TECHNICAL EFFICIENCY IN SUGAR PROCESSING: WHAT DIFFERENCE HAVE SAPs MADE IN MUMIAS SUGAR COMPANY?

BY

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DECLARATION

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

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This Paper has been submitted for examination with our approval as University supervisors.

03 · 10 · 2001

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DEDICATION

To My Parents Lucas and Juliana.

ABSTRACT

The structural adjustment programs (SAPs) have been operational in Kenya from early 1980's. With their market-determined prices, they are supposed to address prevalent economic distortions and inefficiency in various sectors of the economy.

In agricultural sector, most reforms became operational in 1990's with the sugar sub-sector reforms introduced in 1992. This study, therefore, aims at examining how far these SAPs have addressed inefficiency in sugar processing. It majors on technical efficiency and Mumias Sugar Company has been chosen as a case study, in the processing industry.

It covers the period 1980-2000, with the SAPs period lying between 1993-2000. Technical efficiency of the period 1980-1992 is compared with that of the period 1993-2000 to determine whether it increased or declined and if so, by what percentage.

ACRONYMS

KSA ----------------Kenya Sugar Authority

SAPs ---------------Structural Adjustments Programs

BOD ---------------Board of Directors

TC/TS -------------Total cane to Total Sugar ratio

KNTC ------------- Kenya National Trading Corporation

KFA--------------- --Kenya Farmers Association

SDF -----------------Sugar Development fund

VAT --------------- Value Added Tax

ICUMSA------------International Commission on uniform Methods on Sugar Analysis

KEBs --------------- Kenya Bureau of Standards

MVP ---------------- Marginal Value Products

MFC ---------------- Marginal Factor Costs

ALS ---------------- Aigner, Lovell and Schmidt

C-D -----------------Cobb-Douglas

PLC ---------------- Public Limited Company

CHAPTER I

A. INTRODUCTION

A.1 Background information.

Before independence, the sugar industry in Kenya was predominantly a private sector enterprise, which started with the establishment of Miwani Sugar Company as early as 1922, and Ramisi Sugar Company in 1927. After independence, the government started playing an important role in the ownership, management and control of the sugar industry. It established five sugar factories, these being Muhoroni 1966, Chemelil 1968, Mumias 1973, Nzoia 1978, and Sony 1979. In order to promote and foster effective and efficient development of sugarcane for production of white sugar, Kenya Sugar Authority (KSA) was established under an order of the Agriculture Act, cap 318 through legal notice of 17th march, 1973. It was initially an advisory body to the government on the sugar industry development but overtime, the government empowered the authority with executive responsibilities on sugar matters. At this point, the objective of the government was to: substitute imports and therefore save on the much-needed foreign exchange; attain self-sufficiency; hold public enterprise on behalf of the taxpayer; create employment; and improve socio-economic aspect in the rural areas.

However, with the exception of the period in the early 1980's, Kenya has had to rely on sugar imports to meet the demand for local consumption (see table 1).

TABLE 1: SUGAR PRODUCTION, CONSUMPTION, IMPORTS AND EXPORTS IN KENYA:1980-1999 (METRIC TONNES)

YEAR	PRODUCTION	CONSUMPTION	EXPORTS	IMPORTS	CARRY OVER-STOCKS
1980	401239	299514	94674	1482	7051
1981	368970	324054	69054	NIL	-
1982	308019	328236	18200	NIL	-
1983	326329	332973	3880	NIL	-
1984	372114	348678	4001	4000	19435
1985	345641	373890	NIL	33000	-
1986	365796	381394	NIL	142500	-
1987	413248	400700	NIL	11500	1048
1988	411296	462207	NIL	42000	-
1989	441261	489544	NIL	80000	-
1990	431836	537999	NIL	64050	-
1991	433713	493967	NIL	21288	-
1992	371225	552000	NIL	124463	-
1993	381211	560000	NIL	65217	-
1994	303292	560000	NIL	174049	-
1995	384171	560000	17220	24440	-
1996	389138	570000	24478	65826	-
1997	401610	580000	25050	52372	-
1998	449132	650617	NIL	186516	-
1999	470788	665595	NIL	57701	-
MEAN	388501.5	473568.4	12827.85	57520.2	
DEVN.	46650.62	115903.6	25470.37	58002.72	

Source: KSA Year Book of Sugar Statistics (1999).

There was a sharp increase in the demand for sugar since 1990 and this can be attributed to increase in the population. The production of sugar in the same period remained almost the same, with some notable increase in the last three years. This difference warranted importation in order to cater for the imbalance. The mean production over the years was 388,501.5 tons against a mean consumption of 473,568.4 tons. This calls for increased production of sugar to meet the local demand. For the country to be self sufficient, it needs to produce more sugar. Low production can also be explained by high amounts of imports against low levels of exports, as shown in the mean values. This requires more efficient production methods to cater for local production and for export market. The years 1980, 1984 and 1987 reported carry over stocks. Production exceeded both consumption and exports, and yet we had imports in the same years.

In 1992, the government announced its intentions to liberalize the industry and include a high level of private sector involvement. The aim was to reduce the role of parastatals in the manufacturing sector. This was declared in the policy paper on public enterprise reform and privatization of july1992 by the ministry of finance. All the sugar factories were listed for privatization. The structural adjustment programs (SAPs) with their market determined prices were supposed to address prevalent economic distortions and inefficiency (Mwase, 1998). Privatization of all the factories, however, cannot be achieved until the whole industry is decontrolled. The future development of the industry will depend on removal of controls on production, prices and marketing (Chalon, 1994). Infact, the government should continue regulating a decontrolled system.

Kenya's favorable climate and conditions for growing sugar cane enable factories to process cane all year round. Factories operate on average 10 months of the year using the other two months for scheduled machinery maintenance. Historically, year round growing conditions have given Kenya a comparative advantage in Sugar production. Most sugar producing countries are able to produce for only six months a year. Large-scale capital intensive factories do processing of sugar. Expensive equipment, imported chemical inputs and raw cane are three largest costs involved in sugar processing. The other costs involved are labour costs and power costs.

A.1.1 Restructuring of The Industry

In the recent years, the government has committed itself to major structural reforms which include inter-alia economic liberalization and privatization of public enterprises. The sugar sub-sector has not been left out. The KSA is also to be strengthened and restructured to be able to address the privatized sugar industry. The industry's policy paper and legal framework has been drafted to regulate the activities in a liberalized environment. Under the sugar industry long-term policy of plant modernization, capacity expansion and privatization, it is envisaged that sufficient sugar production shall be sustained at a higher level leading to surplus sugar for export market. The strategies outlined in the industry policy paper are designed to make Kenya a net exporter.

In 1992, the government of Kenya issued a policy paper on public enterprise reform and privatization in which it listed public enterprises to be restructured and privatized. The government commissioned a sugar sub-sector restructuring study (SSRS) in 1994. The main objective of the study was to undertake a thorough analysis of the sector with a view to identify feasible options for the restructuring and privatization. In particular, the study focused on the following companies, which were listed for privatization: Mumias, Nzoia, Sony, Chemilil and Muhoroni. This study identified the following government priorities for the sugar industry: To facilitate institutional and policy reforms, effected through necessary changes to legislation; to manage the privatization process, especially in the removing and resolving impediments to sell off parastatal sugar companies including excessive debt load, legal claims and problems such as lack of title, while providing options for meeting the distributional objectives of the government where consumers and cane growers are concerned, in a transparent and effective manner; and to promote measures likely to lead to higher productivity with particular attention to the rising problem of Agricultural productivity.

The study recommendations were: the legal aspects of restructuring KSA; privatization of sugar companies; and the linking between agricultural extension and training through a new apex body. During the initial privatization process of sugar companies, farmers were to be allocated 20% shares and employees 5%. This was to be increased when farmers were ready to purchase more shares.

A.1.2 Performance of the Sugar industry in Kenya

Kenya has the potential to become and retain self-sufficiency in sugar production and also produce surplus for export (KSA report). Chalon (1994) reported that factories had to increase capacity utilization and reduce their cane input ratios to achieve a high level of output. Mumias was the most efficient in capacity utilization and total cane to total sugar ratio. Its capacity was 86.7% and TC/TS ratio of 8.91. Domestic demand for sugar has steadily risen from 217,462Tonnes in 1973 to 609,428Tonnes in 1998 while production has risen from 137,808T to 471,283Tonnes in the same period. Production of 471,283T has been the highest since the inception of the sugar industry. There has been a marked upward growth since 1995. This is attributed to a number of factors namely, timely availability of farm inputs to cane farmers, rehabilitation of sugar factories, improved cane husbandry, improved cane varieties and good weather conditions. As a result, sugar cane yields have increased from 61.4T per Ha in 1994 to 78.42T per Ha in 1999 representing a 28% increase.

A.1.3 Social-economic Importance of the Industry

The sugar sub-sector holds a key position in the Kenyan Agricultural sector. It provides direct and regular employment for about 40,000 workers. Indirectly however, the industry employs thousands of casual workers on farms as weeders, cane cutters, among others, input supply and support companies and as marketing and distribution agents for sugar and by products.

Sugar can also act as a foreign exchange earner and if sufficiently produced it can save on import expenditure.

Sugar is a major food item in the household budget of the average Kenyan while refined sugar is an essential raw material in food processing, beverage manufacture, soft drinks and pharmaceutical industries among others.

Sugar cane growing is a major source of income to over 150.000 small holders. Out of the 113330 Ha under cane in 1999, 85% belonged to small-scale growers. This majority ownership of cane farms by small-scale farmers is a deliberate government policy whose strategy is to promote rural development through direct participation of rural families in sugar cane producing areas.

Sugar recorded marketed production at current prices of 7.968 Billion Shillings in 1998 thus occupying third position after coffee and tea. Of all recorded-marketed production, sugar accounted for 11% in the same period. Overall, the sugar industry is estimated to support approximately 5Million people (i.e.) 16% of the entire population.

A.2 Sugar Marketing and Pricing

Agricultural Marketing is the performance of all business activities involved in the flow of food products and services from the point of initial agricultural production until they are in the hands of consumers. There are two major approaches to marketing, namely; functional and institutional approach (Kohls and Uhl, 1990.)

Institutional approach studies how various agencies and business structures perform the marketing processes. It attempts to answer the question 'Who' in 'Who does what'. The agencies and business structures include merchant middlemen, agent middlemen, speculative middlemen, processors and manufacturers, and facilitative organizations.
Functional approach which is the area of interest in this study breaks down the processes in to functions and tries to answer the question 'What' in 'Who does What'. These functions include; Exchange functions (buying and selling); Physical functions (storage, transportation, financing and processing); and Facilitating functions (standardization, risk bearing and market intelligence). Processing function is a form changing activity and would include all those essentially manufacturing activities that change the basic form of a product in our case sugar cane in to sugar.

