivalents, managing agency fees and commissions, dividends to Booker Agriculture International (BAI), overseas finance and interest payments.

The sum of available estimates for fertiliser expenditure between 1974 and 1978 amount to K£1,917,990 or UK£2.4 million; petroleum usage (1974 to 1978) K£1,311,360 or UK£1.6 million; management fees (1973 to 1977) K£670,000 or UK£837,500; dividends to BAI (1973 to 1977) who hold a 5 per cent equity, K£130,000 or UK£162,500; finance and interest charges (1973 to 1977) K£1,087,000 or UK£1,358,750; of which less than 10 per cent are local. Records at MSC show that a Kenya Government soft loan of K£2.5m at 2½ per cent interest has been largely repaid as at 1979, only K£126,927.4 being outstanding. This figure does not include interest which has been capitalised for the five years and will be repaid over 1978 to 1981. Thereafter, MSC will pay the Kenya Government the principal remaining and the interest due over five years. The loan was provided to the Kenya Government by the British Government, and so we can assume that the repayments accrued or will accrue to Britain in sterling.

Roughly therefore, the amount of foreign exchange spent on the project so far could amount to UK£20 million even if we included the salary transfers of expartriates.

Against this expenditure must be weighed the savings and generations in foreign exchange of sugar and molasses produced by MSC valued at the import price C.I.F. Mombasa (for sugar) and the export value for molasses. Records at MSC show that between 1973 and 1978, this saving of foreign exchange (in the case of sugar) and generation (in the case of molasses) amounted to K£43 million on sugar alone and K£465,125 on molasses, or a combined K£43,465,125 on molasses and sugar. We find that, so far, the net flow of foreign exchange has been in favour of Kenya by about UK£34 million.

5.3.1 Projections

In order to obtain a more complete view of the foreign exchange effect of MSP, it is necessary to project future savings and expenditure of foreign exchange for at least the period 1979 to 1986 after which time most overseas payments will be for recurrent and minor inputs.

The records available at MSC on loan and interest repayments, both local and overseas, for the years 1979 to 1986 are detailed and provide accurate estimates. Between 1979 and 1986, MSC will repay principal(s) and interest(s) amounting to K£22,261,000 overseas. This is about UKStg£27,826,250 equivalent. Over the same period, dividend repartriations to BAI will amount to K£595,000 or UK£743,750. Managing agency fees, which are not delienated in the mimeographed projections of operating expenses are estimated at UK£500,000 p.a. since they include a production commission, and production is expected to double its 1978 level by mid 1980's. By 1986 therefore, we can estimate management fees at UK£4 million in total.

According to the management of MSC, the expansion, which is due to be operative in 1979, will entail an expansion in the outgrower farm area that will demand almost double use of fertiliser and certain agricultural and factory inputs. Based on 1978 records, fertiliser expenditure is estimated at K£1 million per annum i.e. K£8 million between 1979 and 1986, or UK£10 million payments to Crown Agents, representing material imports, and spare parts are similarly doubled from the 1978 figure to K£800,000 per annum (UK£1 million)

or K£6.4 million (UK£8 million) between 1979 to 1986 ; as is done with petroleum whose 1979 to 1986 expenditure estimate is K£10 million (UK£ 12.5 million) allowing for recent but not potential increases in prices. Although other capital purchases involving imports will increase, these are deemed to be a part of the loan financed purchases whose repayments have already been detailed.

The sum total of these projected foreign exchange outflows is UK£61 million. Savings of foreign exchange from the increased sugar production over the same period will amount to K£81,883,000 using the 1979 Carribean Port price (f.o.b.) of US$156.8 per ton (KSh.1187). This is equivalent to UK£100 million approximately. Kenya therefore stands to gain considerably from the foreign exchange point of view from the operations of an expanded Mumias Sugar Project over 1979 and 1986.

Estimates could not be made for the remaining life of the project 1986 to 2002 because they would neither be accurately projected nor be meaningful if such a feat was achieved.

Accordingly, we conclude that the foreign exchange impact of the Mumias project is very

favourable to Kenya.

5.4 A Social Cost Benefit Appraisal of MSP

In social cost benefit analysis (SCBA), an effort is made to reflect real costs and benefit without market distortions. The Little and Mirrlees procedure is used for this purpose. Therefore, the first step of the SCBA is to identify the flows of inputs and outputs. Briefly, Table 17 summarises the flows in the case of MSP.