A.2.1 Pre-SAPs Sugar Marketing and Pricing

In 1973, government control was tightened when sugar cane and sugar were declared special produce under section 190 of the Agriculture Act. Sources sugar were either from local factories or imports.

The Ministry of commerce and industry arranged the general distribution and marketing of sugar, through its department of trade and supplies. It instructed various sugar factories in the country to dispatch a stated quantity to various KNTC (Kenya National Trading Corporation) depots. KNTC with a system of 18 depots strategically located throughout the country was a government owned organization, which acted as a sole distributor of sugar in the country. It also received imported sugar through Kenya farmers association (KFA) which was a government agent for handling imported sugar. The Sugar received in the 18 KNTC depots was distributed further through appointed wholesalers in various consumption centers. To be appointed a KNTC distributor, one had to fill KNTC distributorship forms in which applicants stated their business experience and financial ability. There were numerous retailers in consumption centers. They included and ranged from small traders in the countryside, kiosk dealers, shop keepers, general store dealers, supermarkets and self service stores in major urban centers. The retailers bought in bulk i.e. at least 100 Kg bag and sold in smaller quantities desired by consumers (Mbogo 1980.)
(See flow chart in appendix1).

The world sugar market then was characterized by large fluctuations in prices for a long time. Over production during certain years led to depressed prices. This discouraged production in predominantly sugar exporting countries for the period following these prices. On the other hand, under production in certain periods led to high prices. Such high prices had dual effects; First, they discouraged sugar consumption in sugar importing countries and secondly, they induced sugar production especially in sugar exporting countries. The outcome was a cyclic fluctuation of quantities of sugar demanded and supplied at the world market. The sharp increases of sugar prices in the 1970s for example could be attributed to modification in the market structure and faster growth in world sugar consumption relative to world sugar production (Mbogo 1980).

The government controlled prices of cane and sugar at all levels of their marketing channel. As a corollary, therefore all margins ranging from ex-factory to retail price were regulated. The government imposed some excise duty on all sugar consumed in the country (Odhiambo 1978.) Sugar imports were financed by the sugar and cereals finance corporation, which ran a Sugar price stabilization fund. This fund was maintained through a pooling system in which all the sugar in the country was sold at the same price (pan territorial pricing). When sugar imports were cheaper relative to domestic price, the price stabilization fund was regenerated. If he imports were more expensive, the fund was depleted. As aforesaid, the price of sugar had some excise duty and this contributed to the price stabilization fund. This was a buffer type of operation. This sugar pricing policy had been a problem because producers were paid very little while consumers didn't always pay the full cost of their sugar. This shortcoming affected the supply of cane, which led to under utilization of mill capacities (Mbogo 1980). There was limited co-ordination of price increases or assessment of correct sugar price. In general the government pricing policy favored consumers mainly to the disadvantage of producers and processors.

The ministry of Agriculture, through its commodity analysis section, was responsible for an annual review of sugar cane producer prices used to decide the appropriate price that farmers were to receive. The basic pricing method used a 'cost plus' approach based on farmers average cost of production in each of the different sugar zones. The price was uniform for all zones based on one ton of cane regardless of quality of sucrose levels. Factories had fallen into financial difficulties due to the increasing costs associated with producing sugar. Though input prices were increasing the ex-factory prices remained controlled by the government. The inter-ministerial price review committee, consisting of representatives from various ministries and KSA used to set the ex-factory price of sugar. This was production oriented pricing through the use of 'cost plus' approach. The committee determined the average operating costs of all factories and provided an industry wide price. This pricing structure for the ex-factory price could not allow for adequate margins or provide for proper amounts of investment into the factories (Chalon, 1994).

A.2.2 Sugar marketing and pricing after SAPs

As Kenya moved towards a more liberalized sugar industry, changes regarding incentive structure and more competitive production are likely to emerge. Liberalization is supposed to enable producers to compete with world prices. The reduced role of government meant that factories unable to cut costs and become more efficient were forced out of production. In a liberalized market, prices are market determined. Profitability is the key factor as lower cost production at competitive prices will prevail in the market. For local producers to compete with imports they must produce below at the import parity price. Importers are now allowed to bring sugar free of quota restrictions, local inefficient producers will be compelled to lower their operating costs to maintain local production. The import parity price is highly dependent on the exchange rate. Appreciation of exchange rate makes imports more attractive while placing added pressure on domestic producers. If the currency depreciates, imports will become relatively more expensive giving local producers a greater operating margin (Chalon, 1994).

A.3 Statement of the problem

Since its inception, the sugar industry has been experiencing a number of problems. In the period before SAPs, i.e. before 1992, the average retail price exceeded the import parity prices by an average of Ksh 5,000 (see appendix Tables 2 and3). This means that the factories were inefficient in sugar processing compared to the firms importing sugar in to the country. The deteriorating performance of the sugar sub-sector was attributed to several factors, ranging from: under capacity utilization of processors, inefficient parastatals, to an inadequate policy environment that created disincentives to producers. The under capacity utilization shows inefficiency in allocation of the available resources.

There was also a problem of poor quality sugar, which was below the Kenya Bureau of Standards (KBS) requirements of 400 International Commission on Uniform Methods of Sugar Analysis (ICUMSA).

Prolonged maintenance closure has also caused reduction in the amount of sugar processed at a given year. This has adversely affected the domestic supply of sugar as explained by the high amounts of imports.

Poor state of the machinery and slow pace in adopting modern technology in some factories has negatively affected most of the firms in the industry. Other than Mumias which is using the diffuser, all the other firms are still using old crushing methods. This has had a great negative impact on production levels. Poor rural infrastructure and management problems have also adversely affected the levels of sugar production.

Overally, the Kenyan sugar is more expensive compared to imports from the COMESA region. This is an indication that, the Kenyan industry is less efficient compared to the industries in the region..

A.4 Objective of the Study

After SAPs, the forces of demand and supply now control the sugar prices. The primary purpose of the study was therefore to determine how far the SAPs have gone in addressing the problems in the sub- sector in terms of whether the sugar processing firm was more technically efficient in the SAPs period than it was in the pre-SAPs period.

The specific objectives of the study were:-

(1) To specify and estimate the level of significance of amounts of inputs utilized in sugar processing.

(2) To determine the levels of technical efficiency of the firm.

(3) To determine whether there was any significant change in technical efficiency between the pre-SAPs and SAPs periods.

(3) To determine the levels of technical efficiency of the firm.

A.5 Justification of the Study

The sugar sub-sector is very important to the economy of this country. This can be seen in the section of socio-economic importance of the industry. Being of such importance however, the sub-sector has it's problems as seen above. For the sub-sector to perform well, then, the above problems should be addressed. One way of addressing them has been through the SAPs. Its important to investigate the impact of such policies in correcting the problems, that is, if the policies are effective in addressing the problems in the sub-sector or not.

A.6 Hypotheses Tested

The following hypotheses were tested in the study:-

(1) That all the inputs that used in sugar processing were significant.

(2) That the sugar-processing firm was technically efficient.

(3) That the firm was more technically efficient in the SAPs period than it was in the pre-SAPs period.

CHAPTER II

B. LITERATURE REVIEW

This chapter gives a review of available literature considered relevant to this study. First, it presents a comparative analysis on sugar production and pricing in the different COMESA countries and secondly, a theoretical background on the meaning of efficiency of resource use as it applies to this study. Thereafter, it reviews a number of studies which have attempted to measure economic efficiency of resource use and the need for further assessment.

B.1 Theoretical Literature

B.1.1 Comparative Analysis

The government has embraced the ideals of economic liberalization price controls on sugar have been abolished. Domestic marketing on sugar has been liberalized since 1992. Individual institutions are therefore free to approach any of the sugar companies with respect to procurement / purchase of sugar. According to a fact file on The Daily Nation, May 2001, the local firms are now competing with producers mainly from Common market for Eastern and Southern Africa (COMESA), which are Zambia, Malawi, Zimbabwe, Sudan, Egypt and Mauritius.

Zambia for example, has two private sugar factories owned by Zambia Sugar plc which for a long time were controlled by CDC group plc and Tate & Lyle plc. but now have sold 50% Stake to Ilovo Sugar limited of South Africa. The factories have installed capacity of 200,000 tonnes of sugar per year and have a capacity utilization of 100 percent. In the year 2000, their production was 210,000 tonnes against a domestic consumption of 100,000 tonnes. Their Ex-factory price for domestic Sugar is US$480 per tonne and for export is US$280. Most of their sugar is grown under irrigation.

Malawi has two sugar firms owned by Ilovo with installed capacity of 240.000 tonnes per year. Their capacity utilization is also 100 percent. In the year 2000. they produced 187,353 tonnes against domestic consumption of 91.000 tonnes and exported 30,435 tonnes to Kenya between December 2000 and March 2001. Their domestic Ex-factory price is US$375. Their TC/TS ratio is 7.6.

Zimbabwe has two Sugar factories each with installed capacity of 350.000 tonnes and capacity utilization of 80%. They produce 560.000 tonnes per year against domestic consumption of 370.000 tonnes per year. Exports to Kenya amounted to 15,340 tonnes between October 2000 and March 2001. Their ex-factory prices are US$450 & US$223 for refined and raw sugar respectively.

Sudan has five factories producing 663,792 a year with the largest being Kenana sugar factory. Domestic consumption is 400.000 tonnes. The Cost, insurance & Freight (CIF) prices at the Kenyan port of Mombasa is US$280-US$290 a tonne (of Free on Board (FOB) US$260-US$270). Since it's not a member of World Trade Organization (WTO), the imports attract a 24% duty.

Egypt has eight factories, three of which produce beet Sugar. It produces 1.1 million tonnes of cane sugar and 450,000 tonnes of beet sugar per year. Domestic consumption is 1.8 million tonnes a year. The cost of producing cane sugar is US$325 a tonne. It exported 8,500 tonnes to Kenya in the first three months of 2001.

In Kenya, average capacity utilization in all the firms for the year 1999 was 67.1% up from 66.2% in 1998. Mumias had a capacity of 92.1% but recent reports say that it's now operating at full capacity (E.A standard, Jan 2001). Sony capacity for the year 1999 was 37.4%. However, the local producers are protected from dumping cheap imports through a tariff structure, which complies with world trade organization rules. In order to protect the local sugar industry form the dumping of cheap subsidized sugar imports the government of Kenya has enforced the charge of viable duty and the necessary levies on such imports. For example, currently imported sugar carries a VAT (value added tax) value of 18% and sugar development levy change of 7.0% (KSA report 1999).

B.1.2 The Concept of Efficiency

Efficiency is an elusive concept, defined differently by different disciplines. The economist, the engineer and the policy maker, for example, all will define efficiency differently. The policy implications arising from economic efficiency are relevant to both micro- and macro- level decision making. For example, suppose that we can measure the efficiency of small and large firms. We can, therefore, determine how much a given set of firms, through appropriate reorganisation, could be expected to increase their output without the necessity of investing in many more resources.

B.1.3 Efficiency as a Criterion

As one examines the usefulness of efficiency as a criterion to evaluate policy, it is important to realise that efficiency is an indicator not of welfare, but of rational utilisation of resources. It should be pointed out at this stage that, efficiency may not be a universally acceptable social criterion, first because it does not admit the discussion of the social desirability of the initial distribution of resources which results in a particular distribution of social welfare that may, indeed, be efficient though perhaps highly unequal. Second, the collective efficiency or pareto criterion, rules out the possibility of policies that, for example, substantially increase the welfare of a large number of the least well off members of society at the expense of even a small sacrifice on the part of a few of the most well off members of the community. Third, for any given initial distribution of resources there exists, generally, not one, but a multitude of pair to optimal states, each of which implies a different distribution of welfare among members of society. Efficiency then does not usually lead to a uniquely preferable social state but rather leads to the specification of a number of efficient states each of which has different consequences for individual welfare. Since it is not possible to choose from among these potential efficient states by means of the efficiency criterion, the criterion becomes both vague and indeterminate (Pachico, 1980).

To summarise the applicability of the efficiency criterion, efficiency is of clear importance in that it directs attention to the problem of resource wastage. However, it is in many respects a limited criterion and efficiency alone may be a poor guide to policy (Just and Pope, 1978; Wilson et. al., 1980). Individual firms may be efficient and thus rational while at the same time the collective behaviour of all efficient firms may disastrously irrational. Efficiency is of relevance only with respect to given objectives although the specification of objectives may, upon occasion, be of great importance. Efficiency tends to be expressed in terms of prevailing prices, which may not be sound indicators of social value. Even if all firms are efficient, less than the maximum total output that is feasible with given technology may be produced depending on the distribution of resources. Individual firm efficiency is a necessary condition for a universal social efficiency or Pareto Optimality and is of particular concern in consequence. Pareto Optimality may not be a universally acceptable criterion both because it does not incorporate distributional considerations and also because it is indeterminate (Pachico, 1980).

B.1.4 Problems of Interpretation of Efficiency Analysis

Although efficiency is commonly accepted as a reasonably valid criterion despite of the above noted theoretical issues, there may occur difficulties in measuring costs and profits as well as specifying correctly the objective function of the firm. For example, measurement of profits requires both cost of inputs and value of output. For a firm purchasing its inputs and marketing its produce, market prices are generally accepted as an appropriate numeraire for firm level behaviour analysis, although market prices may not be entirely acceptable indicators of social value. The earlier discussion of efficiency has so far made the usual micro-economic assumption of the profit maximising behaviour of firms. Firms may pursue objectives other than profit maximisation. Therefore, if firms are not attempting to maximise profits, the applicability of efficiency analysis may be somewhat dubious (Pachico, 1980). The presence of risk or uncertainty, for example, complicates the usefulness of production function estimates of allocative efficiency as a measure of the quality of firms decision making although it does not affect estimates of technical efficiency except as a component of the error term. In this case such a firm may not equate marginal costs with marginal value product. Such a firm may be facing risk rather than wasting resources through allocative inefficiency. Theory states that with risk, the optimal input level occurs when marginal factor cost is equated with marginal expected value product minus a marginal risk deduction which depends on the utility function of the decision maker and the marginal variance or revenue. Except in the cases when the decision maker is risk neutral or the variance of output is not affected by the level of the decision variable, will decision making under certainty be equivalent to decision making with certainty (Anderson *et al.*, 1977). In general, the marginal value products of resources may be expected to be less than their marginal factor costs under conditions of risk, and firms facing risk may appear to be inefficient even when actually making optimal decisions. Some researchers (Just and Pope, 1979; Wilson *et al.*, 1980) have argued that production is stochastic and not deterministic and as such, analysis must incorporate some element of risk analysis. Indeed in a liberalised economy, where prices are not controlled, firms not only face production risk but also risk in both the input and product markets. They argue that traditional production-function formulations are uninformative with respect to risk. While the above consideration of risk may serve to undermine the suitability of the standard tools of efficiency analysis as indicators of rational decision making, the existence of risk may actually reinforce the importance of human capital as a factor in improving the ability to manage production (Pachico, 1980).

These are some of the limitations which render interpretation of efficiency analysis difficult when production is assumed to be deterministic. Nevertheless, this study uses the traditional production-function formulation because of the advantages discussed later in Chapter 3. Study of efficiency through the traditional production-function formulations reveals that there are gains to be realised by improving the current allocative and technical efficiency of resources.

A number of difficulties exist with regard to the measurement of efficiency. These difficulties are both conceptual and empirical. To illustrate the various ambiguities of the conventional variants of efficiency, we categorise them as economic efficiency, price or allocative efficiency and technical efficiency. In addition, analysis may consider the efficiency of various combinations of factors. For example, Paglin (1965) measured economic efficiency by a partial productivity index approach, usually considering the productivity of labour and land. This approach ignores the presence of other factors, which affect average productivity. A more complicated approach constructs an index of efficiency consisting of a weighted average of inputs (either relative prices or relative factor shares), which is compared to output. This index is essentially an output-cost ratio (Paglin, 1965; Bennett, 1967).

If, for example, firms are inefficient in the allocation of resources, it follows that increased production can be achieved by better allocation of resources without the need to develop new technologies. Alternatively, if a new technology is introduced, inefficient decision making may decrease the potential gains from such a technology. This can be solved through educating firm workers on the use of such technologies.

B.1.5 Economic Efficiency

Doll and Orazem (1978) defined economic efficiency as the combination of inputs that maximise individual or social objectives. In their definition, they identified the necessary and sufficient conditions, used to judge the attainment of economic efficiency. They argued that the necessary condition is met if in the production process there is no possibility of producing the same amount of product with fewer inputs and when there is no possibility of producing more product with the same amount of inputs. On the other hand, the sufficient condition encompasses individual and social goals and values. This condition allows for variations in the objectives of individual producers. Therefore, firms can allocate inputs given their objectives. For example, a commonly assumed objective is that firms strive to maximise profit from their enterprises as is commonly assumed in any other business. However, firms may choose to maximise environmental, social or other criteria. This study assumed an objective of profit maximisation by Mumias sugar company. It is also assumed that as the firm attempts to maximise profits, it will need to raise sugar production from the present level.

Kohls and uhl (1990) said efficiency in the food industry is the most frequent tool used to measure the market performance. Improved efficiency according to them is a common goal to farmers, firms, consumers and society. They identified two components of efficiency, i.e. operational (technical) efficiency which refers to the situation where the costs of marketing are reduced without necessarily affecting output side of the efficiency ratio. For example, a new labour saving machine that will reduce the cost of sugar processing or a less expensive method of handling and storage. The other form of efficiency they identified was pricing efficiency. It's concerned with the ability of the market system to efficiently allocate resources and co-ordinate entire food production and marketing in accordance with consumer directives. It's less than perfect when prices fail to fully represent consumer preference, direct resources from lower to high value users, co ordinate the buying and selling activities of farmers, marketing firms and consumers. It's goal is efficient resource allocation and maximum economic output.

In a similar way, Wolgin (1973), identifies two components of overall economic efficiency. These are technical (engineering) efficiency (the necessary condition) and allocative efficiency (the sufficient condition). The relative importance of each component of economic efficiency varies from case to case, and the knowledge of which component offers the greatest scope for improvement can be important in guiding efforts to achieve higher levels of income in developing countries in both the short and the long-runs (Yotopoulos and Nugent, 1976). In some cases, the two components are quite independent of each other, whereas in others, they are interdependent.

B.1.6 Allocative Efficiency

In the study of microeconomic theory, it is assumed that firms attempt to maximize profits. This implies that they try to obtain the highest possible value of production net of the costs of producing. Assuming competitive markets, certainty, no input constraints and a certain level of technology; allocative efficiency, aims at correcting dis-equilibria which may exist in the use of factors of production. Allocative efficiency is realized when the marginal value products (MVPs) of the variable factors are equated to the marginal costs of these factors (MFCs). In a competitive market, this is also equal to the prices of those factors. Whenever allocative inefficiency occurs, this represents resource wastage. Heady and Dillon (1961) reported that within the limits of statistical reliability, the ratios of MVPs to factor opportunity cost or MFCs provide a measure of the efficiency of the prevailing resource use. If the ratio is greater than one, it indicates that little of the particular resource is being used under the existing price conditions given the levels at which other resources are operating. This means that the use of more of such a resource would lead to an increase in profit and also output. If the ratio is less than one, a reduction of such a resource would lead to an increase in profits. Efficiency is measured as a ratio of output to input. Efficiency ratios can be expressed in physical or monetary terms in which case the efficiency concept becomes a ratio of benefits to costs. Marketing inputs include labor, packaging, machinery, energy and other factors necessary to perform marketing functions. Output includes time, form, place and possession utilities. (Kohls and Uhl, 1990).

B.1.7 Technical Efficiency

Although allocative efficiency is a key component of economic efficiency, which before Liebenstein's (1966) article, was practically equated with efficiency, current theory views efficiency as comprised of allocative and technical efficiency. Technical efficiency occurs when firms are obtaining the maximum output given certain inputs of production (Wolgin, 1973). It involves structural transformation of the production function through introduction of "new" inputs and techniques of production. A technically efficient firm will, therefore, be on the boundary of its production possibilities surface. An allocativelly efficient firm is on that point on the boundary which is tangent to the ratio of factor prices.

Previously, traditional economic theory had always treated technical efficiency as an engineering problem and asserted that economic analysis applies to improving allocative efficiency. "The production function differs from the technology in that it supposes technical efficiency and states the maximum output obtainable from every possible input combination. It follows that the best utilisation of any particular input combination is a technical, not an economic, problem" (Henderson and Ouandt, 1971). It is commonly believed, however, that technical inefficiencies may result in even greater wastage of resources than allocative inefficiency (Timmer, 1970). It follows that, to assume that firms produce the maximum possible output given a set of inputs now appears to assume away an important question (Pachico, 1980).Differences among firms in their abilities to be technically efficient are mainly differences in management. Shapiro and Muller (1977) found that differences in technical efficiency are related to scores on composite modernisation indices derived from factor analysis. Items included in the factor analysis scale include knowledge on new technology, knowledge of factor and product prices and various proxies of wealth. It implies that a technically inefficient firm does not understand its underlying production function. A major source of technical inefficiency arises from the complexity of a given technology and the rate of change of the technology. It can be expected that should technology be static, over some time, all or most firms would be able to achieve technical efficiency.