Table 17

Input and Output Items

Input Flow	Output Flow
Labour	Sugar
Land	Molasses
Materials	Baggase
Sugarcane	

Materials are largely divided into capital equipment, and consumables. Capital equipment

include cement, factory and other machinery, while consumables range from gunny bags, petroleum, fertilisers, spares etc (Table 19).

The second step in the SCBA is to divide the flows into the three categories used in the Little and Mirrlees procedure : - traded goods and services
non-traded goods and services
unskilled labour.

All the flows must be made to fall within one of the three classes. Again, the broad classification is shown in Table 18.

Table 18

Traded, Non-Traded and Unskilled Labour Items

Traded	Non-Traded	Unskilled Labour
All Materials Sugar Molasses Skilled Labour (Clerks and above)	Sugarcane Land Baggase Mud-silt	All labour below Clerical grades

Table 19

Materials Usage in MSC 1973 to 1977

£'000

Item \ Year	1973/1974	%	1975	%	1976	%	1977	%
Fertilisers	250.8	23	458.6	27	448.9	23	472.8	20
Agricultural Chemicals	25.4	2	18.3	1	28.9	1	40.1	2
Factory Chemicals	47.2	4	69.9	4	46.8	2	58.4	2
Furnace Oil	15.8	1	20.8	1	11.4	0	10.2	0
Other Fuels	157.4	15	219.9	13	308.0	16	433.2	20
Spares - Mechanical	290.8	28	393.7	23	545.9	28	560.4	24
- Electrical	-		42.3	2	46.9	2	103.2	4
Instruments & Tools	-		34.6	2	16.8	0	25.4	1
Tyres and Tubes	-		91.6	5	114.0	6	125.2	5
Medicines & Drugs	-		10.2	0	17.2	0	27.8	1
Bags and Twines	176.3	17	208.0	12	210.9	11	292.4	12
Other (Sundry)	85.9	8	142.7	8	190.3	10	224.9	9
Total	1049.6	100	1710.9	100	1986.0	100	2374.0	100

Source: Mumias Sugar Company Records 1973 - 1977.

The Little and Mirrlees (LM) procedure then requires us to value traded goods at border prices, non-traded goods at their opportunity costs, and unskilled labour at the shadow wage rate. This is the third step.

To obtain border prices, it is necessary to remove the duty or subsidy element in the price. In the case of sugar, its border price is obtained as c.i.f. Mombasa price. The same is true of molasses whose border price is the f.o.b. Mombasa price. Skilled labour, being internationally transferrable, is assumed to earn its border wage where it is, or else it would quit . But as for materials, the valuation is not simple. In the first place, the number of inputs is high, literally in hundreds. In 1978, the sum of cost and expense centres was over 750. Each of these could absorb at least two flow items. It was therefore found not to be practical or necessary to obtain individual border prices for each input. For this purpose, the reported cost of materials was multiplied by the SCF to obtain a price devoid of taxes and subsidies. This gave an estimated world price equivalent.

For non-traded goods, sugarcane was the most difficult to value. The following method was applied.

	K£.
The cost of maize foregone	
33 bags/hectare at 85/0 x·4 crops	561.0
Cost of labour on a hectare of cane	
63.4 days at 6/=	19.02
Less the cost of labour on maize saved	
105 days x 4 crops x 6/= per day	(126.0)
Opportunity cost of cane per hectare	454.02

The sample survey found that one hectare of sugarcane yielded a mean 92.2 tons of cane. Therefore, the opportunity cost per ton of cane is £4.92. The foregoing analysis obviously includes the opportunity cost of land, and so land will not be separately valued. Although the quantity of mud-silt and baggase produced at MSC is substantial, most of it is wasted away, and no value is given to them.

Unskilled labour is valued at the going wage rate, converted to 1972 constant prices, times the shadow wage rate of 0.75.

The price of sugar has been an average US$156 per ton since 1977 Port of Carribean according to the monthly F.A.O. Bulletin "Food Outlook".

Adding to that the shipping rate of US$20 per long ton to East Africa, we obtain an estimated Mombasa import parity price of US$176 per ton, or KSh.1320 per ton. Molasses are sold to U.S.A. mainly and their price f.o.b. Mombasa has been an average KShs.320 per ton, -see Odada (49, p.17) .

Capital costs of MSP are represented by net additions to the fixed assets of MSC as reported in its Balance Sheets, both past and projected.

Table 19 shows a breakdown of materials used at MSC. Projections of materials used are based on the premise that materials usage varies in direct proportion to output and assumes the absence or constancy of stock carryovers. Using 1977 as a base year, the formula applied to every projected year was

$$M_t = \left(\frac{M_o}{Q_o}\right) Q_t \qquad (5.11)$$

where M_t = materials used in year 't' in K£ value.