B.1.8 Empirical Literature

A number of methodologies have been developed in order to empirically apply the concept of technical efficiency. The most common method has been to compare the behaviour of the best practice firms with other firms. This, essentially, entails the use of linear programming to estimate a "frontier production function" of the most productive firms (Farrell, 1957; Aigner and Chu, 1968). Therefore, the relative technical efficiency of other firms can then be determined by comparing their performance to that of the best practice firms. Major problems are associated with this approach, the most serious of which may be the reliance on outliers for the computation of the frontier function. The estimation may be highly sensitive to extreme values because it is unlikely that all the data will be utilised (Yotopoulos, 1974). Above all, since the estimated frontier relationships are efficient only relative to observed firms, not to any actual, underlying efficient production relationship, whether any firms are truly technically efficient cannot be answered from this approach (Carlson, 1976).

An alternative method for measuring differences in technical efficiency which used data from controlled experiments to estimate the frontier production function was developed by Mandac and Herdt (1978). They used data gathered by agronomists from experiments conducted on farmers' fields, to estimate a frontier or technically efficient production function. The extent of technical inefficiency of farmers can then be calculated from the difference between actual yields and the yields that technically efficient producers are estimated to get from the same levels of resources as the farmer used. This approach is faced with two problems, which deter its wider application. First, it is not clear whether the experimental data does lie in the production possibility set that the farm actually faces. Second, this methodology requires both farm survey and experimental data. It should be noted at this stage that, such combinations of data sets are neither widely available at present nor are they inexpensive to obtain. A third approach to estimating technical and allocative efficiency uses profit function models (Lau and Yotopoulos, 1971; Yotopoulos and Lau, 1973). This method depends on the theoretical duality between production and profit functions. It is true that for every production function, there is a corresponding profit function where profits are a function of input prices and fixed inputs. Differences in technical efficiency between groups of firms can be observed through neutral shift parameters, i.e., terms estimating the difference between profit functions between the firms. This methodology, is of questionable value in a multi-product situations since profit is expressed as Unit-Output-Profit (UOP), which only allows the comparison of relative technical efficiency between firm groups and can say nothing about the absolute level of technical efficiency. Additionally, it is usable only where there are differences in the prices of resources and output among firms (Pachico, 1980).

The fourth approach of estimating technical efficiency was a stochastic frontier function by Lovell and Schmidt (1976). It's a derivative of the C-D production function and it takes the following form.

$$\ln Y_t = \ln\alpha_{0t} + \sum_{i=1}^{n} \alpha_{it}\ln X_{it} + (v_{it} - u_{it})$$

$$\varepsilon_t = v_t - u_t$$

v_{it} is a symmetric component representing random factors, and $u_{it} \geq 0$ is a one sided component (has half normal distribution) representing technical inefficiency.

B.1.9 Critique of the literature

The first two empirical approaches to estimation of efficiency have serious shortcomings and cannot be used for this study. The problem with the approach of comparing best practice firms with others is reliance on outlier firm for computation of frontier function. This may not reflect the true efficiency of the other firms.

The problem of the second approach of using data from controlled experiment is that the experimental data may not lie in the production possibility frontier set the firm is actually facing. It also requires firm survey data and experimental data. Such combinations are not widely available and could be expensive to obtain. Additionally it could be more useful in biological studies and may not be applicable in industrial research. Finally, the two approaches tell us little or nothing about allocative efficiency without which the firm cannot attain economic efficiency. The use of profit function models allows for comparison of technical efficiency between firm groups and says nothing about absolute level of technical efficiency. The fourth approach however, overcomes most of these problems. The fourth approach (stochastic frontier estimation) was used in this study.

CHAPTER III

C. METHODOLOGY

C.1 Analytical Procedures

The time series characteristics of each variable were analysed before estimation of the models. This is because time series data exhibit non-stationary characteristics. This involved testing for order of integration of each variable using the Dickey-Fuller (DF) and augmented Dickey-Fuller (ADF) unit root tests. The Dickey-Fuller test assumes that the data generating process (DGP) is an AR (1) process. If this is not the case then there will be auto correlation in the error term, which biases the test (Gujarati 1995.) To overcome this problem, the study used (ADF) test. This ensured that any autocorrelation is absorbed and that the error term is white noise.

After testing for stationary of each variable, the time series may be found stationary or non-stationary. If it's stationary, the models are estimated in their present form. If not, the variable could be differenced to achieve stationarity. However, estimating a model in difference form neglects long-term relationships of the variables. To ensure that the model incorporates the long-term effects, the error correction model (ECM) is utilised.

Cointegration analysis was performed using two-step Engle-Granger procedure. The basic idea behind co-integration analysis is that though macro variables may tend to move up and down over time, groups of variables may drift together.

The diagnostic tests that were performed are:

(1) Lagrange Multiplier (LM) test for presence of heteroscedasticity.

(2) LM autocorrelation test.

(3) Jaque Bera (JB) test for normality.

(4) Ramsey's RESET test for omitted variables and functional form.

One analytical procedure was used to assess the efficiency of firm resource use in sugar processing. This procedure was the production function analysis. By using this procedure, important measures of technical efficiency of resource use was assessed.

C.1.1 Production Function Analysis

Theoretical Framework

This type of analysis shows the technical relationship between input and output. Its relationship is expressed as shown in equation (3-1).

$$Y_t = f(X_{1t}, X_{2t}, \text{------} X_{nt}) \quad \text{(3-1)}$$

where: Y_t = Tonnes of sugar processed per year, and X_{1t}-X_{nt} are processing inputs X_{1t}, X_{2t}, ..., X_{nt}, that is, annual levels of Sugarcane, labour, capital, power and process consumables used. Among the various functional forms used to study the productivity of agricultural inputs, the most commonly used production function is the Cobb-Douglas (Welsch, 1965). This production function defines what production possibilities are open to the producer. It takes into considerations the inputs affecting the output. It is possible to know the production with certainty and the information on prices and opportunity costs, so, it would be possible to use production function analysis to: (1) determine for the firm's the optimal combinations of inputs which maximise firm's incomes, and (2) assess the effects on production of certain government policies which affect prices and the quantity of resources available to the firm.

Despite it's limitations, production function analysis is useful, especially in studies planned for general diagnostic purposes (e.g. firm resource returns and capital productivity). Hence, results from such analyses can help in advising the producers as to whether they are using too many or too few resources or whether reallocation from one enterprise to another will increase profitability.

The estimation of production functions can take different algebraic forms. These include the linear function, the quadratic function, the power or Cobb-Douglas (C-D) function and the square root function among others. Dillon (1977) argues that, although there has been a lot of empirical interest generated in the areas of production analysis, there has not been any algebraic form of production function, which has proved to be best for all situations. The problem is in how to strike a balance between simplicity and sophistication. Dillon (1977) and Hu (1974) consider a number of features which should dictate a good model, namely: a combination of statistical measures of goodness of fit, for example, coefficient of determination (R^2), the adjusted R^2 (adjusting for degrees of freedom), the F-ratio value, statistical significance and the signs of the estimated regression coefficients; biology and economics of the response process under study; subjective judgement and computational ease. The higher the R^2, the greater the proportion of the dependent variable being explained by the explanatory variables. The regression coefficients should be statistically significant (measurably different from zero). The insignificant coefficients help in monitoring variables, which may be incorrectly defined or measured, or those, which have coefficients that are unstable with slight changes in the data. This can help detect severe multicollinearity among the variables.

A close examination of the residuals helps to determine whether or not the functional form used is appropriate. In ordinary least squares estimation, if the basic assumption with respect to the error term hold, the residuals when plotted against an independent variable or the dependent variable should be random and homoscedastic. This study makes estimates for the Cobb-Douglas functional form. This choice was made after the above considerations were taken into account. Over the years, the power or Cobb-Douglas production function has been particularly popular. This is confirmed by studies done by Heady (1946) and by Heady and Dillon (1961). The C-D production function has the following merits over the other production functional forms: (1) it makes it possible for diminishing marginal returns to occur without loosing too many degrees of freedom, implying that C-D function is an efficient user of degrees of freedom and (2) simplicity and computational feasibility, that is, its regression coefficients give the elasticities of production, which is defined as the percentage change in the level of output resulting from a one percent change in the level of input, (*ceteris paribus*). These elasticities are independent of the level of inputs. The feature of diminishing marginal returns can be observed without loosing too many degrees of freedom.

In view of the above advantages, the C-D function was chosen for this study to estimate the sugar processing functions. Wonnacott and Wonnacott (1979) give the specification of the power function as follows:-

$$Y_t = A_t X_{1t}^{\beta 1t} X_{2t}^{\beta 2t} \text{--------} X_{nt}^{\beta n} \in_t \text{..............} (3\text{-}2a)$$

OR

$$Y_t = A_t \prod_{i=1}^{n} X_{it}^{\beta it} \in_t \text{..............} (3\text{-}2b)$$

where Y = tonnes of sugar processed per year . A_t = a constant, β_{1t}, β_{2t}, ----, β_{nt} are regression coefficients. (i.e. the elasticities of production with respect to factors X_{1t}, X_{2t} ---X_{nt}) and $\in_t$ is a multiplicative stochastic error or residual term.

When linearised using the natural logarithms, the function takes the form of:-

$$\ln Y_t = A_t + \beta_{1t} \ln X_{1t} + \beta_{2t} \ln X_{2t} + \text{........} + \beta_{nt} \ln X_{nt} + \ln \in_t \text{\_\_\_\_\_\_} (3\text{-}3a)$$

OR

$$\ln Y_t = A_t + \sum_{i=1}^{n} \beta_{it} \ln X_{it} + \ln \in_t \text{\_\_\_\_\_\_} (3\text{-}3b)$$

This expression of Y_t in natural logarithm form makes it possible for the analyst to use the least squares estimation method using the assumptions that the residual error term is independently distributed with a mean of zero and a finite variance.