M_o = materials used in 1977 in K£ value.

Q_o = output of sugar tons in 1977.

Q_t = output of sugar in year 't' in tons.

Although the 'manual grades' represent over 70 per cent of the total labour force at MSC, they account for or receive only 18.4 per cent of the total wage bill whereas skilled labour (the remaining 30 per cent) receives 81.6 per cent of the wage. The social cost of employing skilled labour is thus 81.6 per cent of the reported labour cost, times its 1972 constant price factor. The social cost of employing unskilled labour is the labour cost reported times 18.4% times the SWR of 0.75 times the 1972 constant price factor.

Since the net addition to labour cost arising from change of crop from maize to sugarcane is negative, we assume that there is no opportunity cost in labour on outgrower farms.

When all the inputs are netted against the output, a net flow of benefits or costs is obtained. This flow is discounted over a 30 year period to its 1972 price equivalent and a net present value (NPV) is obtained. The accounting rate of interest (ARI) used is 0.10, and for the purposes of sensitivity analyses, rates of 15 and 20 per cent are used. By obtaining a rate of interest at which the net present value will be zero, an internal of return is obtained. Thus, if the project can be shown to have an internal

rate of return which is higher than the opportunity cost of capital (ARI), it should be accepted as having more benefits than costs. Similarly, if at the ARI, the net present value (NPV) of the project is positive, we would accept the project as having more benefits than costs. A positive net present value at a given ARI implies that the benefit cost ratio, which is the ratio of the present value of benefits over the present value of costs, is greater than one.

Table 20 shows the flow of material inputs into MSP, and includes the non-traded inputs seedcane and sugarcane. Table 21 shows the labour cost incurred in the project. In Table 22, costs and benefits from the project are netted against each other over the project life and discounted at 10, 15 and 20 per cent ARIs to obtain net present values.

By successive trials, the flow of costs and benefits as shown in Table 22 are discounted at various ARIs. As was stated earlier, the internal rate of return is the rate at which the net present value is zero. The trials led us to derive an internal rate of return of 19.4 per cent for MSP. When the ARI was raised to 20 per cent, the net present value was negative. At 19 per cent, the net present value was still positive.

Therefore using the formula below, an internal rate of return of 19.4 per cent was obtained.

$$IRR = r_1 + (r_2 - r_1)\left[\frac{NPV_{r_1}}{NPV_{r_2} - NPV_{r_1}}\right] \qquad (5.12)$$

where IRR = internal rate of return.

r_1 = the rate at which NPV is just negative.

r_2 = the rate at which NPV is just positive.

NPV_{r_1} = NPV at r_1

NPV_{r_2} = NPV at r_2

If follows therefore that MSP is socially profitable if the true cost of capital is 10 per cent. However, in the economic study done on the factory enterprise earlier on, the opportunity cost of capital was put at 20 per cent using market prices. At that rate, MSP would not be socially desirable if market and accounting prices were equal.

Table 20

Material Inputs in MSC Actual and Projected

K£'000

Time t	Year	Book Value (1)	Materials Traded (2)	Sub-total	Times 0.80 SCF	Materials Non Traded (3)	Total	1972 Equiv.
1	1973	5232	24	5256	4204.8	883.973	5088.773	4834.33
2	1974	788	1153.9	1941.9	1553.52	2356.922	3910.442	3104.89
3	1975	966	1841.2	2807.2	2245.76	2505.346	4751.106	3525.32
4	1976	1722	2150.3	3872.3	3097.84	2695.459	5793.299	3869.92
5	1977	8636	2592.2	11228.2	8982.56	3439.209	12421.769	7776.03
6	1978	16572	3178.5	19750.5	15800.4	3914.502	19714.902	11237.49
7	1979	3715	4660.7	8375.7	6700.56	6093.555	12794.115	7292.65
8	1980	1712	5060	6772.0	5417.6	6389.948	11807.548	6730.3
9	1981	654	5931.9	6585.9	5268.72	7659.308	12928.028	7368.97
10	1982	506	6053.1	6559.1	5247.28	7870.868	13118.148	7477.34
11	1983	455	5971.3	6426.3	5141.04	7786.244	12927.284	7368.55
12	1984	455	5796.0	6251	5000.8	7532.372	12533.172	7143.91
13	1985	455	5796.0	6251	5000.8	7532.372	12533.172	7143.91
14	1986	455	5796.0	6251	5000.8	7532.372	12533.172	7143.91
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
30	2002	455	5796.0	6251	5000.8	7542.372	12533.172	7143.91

Sources: (1) Balance Sheet, MSC.
(2) Obtained by: Materials used by MSC+Fertilisers used by Farmers
(3) Obtained by: Sugarcane used at MSC (8.6 ton cane per ton sugar) * year's sugar output x £4.92.
+ Seed cane @ £0.62 per ton cane used.