Despite the wide spread use of C-D production function, there are some limitations, some of which have been stated in previous work done by Chandra and Boer (1970). These are: (1) the use of power function has been found to be unsatisfactory especially where there are ranges of both increasing and decreasing marginal productivity or in the case of both positive and negative marginal productivities; (2) it assumes a unit elasticity of substitution between factors (3) it does not reach a maximum level of output implying that, as you increase the level of input, output increases indefinitely and (4) with undefined economic optimum, the function may over-estimate the input which equates marginal revenue to marginal cost. However, due to its advantages as indicated earlier, this functional form will be adopted.

C.1.1.1 Estimation Problems of Cobb-Douglas Production Function

Problems of estimation usually arise when using C-D functions with some independent variables having zero values. These problems occur because a certain input may not have been used during the period under study. Consequently it becomes difficult to get the natural logarithms of the zero values during the process of linearization of the equation as required. It should be noted that the natural logarithm of zero is minus infinity (undefined). The following options are at the disposal of the researcher to help him go around the problem: (i) replace the zero values with very small values (Heady and Dillon, 1961) or (ii) elimination of all the cases with zero values (Norusis, 1986). For the purposes of the study, all cases with zero values will be eliminated.

C.1.1.2 The ALS (Aigner, Lovell and Schmidt) Model.

This is a derivative of the C-D function. Most applications of frontier methodology have been estimating production frontiers. Estimation of production frontiers only yields information on technical efficiency (It uses data on input quantities but not on input prices.) It's well known that either cost function or production function uniquely define technology; which one is to be estimated depends on ones assumption and/or data. The behavioural assumption underlying direct estimation of cost function is generally cost minimisation with output exogenous. It requires data on the input prices but not input quantities and it yields information on extra cost of technical and allocative efficiency (though not separate costs of each, without further assumptions.) For these reasons the model is considered appropriate for estimating efficiency levels in the firm and also for comparative analysis between the pre and post SAPs periods.

C.1.1.3 Model Specification

Frontier functions can either be deterministic or stochastic. A stochastic Cobb-Douglas frontier function was estimated by Aigner, Schmidt and Lovell (1977). They considered the following C-D form.

$$\ln Y_t = \alpha_{0t} + \sum_{i=1}^{n} \alpha_{it} \ln X_{it} + (v_t - u_t) \text{ ....} (3\text{-}4a_1)$$

For the purposes of the study a structural shock dummy variable was introduced to capture the effects of SAPs such that:

$$\ln Y_t = \alpha_{0t} + \phi D_{1t} + \sum_{i=1}^{n} \alpha_{it} \ln X_{it} + (v_t - u_t) \text{ ....} (3\text{-}4a_2)$$

Y_t= Output (Amount of sugar processed per year.)

α_{0t}=Constant (Intercept).

X_{it} = i^{th} variable input used in the production of product Y at time t.

D_{it}= Intercept dummy variable where: D_{it}=1 in the SAPs period.

D_{it}= 0 Otherwise

ϕ= Coefficient of the production frontier dummy variable. It will indicate the direction and the magnitude of the shift in the intercept, hence an increase or decrease in technical efficiency.

v_t and u_t are error terms. v_t is a symmetric component representing random factors, and $u_t \geq 0$ is a one sided component (has half normal distribution) representing technical inefficiency. The former represents effects that cannot be controlled by the firm, while the latter represents effects that can be controlled by the firm. The random component v_{it} makes the frontier stochastic.

The stochastic production is obtained by setting u_t=0.

v_t is iid $N(0,\sigma^2 v_t)$ and u_t is iid $N(0,\sigma^2 u_t)$ truncated as zero.

C.1.1.4 Testing of Hypotheses under Production Function Analysis

The following hypotheses will be tested as follows:

1. The hypothesis that each of the resources identified significantly influenced sugar processing was tested for statistical significance of each of the β_{it} coefficients. We ran an OLS estimation for the C-D function. The hypothesis testing takes the following form:

$$H_o: \beta_{it} = 0 \text{ ------------------ } (3\text{-}5a)$$

$$H_A: \beta_{it} \neq 0 \text{ ------------------ } (3\text{-}5b)$$

and the t-statistic will be calculated using the formula:

$$t = \beta_{it}/S.E(\beta_{it}) \text{ ------------------ } (3\text{-}5c)$$

After calculating the "t" value, it was compared with the tabulated "t" value at a predetermined level of significance and degrees of freedom. Given the two values of "t", the null hypothesis (H_o) was accepted or rejected depending on whether the calculated "t" value was less or greater than the tabulated "t" value respectively. If H_o will be accepted, this means that the input under consideration did not influence sugar processing. On the other hand, its rejection indicates that the input influenced sugar processing.

2. In testing the second hypothesis, that the firm was more technically efficient in liberalization period than it was in the pre-liberalization period, we ran OLS estimates of the ALS Model.

(a) In testing for a change in technical efficiency, the following hypothesis was tested from equation (3-4a₂)

$H_o: \phi = 0$ .... (3-6a)

$H_A: \phi \neq 0$ .... (3-6b)

If the first hypothesis (H_o) is accepted then, ϕ is not significantly different from zero hence, the production frontier's intercept was not changed by liberalisation. If it's rejected then we accept the second hypothesis (H_A) that, ϕ is significantly different from zero, which implies a shift in the intercept (technological constant, A) hence a different level of technical efficiency.

C.2 Data Sources and Collection

The data used for this study is mainly secondary. It's majorly from.

(1) The KSA yearbooks of statistics.

(2) Annual records for the six firms.

(3) Central Bureau of statistics publications.

Information gathered will include quantitative form of data for Mumias Sugar Company. These include the quantity of cane crushed, amount of sugar processed, processing consumables used, amount of power used, amount of labour used and the level of fixed inputs/ capital. The study utilised time series data covering the period 1980-2000. This period enabled us to capture the behaviour of these variables before and after SAPs.

C.3 Variables Used in Production Function

In this Section, the dependent/endogenous and independent/exogenous variables included in the model are defined.

C.3.1 The dependent variable

The dependent variable in this study will be the tonnes of sugar processed per year.

C.3.2 The Independent Variables

The major independent variables considered in the production function model are: Capital (i.e. plant machinery and Equipment), labour (i.e. permanent and casual workers), cane used in processing, chemicals fuel and power.

Capital

This input category comprises of plant and machinery equipment - these are weighbridges, mills for cane crushing, clarifiers, evaporators, crystallizers, centrifuges, dryers and packaging equipment, turbo-alternators and boilers. They are converted to an annual capital charge and may be considered fully depreciated after five to fifteen years depending on company policy. The units are in shillings of capital.

Labour

This will be the total amount of labour input used in the processing activities per year. It includes those employed during on season, the permanent workers and also the casuals employed during the out of crop shutdown period. Some scholars recommend that the total number of employees- managers, supervisors and wage group should be at the ratio of 0.65 to 0.85 of a person per tonne of cane crushed.

Cane

It's the main cost item in sugar production process. In Kenya it's priced on quantity, regardless of sucrose content and cane trash. The units are in tonnes.

Chemicals

These are tonnes of chemicals such as lime, sulphur and flocculant.

Power

This is the amount of MW/h(kilowatt hour) used in processing sugar per year.

Fuel

These are tonnes of firewood and oil used.

CHAPTER IV

D. DATA ANALYSIS AND RESULTS

This chapter gives results on the different tests performed in this study, and also results of the regression equations.

D.1 Stationarity Test

If X_t is a stationary variable, then it will have the following properties:

- The mean is constant through time, $E(X_t) = \mu$ time.
- The variance is constant through time, $Var(X_t)=E(X_t-\mu)^2=\sigma^2$; and
- The covariance depends, only upon the number of periods between two values. $Cov(X_t, X_{t-k}) = E[(X_t - \mu)(X_{t-k} - \mu)] = \gamma_k$

For the results of any time series regression to be meaningful, it is important that the series be stationary. If the series are not stationary, the above properties do not hold. A series may be non-stationary because it has a trend. The trend could be either deterministic or stochastic. A series has a deterministic trend if its mean is a function of time. Thus if a function is a linear one, we can demonstrate it as:

$$X_t = \mu_t + e_t$$

Where $\mu_t = \lambda + \beta_t$

or $X_t = \lambda + \beta_t + e_t$

A stochastic trend is manifested in a series if the series moves upward and downward as a result of stochastic effects.

Besides time series being non-stationary, studies have shown that one can still get good regression results. In this case it is difficult to make a judgment as to whether an economic relationship suggested by theory has any empirical support for the data. Hence the regression results will only make sense if the series are not affected by a trend. We therefore have to de-trend any variable subjected to a trend. If we have a stochastic series X_t with a trend such that:

$$X_t = X_{t-1} + e_t$$

Then our de-trended variable will be

$$\Delta X_t = X_t - X_{t-1} = e_t$$

Where ΔX_t is stationary

This means that a non-stationary variable can be made stationary by differencing it once. In this case the variable is said to be integrated of order one. However, a non-stationary variable can be made stationary by differencing it **d** times. Such a variable is said to be integrated of order d and is denoted as:

$$X_t \neg I(d)$$

Clearly, a stationary series is integrated of order zero $(i.e., I(0))$

A time series can also be non-stationary if it is subject to a drift or seasonality and to make it stationary we difference the series.

The order of integration of each variable in this study is therefore identified using the Dickey-Fuller (DF) class of unit root tests suggested by Dickey and Fuller (1979). The DF test involves testing the size of the coefficient ρ in the equations as shown below.

$$X_t = \delta_0 + \alpha X_{t-1} + e_t \text{..} (4-1a)$$

We test for the hypothesis $\alpha = 1$ (i.e., unit root test). The above equation can be rewritten as:

$$\Delta X_t = \delta_0 + \rho X_{t-1} + e_t \text{..} (4.-1b)$$

Where

$\alpha = 1 + \rho$ or $\alpha - 1 = \rho$

In the last equation we test for negativity of ρ in the OLS regression in equation 2 that is:

$H_0 : \rho = 0$ which implies that $\alpha - 1 = \rho = 0$ then $\alpha = 1$

$H_A : \rho < 0$ which implies that $\alpha = 1 < \rho < 0$ then $\alpha < 1$

If ρ is negative, thus rejecting the null hypothesis implies that $\rho < 1$ and that X_t is integrated of order zero. This means X_t is stationary (i.e., $X_t \sim$ I (0)). However, if the null hypothesis cannot be rejected, then the series has a unit root and is non-stationary at levels. Hence the order of integration could be higher than zero or may not be there at all.

If X_t is non-stationary, we continue testing for the order of integration by differencing further until it is established or until X_t cannot be made stationary by differencing.