Table 21

Labour and Material Inputs into MSP

K£'000

Time t	Year	Labour		1972 Price Equivalent	Material Inputs	Total Inputs 1972 Prices
		Skilled	Unskilled			
1	1973	-	-	-	4834.33	4834.33
2	1974	537.17	90.84	498.6	3104.89	3603.49
3	1975	741.09	125.3	642.86	3525.32	4168.18
4	1976	803.46	135.8	627.4	3869.92	4497.32
5	1977	1044.11	176.6	764.16	7776.03	8540.19
6	1978	1065.86	197.2	719.94	11237.49	11957.43
7	1979	1144.55	211.7	773.06	7292.65	8065.71
8	1980	1228.99	227.3	830.08	6730.3	7560.38
9	1981	1382.70	255.8	933.9	7368.97	8302.87
10	1982	1536.7	284.2	1037.9	7477.34	8515.24
11	1983	1536.7	284.2	1037.9	7368.55	8406.45
12	1984	1536.7	284.2	1037.9	7143.91	8181.81
13	1985	1536.7	284.2	1037.9	7143.91	8181.81
14	1986	1536.7	284.2	1037.9	7143.91	8181.81
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
30	2002	1536.7	284.2	1037.9	7143.91	8181.81

Source: Mumias Sugar Co. Records and Author's Computations.

Table 22

Flow of Costs and Benefits into MSP

K£'000

Time t	Year	BENEFITS Molasses(1)	Sugar(2)	Total Benefits	Costs	Net Flow	N. P. V. @ 10%	@ 15%	@ 20%
1	1973	28	1379.8	1407.-	4834.33	(3426.53)	(3115.02)	(2979.5)	(2855.4)
2	1974	74	3676.2	3750.2	3603.49	146.71	121.25	110.9	101.8
3	1975	79	3907.66	3986.66	4168.18	(181.52)	(136.4)	(122.34)	(105.1)
4	1976	85	4204.1	4289.1	4497.32	(208.22)	(142.2)	(119.04	(100.4)
5	1977	108	5364.15	5472.15	8540.19	(3068.04)	(1905.0)	(1525.0)	(1232.9)
6	1978	120	6105.0	6225	11957.43	(5732.43)	(3235.8)	(2478.0)	(1919.77)
7	1979	230.4	9504.0	9734.4	8065.71	1668.69	856.3	627.3	465.6
8	1980	241.6	9966	10207.6	7560.38	2647.22	1234.9	865.4	616.65
9	1981	289.6	11946	12235.6	8302.87	3932.73	1667.86	1117.7	762.18
10	1982	297.6	12276	12573.6	8515.24	4058.36	1564.7	1003.1	655.4
11	1983	294.8	12144	12438.8	8406.45	4032.35	1413.3	866.7	542.7
12	1984	294.8	11748	12032.8	8181.81	3850.99	1227.1	719.75	431.91
13	1985	294.8	11748	12032.8	8181.81	3850.99	1115.49	625.78	359.92
14	1986	294.8	11748	12032.8	8181.81	3850.99	1014.09	544.14	299.93
30	2002	294.8	11748	12032.8	8181.81	3850.99	22066	5816	16.22
						NPV	9614.3	2495.6	(563.75)
						IRR	19.4%		

Source: Author's Computations.

CHAPTER SIX

CONCLUSIONS AND POLICY RECOMMENDATIONS

This thesis had the following objectives: to determine the degree of returns to scale in outgrower farms in MSP; to determine the price elasticity of supply of sugarcane in MSP; to determine the optimum size of the Mumias Sugar factory; to compare actual and required levels of capital and labour at Mumias sugar factory; to determine whether or not labour is paid at least equal to its marginal value product at Mumias sugar factory; to estimate the foreign exchange effect of the MSP; and to carry out a social cost benefit analysis of the MSP.

From the analysis and results presented, the following conclusions may be drawn. The first conclusion is that although the sugarcane farms in the outgrower smallholder area average 5 hectares each, many of them already experience diseconomies of scale. The second conclusion is that the price elasticity of supply of sugarcane is very high, being 2.45. Farmers in MSP who plant sugarcane are therefore very responsive to sugarcane prices. The third conclusion is that the optimal size of the Mumias factory is indeterminate, as the average cost curve is apparently continually downslopping. At current

(1979) sugar prices however, the economic minimum size was found to be a capacity to make 50,000 tons of sugar. The fourth conclusion is that MSC employs capital and labour in quantities roughly equal to the quantities that would be required to produce various levels of output, assuming the correctness of the estimated sugar production function. The fifth conclusion which follows from the results is that labour is paid less than its marginal value product at MSC. This conclusion, however, only applies to unskilled labour because we assume that skilled labour is paid its marginal value product. The sixth conclusion is that MSP is an effective method by which Kenya is saving foreign exchange. The seventh and last conclusion which we can make from this study is that, at current or higher sugar prices on the world market, the social profitability of MSP is very high.

The policy recommendation which can be made from this study is generally that the establishment of sugar factories in Kenya along the lines of the Mumias model should be encouraged, provided the sugar produced is for domestic consumption and there is a market. The minimum size of such a factory should be in the order of 50,000 tons per annum throughput.

Such a factory should be built in an area equally or better suited for the project, such as Busia and Siaya. On the whole, the labour requirements of a sugar factory are large, and so a factory ought to be built where cheap unskilled labour is abundant. However, this conflicts with the land requirements of a large factory, since a rural area with abundant labour is likely to have high population densities. To ensure that unskilled labour is not paid below its marginal value product, the government should institute higher minimum wages in factories whose labour productivity is comparable to that of MSC. Alternatively, the unions should be allowed to bid for higher wages in MSC. There is therefore a case for productivity based wage scaling for unskilled labour at MSC.

APPENDICES

Appendix 1

Farm Survey Questionnaire No. .....

Enumerator's Name : .....

Date: .....

Time Started: .....

Time Completed .....

1. The Farmer:

(a) Farmer's Name and Address: .....

.....

.....

(b) Contract No. .....; Field No. .....

(c) Location .....;

Sub-Location .....

(d) Farmer's Occupation - Present .....

Past .....

(e) Farmer's Age .....; Sex .....

(f) Family Details: Size Adult Equivalent .....

(g) Farmer's level of Education .....

2. The Farm:

(a) Have you harvested a plant crop this year or in 1977. If "No" stop the interview.

(b) Do you own this farm: Yes ....., No.....

(i) If "YES" (a) Where is your title deed and number .....

(b) When did you acquire ownership of the farm ..... and how .....

(ii) If "NO", state the terms of occupation on this land.

(c) What is the size of your farm? ..... hectares.

(d) What area is under sugarcane? ..... hectares.

4. Sugarcane Farm Details:

Please indicate the cost and approximate man-days spent on your harvested plant crop.

(i) Ploughing and land preparation

KShs. ..... labour days (or cost) .....

(ii) Seedcane

KShs. ..... labour days (or cost) .....

(iii) Planting

KShs. ..... labour days (or cost) .....

(iv) Gapping

KShs. ..... Labour days (or cost)

.....

(v) Fertilising

KShs. ..... Labour days (or cost)

.....

(vi) Weeding

KShs. ..... Labour days

(or cost) .....

(vii) Harvest and Transportation :

Yield Tons: .....

KShs. ..... Labour days

(or cost) .....

(viii) Levies and Interest:

KShs. .....

(ix) What daily rate of labour do you pay your employees on sugarcane manual tasks?

.....

(x) What is the main source of labour on your farm?

(a) Mumias Sugar Co. labourers .....

(b) Family labour .....

(c) Local + hired labour .....

(d) Assorted Combination of above .....

(xi) Are you satisfied with the supervisory role of MSC outgrower staff? Explain in detail.

(xii) Would you like to operate a larger sugarcane farm or a smaller one? Please explain why?

(xiii) How much additional expense would you incur if you were to expand your sugarcane farm by one hectare?

(xiv) Do you think that the recommendations by MSC on how you should run the farm e.g. on inputs are adequate or over-estimated?

Adequate .....

Inadequate .....

Over-estimate .....

(xv) What aspects of farm practice would you like to have complete control over which you now have none or little?

(Detail) .....

.....

(xvi) Have you been to a Farmer's Training College? Yes/No. If "Yes", name of College .....

Appendix 2

Debts and Interest Rates at MSC

K£'000

	Debt (D)	Interest paid (I)	I/D Ratio(1)
1973	2237	60	0.027
1974	2402	100	0.042
1975	2518	80	0.032
1976	4962	428	0.086
1977	7485	419	0.056
1978	22320	N/A	N/A
1979	22590	1797	0.080
1980	17998	1584	0.088
1981	14564	1243	0.085
1982	11854	942	0.079
1983	9224	734	0.079
1984	6594	539	0.082
1975	3797	338	0.089
1976	2337	177	0.076
			0.9009
			Mean 0.069

Source: Mumias Sugar Co. Records.