The DF test, however, does not take into account the possibility of autocorrelation in the error term and if the error term (e_t) is not a white noise process, then the OLS estimate will not be efficient. The appropriate method that is therefore used to overcome this problem is the Augmented Dickey-Fuller (ADF) test as proposed by Dickey and Fuller (1981). This involves using the lagged values of the endogenous variable as additional explanatory variables to approximate autocorrelation. We therefore specify our ADF equation as:

$$\Delta X_t = \delta_0 + \rho X_{t-1} + \sum \Delta X_{t-1} + e_t \text{..............................} (4-1c)$$

We again test the hypothesis:

$H_0 : \rho = 0$

$H_A : \rho < 0$

If the null hypothesis is rejected and the alternative accepted, the series is stationary at levels. If the null hypothesis cannot be rejected, the series is non-stationary at levels, though it could be stationary at higher levels or not stationary at all.

There is another test for order of integration besides the DF and ADF tests. This is the Sargan Bhargava Watson (SBDW) test. It is used together with the DF and ADF with the null hypothesis same as the alternative hypothesis in DF and ADF to cross check the tests. This is because tests for unit root are usually biased and have low power in detecting stationary series. We therefore make inferences on order of integration the ADF test. After testing for unit roots. all the variables were found non-stationery at levels. To achieve stationarity. the variables were differenced. From the ADF table below. it can be seen that. the variables attain stationarity after being differenced once or twice. Cane sugar. power and capital had to be differenced twice therefore they are I (2). The remaining variables had to be differenced once to attain stationarity hence they are I(1). This can be shown in the following table.

ADF UNIT ROOT TESTS

VARIABLE		ADF VALUES	OPTIMAL LAGS	I(d)
CANE	ADF(1)	-2.9969	1	
	ADF(2)	-5.3165*	1	I(2)
SUGAR	ADF(1)	-2.2247	1	
	ADF(2)	-4.8944*	1	I(2)
POWER	ADF(1)	-2.9011	1	
	ADF(2)	-5.4296*	1	I(2)
CAPITAL	ADF(1)	-3.1737	1	
	ADF(2)	-4.3715*	1	I(2)
CHEMS	ADF(1)	-5.6726*	1	I(1)
LABOUR	ADF(1)	-4.5984*	1	I(1)
FUEL	ADF(1)	-4.1420*	1	I(1)

Note:
The critical values at 1%, 5% and 10% CI's are -3.887, -3.5021 and –2.6672 for ADF (1) and –3.9228, -3.5021 and –2.6672 for ADF (2).

ADF (1)= Augmented Dickey-Fuller first difference.

ADF (2)= Augmented Dickey-Fuller second difference

CI = confidence interval

* Denotes significance at all CI's.

This was also be shown by way of graphs (see appendix 4 and 5). The first set of graphs showed the variables before differencing (at levels) and the second set showed the variables after differencing. The variables were regressed at their stationary forms.

D.2 Cointegration Analysis

The model was also subjected to cointegration test in order to ascertain whether there was a stable long run relationship between the dependent variable and its regressors. This test is basically required to guard against loss of information relating to possible long run relationship in a model specified in differences.

The process of testing for the existence of cointegrating relationship is two fold. First, test for the unit root on the individual series and if the variables of interest appear to have a unit root, then a model in the static form is estimated for the cointegrating regression. Second, test for order of integration of the residuals generated from the static model in step 1. In line with the two steps outlined above, cointegration in this study will be conducted using analogenous tests to those used for integration tests of the series.

If on running the regressions, all the variables are nonstationary or random stochastic processes i.e. capital, labour, fuel, chemicals, sugar, cane and power are I(d) the series can be cointegrated. Despite this, the linear combination of these variables might be stationary. More specifically, if we write (3-3b) as

$$\epsilon_t = \ln Y_t - \alpha_{0t} - \Sigma_{i=1}^{n} \beta_{it} \ln X_{it} \text{ ———————— } (4\text{-}2a)$$

and find that ϵ_t [i.e. the linear combination ($\ln Y_t - \alpha_{0t} - \sum_{i=1}^{n} \beta_{it} X_{it}$)] is I(0) or stationary, then we say that the variables are cointegrated; so to speak, they are on the same wavelength. Intuitively, we see that when the ϵ_t is I(0) the 'trends' in the variables cancel out.

Using both DF and ADF tests discussed above, we specify the cointegrating regressions as:

$\Delta\varepsilon_t = \pi\varepsilon_{t-1} + v_t$......................................4 − 2b

$\Delta\varepsilon_t = \alpha + \pi\varepsilon_{t-1} + v_t$................................4 − 2c

$\Delta\varepsilon_t = \alpha + \pi\varepsilon_{t-1} + \beta T + v_t$.......................4 − 2d

Where

$\Delta\varepsilon_t = \varepsilon_t - \varepsilon_{t-1}$

ε_t = residuals generated from the static equation

α=a drift term, T=Trend and v_t=error term

In both cases stated above H_0 and alternative H_A hypotheses to be tested are given as:

$H_0 : \pi = 0$ (not cointegrated)

$H_A : \pi < 0$ (cointegrated)

The Augmented Dickey-Fuller (ADF) unit root test used in this study to test for cointegration is based on the following model:

$\Delta\varepsilon_t = \alpha + \beta T + \pi\varepsilon_{t-1} + \sum_{i=1}^{k} \pi\Delta\varepsilon_{t-1} + v_t$.................4 − 2e

Where i is the number of lags for $\Delta\varepsilon_{t-1}$ and the other notations as defined above. The null and alternative hypotheses to be tested are given as:

$H_0 : \pi = 0$ (not cointegrated)

$H_A : \pi < 0$ (Cointegrated)

The t-statistics of the coefficient of ε_{t-1} using both versions of DF and ADF tests determine whether the variables are cointegrated or not. Since the estimated ϵ_t is based on the cointegrating parameters β_{1i}.. the DF and ADF critical significance values are not quite appropriate. Therefore, the DF and ADF tests in this context are known as Engle-Granger (EG) and Augmented Engle-Granger (AEG) tests.

To determine whether there was any cointegration a regression was run with the variables at levels (non-stationary) as seen below.

```
EQ( 1) Modelling LSUGAR by OLS
       The present sample is:   1980/81 to 1999/00

 Variable       Coefficient     Std.Error   t-value   t-prob   PartR^2
 Constant            2.3389        1.8908     1.237   0.2419   0.1221
 LCANE              0.85143       0.11247     7.571   0.0000   0.8390
 LPOWER           -0.051806      0.025041    -2.069   0.0629   0.2801
 LFUEL             0.015459      0.020946     0.738   0.4759   0.0472
 LCHEMS           -0.053958      0.043144    -1.251   0.2370   0.1245
 LLABOUR          -0.089596      0.073864    -1.213   0.2505   0.1180
 LCAPITAL         -0.041636      0.016459    -2.530   0.0280   0.3678
 DUMMY            -0.050111      0.039704    -1.262   0.2330   0.1265
 Trend             0.013122     0.0060053     2.185   0.0514   0.3027

R^2 = 0.978189  F(8, 11) = 61.666 [0.0000]  σ = 0.0304483  DW = 1.84
RSS = 0.01019810326 for 9 variables and 20 observations
```

The residuals are stored as ECM and DF test is used to test for cointegration.

VARIABLE	t Value
ECM (Residuals)	-3.793

The EG 1%, 5% and 10% critical 't' values are –2.5899, -1.9439, and –1.6177 respectively. The calculated t-value is –3.793.

The results from the above table indicate that the test statistics are less than the critical values implying that the error term is I(0) i.e. it's stationary. This stationarity of the **error term** implies that the variables are cointegrated. The model incorporated ECM to capture the long term relationship.

D.2.1 Cointegration and Error Correction Mechanism (ECM)

We have showed that our variables are cointegrated, that is, there is a long term equilibrium relationship between the variables. In the short-run there may be disequilibrium. Therefore, one can treat the error term as the 'equilibrium error'. We therefore can use this error to tie the short-run of the dependent variable to its long-run value. The ECM corrects for the disequilibrium. Consider the following model.

$$\Delta \ln Y_t = \alpha_{0t} + \alpha_{it} \Delta \ln X_{it} + \alpha_{ut}\, u_{t-1} + \epsilon_t \text{ ----------------------- (4-2f)}$$

Where Δ denotes the first difference; u_{t-1} is the one period lagged value of the residual from regression, the empirical estimate of the equilibrium error term; and ϵ_t is the error term with usual properties. In this regression, $\Delta \ln Y_t$ captures the short-run disturbances in Y_t whereas the error correction term u_{t-1} captures the adjustment toward the long-run equilibrium. If α_{ut} is statistically significant, it tells what proportion of the disequilibrium in the exogenous variables in one period is corrected in the next period.

D.2.2 Model Respecification

The original model will therefore be respecified to accommodate the ECM because of the presence of cointegration. It therefore takes the following form.

$$\ln Y_t = \alpha_{0t} + \phi D_{1t} + \sum_{i=1}^{n} \alpha_{it} \ln X_{it} + ECM_{-1} + (v_t - u_t) \text{ \_\_\_\_\_\_(4-2g)}$$

Before interpreting the above results, it is important to subject the models to the aforementioned diagnostic tests. These tests are reported beneath the respective regression results. The tests indicate whether the model is consistent with data or not. If the models do not track the data well over the sample period, it will be needless interpreting the results. Among the diagnostic tests considered are the mis-specification tests testing on the residuals for a range of null hypothesis of interest, including:

autocorrelation (AR). autoregressive conditional heteroscedasticity (ARCH). the Jarque-Bera normality of the distribution of the residuals and functional form mis-specification (Ramsey's RESET test).

The model tests for all the models are not significant starting with AR for autocorrelated residuals. the ARCH for heteroscedastic errors. normality test for the distribution of the residuals and the RESET test for the regression specification both at 1% and 5%. The null hypothesis is accepted in all cases. The test outcomes are satisfactory. consistent with the equations estimated.

The normality of the error term is necessary for the efficiency and consistency of the OLS estimates to hold. The RESET test shows that the model was correctly specified as linear. The ARCH test indicates absence of heteroscedasticity. that is. it does not reject the hypotheses that the conditional variance of the estimated model is not related to the size of its past errors.

In addition to the above tests. Chow test for establishing stability of parameters was also done. The test statistic obtained revealed that the parameters were stable. We now proceed with the discussion of the results under the assumption of best linear unbiased estimates with residuals being a white noise process.

Equation 2 shows the regression with values at their differenced levels with ECM and dummy variable inclusive. ECM_{-1} are the lagged values of the residuals.

EQ(2) Modelling DDLSUGAR by OLS
The present sample is: 1982/83 to 1999/00

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	0.0071404	0.0077625	0.920	0.3816	0.0859
DDLCANE	0.96621	0.054191	17.830	0.0000	0.9725
DDLCAPIT	-0.076907	0.015465	-4.973	0.0008	0.7332
DDLPOWER	-0.016687	0.013884	-1.202	0.2601	0.1383
DLLABOUR	-0.14091	0.060861	-2.315	0.0458	0.3733
DLFUEL	0.081481	0.017194	4.739	0.0011	0.7139
DLCHEMS	-0.21299	0.041160	-5.175	0.0006	0.7485
DUMMY	0.013857	0.012321	1.125	0.2898	0.1232
ECM_1	-0.78459	0.32205	-2.436	0.0376	0.3974

R^2 = 0.983138 F(8, 9) = 65.595 [0.0000] σ = 0.0248643 DW = 1.89
RSS = 0.005564116666 for 9 variables and 18 observations

AR 1- 1 F(1, 9) = 0.44292 [0.5224]
ARCH 1 F(1, 8) = 1.3319 [0.2818]
Normality Chi^2 (2)= 1.3468 [0.5100]
RESET F(1, 9) = 0.36062 [0.5630]

The model was also estimated without the dummy varible in order to compare the levels of efficiency before and after SAPs. The following results were obtained.

EQ(3) Modelling DDLSUGAR by OLS
The present sample is: 1982/83 to 1999/00

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	0.012341	0.0063170	1.954	0.0793	0.2762
DDLCANE	0.96441	0.054880	17.573	0.0000	0.9686
DDLCAPIT	-0.075021	0.015576	-4.816	0.0007	0.6988
DDLPOWER	-0.017356	0.014053	-1.235	0.2450	0.1323
DLLABOUR	-0.14769	0.061359	-2.407	0.0369	0.3668
DLFUEL	0.078806	0.017252	4.568	0.0010	0.6760
DLCHEMS	-0.20967	0.041594	-5.041	0.0005	0.7176
ECM_1	-0.79606	0.32612	-2.441	0.0348	0.3734

R^2 = 0.980769 F(7, 10) = 72.854 [0.0000] σ = 0.0251915 DW = 1.61
RSS = 0.006346135994 for 8 variables and 18 observations

AR 1-1 F(1, 8) = 0.0031922 [0.9563]
ARCH 1 F(1, 7) = 1.843 [0.2167]
Normality Chi^2(2)= 1.3995 [0.4967]
RESET F(1, 8) = 0.27013 [0.6173]

D.2.3 Calculation of Technical efficiency

v_{it} and u_{it} are independent of each other as well as the X variables. The model can be estimated by MLE in a single step. We consider a corrected OLS (COLS) technique to estimate the parameters of the model and the firm's level of technical efficiency (Greene, 1993.), that is, OLS in the first stage and method of moments in the second stage.

Assuming inputs are uncorrelated with v_{it} and u_{it}, the OLS estimators will be consistent except for the intercept α_{0t}. The COLS has the advantage that, these estimators do not depend on any distributional assumptions with regard to error components.

To estimate technical efficiency, the variance components are to be obtained first, that is, $\sigma^2 v_{it}$ and $\sigma^2 u_{it}$. Consistent estimates of $\sigma^2 v_{it}$ and $\sigma^2 u_{it}$ are obtained using 2nd and 3rd moments of OLS residuals using the assumptions mentioned above.

$M^2 = E(e_{it})^2 = \sigma^2 v_{it} + ((\Pi-2)/\Pi)\, \sigma^2 u_{it}$. ....(4-2h)

$M^3 = E(e_{it})^3 = \sqrt{2/\Pi}\, ((4-\Pi)/\Pi)\, \sigma^3 u_{it}$. ....(4-2i)

Where e_{it} are the OLS residuals including the intercept α_{0t}. M^2 and M^3 are 2nd and 3rd moments. These equations can be solved for $\sigma^2 v_{it}$ and $\sigma^2 u_{it}$. Since α_{0t} is biased it can be adjusted. The estimate of σu_{it} is used to adjust it. Consistent estimate of α_{0t}, α_{0t1} is obtained by correcting α_{0t} as,

$\alpha_{0t1} = \alpha_{0t} - E(u_{it})$ ....(4-2j)

where,

$E(u_{it}) = \sqrt{2/\Pi}\, \sigma u_{it}$. ....(4-2k)

Thus using COLS technique, consistent estimates of all parameters are obtained. We calculate OLS residuals as,

$e_{it1} = e_{it} + E(u_{it})$ ....(4-2l)

The adjusted OLS residuals and estimated variances are used to calculate the firm's specific rate of technical efficiency. Estimator of u_{it1} is given by:

$u_{it1} = (\sigma^2 u_{it}/(\sigma^2 u_{it}+\sigma^2 v_{it}))e_{it1}$................ (4-2m)

Where the ratio $(\sigma^2 u_{it}/(\sigma^2 u_{it} + \sigma^2 v_{it}))$ is an indicator of the influence of the inefficiency component on the total variance.

D.2.3.1 Technical inefficiency Before the SAPs

$E(e_{it})^2 = 4.02735$ e-5

$E(e_{it})^3 = 2.556$ e-7

$u_{it} = 0.13$

$v_{it} = 0.01623$

$E(u_{it}) = 3.7134$ e-5

$e_{it1} = 0.0063833$ or 1.006404

$u_{it1} = 2.44828$

Technical efficiency = exp u_{it1} = **11.5689 %**

Technical efficiency before SAPs was **88.431%**

D.2.3.2 Technical inefficiency During the SAPs

$E(e_{it})^2 = 3.096$ e-5

$E(e_{it})^3 = 1.723$ e-7

$u_{it} = 9.11$ e-2

$v_{it} = 1.697$ e-2

$E(u_{it}) = 1.02$ e-3

$e_{it1} = 6.584$ e-3 or 1.0066057

$u_{it1} = 2.33861$

Technical inefficiency = exp u_{it1} = **10.3668%**

Technical efficiency during the SAPs period was therefore **89.6332%.**

D.2.4 Discussion

From the results, the coefficient of determination R^2= 0.98314 with the dummy variable and R^2= 0.98077 without the dummy variable. The variables in the model therefore explain about 98% of the inputs used in sugar processing. All the diagnostic tests indicate that the models are consistent with data.

All the variables other than cane and fuel are experiencing diminishing marginal returns. Cane explains much in sugar processing. Every increment in a single unit of cane causes 0.966 units increment in sugar in the SAPs period and 0.964 in the pre SAPs respectively. This can also be seen on the graph on Lcane which moves almost in the same direction as the graph of Lsugar (see appendix 4). This is expected because cane comprises much of the components in sugar. It also shows us that the SAPs period have increased the utilisation of cane by only 0.2% which is not very signficant..

Fuel experiences increasing marginal returns. Any increment in the use of fuel causes 0.081 units in sugar production in the SAPs period and 0.0788 units in the pre-SAPs respectively. This shows that utilisation of fuel in the SAPs period improved by 0.1% which still is not significant. The inceament in the use of fuel is attributed to the firm's improved capacity in generation of it's own power by combustion of wood and baggasse. Diesel is used when there are power shortages.

Chemicals are experiencing diminishing marginal returns. Any unit increment in the use of chemicals causes a 0.212 decrease in sugar production in the SAPs period and 0.209 units in the pre-SAPs respectively.This is a 0.3% improvement in the use of the input which is also not very significant. The Lchems graph shows periodic decrease and increments in the level of chemicals used in processing. The study shows that the firm is using high amounts of chemicals such that they do not exactly match the level of sugar produced.

Power is also experiencing diminishing marginal returns. A unit increase in power decreases sugar production by 0.017 units in the SAPs period and 0.0166 units in the pre-SAPs. Note that the power in this study is the MWHr from KPLC. This shows that the power from KPLC declined by 0.08% in the SAPs period. This amount has been decreasing over the years and is explained by the company's production of its own power through combustion of bagasse and wood. This is good for the company as this will help in decrasing the overall processing cost since power produced from within is much less expensive.

Capital is also experiencing diminishing marginal returns. Over the years, the company has been using rollers for crushing. This method has not been very efficient because less sucrose is recovered fro the process. A unit increment in the level of capital decreases production by 0.0769 units in the SAPs period and 0.0750 units in the pre-SAPs.This is a 0.19% increment in the utilisation of capital. Recently the company introduced the diffuser which is a more efficient form of technology. This has been operational for the last 3.5 years and with it, sugar recovery per tonne of cane has improved though not very significantly also.

Labour is also in the same calibre as capital in that, every additonal unit of labour is contributing to less amounts of sugar processed. In the SAPs period a unit of labour contributes 0.1409 units decline in sugar producton as opposed to 0.1476 units decline in the pre-SAPs.This is a 0.67% increase in the utilisation of labour. The company employs an average of 12,000 workers per year- both permanent and casual. The firm being highly mechanised it shows that the optimal combination of capital and labour has not been achieved and this cuold explain why both of these variables are experiencing diminishing marginal returns.

The dummy variable is statistically insignificant and this shows that SAPs have not had a very significant impact on the level of sugar processing . It shows that SAPs have caused 0.0138 (1.38%) increment in the level of sugar production.

Overall improvement in the use of the inputs is within the range 0.08% and 0.3% which is not very significant. Since this is a highly mechanised firm. technology was not expected to adjust overnight. It may take the firm some time before the full impact of SAPs on technical efficiency is noticed. However, the firm is seen to be adjusting to the impacts of SAPs by changing the form of capital from crushers to difusser and also improvement in the use of the other inputs, though dismal.

From the technical efficiency calculations it can be shown that, before the SAPs the firm had efficiency levels of 88.431% as opposed to the SAPs period efficiency of 89.633%. this shows a difference of 1.20% between the two periods. This is confirmed by the dummy coefficient of 1.38%. the change in the level of eficiency in both period is therefore not very significant. This means that the level of sugar produced in both periods is not significantly different.

The ECM is significant and has a coefficient of 0.796 and 0.7846 in the pre-SAPs and SAPs respectively. This tells us that 78.46% and 79.6% of the disequilibrium in the exogenous variables in the SAPs and pre-SAPs respectively was corrected in the next period.

CHAPTER V

E. CONCLUSION AND POLICY RECOMMENDATIONS

This study confirms the conslusion by Kaumbutho et al (1996). that cane. capital and chemicals are the major costs utililsed in sugar production.

Cane is experiencing increasing marginal returns but it could be improved by identifying the best yielding varieties of cane with high sucrose levels to improve on the TC/TS ratio. The company is competing with firms having TC/TS ratios of 7.6 and less from COMESA. so this calls for research on cane varieties to improve on this.