(1) Author's Computations.

Appendix 3

Deflation Factors Used in Time Series Analysis

Year Data	Deflation Constant	Derived By	Source
1973	0.95	$\frac{93.09}{97.82}$	Economic Survey 1976 p.13
1974	0.794	$\frac{94.5}{119.07}$	Economic Survey 1978 p.13
1975	0.742	$\frac{94.31}{127.13}$	Economic Survey 1978 p.13
1976	0.668	$\frac{111.8}{167.41}$	Economic Survey 1978 p.13
1977	0.626	$\frac{128.61}{205.38}$	Economic Survey 1978 p.13
1978	0.57	Since the 1973-77 deflation factor decreases by a mean of 0.056, we deduct 0.056 from the 1977 constant.	
1979-1986	0.57	Same as for 1978.	

Source: Government of Kenya, Economic Surveys. 1973-1978, Government Printer, Nairobi.

Appendix 4

Average Costs at Mumias Sugar Factory at 1972 Prices

K£.

Year	AFC	AVC	ATC	TON OUTPUT(1)
1973	55.3	40.1	95.4	20891
1974	21.6	34.5	56.1	55700
1975	21.7	47.6	69.3	59207
1976	23.4	55.4	78.8	63699
1977	23.7	58.1	81.8	81275
1978	22.8	62.0	84.8	92500
1979	21.9	61.0	82.9	144000
1980	21.5	60.97	82.5	151000
1981	19.32	57.1	76.4	181000
1982	19.4	56.2	75.6	186000
1983	19.9	56.0	75.9	184000
1984	21.0	55.98	76.98	178000
1985	21.6	55.0	77.1	178000
1986	22.3	55.5	77.3	178000

Source: Author's Computation

(1) Mumias Sugar Co. Records.

Appendix 5

Return on Investment at MSC

£'000

Year	Capital (1) Employed	Profit (2) Realised	R.O.I* (2)/(1) x 100
1973	4989	153	3.06
1974	5084	751	14.77
1975	5555	1291	23.24
1976	9353	1702	18.19
1977	16675	3019	18.1
1978	36500	N/A	N/A
1979	40215	3192	7.9
1980	41927	3689	8.79
1981	42381	6266	14.78
1982	43087	7046	16.35
1983	43542	7273	16.7
1984	43997	7251	16.5
1985	44452	7616	17.13
1986	44907	7922	17.64

Mean 14.85

Source: Mumias Sugar Co. Records.

* Derived.

Appendix 6

Comparative Turn-Key Cost of Sugar Factories Built World Wide in 1978

Project Name	Country	Capacity (TS)	Cost US$m	Labour Force	Source
Mumias	Kenya	178,000 tons	119.7	4000	1
Kenana	Sudan	350,000	600.	10000	2
Simunte	Swazi-land	110,000	7.628	3000	3
Nossi Be	Malagasy	14,000	-	-	4
Karun	Iran	400,000	180.	2900	5
Nangwa	Malawi	67,000	64.9	-	6
Ngomane	Swazi-land	100,000	140.	-	7
Juba	Somalia	100,000	152		8
Triangle	Rhodesia	100,000	90	8500	9
de Chiriqui	Panama	180,000	42	-	10
South Nyanza	Kenya	60,000	137.9	3344	11

Sources: 1. Author

2. Ling (40)

3-10. Donald (14)

11. Government of Kenya (24).

Appendix 7

Suppose $\Pi = R - C$

where Π = Profit

R = Total revenue

C = Total cost

and $R = f_1(Q)$

$C = f_2(Q)$

The first order profit maximisation condition is that the first derivative of a profit function should equal zero i.e.

$$\frac{\partial \Pi}{\partial Q} = \frac{\partial R}{\partial Q} - \frac{\partial C}{\partial Q} = 0,$$

$$\Rightarrow$$

$$\frac{\partial R}{\partial Q} = \frac{\partial C}{\partial Q} = MC = MR.$$

of course, $\frac{\partial R}{\partial Q}$ is the price of sugarcane per ton which is 133/=, and $\frac{\partial C}{\partial Q}$ is the marginal cost curve.