On capital. the company has made efforts towards the right direction by introducing the diffuser. However, some cane is being crushed using the old crushing methods. There needs to be a gradual phasing out of the old technology and replacing it with the new ones to improve on sugar recovery. This could turn around the negative returns on this input.

Optimal amounts of labour that match the capital in place need to be determined to avoid employing too many workers since the firm is capital intensive.

The declining levels in the use of power from KPLC is good news to the company as a cost cutting measure. The company should strive to produce more power to cater for it's needs and also sell outside. Money that would otherwise be used to purchase power could be diverted towards improving on capital. conducting more cane research and purchasing chemical inputs. Extra money to improve on the three major costs could be sourced from privatisation which is already under way.

Optimal combinations of chemicals to match amount of cane crushed should be determined in order to avoid either too little or too much of these chemicals. This input consists a bulk of the company expenses and hence should be utilised efficiently.

As shown in the technical efficiency calculation, the change is not very significant so the company should check on it's capacity utilisation to ensure that there is no under capacity utilisation. The change in efficiency , though minimal, it's a step in the right direction and the firm should strife to achieve higher levels of efficiency as competition continues to increase both from within and without, so as to remain ahead in the competition.

For any reform to be successful, it needs to be well timed to ensure the necessary capacity is in place, should be well sequenced, steady, gradual, well co-ordinated, at the right speed and backed by legislation. This may not have been the case during liberalisation in the sugar industry. The infant industry argument was not put in to place and the local industry was abruptly exposed to high competition from more efficient firms. This has had adverse impact on the industry as a whole. This industry supports many Kenyans and unfair competition could mean closure of some firms and subsequent lose of livelihood for many. If the reforms had been performed considering the factors mentioned above, the impact would have been less negative and it would have helped the industry attain high competitive capacity over time. The competition, though unfair has helped firms like Mumias to improve on their technology and achieve higher levels of efficiency. The government, however, has a role in continued protection of the industry by imposing duty on cheaper imports while continuing with the privatisation plan in order to improve on efficiency of the firms. When the firms have fully achieved high competitive capacities, then the government can fully open up the market.

E.1 Areas of further research

It's possible for a firm to achieve high levels of technical efficiency yet be using outdated technology. It's therefore important for a firm to keep in pace with the change in technology. Achieving high levels of technical efficiency does not imply high levels of allocative efficiency. For a firm to be economically efficient, the inputs price line (allocative efficiency) should be tangent to the level of technical efficiency. Therefore, further research needs to be done on the allocative efficiency and hence economic efficiency of this firm and others in the sector inorder to advice the firms on the best ways of combining their inputs for optimal production and profitability.

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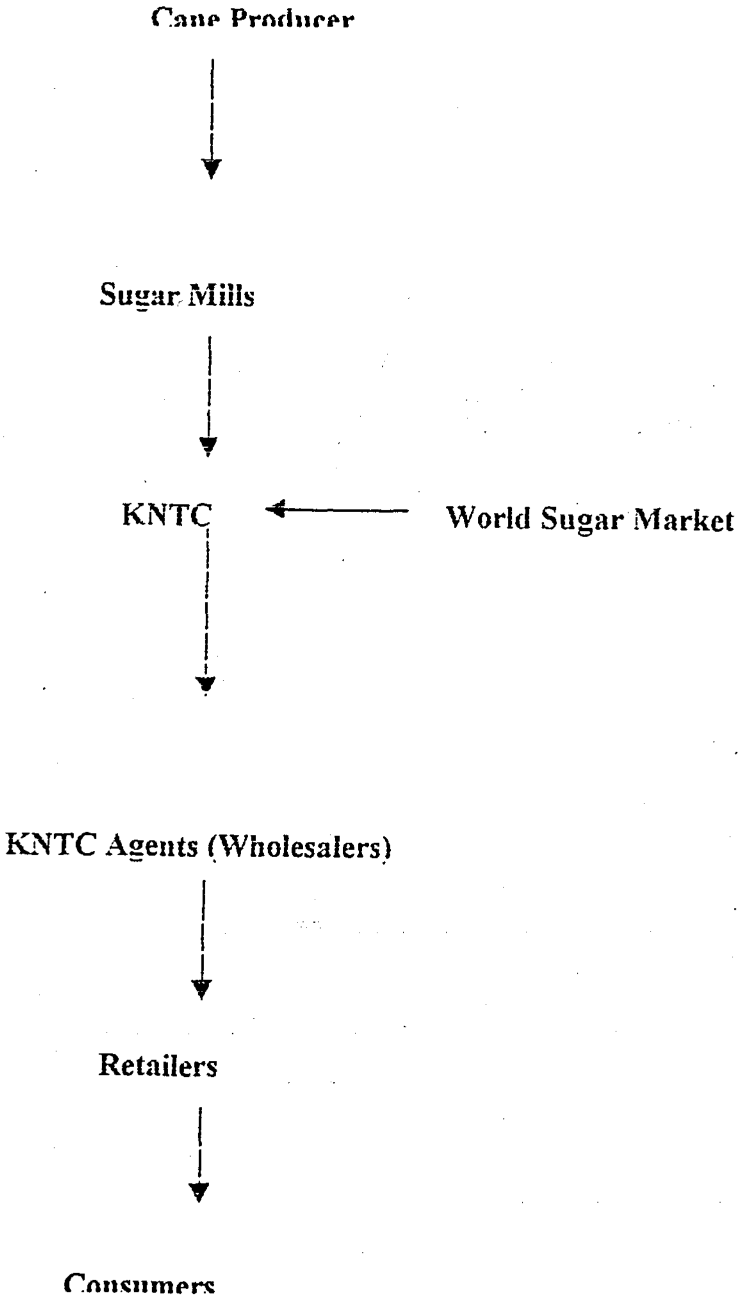
APPENDIX

Appendix 1: Flow Chart of Sugar marketing Channel Before SAPs



Appendix 2: Import parity price is determination.

Sugar import parity prices for 1992/93:

World sugar price (London Market)	US $ 263.00
Freight costs to Mombasa @ $ 53.00	US $ 316.00
Convert to Kshs @ US $= Kshs 65	Kshs 20,540.00
Port charges	Kshs 728
CIF Mombasa	Kshs 21,268
Transport charges Mombasa to Nairobi.	Kshs 1,490
Landed price in Nairobi	**Kshs 22,758**

Source: PAM-Egerton (1994)

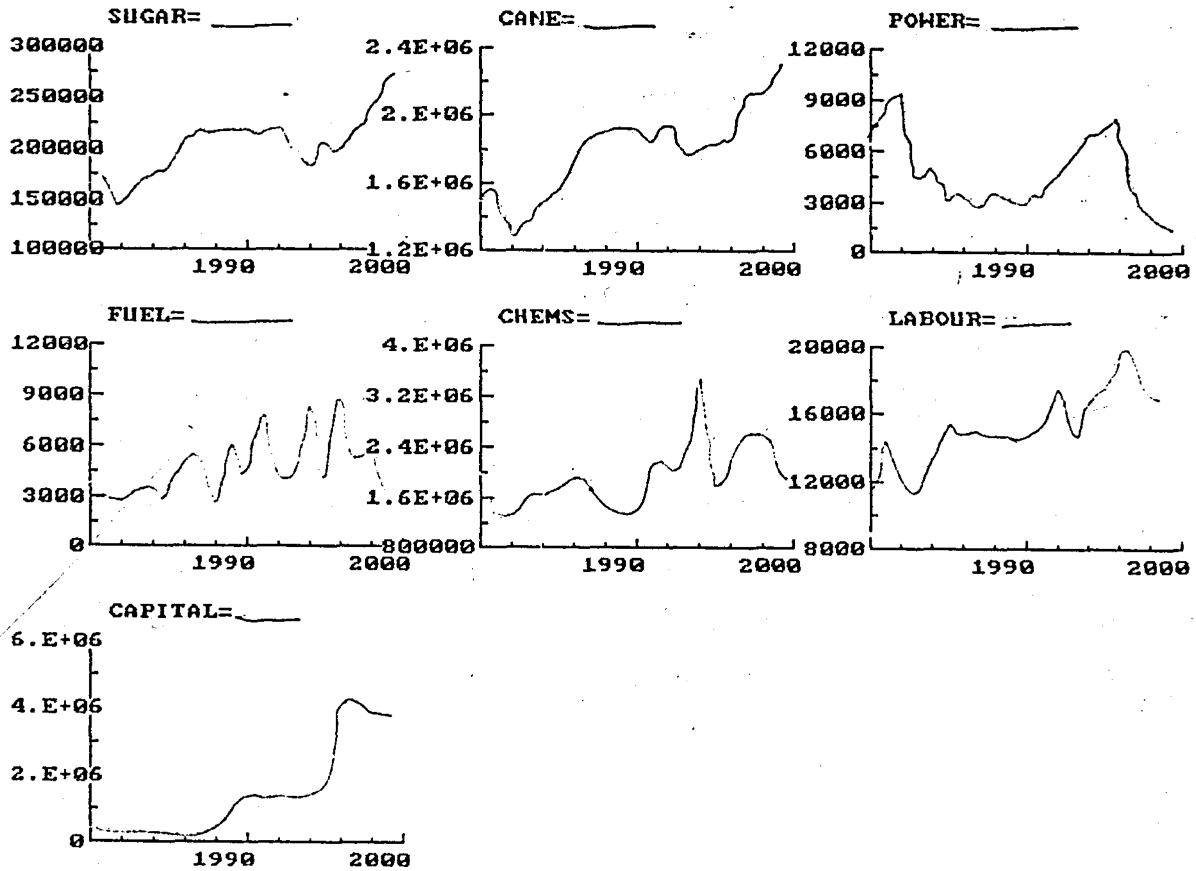
Appendix 3: Price Structure For 1992/93.

Sugar price structure /ton

▪ Cane price	Ksh	1,250.00
▪ Ex factory Price	Ksh	23,000.00
- SDF (5%)	Ksh	1,150.00
- VAT (5%)	Ksh	1,150.00
▪ Price to distributors	Ksh	25,300.00
- Margin (5%)	Ksh	1,65.00
▪ Price in wholesaler	Ksh	26,565.00
- Margin (3%)	Ksh	796.00
▪ Price to retailer	Ksh	7,361.00
-Margin (5%)	Ksh	1,368.00
▪ Retail price	**Ksh**	**28,730.00**

Source: PAM-Egerton (1994)

Appendix 4 : Graphical representation of the variables at levels



Appendix 5 : Graphical representation of variables in differences