The second order condition is that

$$\frac{\partial^2 C}{\partial Q^2} > 0 \text{ and } \frac{\partial^2 \Pi}{\partial Q^2} < 0$$

since $\Pi = R - C$,

$$\frac{\partial^2 \Pi}{\partial Q^2} = \frac{\partial^2 R}{\partial Q^2} - \frac{\partial^2 C}{\partial Q^2} < 0 \text{ i.e. } \frac{\partial^2 C}{\partial Q^2} > \frac{\partial^2 R}{\partial Q^2}$$

This means that the slope of the marginal cost curve must be greater than the slope of the marginal revenue curve. Since we have postulated that the slope of the marginal revenue curve is zero, i.e. $\frac{\partial^2 R}{\partial Q^2} = 0$, then profit maximisation will occur when

$0 < \frac{\partial^2 C}{\partial Q^2}$.

Appendix 8

$U = aQ + b\Pi$, such that $a + b \leq 1$.

$C = f(Q)$ where C is total cost.

If P is the price of sugar per ton, then

$$\Pi = P(Q) - C(Q).$$

and $$U = aQ + b\left[P(Q) - C(Q)\right]$$

$$= aQ + b\overset{P}{\wedge}(Q) - bC(Q).$$

so that the optimum output is the output such that

$$\frac{\partial U}{\partial Q} = a + bP - b\frac{\partial C}{\partial Q} = 0$$

$$\rightarrow \quad a + bP = b\frac{\partial C}{\partial Q}$$

$$\rightarrow \quad \frac{a + bP}{b} = \frac{\partial C}{\partial Q}$$

and $$\frac{a}{b} + P = \frac{\partial C}{\partial Q}$$

i.e. marginal cost equals price if $a = 0$ and this is the point of profit maximisation. Profit is maximised only when the utility of output per se is zero.

Appendix 9

Assume a production function $Q = AL^{\alpha} K^{\beta}$.

Further assume that a farmer can maximise profit (Π) subject to the technological constraint that $Q = AL^{\alpha}K^{\beta}$. His objective function is

$$\Pi = pQ - wL - rK - \lambda\left[Q - f(L,K)\right]$$

where p = the sugarcane ton price.

w = wage rate

r = the rate of interest.

The first order conditions for a maximum are:

$$\frac{\partial \Pi}{\partial L} = -w + \lambda\alpha \frac{Q1}{L} = 0$$

$$\frac{\partial \Pi}{\partial K} = -r + \lambda\beta \frac{Q_k}{K} = 0$$

$$\frac{\partial \Pi}{\partial Q} = p - \lambda = 0$$

$$\frac{\partial \Pi}{\partial \lambda} = -Q + f(L,K) = 0.$$

The above set of equations means that

$$w = \lambda\alpha \frac{Q_1}{L}, \qquad r = \lambda\beta Q_k \frac{}{K}, \qquad p = \lambda \quad \text{and} \quad f(l,k) = Q$$

$$\Rightarrow wL = \lambda\alpha Q_1, \; rK = \lambda\beta Q_k, \; p = \lambda, \quad Q = AL^{\alpha} K^{\beta}$$

$$\text{and } \frac{wL}{\alpha} = \lambda Q_1, \; \frac{rK}{\beta} = \lambda Q_k, \quad p = \lambda \text{ and } Q = AL^{\alpha}K^{\beta}$$

$$\frac{wL}{\lambda Q_1} = \alpha, \; \frac{rK}{\lambda Q_k} = \beta, \text{ and since } p = \lambda, \text{ therefore}$$

$$\frac{wL}{pQ_1} = \alpha, \; \frac{rK}{pQ_k} = \beta \quad \text{and } Q = AL^{\alpha}K^{\beta}$$

giving us the sufficient equations to determine the three variables Q, L, and K. The above equation implies that at

$$\frac{\partial \Pi}{\partial Q} = 0 \quad \text{and} \quad \frac{\partial^2 \Pi}{\partial Q^2} < 0,$$

the farmer deploys his factor inputs so that the ratio of each factor cost to total revenue just equals the factor elasticity (or contribution) to output. This is a unique general property of the Cobb Douglas production function, and is not necessarily true for other types of functions.

The sufficient conditions for profit maximisation require that

$$\frac{\partial^2 \Pi}{\partial L^2} = \alpha (\alpha-1) \frac{Q}{L^2} < 0$$

and

$$\frac{\partial^2 \Pi}{\partial K^2} = \beta(\beta-1) \frac{Q}{K^2} < 0$$

We notice that for $\frac{\partial^2 \Pi}{\partial L^2}$ and $\frac{\partial^2 \Pi}{\partial K^2}$ to be negative, each of α and β must be less than one.

Appendix 10

The Cost Equation:

Starting with the Cobb-Douglas production function:

$$Q = AL^{\alpha} K^{\beta}$$

we obtain marginal productivity of labour (MP_L) and marginal productivity of capital (MP_K) as follows:

$$MP_L = \alpha\frac{Q}{L}$$

$$MP_K = \beta\frac{Q}{K}$$

If we assume that each cane-grower, and the sugar factory is a profit maximiser who acts each time to minimise the costs of producing any given level of output, we can write the marginal productivity condition as:

$$\frac{\alpha Q/L}{\beta Q/K} = \frac{P_L}{P_K}$$

From the marginal productivity condition, we can express labour input requirements in terms of capital, the production function parameters and factor prices as:

$$L = \left(\frac{\alpha P_K}{\beta P_L}\right) K$$

Substituting the labour input requirement into the production equation, we obtain:

$$Q = A\left(\frac{\alpha P_K}{\beta P_L}\right)^{\alpha} K^{\alpha+\beta}$$

which yields

$$K = \left(\frac{\alpha P_K}{\beta P_L}\right)^{\frac{-\alpha}{\alpha+\beta}} \left(\frac{Q}{A}\right)^{\frac{1}{\alpha+\beta}}$$

and

$$L = \left(\frac{\alpha P_K}{\beta P_L}\right)^{\frac{\beta}{\alpha+\beta}} \left(\frac{Q}{A}\right)^{\frac{1}{\alpha+\beta}}$$

The long run total cost equation, C(Q), is then obtained by taking the sum of labour costs and capital costs:

$$C(Q) = P_L.L + P_K.K$$

$$\Rightarrow C(Q) = P_L\left(\frac{\alpha P_K}{\beta P_L}\right)^{\frac{\beta}{\alpha+\beta}} \left(\frac{Q}{A}\right)^{\frac{1}{\alpha+\beta}} + P_K\left(\frac{\alpha P_K}{\beta P_L}\right)^{\frac{-\alpha}{\alpha+\beta}} \left(\frac{Q}{A}\right)^{\frac{1}{\alpha+\beta}}$$

which on simplification through algebraic processes yields:

$$C(Q) = P_K \left(\frac{\alpha+\beta}{\beta}\right)\left[\left(\frac{\beta P_L}{\alpha P_K}\right)^{\frac{\alpha}{\alpha+\beta}} \cdot A^{-\frac{1}{\alpha+\beta}}\right] Q^{\frac{1}{\alpha+\beta}}$$

or simpler still

$$C(Q) = P_K \left(\frac{\alpha+\beta}{\beta}\right)\left[\left(\frac{\beta P_L}{\alpha P_K}\right)^{\alpha} \frac{Q}{A}\right]^{\frac{1}{\alpha+\beta}}.$$

Appendix 11

The Supply Equation:

Starting with the cost equation

$$C(Q) = P_K\left(\frac{\alpha+\beta}{\beta}\right)\left[\left(\frac{\beta P_L}{\alpha P_K}\right)^{\frac{\alpha}{\alpha+\beta}} \cdot A^{-\frac{1}{\alpha+\beta}}\right] Q^{\frac{1}{\alpha+\beta}}$$

we differentiate the total cost equation and obtain the marginal cost function as:

$$MC = \frac{P_K}{\beta}\cdot\left(\frac{\beta P_L}{\alpha P_K}\right)^{\frac{\alpha}{\alpha+\beta}} \cdot A^{-\frac{1}{\alpha+\beta}} \cdot Q^{\frac{1-\alpha-\beta}{\alpha+\beta}}$$

Since both sugar and sugarcane are sold under competitive conditions as far as this study is concerned, we can obtain the long run supply equation by equating the long run marginal cost to the government fixed price, P.

$$\frac{P_K}{\beta}\left(\frac{\beta P_L}{\alpha P_K}\right)^{\frac{\alpha}{\alpha+\beta}} \cdot A^{\frac{-1}{\alpha+\beta}} \cdot Q^{\frac{1-\alpha-\beta}{\alpha+\beta}} = P.$$

When this cost equation is rearranged it yields a long run supply function relating price to output:

$$Q = A^{\frac{1}{1-\alpha-\beta}} \cdot \left(\frac{\alpha}{P_L}\right)^{\frac{\alpha}{1-\alpha-\beta}} \cdot \left(\frac{\beta}{P_K}\right)^{\frac{\beta}{1-\alpha-\beta}} \cdot P^{\frac{\alpha+\beta}{1-\alpha-\beta}}$$

This long run supply function is quite well defined once the production function parameters and factor prices are known.

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